Washington State Department of Ecology

Model Toxics Control Act (MTCA)
Cleanup Regulations

Final Cost Benefit and Least Burdensome Analysis for Amendments to Chapter 173-340 WAC

Prepared for

Ecology's Toxics Cleanup Program

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TABLE OF CONTENTS

INDEX OF TABLES

INDEX OF FIGURES

ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirement
Cal-EPA	California EPA
CLARC	Cleanup Levels and Risk Calculation
CBA	Cost-Benefit Analysis
CDC	Centers for Disease Control
DLC	Dioxin-Like Compound
EPA	Environmental Protection Agency
HCA	Healthcare Authority
LBA	Least Burdensome Alternative
MCL	Maximum Containment Limit
MTCA	Model Toxics Control Act
PAC	Policy Advisory Committee
PAH	Polycyclic Aromatic Hydrocarbons
cPAH	Carcinogenic Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCP	Pentachlorophenol
PEF	Potency Equivalency Factor
PLP	Potentially Liable Party
QRA	Quantitative Risk Assessment
RCW	Revised Code of Washington
RPF	Relative Potency Factor
SBEIS	Small Business Economic Impact Statement
SIC	Standard Industry Classification
TCDD	Tetrachlorodibenzo-p-dioxin
TEF	Toxic Equivalency Factor
TEQ	Total Toxicity Equivalence
TPH	Total Petroleum Hydrocarbon
VSL	Value of Statistical Life
WAC	Washington Administrative Code
WHO	World Health Organization

Executive Summary

The Washington State Department of Ecology is amending Chapter 173-340 WAC. The main features of this rule amendment include:

- Establishing risk policies for mixtures of dioxins and furans, carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs), and Polychlorinated Biphenyls (PCBs).
- Updating Toxic Equivalency Factors (TEFs) for dioxin, furan, and dioxin-like PCB congeners to those recommended by the World Health Organization.
- Updating Potency Equivalency Factors (PAFs) for cPAHs to those adopted by the California EPA.
- Establishing a process for modifying one of the default exposure parameters (the gastrointestinal absorption fraction) used to establish soil cleanup levels for mixtures of dioxins and furans.
- Clarifying that cleanup proponents must consider the properties of individual dioxin/furan/PCB congeners and cPAH compounds when evaluating cross-media impacts.

Cost-Benefit Analysis

The Cost-Benefit Analysis estimates the likely costs and benefits of the final rule. Ecology concludes that the quantitative and qualitative net benefit of the rule is likely to be positive.

The Cost-Benefit Analysis estimates that the final rule will likely result in:

- Changes to cleanup levels for mixtures of dioxin/furans and mixtures of cPAHs.
- Changes in dioxin/furan remediation requirements in limited areas that have been affected by air deposition.
- Changes in the frequency and level of effort required to comply with evaluation requirements in other parts of the rule.

Three facilities in Washington currently have known or suspected dioxin/furan contamination. Up to nine additional facilities in the state may be affected due to air deposition of dioxin/furans from smokestacks.

The expected costs to the affected parties are:

- Investigation and remediation costs over the baseline of:
  - $425 – 714 thousand if the three most likely sites are impacted
  - $1.7 – 2.8 million if all 12 facilities in Washington are impacted
- Compensation for access to third-party properties of:
  - $1.8 – 8.0 thousand if the three most likely sites are impacted
  - $7.2 – 32.2 thousand if all 12 facilities in Washington are impacted

Mitigated by:

- Avoided terrestrial ecological evaluation (TEE)
- Avoided evaluation of multiple hazardous substances
- Avoided investigation and remediation of industrial (Method C) sites

The expected benefits to the people of Washington are:

- Avoided human health impacts, resulting in personal and societal benefits that stem from improved health, including:
    - Avoided cancer mortality valued at $5.1 – 11.8 million.
    - Avoided costs of cancer morbidity, including:
        - Healthcare expenditures
        - Associated end-of-life expenses
        - Income loss due to absenteeism or hospitalization
        - Illness and side effects
        - Psychological effects of illness
        - Negative impacts on family
        - Long-term disability
- Reduced risks to plant and wildlife
- Improved existence and bequest values for health and the environment

Least Burdensome Alternative Analysis

Based on research and analysis required by RCW 34.05.328(d)(e) the Department of Ecology determines:

> *There is sufficient evidence that the final rule is the least burdensome version of the rule for those who are required to comply, given the goals and objectives of the law.*

In addition to the final rule, Ecology considered various alternative combinations of policy options during the rulemaking, and determined that those alternatives failed to meet at least one of the following requirements:

- Resulting in rule requirements that adequately protect human health and the environment.
- Consistency with current scientific information.
- Resulting in rule requirements that are less burdensome than the final rule.

CHAPTER 1: Background and Introduction

1.1 Introduction

This report reviews the economic analyses performed by Ecology to estimate the incremental expected benefits and costs of the final amendments to the Model Toxics Control Act (MTCA) Cleanup Regulation (Chapter 173-340 WAC). This document is generally intended for use with an associated Least Burdensome Alternative (LBA, Chapter 7) analysis and Small Business Economic Impact Statement (SBEIS, Ecology publication 07-09-171[1]) to develop an understanding of the full impact of the final rule.

The Washington Administrative Procedure Act (RCW 34.05.328) requires Ecology to evaluate significant legislative rules to "[d]etermine that the probable benefits of the rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the statute being implemented."

The rule amendments revise the Model Toxics Control Act (MTCA) Cleanup Regulation. The rule revisions update and clarify the policies and procedures for establishing and evaluating compliance with cleanup levels and remediation levels for certain chemicals. The rule revisions apply to mixtures of dioxins and furans, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs).

The MTCA Cleanup Regulation specifies that cleanup proponents may use a U.S. Environmental Protection Agency (EPA) methodology to characterize mixtures of dioxins and furans. In 2001, Ecology published a guidance document to explain how to use the EPA methodology to establish cleanup levels for dioxin and furan mixtures. A recent lawsuit raised a number of issues related to the regulation and guidance. Ecology settled the lawsuit, concluding it could not continue to require responsible parties to use the guidance without revising the MTCA Cleanup Regulation.

Ecology decided to re-evaluate this issue and explicitly define in the rule how the federal methodology should be used within the MTCA regulatory framework. This analysis addresses the costs and benefits associated with updating the MTCA Cleanup Regulation.

1.2 Regulatory Background

The Model Toxics Control Act (MTCA), Chapter 70.105D RCW, was passed by the voters of the State of Washington in November 1988 and became effective March 1, 1989. The law establishes the basic authorities and requirements for cleaning up contaminated sites in Washington State. The objective of the MTCA rule is to prevent or remedy threats to human health and the environment caused by hazardous waste sites.

The MTCA requires Ecology to periodically update and publish minimum cleanup standards (RCW 70.105D.030(2)(e)). Ecology originally adopted cleanup standards by rule in February 1991 ("MTCA Cleanup Regulation" or "MTCA Cleanup Rule").

[1] Available at *http://www.ecy.wa.gov/biblio/0709171.html*

Ecology initiated a negotiated rule making process in 1997 that resulted in significant amendments to the MTCA Cleanup Regulation. The amendments were adopted in February 2001 and became effective on August 15, 2001. Many of the rule changes were developed in response to recommendations made by the MTCA Policy Advisory Committee (PAC). The PAC was a body established by the Washington State Legislature in 1995. The PAC represented the interests of:

- The Legislature
- Local governments
- Businesses
- Agriculture
- Environmental organizations
- Financing institutions
- Ports
- Environmental consultants
- The Science Advisory Board
- The Departments of Health and Ecology
- The public

Following amendment in 2001, the MTCA Cleanup Regulation defined the policies and procedures governing toxics clean up. This included the provision that a person undertaking cleanup action may use the US Environmental Protection Agency's (US EPA's) toxicity equivalency factors (TEFs) in calculating cleanup levels for mixtures of chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans (called "dioxins" and "furans" in this report).

The text of the rule did not specify how the TEF should be used in calculating dioxin/furan cleanup levels because the EPA publication referenced by the regulation was thought to adequately describe the procedure. To help users of the rule that did not have access to EPA's publication, Ecology included TEF calculation guidance in the web-based Cleanup Levels and Risk Calculation (CLARC), created later in 2001 (Ecology, 2001).

Dioxins and furans are generally present in the environment as a complex mixture of chemical "congeners" that differ in terms of the number and location of chlorine atoms. 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD, the index chemical) is the most toxic and best studied of the 210 polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran congeners (CDDs and CDFs).

The CLARC guidance describes the process for converting dioxin and furan congener concentrations to a toxic equivalent concentration of the reference chemical—2,3,7,8 tetrachloro dibenzo-p-dioxin (2,3,7,8 TCDD). Using this process, the concentration of each dioxin and furan congener is converted to an equivalent concentration of 2,3,7,8 TCDD, establishing its toxicity relative to this reference chemical. These equivalent concentrations are then added up to obtain a total toxic equivalent concentration for the dioxin/furan mixture. This total toxic equivalent concentration is then compared to the cleanup level for 2,3,7,8 TCDD to determine whether the site requires clean up. The cleanup level for 2,3,7,8 TCDD is set in the MTCA rule and is based on the excess cancer risk[1] posed by the contaminant and assumptions about the amount of contact persons may have with the contaminant.

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[1] In excess of background cancer risk.

1.3 Reasons for the Final Rule

In November 2005, Rayonier Properties LLC filed a lawsuit challenging Ecology's application of the CLARC guidance at the Rayonier Port Angeles Mill Site. Rayonier argued that the CLARC guidance was not consistent with the procedures for establishing soil cleanup levels established in the MTCA rule. The MTCA rule requires cleanup levels to be established using a cancer risk level of one-in-one million (10^{-6}) for individual hazardous substances and one-in one hundred thousand (10^{-5}) for mixtures of hazardous substances. Rayonier argued that the CLARC guidance is inconsistent with the rule because the guidance applied a 10^{-6} cancer risk level to dioxin/furan mixtures, and that a cancer risk level of 10^{-5} should be applied to these mixtures instead.

In April 2006, Ecology settled the lawsuit because the agency agreed that one plausible interpretation of the existing rule is that individual dioxin and furan congeners could be considered individual substances, each regulated at a cancer risk level of 10^{-6} with the mixture as a whole additionally regulated at a cancer risk level of 10^{-5}. Ecology agreed to settle the lawsuit because neither the existing MTCA rule nor the federal guidance referenced in the MTCA rule explicitly requires the procedures in the CLARC guidance.

Concurrent with the settlement discussions, several environmental organizations submitted a rulemaking petition to Ecology in March 2006. These groups requested that Ecology amend the rule to require that dioxin and furan mixtures be regulated at a cancer risk level of 10^{-6}. They listed several reasons for this amendment, including protection against significant health threats posed by such mixtures.

Ecology reviewed the rulemaking petition and decided to launch a focused rulemaking process to address the issues raised in the lawsuit and rulemaking petition. Specifically, Ecology decided to re-evaluate this issue and explicitly define in the rule how the federal methodology for dioxin/furan mixtures should be used within the MTCA regulatory framework. Because the TEF methodology is also applicable to carcinogenic polycyclic aromatic hydrocarbons (cPAHs) and polychlorinated biphenyls (PCBs), procedures for evaluating these chemical mixtures were included in this rule amendment. Ecology believes the final rule better protects human health and the environment from the risks posed by such contamination.

1.4 Document Organization

We have organized this document into the following sections:

- **Comparison of the Current Rule and Final Rule** (Chapter 2): Detailed description and comparison of the previous rule requirements and the final rule, including soil cleanup levels determined by each.
- **Comparison of Cleanup Standards under the Previous and Final Rules** (Chapter 3): Comparison of cleanup levels as determined under the baseline and the final rule.
- **Affected Site Analysis** (Chapter 4): Description and refinement of potentially impacted site types by category.
- **Expected Costs and Benefits of the Final Rule** (Chapter 5): Analysis of the types and

size of costs Ecology expects impacted sites to incur, including sampling, remediation, and real-estate costs. Analysis of the types and size of benefits expected to result from the final rule, including human health, ecological and wildlife health.

- **Comments and Conclusions** (Chapter 6): Discussion of the complete implications of the Cost-Benefit Analysis. Comments on variability of results.
- **Least Burdensome Alternative Analysis** (Chapter 7): Analysis of considered alternatives to the final rule.

CHAPTER 2: Comparison of the Current and Final Rules

2.1 Statutory Background

The Model Toxics Control Act (Initiative 97), Chapter 70.105D RCW, was passed by the voters of the State of Washington in November 1988 and became effective on March 1, 1989. The law establishes the basic authorities and requirements for cleaning up contaminated sites in a manner that will protect human health and the environment.

As a general declaration of policy, the Model Toxics Control Act (MTCA), Chapter 70.105D RCW, states that:

> Each person has a fundamental and inalienable right to a healthful environment, and each person has a responsibility to preserve and enhance that right. The beneficial stewardship of the land, air, and waters of the state is a solemn obligation of the present generation for the benefit of future generations.

RCW 70.105D.010(1). The statute further states that:

> A healthful environment is now threatened by the irresponsible use and disposal of hazardous substances. There are hundreds of hazardous waste sites in this state, and more will be created if current waste practices continue. Hazardous waste sites threaten the state's water resources, including those used for public drinking water. Many of our municipal landfills are current or potential hazardous waste sites and present serious threats to human health and the environment.

RCW 70.105D.010(2). The main purpose of MTCA is to raise sufficient funds to clean up all contaminated sites and to prevent new threats from being created by the improper disposal of toxic wastes into the state's land and waters (RCW 70.105D.010(2)).

To accomplish these statutory goals, MTCA establishes a wide range of powers and duties for the Department of Ecology. In particular, MTCA requires Ecology "to immediately implement all provisions of this chapter to the maximum extent practicable, including investigative and remedial actions where appropriate." RCW 70.105D.030(2). Furthermore, MTCA requires Ecology to adopt, and thereafter enforce, rules under Chapter 34.05 RCW. Ecology must:

> Publish and periodically update minimum cleanup standards for remedial actions at least as stringent as the cleanup standards under section 121 of the federal cleanup law, 42 USC. Sec. 9621, and at least as stringent as all applicable state and federal laws, including health-based standards under state and federal law [.][1]

RCW 70.105D.030(2)(e).

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[1] The federal cleanup law referenced in MTCA is the Comprehensive Environmental Response Compensation and Liability Act of 1980 as amended by the Superfund Amendments and Reauthorization Act of 1986

2.2 MTCA Cleanup Standards

Ecology adopted the original cleanup standards in 1991 ("MTCA Cleanup Regulation" or "MTCA rule"). Ecology completed significant changes to the cleanup standards in February 2001. Under the MTCA rule, there are three methods (Methods A, B, and C) for establishing cleanup levels.

Method A

Can be used to establish cleanup levels at relatively small sites that involve few contaminants. Under Method A, cleanup levels must be at least as stringent as the following:

- Applicable or Relevant & Appropriate Requirements (ARARs): Standards in applicable state and federal laws. For example, Method A cleanup levels must be at least as strict as any applicable surface-water quality standards in the National Toxics Rule.
- Method A Tables: Cleanup levels listed in Tables 720-1, 740-1, and 745-1. These tables provide values for carcinogenic PAHs and PCBs, but not for dioxins and furans.
- Plants and Wildlife: Concentrations that result in no significant adverse effects on the protection and propagation of terrestrial ecological receptors using the procedures in WAC 173-340-7490 through WAC 173-340-7493, unless it is demonstrated under those sections that establishing a soil concentration is unnecessary.

Method B

Can be used to establish cleanup levels at any site. Under Method B, cleanup levels must be at least as stringent as the following:

- Applicable or Relevant & Appropriate Requirements (ARARs): Standards in applicable state and federal laws.
- Risk-Based Cleanup Levels: Cleanup levels calculated using the methods in WAC 173-340-720 through 173-340-750.

  Individual Hazardous Substances: The cancer risk for individual substances cannot exceed one in one million (1×10^{-6}). The non-cancer risk for individual substances cannot exceed a hazard quotient of one.

  Total Site Risk: The total site risk for carcinogens cannot exceed one-in-one hundred thousand (1×10^{-5}). Non-cancer total site risk cannot exceed a hazard index of one. The MTCA rule requires that the cleanup levels established for individual substances be adjusted downward if the total risk posed by the entire mixture exceeds either of these limits. Total site risk includes consideration of multiple hazardous substances and multiple pathways of exposure.
- Plants and Wildlife: Concentrations that are estimated to result in no adverse effects on the protection and propagation of aquatic life and no significant adverse effects on

terrestrial ecological receptors using the procedures in WAC 173-340-7490 through WAC 173-340-7493.

Method C

Can be used to establish cleanup levels in limited situations—typically for soil cleanup levels for industrial land uses. Method C cleanup levels must be at least as stringent as the following:

- Applicable or Relevant & Appropriate Requirements (ARARs): Standards in applicable state and federal laws.
- Risk-Based Cleanup Levels: Cleanup levels calculated using the methods in WAC 173-340-720 through 173-340-750.

  Individual Hazardous Substances: The cancer risk for individual substances cannot exceed one in one hundred thousand (10^{-5}). The non-cancer risk for individual substances cannot exceed a hazard quotient of one.

  Total Site Risk: The total site risk for carcinogens cannot exceed one-in-one hundred thousand (10^{-5}). Non-cancer total site risk cannot exceed a hazard index of one. The MTCA rule requires that the cleanup levels established for individual substances be adjusted downward if the total risk posed by the entire mixture exceeds either of these limits. Total site risk includes consideration of multiple hazardous substances and multiple pathways of exposure.
- Plants and Wildlife: Concentrations that are estimated to result in no significant adverse effects on the protection and propagation of aquatic life, and no significant adverse effects on wildlife using the procedures in WAC 173-340-7490 through WAC 173-340-7493.

2.3 Toxicity Equivalency Factors (TEFs)

People and other organisms are exposed to a wide range of complex environmental mixtures. Yet toxicological information is available for only a limited number of the individual chemicals that comprise mixtures of hazardous substances. Over the last 20 years, scientists have nonetheless developed several approaches for evaluating and characterizing the toxicity of the whole mixture. One approach used is the "Toxicity Equivalency Factor" or "TEF" methodology.

Under the TEF methodology, the toxicity of one member of the chemical group is selected as the index chemical.

The remaining members of the chemical group are assigned TEF values, which provide an order of magnitude estimate of toxicity relative to the index chemical. The TEF values can be used to calculate a toxicity equivalent concentration (expressed in terms of the index chemical) by multiplying the concentration of each chemical by its TEF value. The whole mixture can be characterized by the sum of the toxicity equivalent concentration for all of the chemicals in the mixture. (This is often referred to as the total toxicity equivalent concentration, "TTEC" or "TEQ"). The health risks posed by the whole mixture can then be assessed using the total toxic equivalency concentration (TEQ) and the toxicological information for the index chemical.

The EPA first adopted the TEF methodology as an interim procedure for evaluating the toxicity and risks associated with exposures to dioxin and furan mixtures (EPA, 1987, 1989).

The majority of state, federal, and international environmental agencies currently use the TEF values developed by the World Health Organization in 1998 (Van den Berg, et al., 1998) when evaluating the health risks posed by dioxin/furan mixtures. The World Health Organization recently updated the TEF values for dioxin, furan, and dioxin-like PCBs (Van den Berg, et al., 2006).

Dioxins and furans are generally present in the environment as a complex mixture of chemical "congeners" that differ in terms of the number and location of chlorine atoms. 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD, the index chemical) is the most toxic and best studied of the 210 polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran congeners (CDDs and CDFs).

Polycyclic aromatic hydrocarbons (PAHs) are a group of chemicals formed during the incomplete burning of organic materials such as wood, garbage, oil, coal, gas, tobacco, and charbroiled meat. There are more than 100 different PAHs. EPA (1993) published provisional guidance for evaluating the carcinogenic risks associated with PAH mixtures using a relative potency factor (RPF) approach.

The EPA (1993) approach uses benzo(a)pyrene (BaP) as the index chemical (i.e., having a relative potency of 1.0) and includes RPF values for seven (7) carcinogenic PAHs. The California Environmental Protection Agency (Cal-EPA, 1994) expanded upon the EPA approach when it developed Potency Equivalency Factors (PEFs) for use in evaluating PAH mixtures. The Cal EPA approach also uses BaP as the index chemical and includes PEFs for twenty-two (22) carcinogenic PAHs[2].

In February 2001, Ecology revised WAC 173-340-708(8) by adding new provisions applicable to mixtures of chlorinated dibenzo-p-dioxins, chlorinated dibenzofurans, and polycyclic aromatic hydrocarbons:

- **Chlorinated Dioxins/Furans:** WAC 173-340-708(8)(d) states that cleanup proponents may use EPA's TEF values and methodology when assessing the potential carcinogenic risk of mixtures of chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans. Under the EPA methodology, 2,3,7,8 TCDD is the index chemical. The total toxicity equivalent concentration of the mixture is represented by the sum of the products of the TEF and the concentration of the respective dioxin or furan congener.

- **Polycyclic Aromatic Hydrocarbons (PAHs):** WAC 173-340-708(8)(d) states that cleanup proponents may use the Relative Potency Factors (RPFs) and methodology developed by the California EPA (Cal-EPA) when assessing the potential carcinogenic

[2] In 2001, Ecology amended the MTCA rule to explicitly authorize use of the Cal-EPA (1994) methodology to evaluate the toxicity and assess the risks from exposure to carcinogenic PAH mixtures.

risk of mixtures of cPAH. Under the Cal-EPA methodology, benzo[a]pyrene (BaP) is the index chemical. The total toxicity equivalent concentration of the mixture is represented by the sum of the products of the TEF and the respective cPAH compound concentrations.

2.4 Two Approaches for Using TEF/TEQ Methodology When Establishing Cleanup Levels

The previous MTCA rule did not clearly specify how the TEF methodology must be used within the context of the MTCA Cleanup Regulation, when calculating cleanup levels for mixtures of dioxins/furans and mixtures of PAHs. Two approaches have been used to establish cleanup levels using the EPA TEF methodology under the MTCA rule:

- **Cleanup Levels and Risk Calculation (CLARC) Guidance**: In November 2001, Ecology published guidance on how to use the TEF methodology when establishing and evaluating compliance with MTCA cleanup levels. The guidance directed people to (1) use the TEF methodology to calculate a total toxic equivalency concentration, and (2) compare the calculated value to the applicable cleanup level for the reference chemical (either 2,3,7,8 TCDD or benzo[a]pyrene). Under this approach, the mixture is characterized by a single value (the total toxicity equivalent concentration). Cleanup levels for the mixture are based on using a cancer risk level of one-in-one million (10^{-6}) under Method B and one-in-one hundred thousand (10^{-5}) under Method C.

- **Rayonier Settlement**: As discussed above, Rayonier Properties LLC argued that the MTCA rule requires Ecology to establish cleanup levels using a cancer risk level of 10^{-6} for individual substances and 10^{-5} for mixtures of hazardous substances, as opposed to applying 10^{-6} risk level to the whole mixture. Ecology agreed that Rayonier's approach was a plausible approach for using the TEF methodology to implement the current MTCA rule. Under this approach, the TEF methodology is used to calculate a toxic equivalent concentration for *each* congener, which can be compared to the cleanup level for 2,3,7,8 TCDD. The total site risk (taking into account all congeners, other hazardous substances, and multiple exposure pathways) cannot exceed a cancer risk of one in one-hundred thousand (10^{-5}).

Because neither the current MTCA rule, nor the federal guidance referenced in the MTCA rule, explicitly requires the procedures in the CLARC guidance, Ecology considered the Rayonier Settlement approach described above to be the baseline interpretation for this issue. However, it is important to note that the final rule contains additional revisions that would result in changes to how cleanup levels are calculated under both approaches discussed above, in certain limited contexts.

2.5 Description of the Final Rule

Ecology developed the final rule to establish policies and procedures for calculating cleanup levels for mixtures of dioxin/furan, PCBs, and PAHs. The final rule includes:

- **Clear Statements on the Cancer Risk Policies Applicable to Dioxins/furans, cPAH and PCBs:** Ecology is amending WAC 173-340-708(8) to clarify how the TEF methodology should be used to establish cleanup levels for mixtures of dioxin/furan, carcinogenic PAHs, and PCBs. Under the final revisions, cleanup levels for these mixtures are to be established using a cancer risk level of one-in-one million (10^{-6}) under Method B and one-in-one hundred thousand (10^{-5}) under Method C.

- **Updated Toxic Equivalency Factors:** Ecology is amending WAC 173-340-708(8) to incorporate the most recent toxicity equivalency factors (TEFs) for dioxin/furan and PCBs recommended by the World Health Organization (Van den Berg et al. 2006) and updated potency equivalency factors (PEFs) for carcinogenic PAHs adopted by the California EPA (Cal-EPA, 2005).

- **Relative Bioavailability:** Ecology is modifying one of the default exposure parameters (the gastrointestinal absorption fraction) used to establish soil cleanup levels for mixtures of dioxins and furans.

- **Cross-Media Transfer:** Ecology is amending the rule to clarify that cleanup proponents must consider the properties of individual dioxin/furan/PCB congeners and cPAH compounds when evaluating cross-media impacts (e.g., migration of contaminants from soil to ground water).

CHAPTER 3: Comparison of the Cleanup Standards

3.1 Introduction

The final rule described above in Section 2.3 may lead to changes in cleanup levels determined under the MTCA. **The costs and benefits associated with the final rule are due to differences between the cleanup levels established under the past and final rules.**

Ecology has calculated the cleanup levels that the final rule requires, and compared those to cleanup levels required under the past rule. In making that comparison, Ecology has evaluated the incremental changes relative to:

Regulatory Baseline: Cleanup levels are established for each dioxin/furan congener using a cancer risk level of 10^{-6} (as opposed to applying 10^{-6} risk level to the whole mixture). The TEF methodology published by the EPA (1989) is used to calculate a toxic equivalent concentration for each congener, which can be compared to the cleanup level for 2,3,7,8 TCDD. The total site risk (taking into account all congeners, other hazardous substances, and multiple exposure pathways) cannot exceed a cancer risk of one-in-a-hundred thousand (10^{-5}). A similar methodology has been developed for cPAHs and for PCBs. Under this approach, cleanup levels must also:

- Comply with all applicable or relevant and appropriate requirements
- Comply with the requirements based on preventing non-carcinogenic health risks (Hazard Index must be less than one)
- Comply with the ecological protection requirements in the MTCA rule

3.2 Expected Changes to the MTCA Cleanup Levels

Ecology is revising to the policies and methods for establishing and evaluating compliance with cleanup levels and remediation levels. The final rule amendments will not result in significant changes to cleanup standards for PCBs because the use of the TEF methodology for PCBs is optional.

However, the final rule revisions may result in changes to cleanup levels for sites with elevated levels of dioxin/furan and carcinogenic PAHs. **The incremental costs of the final rule amendments result from additional cleanup actions (if any) to achieve compliance with these revised cleanup standards.**

Ecology has evaluated cleanup standards—including all applicable state and federal standards, using the MTCA rule as amended. Ecology calculated cleanup levels that might result from the amended rule, and based on that evaluation, Ecology ahs reached several conclusions regarding dioxin/furan mixtures, cPAH mixtures, and PCB mixtures, as described in the following subsections.

3.2.1 Dioxin and Furan Mixtures

- **Ground Water and Surface Water Cleanup Levels**: The final rule revisions will not affect dioxin and furan mixture cleanup levels for ground & surface waters. Ground water cleanup levels established under WAC 173-340-720 will continue to be based on the Maximum Contaminant Limit (MCL) for dioxin in the state and federal drinking water regulations. Surface-water cleanup levels established under WAC 173-340-730 will continue to be based on the dioxin surface-water standard in the National Toxics Rule, Section 304 of the federal clean water act, state water-quality law, and other applicable or relevant and appropriate requirements (ARARs).

- **Method B Soil Cleanup Levels Based on Non-Cancer Human Health Risks** The final rule revisions will not change the methods and policies for establishing Method B soil cleanup levels based on non-cancer human health risks.

- **Method B Soil Cleanup Levels Based on Ecological Protection:** The final rule revisions will not change the methods and policies for establishing Method B soil cleanup levels based on ecological protection.

- **Method B Soil Cleanup Levels Based on Cancer Risks** The final rule revisions will result in changes to dioxin and furan mixture soil-cleanup levels based on human cancer risks. The final rule revisions will result in Method B soil cleanup levels for dioxin and furan mixtures that are 40 percent higher (less stringent) than cleanup levels established using the approach specified in the CLARC guidance document. The final rule revisions will result in Method B soil cleanup levels that are 30 to 50 percent lower (more stringent) than cleanup levels that would be established under the baseline. See Appendix A for an explanation of the methodology used by Ecology for these calculations.

Table 1: Comparison of Method B Cleanup Levels for Dioxin

Comparison of Method B Soil Cleanup Levels* for Dioxin/Furan Mixtures			
Contaminants	Current MTCA Rule		Final Amendment
	CLARC comparison	Baseline	
2,3,7,8 TCDD	6.7 ppt	6.7 ppt	11 ppt
Dioxin/Furan Mixtures (TEQ)	6.7 ppt	16 – 24 ppt**	11 ppt***
*Assumes direct contact (via soil ingestion) is the controlling exposure pathway. **Based on median cleanup level at dioxin/furan contaminated sites in Washington State (See Appendix A) *** Based on a gastrointestinal absorption fraction (bioavailability) of 0.6.			

- **Industrial Soil Cleanup Levels:** The final rule revisions will result in changes to industrial soil cleanup levels for dioxin and furan mixtures based on human cancer risks. Under the current CLARC guidance and the baseline, the standard is the same, because both are based on a 10^{-5} cancer risk. In general, the levels established under the final rule revisions will be 70 percent higher (less stringent) than those established under the baseline and CLARC guidance (Table 2). However, the final revisions will not change the methods and policies establishing industrial soil cleanup standards based on ecological protection, which will control the soil cleanup at some industrial properties.

Table 2: Comparison of Method C Soil Cleanup Levels for Dioxin

Comparison of Method C Soil Cleanup Levels* for Dioxin Mixtures			
Contaminants	Current MTCA Rule		Final Amendment
	CLARC comparison	Baseline	
2,3,7,8 TCDD	875 ppt	875 ppt	1460 ppt
Dioxin/Furan Mixtures (TEQ)	875 ppt	875 ppt	1460 ppt**

*Assumes direct contact (via soil ingestion) is the controlling exposure pathway.
** Based on a gastrointestinal absorption fraction (bioavailability) of 0.6.

- **Cleanup Standards for Sediments:** Ecology compared background level concentrations for dioxins/furans to sediment cleanup screening levels calculated based on a cancer risk of 10^{-6}. The analysis considered various fish consumption rates. In each instance background levels are seen to be higher than screening levels. Ecology concludes that the rule revisions will not result in changes to sediment cleanup standards for dioxins/furans because cleanup standards for these contaminants will be driven by background levels.

3.2.2 Carcinogenic PAH Mixtures

- **Ground Water and Surface Water Cleanup Levels**: The final rule revisions will not significantly change ground water and surface water cleanup levels for carcinogenic PAH mixtures. Ground water cleanup levels established under WAC 173-340-720 will continue to be based upon the Method A cleanup level or the Maximum Contaminant Limit (MCL) for benzo[a]pyrene in the state and federal drinking water regulations. Surface-water cleanup levels established under WAC 173-340-730 will continue to be based on the National Toxics Rule, section 304 of the federal clean water act, state water-quality law, and other ARARs.
- **Method A Soil Cleanup Levels**: The final rule revisions will not change the Method A soil cleanup levels for carcinogenic cPAH mixtures for unrestricted land use (0.1 mg/kg) and industrial land use (2 mg/kg). The change in the TEF value for dibenz(a,h)anthracene from 0.4 to 0.1 will result in approximately five percent higher mixture concentrations meeting this cleanup level (five percent less stringent cleanup levels).
- **Method B Soil Cleanup Levels Based on Non-Cancer Human Health Risks**: The final rule revisions will not change the methods and policies for establishing Method B soil cleanup levels based on non-cancer human health risks.
- **Method B Soil Cleanup Levels Based on Ecological Protection**: The final rule revisions will not change the methods and policies for establishing Method B soil cleanup levels based on ecological protection.

- **Method B Soil Cleanup Levels Based on Cancer Risks**: The final rule revisions may affect Method B soil cleanup levels for cPAH mixtures that are based on human cancer risk. The final rule revisions will not change the Method B cleanup level for benzo(a)pyrene (BaP) which is the reference chemical in the TEF approach.

  The final rule revisions will result in Method B soil cleanup levels for cPAH mixtures that are 10 – 30 percent lower (more stringent) than cleanup levels that would be established under the baseline (Table 3). However, the change in the TEF value for dibenz(a,h)anthracene from 0.4 to 0.1 will result in approximately five percent higher mixture concentrations meeting this cleanup level (five percent less stringent cleanup levels), balancing this out to some extent. Overall, there is very little difference in cleanup levels selected under the two rulemaking options because benzo[a]pyrene generally contributes 60-80% of the TEQ for the whole mixture.

Table 3: Comparison of Method B Cleanup Levels for PAHs

Comparison of Method B Direct Contact* Soil Cleanup Levels for PAHs			
Contaminants	Current MTCA Rule		Final Amendment
	CLARC comparison	Baseline	
Benzo[a]pyrene	0.14 ppm	0.14 ppm	0.14 ppm
cPAH mixtures (TEQ)	0.14 ppm	0.16 – 0.26 ppm**	0.14 ppm
*The direct contact pathway is expected to be the controlling pathway for soil CULs. ** Based on median cleanup level at cPAH contaminated sites in Washington State.			

- **Industrial Soil Cleanup Levels**: At industrial sites, the cancer risk target for the individual PAHs (10^{-5}) is the same as the cancer risk target for total site risk (10^{-5}). Consequently, the final rule revisions will not change Method C industrial soil cleanup levels (Table 3). However, the change in the TEF value for dibenz(a,h)anthracene from 0.4 to 0.1 will result in approximately five percent higher mixture concentrations meeting this cleanup level (five percent less stringent cleanup levels).

Table 4: Comparison of Method C Industrial Soil Cleanup Levels for PAHs

Comparison of Method C Direct Contact & Leaching* Soil Cleanup Levels for PAHs			
Contaminants	Current MTCA Rule		Final Amendment
	CLARC comparison	Baseline	
Benzo[a]pyrene	18 or 2 ppm	18 or 2 ppm	18 or 2 ppm
cPAH mixtures (TEQ)	18 or 2 ppm	18 or 2 ppm	18 or 2 ppm
*The cleanup level for the direct contact pathway is the first number. If the leaching pathway is a concern at the site, the cleanup level will be 2 ppm (based on the 3 phase model in WAC 173-340-747 using standard assumptions for soil above the water table).			

- **Cleanup Standards for Sediments:** At industrial sites, the cancer risk target for the Ecology compared background level concentrations for carcinogenic PAH to sediment cleanup screening levels calculated based on a cancer risk of 10^{-6}. The analysis considered various fish consumption rates. In each instance background levels are seen to be higher than screening levels. Ecology concludes that the rule revisions will not result in changes to sediment cleanup standards for carcinogenic PAH because cleanup standards for these contaminants will be driven by background levels.

3.2.3 Polychlorinated Biphenyl (PCB) Mixtures

- The final rule revisions will not affect PCB cleanup levels because cleanup proponents will not be required to use the Toxic Equivalency Factor (TEF) methodology when establishing cleanup levels for PCBs. Furthermore, evaluation of available PCB congener data from contaminated sites in Washington State indicates that using TEFs will not significantly change cleanup levels from the current method of using a slope factor from the EPA's IRIS database. Cleanup proponents will continue to have the option of using the current rule to establish soil cleanup levels for PCBs. Ecology expects that many cleanup proponents will continue to use Method A to establish cleanup levels. (Ecology is not revising the Method A cleanup levels.)
- Ecology also expects that ground water and surface water standards will continue to be based on applicable or relevant and appropriate requirements (ARARs). Ecology is not revising requirements established under other laws and regulations.

- **Cleanup Standards for Sediments:** Ecology compared background level concentrations for PCBs to sediment cleanup screening levels calculated based on a cancer risk of 10^{-6}. The analysis considered various fish consumption rates. In each instance background levels are seen to be higher than screening levels. Ecology concludes that the rule revisions will not result in changes to sediment cleanup standards for PCBs because cleanup standards for these contaminants will be driven by background levels.

CHAPTER 4: Identification of Affected Cleanup Sites

4.1 Potentially Affected Industries[1]

4.1.1 Dioxin/Furan Mixtures

Currently 40 sites have dioxin/furan soil contamination.[2] They appear in multiple Standard Industry Classifications (SICs). The most common dioxin/furan-contaminated sites are:

- Landfills (eight sites = 20%, SIC 4953)
- Wood preservation operations (five sites = 12%, SIC 2491)
- Pulp and paper mills (four sites = 10%, SIC 2611 and 2621)[3]

The remaining sites include horticultural facilities, auto repair facilities, and mechanical and chemical manufacturers. The particular impacts on each industry are discussed below, in Section 4.2.

4.1.2 Carcinogenic PAH Mixtures

Currently 307 sites have cPAH soil contamination. These cPAH-contaminated sites occur in a more diverse set of SICs. The most common sites are:

- Landfills (32 sites = 10%, SIC 4953)
- Bulk oil facilities (Petroleum Bulk Stations and Terminals, 22 sites = 7%, SIC 5171)
- Scrap/salvage yards (Scrap and Waste Materials, 19 sites = 6%, SIC 5093)
- Auto repair (Motor Vehicle Parts, Used; 18 sites = 6%, SIC 5015
- General Automotive Repair Shops, 18 sites = 6%, SIC 7531)
- Wood preservation operations (14 sites = 5%, SIC 2411) (Ecology, 2006)

Related facilities also populate the SIC list. They include:

- Air, Water, and Solid Waste Management
- Auto Repair
- Services and Parking
- Gasoline Service Stations
- Refuse Systems

[1] SIC codes listed in Appendix B.
[2] Ecology ISIS database. Three additional sites have been remediated and two other sites detected trace levels needing remediation.
[3] Two of these sites—Port of Anacortes and MJB Properties—are separate properties on the former location of one facility.

The remaining sites contaminated with cPAH are distributed among manufacturers of ships and shipping industry materials, railroads, transportation, drycleaners, and chemical manufacturers.

4.1.3 PCB Mixtures

Currently 211 sites have PCB soil contamination. These PCB-contaminated sites are most commonly:

- Disposal sites (Landfills, Refuse Systems, Recycle Operations, Hazardous Waste Disposal Sites; 39 sites = 18%, SIC 4953)
- Electric generation, transmission, or machinery sites (SIC categories 35, 36, and 49; 19 sites = 9%)
- Metal smelting, production, or forming locations (SIC categories 33 and 34; 18 sites = 9%)
- Scrap and Waste Materials sites (SIC 5093; 17 sites = 8%)
- Sawmills, pulp mills, and wood preserving sites (SIC categories 24 and 26; 13 sites = 6%)

The remaining sites in this category include locations with ship/boat-building, automotive maintenance, parts, and repair, petroleum product storage and delivery, transportation, and chemical manufacture.

Ecology's analysis in Chapter 3, determined that cleanup levels for PCBs do not change under the final rule. Therefore, Ecology found that none of the PCB-contaminated sites listed here will be affected by the final rule as it affects PCBs.

4.2 Expected Remediation Changes at Sites

While this section does not specifically address each chemical mixture in each industry separately, Ecology expects the reasoning applied to these classes of sites to apply universally, due to common characteristics in operations and contamination by each type of site.

4.2.1 Dioxin and Furan Mixtures

Ecology expects the following impacts to remedial actions at the most common types of sites contaminated with dioxin and furan mixtures. Other sites not in these categories are expected to experience similar cost impacts.

- Wood Treatment Sites: Wood treatment sites where pentachlorophenol has been used to treat wood to minimize damage by insects, fungi, marine borers, and weather. Pentachlorophenol contains dioxins and furans as contaminants and historically was spilled or allowed to drip on the ground at these facilities. Cleanup of wood treatment sites typically involves treatment or removal of contaminant "hotspots" and free product that has accumulated on the water table. It also typically involves consolidation and on-site containment of residual contamination. Ecology does not expect these remedial actions or the cost of these actions to change under the final rule.

- Landfills: Landfills are disposal sites where dioxin and furan contaminated waste materials have been disposed. Cleanup typically involves containment of the fill area by capping and/or ground water barriers. Ecology does not expect these remedial actions or the cost of these actions to change under the final rule.

- Pulp Mills: Pulp mills are mills that create pulp for the making of paper products from the processing of wood. Cleanup typically consists of remediation of:
  - Pulp-mill sludge disposal areas.
  - Ash disposal areas.
  - Air-deposition-contaminated soil: This is primarily the result of dioxin emissions from the historic practice of burning of salt-water saturated bark that has been stripped from logs delivered to the mill via salt water in floating rafts. The papermaking process also produces dioxin during the bleaching process. Dioxin remains in the "sludge" created as a byproduct of the process. This sludge contains paper fibers, and can be dewatered and burned. Smokestack emissions of dioxin eventually deposit on the surrounding soil.

  Ecology does not expect these remedial actions of sludge or ash disposal areas or the cost of these actions to change under the final rule, because the remedial methods of soil removal or capping are identical under both baseline and final rule concentrations, and the amount of remediation is independent of concentration.

  Based on a review of actual site data and an air deposition model of smokestack emissions (see Chapter 4 and Appendices A and G), some pulp mills may be required to remediate a somewhat larger area of soil in off property non-industrial areas contaminated by air deposition under the final rule than under the baseline. That portion of the pulp mills and nearby impacted area remaining in industrial land use may be required to remediate a smaller area of soil under the final rule.

- Salt-Laden Wood Waste Boilers: Similarly to pulp and paper mills, boilers that burn salt-laden wood waste may experience air deposition of dioxins. In fact, the category of boilers that burn salt-laden wood waste includes many affected pulp and paper mills.[4]

  Ecology does not expect currently operating wood waste boilers to be affected by the final rule, due to modern air pollution controls resulting in low emissions.

  However, facilities that historically burned salt-laden wood waste prior to the installation of air pollution controls would have likely emitted much greater emissions. These facilities are considered in the modeling conducted for this analysis.

  For extensive discussion for salt-laden wood waste boilers, see Appendix F.

[4] Das, Tapas, Hog Fuel Boiler RACT Determination, Publication #03-02-009, Department of Ecology, 2003.

- Other Dioxin Sources: Appendix F contains extensive discussion of the impact of the final rule on other dioxin sources. Ecology does not believe additional sources of dioxin will be affected by the final rule.

4.2.2 Carcinogenic PAH Mixtures

Ecology expects the following impacts to remedial actions at the most common types of sites contaminated with carcinogenic PAH mixtures.

- Auto Repair and Related Trades: Auto repair and related trades sites tend to be small (1/4 acre or less). cPAH contamination in auto repair comes from leaky hydraulic lifts and dumping of waste oil. These sites typically establish cleanup levels using Method A, and based on this, Ecology expects future auto-repair sites to continue to use Method A. Since the final rule does not change Method A, most auto repair and related trades sites are not expected to incur additional remedial actions and costs under the final rule. In fact, there may be a small savings from the current rule due to the new TEFs resulting in slightly less stringent toxic equivalent concentrations.

  Auto repair and related trades sites not using Method A typically develop site-specific Total Petroleum Hydrocarbon (TPH) cleanup levels using petroleum fraction testing. At most of these sites, TPH cleanup levels—not cPAH—are expected to continue to drive cleanup levels, and thus additional remedial actions and costs are not expected under the final rule.

- Scrap and Salvage Yards: Salvage/scrap yards occupy larger areas of land but contamination typically occurs in the surface soils. cPAH contamination for these sites comes from waste oil leaked on the ground from automobiles and poor housekeeping. Smaller sites in this category typically establish cleanup levels using Method A. Sites not using Method A typically develop site-specific TPH cleanup levels using petroleum fraction testing. Since cleanups at most of these sites are driven by TPH and metals—not cPAHs—Ecology does not expect additional remedial actions and cost to be incurred by these sites because of the final rule.

- Bulk Oil Facilities:
  - Small: Small bulk oil facilities are expected to continue to use Method A cleanup levels. Since the final rule does not change Method A, most small bulk oil facilities are not expected to incur additional remedial actions and costs under the final rule. In fact, there may be a small savings from the current rule due to the new TEFs resulting in slightly less stringent toxic equivalent concentrations.
  - Large: These sites currently use Method B or Method C to determine cleanup levels for the mixture of petroleum products present at these sites (typically gasoline, diesel, and heavy fuel oil). Although cPAH cleanup levels change under the final rule for Method B, these petroleum products—not the cPAHs—typically drive the cleanup at these sites. Furthermore, many of these

sites remain in industrial use after cleanup. As such, these sites are not expected to incur additional remedial actions under the final rule.

4.2.3 PCB Mixtures

To date, sites contaminated with PCB mixtures have used the Method A cleanup levels to establish the area needing remediation. Under the final rule amendments, most sites are expected to continue to use Method A cleanup levels. Since the final rule does not change Method A, and the use of Method B with TEFs is optional, PCB-contaminated sites are not expected to incur additional remedial actions and costs under the final rule.

4.3 Total Number of Sites Experiencing Change under the Final Rule

As identified in Section 4.2, the only types of site where Ecology expects cleanup to be affected by the final rule are pulp and paper mills and other wood waste boilers that historically burned salty wood wastes. Ecology identified the range of facilities that may be affected by the final rule, using available data on facilities and dioxin emissions. The process Ecology used to identify the number of likely and possibly affected facilities is summarized below.[5]

The initial task Ecology faced was to identify current and historic sources of dioxins/furans in Washington State. Pulp and paper mills are known to have used bleach in the manufacturing process, and were the initial focus. However, further investigation revealed that, for dioxins in soil, the real issue was contamination resulting from air deposition. The analysis shifted to identifying likely sources of dioxin-contaminated air emissions, leading to the category of wood-waste boilers.

Ecology regulates wood-waste boilers as an air pollution source. Dioxin formation appears to be a problem for wood-waste boilers primarily when they burn salt-laden hog fuel. Hog fuel is bark and wood waste that is stripped from the logs prior to further processing. Logs that have been stored or transported in salt water absorb significant amounts of salt—especially in the bark. The chlorine from the salt—when combusted with organic material—chemically reacts to create dioxins. As compared to non-salty wood, dioxin formation increases by a factor of one hundred for each ton of salt-laden wood combusted. Facilities adjacent to Puget Sound or the Pacific Ocean are more likely to have burned salty fuels after logs were transported via barge or rafting. Inland facilities or those on fresh water are less likely to have burned salty fuels.

In recent years, Ecology has been identifying sources of dioxin in Washington and has begun collecting information about wood-waste boilers for regulatory purposes. These reports do not include information about historical practices prior to the 1990s. It is unknown how much salty fuel was historically burned, as records do not exist, but the practice of burning salt-laden wood wastes is though to be relatively recent; early practices would have been to dump

[5] This summary information is from a memo made for the Rulemaking File by Martha Hankins, Re: Estimating the number of facilities possibly impacted by changes to dioxin cleanup levels. Additional information is taken from personal communication with Martha Hankins regarding updates to the information in the memo.

these wet salty wastes without burning.

According to Ecology reports, as of 1997, there were 67 facilities operating 87 wood-waste boilers in Washington State. Many of these facilities are now closed.

According to the reports analyzed, the number of wood-waste boilers using salty fuels in Washington is at most between seven and 19. Some of the data comes from surveys that queried facilities about whether they burn salty fuels. Some of the answers were ambiguous or conflicted with data in more recent reports from Ecology.

In addition, there are three pulp and paper mill sites in Washington State identified as having confirmed dioxin/furan soil contamination.[6] One of these mills is identified in the above documents as burning or having burned salty wood waste; the remaining two are not identified in these documents. Ecology believes that all three of these sites are likely to be affected by the final rule.

Ecology concluded that 10 wood-waste boilers—one of which is a pulp and paper mill—and two additional pulp and paper mill sites will possibly be affected by the final rule. Overall, these 12 facilities belong to corporations with a total workforce of over 229 thousand and annual sales totaling over $68 billion.[7]

As noted above, three facilities are identified to date as having confirmed or suspected dioxin/furan contamination still in need of additional investigation and potential remediation. These three facilities are the most likely to be impacted by the final rule:

- Rayonier, Inc., Port Angeles
- International Paper, Longview
- Scott Paper (Kimberly-Clark, MJB Properties, and the Port of Anacortes), Anacortes

This analysis assumes no new facilities could be affected by the final rule. There are two reasons for this assumption:

1. There are currently no known plans to build a new pulp and paper mill in Washington.
2. Changes in operational practices and new technology to control emissions have greatly reduced dioxin/furan emissions, so even if a facility does choose to build in Washington, Ecology does not expect it to undergo cleanup based on dioxin/furan contamination in the future. This is because of a change in EPA requirements that limited dioxin emissions into the air and water beginning in 2001.[8]

[6] Note that one of these—the Former Scott Paper Mill in Anacortes—is listed in Ecology databases as two separate sites, due to split ownership of the land on which the Scott Paper mill operated.
[7] See Chapter 7 for employment statistics. Total sales based on most recent annual sales available through Hoovers (2007; www.hoovers.com), from either 2005 or 2006.
[8] *See:* 63 Fed. Reg. 18504-18751 (April 15, 1998) *and* 63 Fed. Reg. 42238-42240 (August 7, 1998). In response to the EPA requirements, pulp and paper mills now use chlorine dioxide (ClO_2) in the paper bleaching process instead of elemental chlorine or hypochlorite. Chlorine dioxide bleaching produces significantly less dioxin than previous technologies.

In conclusion, Ecology estimated the impacts of the final rule based on a minimum of three, and a maximum of 12 possibly impacted facilities.

CHAPTER 5: Costs and Benefits of the Final Rule

5.1 Expected Costs and Benefits of the Final Rule Relative to the Baseline

Changes to the mandatory soil-contamination cleanup levels for dioxin/furan mixtures drive the expected cost impact of the final rule for affected sites (see Chapters 3 and 4 for affected-site analysis). Ecology performed a series of calculations for determining and evaluating Method B soil cleanup levels for mixtures of dioxins/furans. The purpose of the calculations was to identify the cleanup level for both unrestricted (residential) and industrial land sites and to compare the values depending on which interpretation of the MTCA rule was used.

The baseline calculation results in a cleanup level of 16 – 24 ppt. This range of values reflects the different congener profiles at various sites.[1]

The calculation under the final rule (using Ecology's CLARC methodology and updated TEF values) results in a cleanup level of 11 ppt.

Moving from a cleanup level of 16 – 24 ppt to 11 ppt may result in increased remediation required by Ecology for affected site soil-cleanup actions. Cleanup proponents may be required to undertake additional measures to comply with the final rule. In evaluating the effects of the final rule, Ecology considered four types of expenditures:

- Sampling expenditures associated with defining the nature and extent of soil contamination
- Site cleanup expenditures associated with measures to remove, treat, or cover contaminated soils with clean materials (e.g., soil or pavement)
- Expenditures associated with preparing Terrestrial Ecological Evaluations (TEE)
- Expenditures associated with evaluating multiple hazardous substances and multiple exposure pathways

In evaluating the benefits of the rule for the populace and environment, Ecology considered four types of values:

- Cancer illness and mortality avoided
- Noncancer illness and mortality avoided
- Improved wildlife and environmental health
- Non-use value of cleaner soils

5.2 Probable Costs of the Final Rule

Ecology expects the final rule to generate:

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[1] During the public review process, no new data on contamination at actual sites was presented to Ecology. The calculations analyzed data from actual sites, and the range reflects the fact that congener concentrations differ from site to site. Results were subjected to rigorous statistical analysis.

- Increased investigation and remediation costs (Section 5.3)
- Avoided evaluation and compliance costs (Section 5.4)
- Real estate costs (Section 5.5)

Costs do not include changes in applied ecological cleanup levels, because separate parts of the MTCA Cleanup Regulation govern Terrestrial Ecological Evaluation (TEE) and the final rule does not change them. Because there is no change, there is no increased cost imposed by this rule change. The cleanup levels calculated for ecological evaluations do not change under the final rule, and Ecology concluded that there is no impact on cleanup at sites where cleanup is driven by ecological risk.

5.3 Changes in Compliance Expenditures

To meet the requirement of RCW 34.05.328, Ecology has attempted to develop an estimate of compliance costs related to this rule. The compliance estimates are necessarily imprecise because affected firms have not provided Ecology with detailed cost data from which it could calculate more precise estimates, and because estimating compliance costs requires Ecology to make speculative predictions about which sites will be affected by the rule, how much increased clean up will be required, and what those clean up costs will be.

Ecology has relied upon the best evidence available to it, and its experience in implementing the Model Toxics Control Act to estimate the probable costs of complying with the rule. Industry did not provide to Ecology additional information about specific affected sites or the costs of compliance on those sites in the course of rulemaking.

In doing so, Ecology assumes that the incremental cost of cleanup for areas which must be cleaned under the 1×10^{-5} standard, but which, under the revised rule, must be cleaned to a more stringent level are *de minimis*. That is, companies typically employ a total control strategy. Under such a strategy, contaminated soil is removed to the extent practicable. Soil removal techniques are usually not precise enough to distinguish between the amount of soil removal needed to meet a 16 – 24 ppt clean up level and that needed to meet an 11 ppt clean up level. Therefore, for areas within sites already subject to a clean up requirement, the rule will not likely impose any practical changes to clean up activities.

Where sites are likely to be affected is when a larger area must be cleaned up. That is, the extent of the contamination extends further based on the more stringent cleanup standards. This is typically not an issue for spills or localized releases where all contaminated soil is excavated and removed.

Since they are byproducts of the combustion process, dioxin/furan mixtures are found at numerous sites throughout the state and in many industries. However, most sites do not have quantities resulting in exposures that exceed the 1×10^{-6} risk level and, therefore, will incur no incremental compliance costs as a result of this rule (see Chapter 4).

Ecology believes other sites where levels of dioxin mixture may exceed 1×10^{-5} will have no increased compliance costs for any of three reasons. First, Ecology is amending only one of the three cleanup calculation methods—Method B. Thus, sites that rely on Method A or Method C to determine their cleanup responsibilities are not affected by these rule amendments. Second, Ecology has been interpreting the MCTA rule to impose the same clean up obligations as are being adopted through this rule. Although Ecology agreed that the baseline interpretation of the current rule was reasonable—such as that advocated in the Rayonier settlement—Ecology believes that most firms followed its prior interpretation. Therefore, these amendments, which codify Ecology's preexisting interpretation, impose no new compliance obligations on firms which had followed Ecology's CLARC guidance. Finally, at some sites, ecological and other risks—not cancer risk—dictate clean up obligations.

For these reasons, Ecology believes very few firms will incur actual compliance costs associated with the rule. Ecology believes that the new rule will extend the area subject to clean up standards, and hence impose new clean up requirements, only at three likely pulp and paper mills or wood waste boilers. Therefore, Ecology's estimate of the costs of compliance of the new rule is limited to the added clean up costs imposed on these sectors. Ecology has attempted to provide "a reasonable assessment of the likely range of costs," relying on data already available to it. For this purpose, Ecology has estimated costs for up to 12 possibly affected sites as well.

5.3.1 Additional Costs of Investigation and Remediation

Sampling Expenditures Associated with Defining the Extent of Soil Contamination

Cleanup proponents must characterize the nature and extent of contamination when preparing a Remedial Investigation (RI) report. The MTCA rule states that "… [t]he purpose of the remedial investigation is to collect data necessary to adequately characterize the site for the purpose of developing and evaluating cleanup alternatives…" Cleanup alternatives must protect human health and the environment.

In general, lower cleanup levels will require cleanup proponents to characterize larger areas of contamination. Consequently, the final rule would tend to increase sampling costs relative to the baseline if the sole focus of the RI was to evaluate impacts on human health from dioxin and furan mixtures.

The actual impact of the final rule on sampling costs (if any) will depend on a wide range of site-specific factors such as the amount of covered surfaces in the potentially impacted area, whether other contaminants are driving sampling costs, and whether there are other sources of the contaminants in the area that need to be distinguished from site-related impacts.

Ecology believes the rule revisions may have minimal or no impact on costs related to RI sampling at sites other than pulp and paper mills and wood waste boilers because:

- Site investigations typically characterize the full extent of impacts to non-detect or background levels.

- Small differences in cleanup levels are unlikely to impact sampling requirements at sites where soil contamination was caused by spills and/or disposal of highly contaminated materials. Dioxins, furans, PAHs, and PCBs are highly immobile.
- Cleanup levels based on human cancer risk are not always the most stringent cleanup level. This is particularly true for contaminants that bioaccumulate in the food chain. For example, the ecological screening values for dioxins are similar to (slightly lower than) cleanup levels calculated based on human cancer risk. Ecology is not changing the requirements for ecological evaluations and cleanup levels based on ecological risks.

Pulp and paper mills and wood waste boilers—which Ecology determined are likely to be the only cleanup proponents affected by the final rule (see Chapter 4)—may, however, incur additional investigation costs due to the need to define a larger contaminated footprint in soil surrounding smokestacks. These costs may differ for each site depending on wind patterns and contaminant dispersal levels. Ecology has estimated the likely additional acreage impacted as 1.65 acres (see Appendix C). Sampling costs for this additional acreage, with ten samples per acre, are likely to be between $11,550 and $18,150 (based on costs of $700 and $1100, respectively, per sample; see EPA, 2005c and Manchester Lab, 2007).

If three sites are impacted by the final rule, Ecology expects a total additional sampling and investigation cost of $35 –54 thousand.

If all 12 facilities are impacted by the final rule, Ecology expects a total additional sampling and investigation cost of $139 –218 thousand.

Site Cleanup Expenditures Associated with Measures to Remove, Treat, or Cover Contaminated Soils with Clean Materials

Cleanup proponents are required to implement remedial measures to reduce threats to human health and the environment. In general, lower cleanup levels will require cleanup proponents to remediate larger areas of contamination. For pulp and paper mills and wood waste boilers—which Ecology determined are likely to be the only cleanup proponents affected by the final rule (see Chapter 4)—this means potentially incurring higher remediation costs due to a larger contaminated footprint in soil surrounding smokestacks.

Ecology expects a number of factors that play a part in determining actual remediation levels to limit remediation costs at affected sites:

- Cleanup requirements at many impacted facilities will continue to be driven by cleanup levels for other contaminants.
- Ecology does not expect that the final rule will result in meaningful differences in soil removal volumes in areas already required to conduct remediation at affected facilities because:

    (1) There is very little difference between cleanup levels under the two

rulemaking options because one congener typically contributes a substantial amount of the TEQ for the whole mixture.

(2) It is difficult to make fine distinctions in soil contamination levels during removal (e.g., removal with a backhoe).

- Cleanup levels based on ecological risk will drive cleanup at some affected facilities. If ecological cleanup levels drive remediation under both the baseline and final rule, Ecology expects no change in remediation.

Expenditures Associated with Distinguishing Site from Background Contamination

Sampling by the Department of Ecology in 1998 found the following concentrations of dioxin/furan mixtures in soils in Washington State. (1)

Land Use	Range of TEQ (ppt)	Mean TEQ (ppt)	Median TEQ (ppt)	Background TEQ (ppt)*
Forested Land	0.033 – 5.16	2.3	2.2	4.8
Open Areas	0.04 – 4.59	1.0	0.2	1.0
Urban Areas	0.133 – 19.5	4.1	1.7	7.7
Forested & Open	0.033 – 5.16	1.7	0.8	2.2
All Combined	0.033 – 19.5	2.8	1.2	3.9

*Upper 90% or 4X50%, whichever is less (WAC 173-340-709(3)(c)

(1) Screening Survey for Metals and Dioxins in Fertilizers, Soil Amendments, and Soils in Washington State, Ecology Publication #98-331, 1998.

Under MTCA the "natural background" level is defined by rule as concentrations consistently present in the environment, not influenced by localized human activity. Based on sampling done by Ecology (Ecology, 1999b), the natural background TEQ for dioxin mixtures in Washington soils is estimated at 2.2 ppt. This is the calculated background TEQ for sampling data combined from forested and open areas.

MTCA does not require cleanup sites to perform remediation in excess of the natural background level of contamination. The final cleanup level provided by the rule amendments is well in excess of the natural background concentration and higher than typical urban background TEQ found in Washington State (7.7 ppt). This means extra expenses are not anticipated to distinguish site impacts from natural and area background soil concentrations.

Expected Remediation Ignoring Background Contamination

Ecology used a simple, four-step model to estimate the expected change in remediation costs associated with the final rule. See Figure 1 for a summary of the expected cost model.

Figure 1: Expected Remediation Model

Expected Remediation Model
Expected costs/site = ΔSV x TUC Where:

ΔSV	=	Estimated change in soil volume cleaned up on a representative site (cubic yards)
TUC	=	Cost of soil cleanup per unit ($/cubic yard)

Step 1: Cleanup Level Determination

Ecology determined the baseline and final cleanup levels for comparison. See Table 4 for a summary of cleanup levels. See Appendix A for an outline of the methodology used for this step.

Table 5: Soil Cleanup Levels for Typical Dioxin/Furan Mixture

Soil Cleanup Levels for Typical Dioxin/Furan Mixture			
	Past Practice: CLARC	Baseline	Final Rule
Cleanup Level (ppt)	6.7	16-24	11.0

Step 2: Change in Soil Volume

Ecology estimated the change in impacted soil area using an EPA-approved air deposition model for a hypothetical pulp and paper mill smokestack. See Appendix C for a description of the model methodology.

The simulation found that for soil contaminated with stack emissions, a site must clean 1.65 more acres at the median.[2] Based on a depth of six inches, and assuming 10% of the ground is covered by impervious surfaces, this translates to a volume of 1,200 cubic yards.

Note that this is a highly conservative value, given that 10 to 50% of soils at the periphery of existing sites in developed areas are likely to be covered by existing buildings, roads, and other structures. In addition, this estimate does not take into account the potential reduction in industrial properties needing remediation. Further, Ecology believes many sites have voluntarily remediated to this level based on its CLARC interpretation. Taking these factors into account, Ecology believes that the actual change in remediated soil volume will be considerably smaller than the above estimate.

Step 3: Unit Cost of Soil Remediation

Ecology calculated an expected price of remediation based on selected remedial options for dioxin/furan. See Appendix C for a summary of the unit cost calculations.

Ecology used a weighted average of remedial options based on primary excavation of soil, with additional capping measures. Per cubic yard, this weighted average remedy costs $145 per cubic yard.

[2] Assumes contamination has been mixed over a 3-inch depth of surface soil by natural or human influence: 0.9 more acres at the 25th percentile, and 3.49 more acres at the 75th percentile.

To incorporate the most conservative—yet not as likely—unit cost, Ecology also used the highest per unit remedial cost to calculate an upper bound for remedial costs. This upper-bound remedy (complete excavation and disposal) costs $183 per cubic yard. To incorporate the lowest-cost alternative remediation, Ecology also developed a lower-bound value for cleanup per cubic yard. The lower-bound remedy (in-situ capping with an engineered soil cover) costs $107 per cubic yard. For this analysis, Ecology excluded remedies that were not necessarily applicable to all types of remediated land (e.g., wood-chip surface or gravel surface).

Step 4: Total Expected Cost Estimate

The total per-site expected cost of the final rule equals the product of the unit cost of remediation and the increased volume of soil removed under the final rule.

Per-Site Result:

Ecology estimates remediation costs of the rule at $170,000 per-site, at the weighted average unit cost. Depending on the remedial method chosen, this cost can fall in the range of $130,000 to $220,000 per-site.

At some sites, the cleanup level necessary for ecological health may be lower (more stringent) than cleanup levels driven by human health concerns (cancer risk). The final rule does not change calculation of cleanup levels driven by ecological concerns. This means that for sites on which ecological cleanup levels are lower (more stringent) than human health driven cleanup levels, there will be no change in remediation. Ecology concludes that for sites where the ecological health risk drives cleanup, the per-site cost will be zero since the ecological based cleanup levels are not changing.

This estimated remediation cost is a highly conservative value, given that in urbanized areas where cleanup is likely to be driven by human health risk (instead of ecological risk), larger areas are likely to be covered by existing buildings, roads, and other structures. In addition, industrial properties would need to cleanup less area, offsetting the increase. Considering these factors, Ecology believes that the actual increase in remediation costs will be considerably smaller than the above estimate.

The compliance costs associated with additional investigation and remediation will likely be reduced by the compliance costs avoided under the final rule, as outlined below.

If three sites in the state are impacted by the final rule, Ecology expects an additional remediation cost of $390 – 660 thousand.

If all 12 facilities in the state are impacted by the final rule, Ecology expects an additional remediation cost of $1.6 – 2.6 million.

5.3.2 Summary of Investigation and Remediation Costs of the Final Rule

Ecology estimates that three pulp and paper mills with known dioxin contamination, and nine additional facilities with wood-waste boilers that historically burned salty hog fuel, may incur additional costs to identify areas subject to the new rule and to clean those areas.

Adding the estimated costs of investigation to cleanup costs results in the following estimated cost impact of the final rule:

If three sites in the state are impacted by the final rule, Ecology expects additional compliance costs totaling $425 – 714 thousand.

If all 12 facilities in the state are impacted by the final rule, Ecology expects an additional compliance cost totaling $1.7 – 2.8 million.

5.4 Avoided Evaluation and Compliance Costs

Ecology believes that the above costs are likely to be mitigated to some degree by the benefit of avoided compliance costs, avoided analysis of multiple hazardous substances, and cost savings in remediation of industrial sites. These mitigations are discussed in this section.

5.4.1 Expenditures Associated with Terrestrial Ecological Evaluations (TEEs)

Cleanup proponents must evaluate the impacts of contamination on ecological receptors. In many cases, cleanup proponents must prepare a Terrestrial Ecological Evaluation (TEE). In general, lower cleanup levels based on human health protection will reduce the need for preparing a TEE. Consequently, the final revisions will tend to reduce the likelihood that a cleanup proponent will incur TEE costs, as compared to the baseline.

The final rule does not change calculations for ecological cleanup standards. Therefore, sites on which cleanup is driven by ecological standards under the baseline will not be affected by the final rule, and there will be no change in the ultimate level of remediation.

The final rule alters the likelihood that cleanup proponent will need to perform an ecological risk evaluation (see Appendix D). Compared to the baseline, where the cleanup level decreases (becomes more stringent) under the final rule, this will make dioxin/furan concentrations that are acceptable for human health risk less likely to exceed screening levels for ecological risk.

If concentrations are less likely to exceed screening levels, Ecology is less likely to require an evaluation of ecological risks on the site. WAC 173-340-7493(1)(d) states that Ecology may determine that a site-specific TEE is not necessary because "…the cleanup action plans developed for the protection of human health will eliminate exposure pathways of concern to all of the soil contaminants…" The final rule will result in lower (more stringent) cleanup levels for human health protection than those established under the baseline. Consequently, Ecology expects that the final rule will reduce (to an uncertain degree) the need to perform site-specific TEEs.

5.4.2 Expenditures Associated with Evaluating Multiple Hazardous Substances and Multiple Exposure Pathways

The MTCA rule specifies that total site cancer risk cannot exceed one-in-one hundred thousand (10^{-5}), and total noncancer site risk cannot exceed a hazard index of one. The MTCA rule requires that cleanup levels established for individual substances be adjusted downward if the total site risk (taking into account multiple hazardous substances and multiple pathways of exposure) exceeds these limits.

Under the baseline, total site risk adjustments will need to be made at nearly every site given the need to address all 17 dioxin and furan congeners and the possibility of multiple exposure pathways. Ecology is sensitive to the fact that determining cleanup levels is complex enough as is, and is disinclined to recommend even more complex calculations. The final rule reduces the need to evaluate such adjustments because cleanup levels for the entire mixture are set using a cancer risk level of one-in-one million (10^{-6}) and a hazard quotient of one.

5.4.3 Cost Savings on Industrial (Method C) Sites

In addition, this analysis does not directly consider the reduced costs of the increased cleanup levels for industrial properties from 875 ppt to 1460 ppt in the final rule. Depending on the extent of industrial properties impacted by the site, these reduced costs could potentially offset any increased cleanup costs in other non-industrial areas.

5.5 Real Estate Impacts

5.5.1 Cleanup Cost Responsibility

Under MTCA, the PLP(s) found liable for contamination are responsible for paying for cleanup on *all* impacted properties, including contaminated residential and commercial property owned by third parties that have a defense to liability.

5.5.2 Residential/Commercial Property Not Affected

The impact of the final rule is analyzed in comparison to the baseline—meaning that the incremental impact of the rule on residential sites is limited to those sites within (or intersecting) the estimated additional cleanup acreage (see Section 5.2.1). Residential/commercial sites that would have experienced cleanup under both the baseline and final rule are not included in cost analysis. These properties, however, may experience cleanup to a lower excess cancer risk level under the final rule than under the baseline—within the limitations of background contamination levels. Public perception that property has been cleaned to a greater degree than it would have been under the baseline works to mediate any downward pressure on property values.

5.5.3 Costs of Contamination: Property Values

Ecology acknowledges that there are lags in both real estate transactions and remediation efforts. The effect of these lags means that residential or commercial property owners in the additional cleanup acreage estimated by the Cost-Benefit Analysis may:

- Have difficulty selling property during cleanup lags (after contamination is identified as needing cleanup, but before remediation is complete)
- Have to sell property at a lower price, to reflect the buyer's purchase of additional financial and perceived risk
- Encounter difficulty using property as collateral

(McClusky & Rausser, 2001). Ecology only expects these effects to occur if a residential or commercial property would otherwise wish to sell his property or use it as collateral during the cleanup lag. Furthermore, while there may be some interim impacts during the cleanup phase, the impacts are only temporary and property values are likely to rebound after cleanup.

The size of this prospective cost depends on both the size of devaluation arising from perceived risk, and the length of the cleanup lag. During the cleanup lag, the property will also appreciate, inflation will affect the real property value, and delayed sale will reduce present value.

5.5.4 Likelihood of Property Value Impact

Ecology does not believe the above interim effects are likely (as compared to the baseline) because:

- **Costs of cleanup will be borne by the identified PLP.** This eliminates the impact of possible future remediation costs on third party property owners. This means that buyers' willingness to pay for a property will not be affected by future costs of cleanup, as the buyer is not at risk of paying for cleanup.

- **Perceived risk will drive area property values**. Area property values likely already reflect a perceived risk (stigma) of being near a contaminated site—whether or not the properties are themselves contaminated. The small change in allowable contamination resulting from the final rule is not expected to impact willingness to pay for property in the area.

  Multiple economic studies have estimated the impact of cleanup sites on property values in the surrounding area. These studies find that the stigma and perceived risk of living near a cleanup site impacts properties whether or not the properties are within the area actually contaminated above cleanup standards. This is especially likely when there is uncertainty about the precise extent of contamination.

  Thus, a small change in the cleanup standard, as resulting from the final rule, will unlikely negatively impact property values beyond what is already being experienced. Furthermore, several research studies on the impacts of contaminated sites on residential property values suggest that, if there are short term impacts on property values, once the contamination is cleaned up, the long-term impact of contamination on property values is small or zero, and long-term property values rebound.

- **Affected area reduces over time.** The initial property to be remediated is not clearly defined at the outset of investigation, but develops and becomes more defined as cleanup of more highly contaminated areas progresses and analysis continues.

5.5.5 Final Costs: Compensation for Property Access and Impacts to Third Parties from Cleanup

Access to Property

In order to perform remediation on properties owned by third parties, the cleanup proponent will need to negotiate access. This could include relocating residents and businesses, moving buildings, storing property, and returning property to good condition, and could require compensation to the property owner for these and related expenses.

Ecology reviewed generally those access agreements obtained at similar sites in Washington State:

- At the Everett Asarco site, residential areas have surface soils impacted by air emissions from the historic operation of an arsenic smelter. Ecology is conducting the cleanup of the impacted residential area, where it has remediated 57 properties (as of this publication), and access for testing and cleanup has been granted by all homeowners at no cost. Only one homeowner required relocation at this site, due to impaired mobility that prevented the use of stairs to enter the home. Ecology paid for hotel and meals for the homeowner at the Washington State per-diem rate, for two weeks. Other sites did not require relocation of any individuals.
- At the Northpoint Smelter site, the EPA performed an interim action that included cleanup of the yards of residential homes. The EPA did not need to pay for access to homes during this cleanup, and residents have been able to stay in their homes.
- At a site in Penn Oreille County, the EPA is currently performing an interim action at a mining site. This cleanup includes remediation of residential driveways. Residents have been able to remain in their homes during this cleanup. [3]
- During EPA's cleanup of yards at homes near the Ruston Asarco Smelter site, EPA did not pay for access or relocation during cleanup. At other sites EPA has typically only had to pay for temporary relocation of residents when the cleanup involved actual cleaning of the interior of homes.[4]

Commercial Property

[3] Ecology communication with Sandra Treccani, Washington State Department of Ecology Eastern Regional Office.
[4] Ecology communication with Tim Brinsfield, EPA Region 10.

On commercial property, Ecology expects cleanup to be performed in a manner that imposes minimal interference with business activity. This includes performing cleanup during non-business hours and days that a business does not operate—options that are likely unavailable in residential cleanup. Ecology expects *de minimis* cost of access to commercial properties.

Moreover, Ecology believes that on commercial properties, the high percentage of land covered by buildings and pavement (relative to residential properties) will mitigate the amount of dioxin/furan depositing on soils. This will reduce the impact of the final rule on commercial property because there will be little dioxin contamination in soils on paved and built-up property.

Residential Property

In order to calculate the cost of access to affected residential properties, Ecology made the following assumptions.

- Negotiation of access with property owners will take between two and eight hours per property. This range conservatively assumes that negotiators will need to travel to the site and have more than one contact per affected property.
- Five to ten percent of property owners will need to be temporarily relocated during cleanup. Ecology experience administering cleanup indicates that most property owners prefer to stay in their homes during cleanup work rather than at a hotel, if possible. Temporary accommodations are primarily needed as a result of unique site-specific circumstances where access to the property during cleanup is impossible to do the physical configuration of the property or the limited mobility of the residents in the home.
- If temporary relocation is necessary, it occurs for two weeks. Cleanup of surface soil contamination and restoration can be done in this period of time.
- Reasonable relocation costs are estimated by Washington State per-diem compensation rates. Per-diem is the allowance for lodging (excluding taxes), meals and incidental expenses. The General Services Administration (GSA) establishes per diem rates for destinations within the Continental United States. Lodging per diem rates are based on average daily rate (ADR) data, which is a widely accepted lodging-industry measure based upon a property's room rental revenue divided by the number of rooms rented as reported by the hotel property to the contractor.[5]

  Per-diem rates for lodging and meals vary by county, and range from $78 – 128 per day.[6]

[5] US General Services Administration (2007). Factors Influencing Lodging Rates. Available at http://www.gsa.gov/Portal/gsa/ep/contentView.do?programId=9704&channelId=-15943&ooid=16365&contentId=19902&pageTypeId=8203&contentType=GSA_BASIC&programPage=%2Fep%2Fprogram%2FgsaBasic.jsp&P=MTT.

[6] Map available at http://www.ofm.wa.gov/resources/travel/colormap.pdf.

- The gross density in the impacted areas is two to four homes per acre. Gross density means the land area occupied by roads or open space is not subtracted from the impacted area. For the median additional cleanup area of 1.65 acres (see Section 5.3.1: Change in Soil Volume), this equates to between three and seven homes in the impacted area.

Ecology estimated the wage of an additional negotiator of access as up to $30 per hour. This is an upper limit for the hourly wage of an Environmental Specialist 4 working for the State of Washington.[7] Including the public and private sectors, the US Bureau of Labor Statistics (BLS) estimated that the median wage of an environmental scientist is equivalent to $56 thousand in 2006 (BLS, 2006). This is equivalent to $27 per hour—a value near the $30 per hour figure used by Ecology.

Multiplied by two to eight hours of additional negotiation per affected property, and by three to seven properties per affected site, this equals $180 – 1,680 per affected site.

If three sites in the state are impacted by the final rule, Ecology expects total expenditure for access of $0.5 – 5 thousand.

If all 12 facilities in the state are impacted by the final rule, Ecology expects total expenditure for access of $2.2 – 20.2 thousand.

Ecology multiplied the per-diem lodging, meal, and incidental expense average of $102 by the number of expected relocations and length of relocation for an affected facility.[8] Ecology expects the final rule to result in $427 – 997, per affected site, of additional access cost to the PLP, depending on the location of the site. See Appendix G for calculations.

If three sites in the state are impacted by the final rule, Ecology expects total compensation for relocation of $1.3 – 3.0 thousand.

If all 12 facilities in the state are impacted by the final rule, Ecology expects a total compensation for relocation of $5.1 – 12.0 thousand.

Compensation for Impacts from Land-Use Restrictions

Third-party properties on which contaminated soil is not fully excavated—in favor of capping and institutional controls—will require land-use restrictions via a restrictive covenant to prevent future human exposure to the contamination. The PLP responsible for the cleanup will likely need to compensate the property owner for the

[7] The Environmental specialist 4 is in Washington State Pay Range 55, which pays $21 – 30 per hour.

[8] $102 is the average total per diem for lodging and meals in western Washington counties. Ecology limited its data to western Washington because affected sites are more likely to be located on or near bodies of salt water. See Section 4.3 for further explanation.

impacts from land-use restrictions. This could include compensation for any reduction in property value or lost use of the property that results from the restriction. Future buyers of the property likely will pay less for land with such limitations.[9]

Based on the nature of cleanup of dioxin/furan contamination due to air deposition, Ecology believes that the majority of remediation will be excavation. Contamination occurring in surface soil is more easily excavated than deep contamination, and given the implications of land-use restrictions, PLPs are therefore less likely to use capping and institutional controls.

Because most cleanup of third-party property is likely to be full excavation, meaning that very few—if any—properties will require institutional controls, Ecology believes that compensation for reduced property value is most likely zero.

Commercial Property

Ecology concluded that most properties are unlikely to experience reductions in property value due to land-use restrictions because cleanup of third-party properties is likely to be full excavation (see above). In addition, commercial properties have a higher degree of land-coverage—that is, the amount of land covered with buildings or pavement—that works to prevent dioxin/furans in the air from depositing in the soil.

Based on these factors, Ecology concluded that commercial property in the additional acreage impacted by the final rule is unlikely to experience the impacts of land-use restrictions.

Residential Property

Ecology concluded that most properties are unlikely to experience reductions in property value due to land-use restrictions because cleanup of third-party properties is likely to be full excavation (see above).

Summary of Real Estate Costs

If three sites in the state are impacted by the final rule, Ecology expects compensation for access of $1.8 – 8.0 thousand

If all 12 facilities in the state are impacted by the final rule, Ecology expects compensation for access of $7.2 – 32.2 thousand

[9] Studies indicate that the long-term impact of contamination that is fully remediated on property values is small or zero (see Dotzour (1997); Nelson (1981); Kinnard, et al. (1991)) and that property values rebound to levels similar to surrounding areas, unless deed restrictions are put in place (see Dale, et al. (1999); Simons and Sementelli (1997); Gamble and Downing (1992)). Moreover, area-wide stigma and risk impacts on property values have also been shown to rebound over time (see Wise and Pfeifenberger (1994); Greenberg and Hughes (1992); Kohlhase (1991); and Dale, et al. (1999)).

5.6 Probable Benefits of the Final Rule

Ecology expects the benefits of the final rule to include:

- Cancer mortality and morbidity avoided (Section 5.7)
- Noncancer illness avoided (Section 5.8)
- Improved ecological, existence, and bequest values for improved environmental and wildlife health (Section 5.9)

5.7 Avoided Cancer Mortality and Morbidity

In deciding to adopt this rule, Ecology relied on quantitative risk assessments (QRAs) of the cancer risks posed by dioxin/furans to the Washington public. Ecology's estimate of cancer cases avoided is based on its assessment of the probable cancer risks posed by dioxin/furans. Several authoritative scientific and regulatory bodies[10] have evaluated the wide range of toxic effects of dioxins/furans. In addition to the cancer benefits which Ecology has quantified, Ecology has also identified other benefits it believes will flow from the rule. In adopting this rule, consistent with the RRA, Ecology considered both the cancer benefits it has quantified and a number of other qualitative benefits of the rule.

In addition to reducing exposure to dioxin associated with pulp and paper mills and wood waste boilers (through increased remediation), the final rule will prevent other sites from increasing soil concentrations beyond those with a 1×10^{-6} excess cancer risk. This holds for the entirety of state soils, because the baseline rule would do nothing to prevent any site in Washington from increasing soil dioxin concentrations up to those with a 1×10^{-5} excess cancer risk. The actual composition of congeners on any given site would determine the associated soil concentration for these excess cancer risks.

The final rule will prevent contamination from rising to levels that could exist under the baseline. Consequently, Ecology believes that all residents of Washington State will benefit from the final rule, through a lower statewide excess cancer risk.

Children and adults are exposed when they come into contact with dioxin-contaminated soils at home, schools, parks, and in the workplace. Ecology expects that the final rule changes will reduce dioxin/furan exposures and therefore reduce the incidence or severity of associated cancer effects. In addition, residents of Washington are likely to benefit from a number of additional reductions in noncancer health risks associated with lower exposure to dioxins/furans.

5.7.1 Cancer Mortality:

Numerous scientific organizations have concluded that 2,3,7,8 TCDD[11] is a carcinogen. The International Agency for Research on Cancer (IARC) has classified 2,3,7,8-TCDD as

[10] World Health Organization (1989); International Agency for Research on Cancer (IARC, 1997); Agency for Toxic Substances and Disease Register (ATSDR, 1999); Environmental Protection Agency (2003): California Environmental Protection Agency/Office of Environmental Health Hazard Assessment (OEHHA, 2005); and the National Research Council (2006).

[11] All 2,3,7,8-substituted PCDDs/PCDFs and coplanar PCBs are believed to act through a common toxicological mechanism. This forms the basis for the TEF approach.

"probably carcinogenic to humans" based on limited evidence in humans, sufficient evidence in animals and extensive mechanistic information that indicates TCDD acts through a mechanism involving the aryl hydrocarbon receptor (AhR). The National Toxicology Program (2004) has classified TCDD has "known to be a human carcinogen". EPA (1985) has classified TCDD and hexachlorodibenzodioxin as "probable human carcinogens". In 2004, EPA classified TCDD as "carcinogenic to humans".[12]

Comments submitted in response to the preliminary cost benefit analysis criticize Ecology for assuming that dioxin/furans pose the same risks at all levels of exposure. These comments suggests Ecology's has just assumed that since dioxin causes cancer at high exposure levels any reduction in exposure will produce substantial benefits. Ecology highlighted the uncertainties inherent in quantifying such risks in the draft CBA. After reevaluating how best to address the uncertainty involved, Ecology has calculated the number of cancer cases that will be prevented by these rule amendments.

Ecology expects the final rule to reduce cancer risk in Washington State—both by requiring increased remediation at affected facilities down to 1×10^{-6} excess cancer risk, and by preventing contamination above that with 1×10^{-6} excess cancer risk in all soils in the State.

It is important to understand that the final rule change applies to lifetime cancer risk in excess of background cancer levels. The population already carries a high body burden of carcinogens. In the case of dioxin, Schecter and Gasiewicz (2003) indicate that dioxin body burdens in the United States are currently at levels that suggest little or no margin of exposure. The study states that, "Using best available estimates of cancer risks, the upper bound on general population lifetime risk for all cancers might be on the order of 1 in 1000 or more."

Avoided Cancer Incidence

The QRA measures the cancer risk posed to Washington residents if cleanup levels for dioxin/furan mixtures were permitted to rise to 24 ppt—the level of exposure which would be permitted under Method B under the baseline. Measuring cancer risk at the level permitted under existing regulations and comparing it to the risk remaining after new regulations are implemented is consistent with the practice of several federal agencies and with the *Benzene* decision.[13] Individuals are exposed to the same risk wherever they encounter dioxin/furans and each should have the same level of protection. Ecology does not believe that regulating in this manner is overbroad. Where levels of dioxin are low and, hence, risk is low, the site will have no clean up responsibility. Where exposures are higher, and hence, risk is higher, clean up responsibilities are likely to be greater. Ecology does not believe it is

[12] The National Research Council (NRC, 2006) was split on the question of carcinogen classification. Some members of the review panel agreed with EPA's classification decision. Other members recommended that EPA consider classifying DLC mixtures (as opposed to TCDD only) as "likely to be carcinogenic to humans."
[13] *See* 448 U.S. at 642.

appropriate or necessary for it to disaggregate the risk industry by industry or site by site. Therefore, Ecology believes all exposures should be reduced to the same risk level.

Ecology has adopted EPA's quantitative analysis of dioxin/furan risks. EPA's analysis represents a "reputable body of scientific thought" upon which Ecology can properly rely. There is no reason for Ecology to reevaluate each study showing dioxin/furan risks. Ecology has reviewed the more recent NAS analysis of dioxin hazards. While that report suggests EPA reconsider its risk assessment for dioxin, EPA has not yet done so. Ecology therefore concludes that EPA's 2003 risk assessment of dioxin/furan is the best evidence available to it for quantifying cancer risk.

Relying on EPA's risk assessment for dioxin, Ecology has used a linear extrapolation of dioxin cancer risks. Reliance on a linear extrapolation means that the predicted probable cancer cases avoided by this rule fall at the upper end of the range of risks predicted by various QRA models. Ecology believes it is appropriate to rely on linear extrapolations of risk for several reasons. First, and most importantly, linear extrapolation models are the most conservative available and err on the side of health protection. Further, as explained below, dioxin exposure at cleanup sites is just one source of dioxin exposure to Washington residents and the effects of dioxin are likely cumulative. The linear model takes the existing dioxin body burden into account.

Background Exposure and Body Burden

Ecology uses a health protective approach when evaluating environmental exposures. With respect to carcinogenic effects, Ecology assumes that there is some level of cancer risk at any level of soil-related dioxin exposure. This is consistent with the intent of the Model Toxics Control Act and the default assumptions specified in the MTCA Cleanup Regulation,[14] and the 2005 EPA Cancer Guidelines[15]. It is also consistent with the wide range of scientific reviews and policies established over the last several decades.

Traditional methods for evaluating non-cancer health are based on identifying exposure thresholds below which no adverse effects are expected to occur. However, Ecology also believes it is appropriate to assume there is some level of non-cancer risk at any level of soil-related dioxin exposure for the following reasons:

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[14] The MTCA rule specifies "…[t]he linearized multistage extrapolation model shall be used to estimate the slope of the dose-response curve unless the department determines that there is clear and convincing scientific data which demonstrates that the use of an alternate extrapolation model is more appropriate…" (WAC 173-340-708(8)(c)(i)(B)). The multistage model predicts a linear dose response at low doses.

[15] EPA (2005) states that "…[i]n the absence of sufficiently, scientifically justifiable mode of action information, EPA generally takes public health-protective, default positions regarding the interpretation of toxicologic and epidemiologic data: animal tumor findings are judged to be relevant to humans, and cancer risks are assumed to conform with low dose linearity." (pp. 1-10 & 1-11)

- Background Dioxin Exposures: The evaluation of soil-related dioxin exposure must take into account background exposures and existing body burdens. As noted below, EPA has elected not to establish a reference dose for dioxin based on the conclusion that any reference dose calculated using current data and methods would be 2-3 orders of magnitude below current background intakes and body burdens. Given that background exposures exceed a health-based threshold, additional soil exposure would presumably pose some level of health risk.

- Background Incidence of Non-Cancer Health Effects: One of the arguments for using a linear low-dose risk extrapolation approach for cancer risks is that the chemical effects are being added to an existing disease process. Clewell and Crump (2005) have concluded that similar arguments can be made with respect to the background incidence of non-cancer toxicities. They noted that there are several types of non-cancer effects with an existing background incidence in the general population (e.g. cardiovascular events, pulmonary insufficiency, male reproductive deficits, and developmental defects).

- Population vs. Individual Thresholds for Health Effects: Ecology believes that, even if thresholds for non-cancer effects can be shown for individuals, such thresholds are unlikely to apply to whole populations because (1) individual variations in human susceptibility and (2) the potential for additive, synergistic and antagonistic interactions with other chemicals and lifestyle factors.

The Dose-Response Relationship

Uncertainties and variability in dose-response relationships arise from:

- Cancer: EPA has developed oral cancer slope factors for 2,3,7,8 TCDD (156,000 $(mg/kg/day)^{-1}$) and hexachlorodibenzo-p-dioxin (6,200 $(mg/kg/day)^{-1}$). These slope factors were calculated using a linear non-threshold model. However, these calculations require a number of assumptions and the resulting estimates have a high degree of uncertainty. For example, EPA (2003) has evaluated available studies and calculated cancer slope factors that range from 570,000 to 5,100,000 $(mg/kg/day)^{-1}$, with a recommended value of 1,000,000. Paustenbach, et al. (2006) reported values ranging from 9,600 to 1,000,000 $(mg/kg/day)^{-1}$.

- Non-Cancer Health Effects: EPA has elected not to establish a reference dose for dioxin based on the conclusion that any reference dose calculated using current data and methods would be 2-3 orders of magnitude below current background intakes and body burdens. An ATSDR update (ATSDR, 2006) retained an MRL-based environmental media evaluation guide (EMEG) of 0.05 ppb (50 ppt) TEQ using ATSDR's chronic minimum risk level (MRL) of 1 pg/kg/day, combined with exposures assumptions for a child and an assumed 100% bioavailability. The EMEG of 50 ppt is an ATSDR screening value for residential soils contaminated with dioxins and dioxin-like compounds.

These calculations require a number of assumptions and estimates have a high degree of uncertainty. For example, Paustenbach et al. (2006) found that reference doses (or equivalent non-cancer toxicity measures) developed by federal and international organizations ranged from 0.013 to 100 pg/kg/day. EPA (2003) evaluated available studies and calculated benchmark doses that range over several orders of magnitude.

- Toxic Equivalency Factors: There are number of uncertainties associated with the use of the TEF approach.[16] The current TEF values have been developed using many sources of experimental data. For many congeners, TEF values can vary by several orders of magnitude depending on the health endpoint and test species.

Susceptibility to carcinogens can vary greatly among individual humans due to genetic, life stage and environmental factors. Sources of variability and uncertainty in human susceptibility to dioxin exposure arise from:

- Genetic Variations in Human Susceptibility: The human population is genetically heterogeneous and genetic variations may make people more or less prone to the effects of hazardous substances. For example, studies have shown that there are large (100 times or more) genetic differences in the metabolism of hazardous substances. The ability or inability to induce enzymes in the body responsible for activating or metabolizing chemicals is in part, a function of an individual's genetic makeup. Halogenated aromatic hydrocarbons, the prototype being 2,3,7,8-TCDD, induce a diverse spectrum of chemical activating and metabolizing enzymes. The variability in enzyme induction and biological responses is typical for halogenated aromatic hydrocarbons that interact with the AhR receptor (2,3,7,8-TCDD) resulting in tissue- / species-specific responsiveness or non-responsiveness.[17]

- Life Stage Variations in Human Susceptibility: In general, the young and elderly are more susceptible to the adverse effects of hazardous substances. Children are more susceptible to hazardous substances than the general population because their organ systems are still developing and dividing cells are more easily harmed than mature cells[18]. Children also

[16] Finley et al. 2003; OEHHA, 2003; EPA 2003; NRC, 2006

[17] Naz, RK (1999)

[18] Ginsberg (2003) concluded that the cancer risk attributable to early-life exposure can be about 10-fold higher than the risk from an exposure of similar duration occurring later in life (Ginsberg, 2003) EPA (2005b) identified a number of factors that contribute to variations in child susceptibility to hazardous substances: (1) differences in the capacity to metabolize and clear chemicals can result in larger or smaller internal doses of the active agent(s); (2) more frequent cell division during development can result in enhanced expression of mutations due to the

consume more food per body weight than do adults while consuming fewer types of foods, i.e., have a more limited diet. In addition, children engage in crawling and mouthing (i.e., putting hands and objects in the mouth) behaviors, which can increase their exposures. Pregnancy may also result in changes in absorption, distribution, and metabolism of hazardous substances. These changes can alter a woman's sensitivity to the adverse effects of hazardous substances. Women may also have exposures that differ from the general population. Exposure to pregnant women may result in exposure to the developing fetus. The elderly and disabled may have important differences in their exposures due to a more sedentary lifestyle. In addition, the health status of this group may affect their susceptibility to the detrimental effects of hazardous substances exposure.

For example, ATSDR reviewed available literature regarding the susceptibility of children to chlorinated dibenzo-p-dioxins, dioxins.[19] Most of the available information involves children living in Seveso, Italy, during the accidental release of airborne trichlorophenol contaminated with 2378-TCDD. Documented effects in children from airborne exposures of trichlorophenol contaminated with 2378-TCDD included chloracne, erythema and edema, peripheral nervous system effects, and potentially increased risks of Hodgkin's lymphoma, myeloid leukemia, and thyroid cancer were reported among children between 0-19 years old at the time of the Seveso accident.

- Interactions with Other Chemical Exposures: Cancer is a multi-stage process with a number of factors contributing the process at different stages. Exposure to other chemicals may increase or decrease an individual's sensitivity to dioxin exposures. Concurrent chemical exposures may result from exposure to other environmental contaminants, therapeutic drugs, and/or diet. There is very little information on the interactions between dioxin and other chemicals. However, the adverse biological effects associated with exposure to dioxin are mediated by the interaction of the chemical with the AhR receptor. Other halogenated aromatic compounds (co-planar PCBs, polynuclear aromatic hydrocarbons) interact with the AhR receptor and are associated with a similar spectrum of effects. When exposures occur to these complex environmental mixtures of halogenated aromatic hydrocarbons, binding with the AhR receptor may occur--which may exhibit a range of adverse effects.[20]

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reduced time available for repair of DNA lesions; (3) some embryonic cells, such as brain cells, lack key DNA repair enzymes; (4) more frequent cell division during development can result in clonal expansion of cells with mutations from prior unrepaired DNA damage; (5) some components of the immune system are not fully functional during development; and (6) hormonal systems operate at different levels during different life stages.

[19] ATSDR, 1998

[20] ATSDR, 1998

Affected Population

Finally, health benefit calculations require information and/or assumptions on exposed populations (including susceptible population groups such as children and women of childbearing age). Ecology has limited sampling data to support identification of contaminated areas. If that information was available, Ecology could use census data to prepare estimates of currently exposed populations. However, current exposures based on current land uses may be significantly different than exposure scenarios associated with future land uses. This is because under the Growth Management Act, the intent is to concentrate development within urban growth areas. Over time, this will likely significantly increase the potentially impacted population in areas impacted by air emissions from affected facilities.

Avoided Cancer Incidence Methodology

Ecology used the following methodology to estimate the number of cases of cancer that might be avoided as a result of the final MTCA Cleanup Regulation.

Ecology estimated the number of avoided cancer cases associated with the dioxin exposure reductions resulting from the rule revisions. The estimates were developed using the model shown in Figure 2. Ecology performed the analysis using a probabilistic risk assessment approach. This approach involves replacing the point values for the three model parameters (population, cancer slope factor, and lifetime average daily dose) with probability distributions for those values.

Figure 2: Avoided Cancer Incidence

Avoided Cancer		
Avoided Cancers = POP * CSF * LADD		
Where:		
POP	=	Population at Risk (number of people)
CSF	=	Cancer Slope Factor $(\text{pg/kg/day})^{-1}$
LADD	=	Lifetime Average Daily Dose (pg/kg/day)

Model Parameters and Assumptions

Ecology used available information to develop estimates for the three input parameters. This section briefly summarizes the information and assumptions used to develop each parameter.

- <u>Population at Risk</u>: Ecology estimated the number of people that might be affected by the final rule. When preparing those estimates, Ecology considered the size and location of the facilities that may have released dioxins and furans, the 2000 census data for Washington and population growth rates compiled by the Office of Financial Management. Ecology used the following distribution of values to characterize the population that might be affected by the final rule (Table 6).

Table 6: Population at Risk Parameters and Weights

Population at Risk – Model Parameters and Weighting Factors		
People	**Weighting Factors**	**Description**
50,000	0.33	Estimated Population—Lower End of Range
75,000	0.33	Estimated Population—Lower End of Range
100,000	0.33	Estimated Population—Lower End of Range

- Lifetime Average Daily Dose (LADD): People may be exposed to dioxin-contaminated soils through several pathways. Soil-related pathways include direct contact (soil ingestion and dermal contact), inhalation of wind-blown dust, and bioaccumulation through the terrestrial and aquatic food chains. Ecology reviewed the available information compiled by EPA (2002[21], 2003[22]), the Office of Environmental Health Hazard Assessment (2000[23]), and other technical information. Based on this review, Ecology used the following distribution of values to characterize the range of potential soil-related exposure estimates.

Table 7: Lifetime Average Daily Dose (LADD) Parameters and Weights

Lifetime Average Daily Dose (LADD) – Model Parameters and Weighting Factors		
pg/kg/day	**Weighting Factors**	**Description**
0.01	0.33	Residential – Direct Contact Pathway
0.1	0.33	Residential – Multiple Exposure Pathways
0.3	0.33	Residential – Multiple Exposure Pathways (including farming scenario)

- Slope Factor: The cancer potency of a substance is typically expressed as a cancer slope factor. Ecology currently uses a cancer slope factor of (156,000 mg/kg/day)$^{-1}$ to calculate MTCA cleanup levels for dioxin mixtures. The EPA developed a new cancer slope factor of 1,000,000 (mg/kg/day)$^{-1}$ when preparing the 2003 Dioxin Reassessment. The National Research Council (2006)[24] has reviewed the EPA value and concluded that the EPA value may overestimate risks at low doses. The NRC recommended that EPA consider the use of non-linear models consistent with a receptor-mediated mechanism of action. Ecology reviewed the dose-response information compiled by Smith

[21] Center for Environmental Analysis. 2002. Exposure Analysis for Dioxins, Dibenzofurans, and CoPlanar Polychlorinated Biphenyls in Sewage Sludge. Technical Background Document (Draft). Prepared for ICF Consulting Inc. and the Office of Water, USEPA. May 2002.

[22] U.S Environmental Protection Agency, 2003, National Center for Environmental Assessment. Exposure and Human Health Reassessment of 2, 3, 7, 8 - Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds. National Academy of Sciences (NAS) Review Draft

[23] Office of Environmental Health Hazard Assessment. 2000. Technical Support Document for Exposure Assessment and Stochastic Analysis. Part IV. September 2000.

[24] National Research Council of the National Academies. 2006. Health risks From Dioxin and Related Compounds, Evaluation of the EPA Reassessment. July 2006.

and Lopipero[25] (2001), EPA (2003), NRC (2006) and Paustenbach et al. (2006)[26]. Based on that review, Ecology selected the following distribution to characterize the range of cancer slope factors.

Table 8: Cancer Slope Factor

Cancer Slope Factor – Model Parameters and Weighting Factors		
Slope Factor $(mg/kg/day)^{-1}$ $[(pg/kg/day)^{-1}]$	**Weighting Factor**	**Description**
50,000 [5E-05]	0.33	Lower end of the range of slope factors summarized by Paustenbach et al. (2006) and Smith and Lopipero (2001).
156,000 [1.6E-4]	0.33	Cancer slope factor published in the EPA Health Effects Assessment Summary Table (HEAST)
1,000,000 [1E-3]	0.33	Cancer slope factor developed as part of EPA Dioxin Reassessment.

Avoided Cancer Incidence Estimate

Ecology used the Crystal Ball software program (Version 7.2.2) to combine the three distributions. Crystal Ball is a commercially available risk analysis simulation and optimization software tool. Using this tool, Ecology calculated the incidence of avoided cancers associated with the dioxin exposure reductions resulting from the final rule revisions.

Table 9 summarizes the range of avoided cancer incidence calculated using this model. Ecology selected the mean (average) value—4 cases—as a reasonable number for estimating the benefits associated with the final rule amendments.

Table 9: Avoided Cancer Incidence

Statistical Measure	Cancers
Median	1
Mean	4
90th percentile	10
Minimum	0
Maximum	30

Avoided Cancer Mortality

Ecology used the above Avoided Cancer Incidence results to calculate avoided cancer mortality.

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[25] Smith A. H. and P. Lopipero. 2001. Evaluation of the Toxicity of Dioxins and Dioxin-Like PCBs: A health Risk Appraisal for the New Zealand Population. February 2001. Report to the New Zealand Ministry for the Environment. ISBN 0-478-09091-9, ME number 351.

[26] Paustenbach, D.J., K. Fehling, P. Scott, M. Harris, B. D. Kerger. 2006. Identifying Soil Cleanup Criteria For Dioxins in Urban Residential Soils: How Have 20 Years of Research and Risk Assessment Experience Affected the Analysis. Journal of Toxicology and Environmental Health, Part B, 9:87-145.

Ratio of Cancer Mortality to Incidence

The Washington State Cancer Registry (2004) reports that the ratio of liver cancer incidence was 79 percent for men (186 deaths / 234 liver cancer cases) and 75 percent for women (67 deaths / 90 liver cancer cases) in 2004. The overall mortality rate given cancer in that year was 78 percent.[27] These rates only represent the ratio of cancer deaths in 2004 to the number of cancer cases diagnosed that year.

Ecology also looked at the ratio of mortalities to cancer incidence in years following the year of diagnosis. In order to get a better idea of the number of individuals that have not died of liver cancer within five years of diagnosis, Ecology used a five-year survival rate. Nationally, the Washington State Cancer Registry reports that the 2003 five-year survival rate for liver cancer at all stages was 14 percent—indicating that 86 percent of individuals with liver cancer died within five years.

In order to maintain conservative estimates, Ecology assumed an 80 percent mortality rate for the most likely cancer that results from dioxin/furan exposure.

Ecology expects that the final rule will reduce cancer mortality in Washington State by an average of 3.2 cases.[28]

Value of Avoided Mortality

To estimate the value of cancer mortality avoided, Ecology reviewed the value of statistical life (VSL) literature. The VSL is generally the basis of an economic value of life. A statistical life is the extrapolated value of a person to society, though <u>not</u> of any particular person.

There is extensive literature that estimates a broad range of statistical values of life from $100,000 to $25 million.[29] Scholars differ on how to gauge the value of each life (willingness to pay v. willingness to accept), to what degree to discount the value of benefits likely to accrue in the future, and whether to adjust life values for diseases affecting the elderly. Each of these issues is controversial with scholars advocating a variety of positions. Most scholars place the value of each cancer death avoided at $3 – 7 million dollars.[30]

<u>Comments on VSL</u>

The VSL literature shows additional evidence of a multiplier effect associated with cancer versus noncancer-related mortality (1/3 greater VSL associated with cancer mortality) and a premium for better-publicized cancers such as lung or

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[27] Dioxin/furan exposure is primarily associated with liver and lung cancer. Lung cancer is associated with inhalation—which applies to a lesser degree with soil contamination. Therefore, Ecology focused on liver cancer in this analysis. See Appendix E for discussion and references for health impacts of dioxin/furan exposure.
[28] The overall range of possible avoided cancer mortality is 0 – 24 deaths.
[29] Mrozek & Taylor (2002)
[30] Mrozek & Taylor (2002)

breast cancer.[31] For example, in studies of VSL in Taiwan, VSL associated with death from acute lung cancer is twice as large as VSL for acute liver cancer.

The difference in VSL across cancers is especially poignant given that in many areas liver cancer has a higher mortality rate than lung cancer. This premium, however, is not uniform across nations and may vary by national income and exposure to cancer information.

VSL does not, however, vary significantly with age.[32]

Latency Discount

There is some degree of dispute over the existence or size of a latency discount on VSL. A latency discount would arise from the time lag between exposure to dioxins/furans, development of cancer, and (if applicable) cancer mortality.

Hammit and Liu (2004) summarize the VSL latency literature, finding a range of empirical discount rates ranging from 1.5 percent to 17 percent. Higher discount rates found in the literature were associated with shorter latency periods.[33] The authors note that,

> … [T]he effect of latency on [willingness to pay] to reduce own mortality risk is uncertain. In theory, latency may increase or decrease WTP depending on whether individual VSL increases enough to offset the individual's consumption discount rate. Empirical studies have not resolved this ambiguity.

Other authors have questioned the appropriateness of VSL and discounting VSL at a nonzero rate on moral grounds.[34]

Hopenhayn-Rich, et al. (1998), indicate that the average latency for all cancers is 20 years. In order to reflect a range of positions, Ecology calculated the value of avoided cancer mortality using a 3.25 percent discount rate.[35]

Table 10 summarizes the likely range of VSL for a 3.25 discount rate over 20 years.

Table 10: Value of Statistical Life: Cancer Latency

Discounted VSL

[31] Hammit and Liu, 2004

[32] Alberini, et al., 2002

[33] High-end discount rates: five to 12 percent was associated with delays of three to five years (Horowitz & Carson, 1990), while 17 percent was associated with a delay of five years (Cropper, Ayded, & Portney, 1994). Low-end discount rates: 1.5 percent was associated with a delay of 20 years (Hammitt and Liu, 2004), and four to five percent was associated with delays of 50 to 100 years (Cropper, Ayded, & Portney, 1994).

[34] See: Heinzerling, L (1999). Discounting Life. *Yale Law Journal* 108; and Heinzerling, L and F Ackerman (2002). Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection. Washington, DC: Georgetown Environmental Law and Policy Institute, Georgetown University Law Center.

[35] 3.25 percent is the average discount rate among those reported for longer lag periods. See note 33. Note also that the median discount rate estimated by these studies is zero percent.

	Discount Rate 3.25%
Low	$1.6 million
High	$3.7 million

Multiplying these values by the estimated number of avoided cancer deaths in Washington State under the final rule, Ecology calculated the total value of avoided cancer mortality. These values are summarized in Table 11.

Table 11: Value of Avoided Cancer Mortality under the Final Rule

Value of Avoided Mortality (millions of $)		
	Discounted VSL	
	Low	High
Minimum	$0.0	$0.0
Average	$5.1	$11.8
Maximum	$38.4	$88.8

Ecology expects that the final rule will generate a social benefit of avoided cancer mortality valued at $5.1 – 11.8 million.

Ecology believes that these benefit estimates may be low, because they deal exclusively with the current population residing in affected areas. Additional individuals are expected to be exposed over time, as new populations come of age or move into the area. It also does not reflect the effects of repeated exposures by particular individuals over time.

5.7.2 Avoided Cancer Morbidity

Each of the cancers avoided by the rule—irrespective of survival—will require significant treatment after diagnosis. Cancer over an individual's lifetime is likely to result in treatment and medical costs, lost work time, and emotional and family costs. These costs are applicable independent of whether the cancer is fatal, but mortality both limits the number of years costs are incurred and increases later costs, as cancer worsens.

The value of avoided cancer morbidity includes the values of avoided:

- Healthcare expenditures[36]
- Associated end-of-life expenses
- Income loss due to absenteeism or hospitalization
- Illness and side effects
- Psychological effects of illness

[36] The EPA (2007) estimates lifetime discounted medical costs per patient of $67 – 126 thousand for lung cancer and $126 – 181 thousand for liver cancer. The ranges depend on whether a patient ultimately survives the cancer.

- Negative impacts on family
- Long-term disability

Ecology was not able to confidently quantify these values due to substantial variability about the attributes of the affected population (see Appendix E). Although these values are not quantified, Ecology expects they are significant, and only serve to increase and further support the overall benefit of the final rule over the baseline.

5.7.3 Summary of Cancer Benefits

The probable value of cancer mortality avoided from the final rule is $5.1 – 11.8 million. This estimate of the probable benefits of the rule is over three times as large as estimated total costs.[37] Since the benefits of the rule so dramatically outweigh the costs, Ecology believes no further monetization of benefits is required.

In addition to the quantified and qualitative cancer benefits of the rule, Ecology believes the rule will provide other benefits as well. Ecology has not quantified these other benefits, but they are nevertheless substantial and important. Ecology finds that these benefits, together with the probable cancer benefits, further demonstrate that the probable benefits of the rule exceed its probable costs.

5.8 Avoided Non-Cancer Costs:

Exposure to dioxins/furans have been shown to increase the risks of developing a wide range of non-cancer health problems including hepatic, immunological, dermal, endocrine effects, neurological effects and reproductive and development effects. While the quantified cancer benefits of the final rule (see Section 5.7) are large enough to justify the probable costs (see Sections 5.2 through 5.5), Ecology believes the final rule will result in additional unquantifiable benefits associated with reducing exposure to dioxins/furans, as described below. For further discussion of noncancer health effects, see Appendix E.

- Impaired Immune Systems: EPA (2003) reviewed a number of studies that show that DLCs suppress the immune system. The National Research Council (2006) reviewed EPA's evaluation and stated "…the committee agrees with EPA's conclusion that these compounds are probably human immunotoxicants…" However, the NRC also discussed a number of uncertainties associated with extrapolating results from animal studies to the human populations.

- Endocrine Effects: EPA (2003) reviewed a number of studies showing that dioxins impair thyroid function and increased risk of developing Type II diabetes. Several studies of nursing infants suggest ingestion of breast milk with a higher dioxin concentration may alter thyroid function.

[37] Total costs for 12 facilities total $1.7 – 2.8 million. The total quantified benefits range is between three and four times as large as these costs. If only those three facilities that currently have confirmed or suspected dioxin/furan-contaminated soil are affected, total quantified benefits may be more than 12 times as large as total costs.

The link to Type II diabetes rests on reduced glucose tolerance. Dioxin-like compounds have been linked to Type II diabetes. Exposure has been shown to decrease glucose tolerance as with Type II, “adult onset” diabetes. There is evidence of altered glucose transport in the blood and alterations to the insulin-signaling pathway in the body.

Ecology expects the total value of avoided immune and diabetes effects under the final rule to include the costs of not only treating diabetes itself, but also to long-term complications of the disease affecting vision, nerves, kidney function, and sexual function, plus medical and psychological costs of possible amputation (National Institutes of Health, 2007).

- Reproductive Toxicity**:** EPA (2003) reviewed several studies indicating that dioxin mixtures have shown to cause decreased fertility in women, inability to maintain pregnancy for the full gestational period, ovarian dysfunction, and suppression of the estrous cycle. This is associated with disruption in levels of reproductive hormones, testosterone, lutenizing hormone (LH), and follicle-stimulating hormone (FSH).

  Women exposed to DLCs during childhood also exhibit alterations in menstrual duration and flow. Men exposed to DLCs exhibit reproductive alterations and reduced fertility, as well as low testosterone levels. Primate trials also indicate increased incidence and severity of endometriosis, which is considered an endocrine disorder that generates immune system alterations and affects estrogen homeostasis.

  Ecology expects the total value of successful childbearing to include costs to compensate for impacts of dioxin mixtures to reproduction, life stage, childrearing, and reduced risk to the mother during pregnancy.

- Developmental Toxicity**:** EPA (2003) reviewed a number of studies that indicate dioxins cause a wide range of developmental effects in animals. These include: (1) reduced viability; (2) structural malformations (e.g. cleft palate formation); (3) reduced growth; and functional alterations (e.g. effects on male and female reproductive systems and learning behavior.

  Changes to the development of the reproductive system can result from a single, low level of exposure, indicating long-term exposure may not be necessary to generate a developmental impact. Children born with developmental impairments can experience reduced intelligence quotient (IQ), behavioral and socialization disorders, and learning impairments.

5.9 Ecological, Existence, and Bequest Values

Ecological Value

The final rule prevents any given site from contaminating soil with dioxin at higher levels (as they could under the baseline). Ecology expects that the final rule will help to maintain local plant and animal populations in impacted areas since addressing human health concerns will also likely address contamination potentially toxic to plants and animals. Protection of local populations could also play a role in a species' overall survival.

Existence and Bequest Values

Both Washington residents and others outside of the state value human and wildlife health, and less ecological damage, without using the environment directly or indirectly.[38] This is commonly referred to as existence value.

Bequest value assigns worth to human health, the environment, and wildlife (and their quality and maintenance) for the values they might give in the future. This is a form of option value—when people value retaining a resource to maintain the option of using it themselves or by future generations. Like existence value, bequest value may comprise a part of values associated above with health and the environment, but it is distinct in that it excludes use by the individual in the present.

Ecology expects the final rule to generate a benefit by avoiding reductions in existence and bequest values that would occur under less stringent cleanup levels.

5.10 Summary

Over the baseline, Ecology expects the final rule to generate the following costs and benefits.

Probable costs of:

- Investigation and remediation costs over the baseline of:
  - $425 – 714 thousand if the three most likely sites are impacted
  - $1.7 – 2.8 million if all 12 facilities in Washington are impacted
- Compensation for access to third-party properties of:
  - $1,800 – 8,000 if the three most likely sites are impacted
  - $7,200 – 32,200 if all 12 facilities in Washington are impacted

Mitigated by:

- Avoided terrestrial ecological evaluation (TEE)
- Avoided evaluation of multiple hazardous substances
- Avoided investigation and remediation of industrial (Method C) sites

Probable benefits of:

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[38] Individuals express concern over national and international events that affect human and wildlife health. Examples of this concern range from oil spills' effect on animals to the impact of toxic chemical exposure on distant communities. Many organizations exist that support improved conditions for humans and wildlife across the globe.

- Avoided human health impacts and related personal and societal benefits that stem from improved health, including:
  - Avoided cancer mortality valued at $5.1 – 11.8 million.
  - Avoided costs of cancer morbidity, including:
    - Healthcare expenditures
    - Associated end-of-life expenses
    - Income loss due to absenteeism or hospitalization
    - Illness and side effects
    - Psychological effects of illness
    - Negative impacts on family
    - Long-term disability
- Reduced risks to plant and wildlife
- Improved existence and bequest values for health and the environment

Note that lower (more stringent) ecological cleanup levels on some sites may mitigate these costs and benefits entirely. For sites at which ecological health risk drives cleanup, Ecology expects zero cost and zero benefit associated with changes in the amount of remediation performed. This is because the final rule does <u>not</u> alter cleanup levels based on ecological risks.

CHAPTER 6: Comments and Conclusions

6.1 Introduction

As discussed in Chapter 1, the Washington Administrative Procedure Act (RCW 34.05.328) requires Ecology to evaluate significant legislative rules to "[d]etermine that the probable benefits of the rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the statute being implemented."

Although there may be little or no increased compliance cost under the final rule (particularly, on a per-site basis), Ecology has conservatively assumed such costs would be incurred and quantified those costs for those sites that could be affected. In evaluating benefits, Ecology has quantified the avoided cancer cases of the final rule based on the current adult population in affected areas. The value of these cancer cases avoided far exceeds costs.

Any determination of costs and benefits is fraught with uncertainty. Experience shows that when regulations impose compliance costs, industry often finds technological solutions to implement regulatory requirements which are less expensive than predicted. This phenomenon means compliance costs for regulations are often overstated when rules are being considered. Similarly, quantitative risk assessment of cancer risks is inherently uncertain.

Further, cancer risk assessments focus on only one health end point. Reducing exposures to dioxins/furans will reduce the incidence of cancer but will also reduce cancer morbidity and mortality from noncancer health effects related to these toxins. Despite these uncertainties, Ecology has a statutory obligation to implement the Model Toxics Control Act and to move forward and protect the public from toxic hazard. The requirement to estimate *probable* costs and benefits is not a "mathematical straightjacket." Nothing in the RRA requires that Ecology defer regulations because data about costs and benefits is uncertain. Indeed, the RRA recognizes that benefit and cost data is likely to be uncertain, by permitting agencies to base rules on an assessment of *probable* costs and benefits and to look at benefits that can be quantified and those that cannot.

Based on the results of this economic analysis then, Ecology concludes the benefits of the final rule—when considering both the quantitative and qualitative costs and benefits, as well as the uncertainty involved—outweigh the costs.

6.2 Comments on Estimated Costs

6.2.1 Ecological Cleanup Levels

Note that costs may be mitigated by the lower (more stringent) ecological cleanup levels on some sites. For sites at which ecological health risk drives cleanup, Ecology expects zero cost and zero benefit associated with changes in the amount of remediation performed. This is because the final rule does <u>not</u> alter cleanup calculations based on ecological risks.

6.2.2 Conservative Estimates

- For likely costs, Ecology employed conservative estimates. This means that the estimates are probably higher than are likely to occur. Factors that will result in lower per site costs include a higher percentage of impervious surfaces than assumed (10%)

- Industrial properties are required to cleanup to less stringent cleanup levels, potentially offsetting increased remediation costs in other non-industrial areas

In addition, Ecology's estimation of costs assumed that all costs will be incurred immediately. It is more likely that sites will:

- Expend remediation funds over time as the cleanup process progresses
- Not begin cleanup immediately in 2007

These factors reduce the present value of both costs and benefits, in terms of 2006 dollars. The extent of the present value reduction depends on the timing and length of time of actual site remediation.

6.2.3 Uncertainty in the Cost Model

Four primary factors affect the actual costs and benefits that will be experienced by cleanup proponents under the final rule:

- The composition of the dioxin mixture at the site
- The actual cleanup level determined for the site, as based on excess cancer risk, noncancer human-health risks, and ecological risk
- The choice of remedial method(s) employed at the site
- The actual volume of additional soil needing remediation

6.2.4 The Composition of the Dioxin Mixture at the Site

The difference in cleanup levels between the final rule and the baseline depends on the actual composition of the dioxin mixture at the site. Ecology has analyzed several data sets from dioxin-contaminated sites in Washington State to determine this difference. The differences are summarized in Tables 12 and 13 below.

Table 12: Comparison of Method B Cleanup Levels for Dioxin

Comparison of Method B Soil Cleanup Levels* for Dioxin/Furan Mixtures			
Contaminants	Current MTCA Rule		Final Amendment
	CLARC comparison	Baseline	
2,3,7,8 TCDD	6.7 ppt	6.7 ppt	11 ppt
Dioxin/Furan Mixtures (TEQ)	6.7 ppt	16 – 24 ppt**	11 ppt***

*Assumes direct contact (via soil ingestion) is the controlling exposure pathway. **Based on median cleanup level at dioxin/furan contaminated sites in Washington State *** Based on a gastrointestinal absorption fraction (bioavailability) of 0.6. .

Table 13: Comparison of Method C Soil Cleanup Levels for Dioxin

Comparison of Method C Soil Cleanup Levels* for Dioxin Mixtures			
Contaminants	Current MTCA Rule		Final Amendment
	CLARC comparison	Baseline	
2,3,7,8 TCDD	875 ppt	875 ppt	1460 ppt
Dioxin/Furan Mixtures (TEQ)	875 ppt	875 ppt	1460 ppt**
*Assumes direct contact (via soil ingestion) is the controlling exposure pathway. ** Based on a gastrointestinal absorption fraction (bioavailability) of 0.6.			

6.2.5 Actual Established Cleanup Level

The area needing remediation necessary on a site is based on the cleanup level. The final rule alters the calculation of cleanup levels based on excess cancer risk posed by contaminated soil. While this is one factor that is considered in determining an ultimate cleanup level on a site, it is not the only factor.

An ecological risk analysis may determine a cleanup level that is lower (more stringent) than the human-health based cleanup level is necessary. In this case, the ecological cleanup level may drive the site cleanup. Alternatively, the cancer-risk-based cleanup level may be below the ecological screening level, and the cancer-risk-based cleanup level will drive the site cleanup. Appendix E examines particular scenarios of relative cleanup levels under the baseline, the final rule, and ecological screening levels.

Because ecological screening levels and actual cleanup levels under the MTCA rule are highly dependent on the mix of congeners on a site, a large degree of uncertainty regarding the actual cleanup level on a site is added to this analysis. One site may experience no change because its cleanup is driven by ecological cleanup levels, while Ecology may require another site to perform additional remediation.

6.2.6 Choice of Remedial Method(s)

As this analysis indicates in Appendix C, there are many combinations of remedial methods available to cleanup proponents, and the overall unit cost of remediation can vary considerably. The actual cost of remediation is highly dependent on whether a cleanup proponent excavates and disposes of all contaminated soil, caps the contaminated soil in a number of ways, or uses a combination of some (or all) of the available methods.

Ecology estimated expected total cost of remediation based on a weighted average of remedial methods, and estimated a range of total cost based on the highest and lowest values per unit that would achieve the level of cleanup necessary and allow former pulp and paper mill or wood-waste boiler sites to be redeveloped. The estimated range should encompass all possible weighted unit costs, but the actual cost experienced by cleanup proponents will vary with site characteristics and business decisions of the cleanup proponent.

6.2.7 Actual Remediated Soil Volume

In calculating the expected change in remediation cost under the final rule, Ecology used the median change in the volume of soil requiring remediation base on the distribution of results of an air deposition model (see Appendix C for methodology). The median change was used to represent the most likely change in soil volume.[1]

The actual change in soil volume, however, will likely fall within a range (see footnote, page 23). The distribution of changes in soil volume is skewed so that smaller changes are more likely, so the estimated change in remediated soil volume is likely to be smaller than the median.

6.3 Comments on Estimated Benefits

Ecology believes that the likely benefits of the final rule are larger than those estimated quantitatively in this document. This is based on:

- Identical treatment of children and adults in avoided cancer calculations, because children may be more dramatically affected by dioxin than adults.
- Usage of the current state population, excluding future population growth, migration, and population replacement.
- Inability to quantify or monetize numerous qualitative benefits of avoided cancer incidence

The value of avoided environmental and wildlife damage includes the values of:

- Reproductive value of healthy wildlife to population maintenance
- Interaction with (or observation of) wildlife
- Use of affected areas by humans and wildlife
- Protection of endangered, threatened, or sensitive species
- Existence and bequest values

Note that all of these costs and benefits may be mitigated by the lower (more stringent) ecological cleanup levels on some sites. For sites at which ecological risk

[1] Given the number of underlying variables and parameters in the air deposition model, Ecology decided not to assume a particular functional form for the distribution of change in soil volume.

drives cleanup, Ecology expects zero cost and zero benefit associated with changes in the amount of remediation performed. This is because the final rule does not alter cleanup levels based on ecological risks.

6.4 Final Comments and Conclusion

Based on qualitative and quantitative assessment of the likely costs and benefits, Ecology concludes that the net benefit of the final rule is likely to be positive. This conclusion is based on:

- The conservative nature of the quantitative cost estimate (the likelihood that it will be smaller than the $1.7 – 2.8 million total estimated for all 12 sites in the state), and the possibility that it will equal zero
- Reduced likelihood of TEE costs
- Higher cleanup levels for industrial properties
- Reduced likelihood of multiple-hazardous-substance adjustments to cleanup level calculations
- Reduced likelihood of multiple-exposure-pathway adjustments to cleanup level calculations
- Improvements in human health:
  - Avoided cancer mortality ($5.1 – 11.8 million)
  - Avoided cancer morbidity costs
  - Other avoided cancer illness and disability
  - Avoided noncancer illness and disability
- Improvements in ecological and wildlife health

It is the conclusion of this analysis that the expected benefits of the final MTCA rule are likely to exceed the costs, as compared to the baseline.

CHAPTER 7: Least Burdensome Alternative Analysis

RCW 34.05.328(1)(d) requires Ecology to "…[d]etermine, after considering alternative versions of the rule and the analysis required under (b) and (c) of this subsection, that the rule being adopted is the least burdensome alternative for those required to comply with it that will achieve the general goals and specific objectives stated under (a) of this subsection."

In June 2006, Ecology distributed an evaluation of rulemaking options for public review and comment. Ecology considered the public comments on that document when preparing the final rule and the Least Burdensome Alternative (LBA) Analysis. Ecology distributed the proposed rule amendments and a preliminary cost-benefit analysis (including the preliminary LBA) for public review and comment in April 2007. To facilitate public review of those documents, Ecology also published an updated background document.

Several individuals and organizations provided comments on the scope and depth of the preliminary LBA. Ecology considered those comments when preparing the final LBA. In particular, Ecology elected to incorporate many of the options discussed in the June 2006 and April 2007 background documents. These options are described in this chapter.

This chapter describes Ecology's evaluation of rulemaking options and conclusions on whether the rule represents the least burdensome alternative that will achieve the statutory goals and objectives in the Model Toxics Control Act. The chapter is organized into eight sections:

- Scope of the Analysis (Section 7.1)
- Evaluation Approach (Section 7.2)
- Statutory Goals and Objectives (Section 7.3)
- Soil Cleanup Levels for Unrestricted Land Uses – Dioxin Mixtures (Section 7.4)
- Soil Cleanup Levels for Unrestricted Land Uses – PAH Mixtures (Section 7.5)
- Soil Cleanup Levels for Unrestricted Land Uses – PCB Mixtures (Section 7.6)
- Industrial Soil Cleanup Levels – Dioxin Mixtures (Section 7.7)
- Industrial Soil Cleanup Levels – PAH Mixtures (Section 7.8)

7.1 Scope of the Analysis

Ecology has evaluated how the rule revisions may impact cleanup standards and cleanup actions (See Chapter 3). Based on that review, Ecology reached the following conclusions:

- The final rule revisions will not result in significant changes to cleanup standards for PCBs because using the TEF methodology for PCBs continues to be optional.

- The final rule revisions will not result in significant changes to ground water and surface water cleanup levels. Ecology expects that ground water and surface water standards for these mixtures will continue to be based on applicable or relevant and appropriate requirements (ARARs). Ecology is not revising requirements that have been established under other laws and regulations.

- The final rule revisions will not change the Method A cleanup levels. Ecology expects that a large number of cleanup proponents, particularly small businesses, will continue to use Method A to establish cleanup levels.

- The final rule revisions will not change the methods and policies for establishing Method B soil cleanup levels based on non-cancer human health risks.

- The final rule revisions will not change the methods and policies for establishing Method B soil cleanup levels based on ecological protection.

- The final rule revisions will result in changes to Method B soil cleanup levels for dioxin and furan mixtures and PAH mixtures.

- The final rule revisions will result in changes to industrial soil cleanup levels for dioxin and furan mixtures and (to a minimal degree) PAH mixtures.

- The final rule revisions will not significantly impact sediment cleanup standards for these types of mixtures.

Ecology considered these conclusions when defining the scope of the least burdensome alternatives analysis and addressed them as follows:

- The final rule revisions result in changes to Method B soil cleanup levels for dioxins and furan mixtures. Ecology's evaluation of rulemaking alternatives is presented in Section 7.4.

- The final rule revisions result in changes to Method B soil cleanup levels for carcinogenic PAHs. Ecology's evaluation of rulemaking alternatives is presented in Section 7.5.

- The final rule revisions do not significantly change the Method B soil cleanup levels for PCB mixtures. However, Ecology considered several options and issues during the rulemaking process. Ecology's evaluation of rulemaking alternatives is presented in Section 7.6.

- The final rule revisions result in changes to industrial soil cleanup levels for dioxin and furan mixtures. Ecology's evaluation of rulemaking alternatives is presented in Section 7.7.

- The final rule revisions do not significantly change the industrial soil cleanup levels for carcinogenic PAHs. However, Ecology considered several options and issues during the rulemaking process. Ecology's evaluation of rulemaking alternatives is presented in Section 7.8.

7.2 Evaluation Approach

Ecology used a five-step evaluation process to determine whether the final rule represents the least burdensome alternative that will achieve the general goals and specific objectives of the Model Toxics Control Act (MTCA):

1. Identify the policy options that Ecology considered during the rulemaking process;
2. Evaluate the policy options using three evaluation criteria:
   - Does the policy option result in rule requirements that protect human health and the environment?
   - Is the policy option consistent with current scientific information?
   - Would the policy option result in rule requirements that are more or less burdensome than previous rule requirements?
3. Combine the policy options into rulemaking alternatives;
4. Evaluate whether the rulemaking alternatives achieve the general MTCA goals and objectives. Ecology considered two main MTCA goals and objectives when preparing this evaluation:
   - Protect human health and the environment (See RCW 70.105D.010 & 0.30);
   - Periodically update minimum cleanup standards for remedial actions based on new scientific information and changes to state and federal laws (RCW 70.105D.030(2)(e)).
5. Evaluate whether the final rule represents the least burdensome alternative that achieves the general goals and specific objectives of the MTCA.

7.3 Statutory Goals and Objectives

MTCA provides Ecology with the authority to accomplish several statutory objectives. These objectives are specified in RCW 70.105D.030(1) and include the following:

(a) Investigate, provide for investigating, or require potentially liable persons to investigate any releases of hazardous substances, including but not limited to inspecting, sampling, or testing to determine the nature or extent of any release or threatened release…;

(b) Conduct, provide for conducting, or require potentially liable persons to conduct remedial actions (including investigations under (a) of this subsection) to remedy releases or threatened releases of hazardous substances…. In conducting, providing for, or requiring remedial action, the department shall give preference to permanent solutions to the maximum extent practicable and shall provide for or require adequate monitoring to ensure the effectiveness of the remedial action;

…

(d) Carry out all state programs authorized under the federal cleanup law and the federal resource, conservation, and recovery act, 42 U.S.C. Sec. 6901 et seq., as amended;

(e) Classify substances as hazardous substances…;

(f) Issue orders or enter into consent decrees or agreed orders that include deed restrictions where necessary to protect human health and the environment from a release or threatened release of a hazardous substance from a facility….;

(g) Enforce the application of permanent and effective institutional controls that are necessary for a remedial action to be protective of human health and the environment;

(h) Require holders to conduct remedial actions necessary to abate an imminent or substantial endangerment…;

(i) Provide informal advice and assistance to persons regarding the administrative and technical requirements of this chapter…As part of providing this advice for independent remedial actions, the department may prepare written opinions regarding whether the independent remedial actions or proposals for those actions meet the substantive requirements of this chapter or whether the department believes further remedial action is necessary at the facility…; and

(j) Take any other actions as necessary to carry out the provisions of this chapter, including the power to adopt rules under chapter 34.05 RCW.

The MTCA directs Ecology to "…[p]ublish and periodically update minimum cleanup standards for remedial actions at least as stringent as the cleanup standards under section 121 of the federal cleanup law, 42 U.S.C. Sec. 9621, and at least as stringent as all applicable state and federal laws, including health-based standards under state and federal law". Several statutory provisions provide guidance on implementing this directive:

- Relationship to Federal Standards: Ecology believes the initiative intended for the state to assess what cleanup standards will be most protective, rather than automatically deferring to existing federal standards. MTCA makes clear that Washington may promulgate cleanup standards that are more protective than the federal cleanup standards.

- Protection of Highly Exposed or Highly Susceptible Population Groups: The MTCA states that "[e]ach person has a fundamental and unalienable right to a healthful environment…" To fulfill this mandate, Ecology believes it is necessary to establish methods and procedures that will result in cleanup levels that protect the whole population – including susceptible or high exposure population groups.

- Responses to Threats or Potential Threats to Human Health or the Environment: The MTCA directs Ecology to "…[c]onduct, provide for conducting, or require potentially liable persons to conduct remedial actions … to remedy releases or threatened releases of hazardous substances." The law defines "remedial actions" as "…any action or expenditure consistent with the purposes of this chapter to identify, eliminate, or minimize any threat or potential threat posed by hazardous substances to human health or the environment…" Ecology believes that the lack of certainty or perfect evidence "…does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action that it appears to demand at a given time..." (Hill, B.A. 1965). Ecology feels it is appropriate to use conservative assumptions in interpreting data with regard to carcinogens, and to risk error on the side of overprotection rather than under-protection.

- Use of Current Scientific Information: RCW 70.105D.030(4) directs Ecology to establish a Science Advisory Board to provide advice on cleanup standards and other topics.

7.4 Soil Cleanup Levels for Unrestricted Land Uses – Dioxin Mixtures

The final rule revisions result in changes to Method B soil cleanup levels for dioxins and furans. Ecology estimates that the rule revisions will result in Method B soil cleanup levels that are 30 to 50 percent lower (more stringent) than cleanup levels established under the previous rule.

Comparison of the Baseline and the Final Rule

Under the baseline, soil cleanup levels for dioxin mixtures are based on the soil ingestion pathway. Soil cleanup levels for individual congeners can be established using a target cancer risk of one-in-one million and a relative bioavailability of 100%. Cleanup proponents may establish cleanup levels for individual congeners using (1) the EPA 1989 Toxic Equivalency Factors (TEF) values or (2) an approach that assumes all congeners are equally toxic as 2,3,7,8 TCDD. Ecology may approve less stringent cleanup levels based on site-specific evaluations of the bioavailability of soil-bound dioxins. Ecology may also require more stringent cleanup levels based on a site-specific evaluation of other soil-related exposure pathways.

Under the final rule, soil cleanup levels for dioxin mixtures will continue to be based on the soil ingestion pathway. However, soil cleanup levels for dioxin mixtures will be based on a target cancer risk of one-in-one million for the whole mixture, the WHO-2005 TEF values and a relative bioavailability of 60%. The final rule also eliminates the option to establish cleanup levels based on the assumption that all congeners are as toxic as 2,3,7,8 TCDD. As with the baseline, Ecology may approve less stringent cleanup levels based on site-specific evaluations of the bioavailability of soil-bound dioxins. Ecology may also require more stringent cleanup levels based on a site-specific evaluation of other soil-related exposure pathways.

Description of the Policy Options

In addition to maintaining the previous rule language (no action alternative), Ecology considered several technical and policy options during the rulemaking process:

- Option 1 – "No TEF": Ecology would require cleanup proponents to establish cleanup levels for individual dioxin and furan congeners using the cancer slope factor for 2,3,7,8 TCDD. Under this alternative, all dioxin and furan congeners would be considered equally toxic to the reference congener (2,3,7,8 TCDD).

- Option 2 – "Site-Specific Exposure Analyses": Ecology would require cleanup proponents to evaluate other soil-related exposure pathways (e.g., dermal contact) and consider the results of those evaluations when establishing soil cleanup levels.

- Option 3 – "World Health Organization TEF Values": Ecology would require cleanup proponents to use the current World Health Organization TEF values (Van den Berg et al. 2006) when establishing cleanup levels for dioxin mixtures.

- Option 4 – "Lower Gastro-Intestinal Absorption Fraction (AB1)": Ecology would revise the default AB1 from 100% (1.0) to 60% (0.6). This modification would account for the reduced bioavailability of soil-bound dioxins and furans.

- Option 5 – "Higher Gastro-Intestinal Absorption Fraction (AB1)": Ecology would revise the default AB1 from 100% (1.0) to 120% (1.2). This modification would account for the potential increased bioavailability of soil-bound dioxins (relative to the studies used to establish the cancer slope factor) under some exposure scenarios.

- Option 6 – "Revised Target Cancer Risk Level": Ecology would establish soil cleanup levels for dioxin mixtures using a target cancer risk of 10^{-6}.

- Option 7 – "Revised Target Cancer Risk Level for all Dioxin-like Congeners": Ecology would establish soil cleanup levels for mixtures of dioxin-like congeners (dioxins, furans and PCBs) using a target cancer risk of 10^{-6}.

Evaluation of Policy Options

Ecology evaluated the seven policy options using three evaluation criteria:

- Does the policy option result in rule requirements that protect human health and the environment?
- Is the policy option consistent with current scientific information?
- Would the policy option result in rule requirements that are more or less burdensome than previous rule requirements?

The evaluation results are presented in Table 14.

Table 14: Policy Options for Method B Soil Cleanup Levels for Dioxin Mixtures

Table 12: Policy Options for Method B Soil Cleanup Levels for Dioxin Mixtures			
Policy Options	Protection of Human Health and Environment	Consistent With Current Scientific Information	Burden on Persons Required to Comply

Option 1 – No TEF: Ecology would require cleanup proponents to establish cleanup levels for individual dioxin and furan congeners using the cancer slope factor for 2,3,7,8 TCDD. Under this option, all dioxin and furan congeners would be considered equally toxic to the reference congener (2,3,7,8 TCDD).	Yes.	No.	Increased.
Option 2 – Site-Specific Exposure Analyses. Ecology would require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels.	Yes.	Yes.	Increased.
Option 3 – World Health Organization TEF Values: Ecology would require cleanup proponents to use the WHO TEF values when establishing cleanup levels for dioxin mixtures.	Yes.	Yes.	Neutral.
Option 4 – Lower Absorption Fraction (AB1): Ecology would revise the default AB1 from 100% (1.0) to 60% (0.6). This revision accounts for the reduced bioavailability of soil-bound dioxins/furans.	Yes.	Yes.	Decreased.
Option 5 – Higher Absorption Fraction (AB1): Ecology would revise the default AB1 from 100% (1) to 120% (1.2). This revision would account for the potential increased bioavailability of soil-bound dioxins/furans under some exposure scenarios.	Yes.	Unclear.	Increased.
Option 6 – Revised Target Cancer Risk Level: Ecology would set soil cleanup levels for dioxin mixtures using a target cancer risk 10-6.	Yes.	Yes.	Increased.
Option 7 – Target Cancer Risk Level for Dioxin-Like Congeners: Ecology would set soil cleanup levels for mixtures of dioxin-like congeners (dioxins, furans and PCBs) using a cancer risk of 10-6.	Yes.	Yes.	Increased.

Description of Rulemaking Alternatives

Ecology reviewed the range of policy options and identified four rulemaking alternatives:

- **Final Rule:** Under this alternative, soil cleanup levels would be established for dioxin mixtures as a whole, using a target cancer risk of one-in-one million (10^{-6}), the WHO 2005 TEF values, and an AB1 value of 60%. This alternative is a combination of policy options 3, 4 and 6.

- **"No Action" Alternative (Previous Rule)**. Under this alternative, soil cleanup levels could be established for individual dioxin congeners using a target cancer risk level of one-in-one million (10^{-6}), the EPA 1989 TEF values, and an AB1 value of 100%. The "no action" alternative is the previous rule.

- **"Less Protective" Alternative.** Under this alternative, soil cleanup levels could be established for individual dioxin congeners using a target cancer risk level of one-in-one million (10^{-6}), the WHO 2005 TEF values, and an AB1 value of 60%.

This alternative is a combination of policy options 3 and 4.

- **"More Protective" Alternative**. Under this alternative, soil cleanup levels would be established for mixtures of dioxin-like compounds (including dioxin-like PCBs) as a whole, using a target cancer risk of one-in-one million (10^{-6}), the WHO 2006 TEF values, and an AB1 value of 120%. Ecology would also require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels. This alternative is a combination of policy options 2, 3, 5 and 7.

Evaluation of Rulemaking Alternatives

Ecology evaluated the four rulemaking alternatives to determine whether the final rule represents the least burdensome alternative that achieves the general goals and specific objectives of the MTCA. As described in Section 8.2, Ecology considered two main factors when performing this evaluation:

- Does the rulemaking alternative achieve the goals and objectives of the MTCA?
- Does the final rule represent the least burdensome alternative for achieving those goals and objectives?

The evaluation results are presented in Table 15 and the following paragraphs.

Table 15: Rulemaking Alternatives for Method B Soil Cleanup Levels for Dioxin Mixtures

Table 13: Rulemaking Alternatives for Method B Soil Cleanup Levels for Dioxin Mixtures

Rulemaking Alternatives	Meets Statutory Goals & Objectives		Least Burdensome Alternative
	Level of Protection	Scientific Information	
Final Rule. Under this alternative, soil cleanup levels would be established for dioxin mixtures as a whole, using a target cancer risk of one-in-one million (10^{-6}), the WHO 2005 TEF values, and an AB1 value of 60%. This alternative is a combination of policy options 3, 4 and 6.	Yes.	Yes.	Yes.
"No Action" Alternative (Previous Rule). Under this alternative, soil cleanup levels could be established for individual dioxin congeners using a target cancer risk level of one-in-one million (10^{-6}), the EPA 1989 TEF values, and an AB1 value of 100%. The "no action" alternative is the previous rule.	Yes. On a site-specific basis.	No.	Not applicable.
"Less Protective" Alternative. Under this alternative, soil cleanup levels could be established for individual dioxin congeners using a target cancer risk level of one-in-one million (10^{-6}), the WHO 2005 TEF values, and an AB1 value of 60%. This alternative is a combination of policy options 3 and 4.	No.	Yes.	Not applicable.

<u>"More Protective" Alternative</u>. Under this alternative, soil cleanup levels would be established for mixtures of dioxin-like compounds (including dioxin-like PCBs) as a whole, using a target cancer risk of one-in-one million (10^{-6}), the WHO 2006 TEF values, and an AB1 value of 120%. Ecology would also require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels. This alternative is a combination of policy options 2, 3, 5 and 7.	Yes.	Yes.	No.

Ecology believes the rule revisions are necessary to more effectively establish cleanup levels that protect human health. The revised cancer risk policies will provide a margin of safety with respect to the health risks associated with other soil-related exposure pathways and other types of health effects. While the previous rule provides the flexibility to address these issues on a site-specific basis, Ecology believes that the revised rule provides a more effective and less-burdensome approach. The revised rule also incorporates recently updated scientific information on the relative toxicity of dioxin-like congeners and the bioavailability of soil-bound dioxins. Ecology's decisions on new scientific information are consistent with the determinations and recommendations of the MTCA Science Advisory Board.

Ecology believes that the second or "no action" alternative would not effectively achieve the MTCA goals and objectives. First, this alternative would maintain previous cancer-risk policies. These policies, as applied to mixtures of dioxins and furans, would not provide an adequate margin of safety and would not meet the goals and objectives of MTCA. Further, under this alternative, the health risks associated with other soil-related pathways and other types of health effects would have to be addressed on a site-specific basis. Ecology believes this approach is less effective and more burdensome than the final rule. Second, this alternative does not incorporate new scientific information on the relative toxicity of dioxin-like congeners and the bioavailability of soil-bound dioxins. This type of new scientific information could be considered on a site-specific basis. However, Ecology believes that this approach is less effective and more burdensome than the final rule.

Ecology believes that the third or "less protective" alternative would not effectively achieve the MTCA goals and objectives. While this alternative would incorporate new scientific information on the relative toxicity of dioxin-like congeners and the bioavailability of soil-bound dioxins, it would also maintain previous cancer risk policies. These policies, as applied to mixtures of dioxins and furans, would not provide an adequate margin of safety and would not meet the goals and objectives of MTCA. Further, under this alternative, the health risks associated with other soil-related pathways and other types of health effects would have to be addressed on a site-specific basis.

Ecology believes that the fourth or "more protective" alternative meets the MTCA goals and objectives. Soil cleanup levels would protect human health and incorporate new scientific information (e.g. WHO TEF values). However, Ecology also believes this alternative would be more burdensome than the final rule because:

(1) Ecology would require additional evaluations to support site-specific cleanup levels that take into account other soil-related exposure pathways.

(2) Cleanup levels would generally be set at concentrations that are at or below concentrations commonly found in urban areas.

Conclusion

Ecology believes that the final rule is the least burdensome alternative that will achieve the general goals and objectives of MTCA.

7.5 Soil Cleanup Levels for Unrestricted Land Uses – Carcinogenic PAH Mixtures

The final rule revisions will result in Method B soil cleanup levels for cPAH mixtures that are 10 – 30% lower (more stringent) than cleanup levels that would be established under the baseline.

Comparison of the Baseline and the Final Rule

Under the baseline, soil cleanup levels for PAH mixtures are based on the soil ingestion pathway. Soil cleanup levels for individual PAH compounds can be established using a target cancer risk of one-in-one million and a relative bioavailability of 100%. Cleanup proponents may establish cleanup levels for individual PAH compounds using (1) the California EPA 1994 Potency Equivalency Factors (PEF) values or (2) an approach that assumes all PAH compounds are equally toxic as benzo[a]pyrene. Ecology may approve less stringent cleanup levels based on site-specific evaluations of the bioavailability of soil-bound PAH compounds. Ecology may also require more stringent cleanup levels based on a site-specific evaluation of other soil-related exposure pathways.

Under the final rule, soil cleanup levels for PAH mixtures will continue to be based on the soil ingestion pathway with a relative bioavailability of 100%. However, soil cleanup levels for PAH mixtures will be based a target cancer risk of one-in-one million (10^{-6}) for the whole mixture and the California EPA 2005 PEF values. Ecology also eliminated the option to establish cleanup levels based on the assumption that all PAH compounds are as toxic as benzo[a]pyrene.

Description of the Policy Options

In addition to maintaining the previous rule language (no action alternative), Ecology considered several technical and policy options during the rulemaking process:

- <u>Option 1 – No TEF</u>: Ecology would require cleanup proponents to establish cleanup levels for all PAH compounds using the cancer slope factor for benzo[a]pyrene. Under this alternative, all PAH compounds would be considered equally toxic to the reference compound (benzo[a]pyrene).

- Option 2 – "Site-Specific Exposure Analyses": Ecology would require cleanup proponents to evaluate other soil-related exposure pathways (e.g., dermal contact) and consider the results of those evaluations when establishing soil cleanup levels.

- Option 3 – "Updated California PEF Values": Ecology would require cleanup proponents to use the most current California EPA PEF values when establishing cleanup levels for PAH mixtures.

- Option 4 – "EPA Relative Potency Factors (RPF) Values": Ecology would require cleanup proponents to use the EPA Relative Potency Factors (EPA 1993) when establishing cleanup levels for PAH mixtures.

- Option 5 – "Revised Target Cancer Risk Level": Ecology would establish soil cleanup levels for PAH mixtures (sum of the toxic equivalent concentrations of the seven PAH compounds identified in the MTCA rule) using a target cancer risk 10^{-6}.

- Option 6 – "Expanded List of PAH Compounds": Ecology would require cleanup proponents to analyze samples to determine the concentrations of all 25 carcinogenic PAHs identified by the California EPA. Cleanup proponents would be required to establish cleanup levels for PAH mixtures using a target cancer risk of 10^{-6}.

- Option 7 – "Early Life Stage Adjustment to Cancer Slope Factor": Ecology would require cleanup proponents to adjust the cancer slope factor for benzo[a]pyrene using EPA's guidance materials and use the adjusted values to set soil cleanup levels.

Evaluation of Policy Options

Ecology evaluated the seven policy options using three evaluation criteria:

- Does the policy option result in rule requirements that protect human health and the environment?
- Is the policy option consistent with current scientific information?
- Would the policy option result in rule requirements that are more or less burdensome than previous rule requirements?

The evaluation results are presented in Table 16.

Table 16: Policy Options for Method B Soil Cleanup Levels for PAH Mixtures

Table 16: Policy Options for Method B Soil Cleanup Levels for PAH Mixtures

Policy Options	Protection of Human Health & the Environment	Consistent With Current Scientific Information	Burden on Persons Required to Comply

Option 1 – No TEF: Ecology would require cleanup proponents to establish cleanup levels for all PAH compounds using the cancer slope factor for benzo[a]pyrene. Under this option, all PAH compounds would be considered equally toxic to the reference compound (benzo[a]pyrene).	Yes.	No.	Increased.
Option 2 – "Site-Specific Exposure Analyses". Ecology would require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels.	Yes.	Yes.	Increased.
Option 3 – "Updated California PEF Values": Ecology would require cleanup proponents to use the most current California EPA PEF values when establishing cleanup levels for PAH mixtures.	Yes.	Yes.	Slightly Decreased.
Option 4 – "EPA Relative Potency Factors (RPF) Values": Ecology would require cleanup proponents to use the EPA Relative Potency Factors (EPA 1993) when establishing cleanup levels for PAH mixtures.	Yes.	Yes. Values are consistent with more recent values.	Slightly Increased.
Option 5 – "Revised Target Cancer Risk Level": Ecology would establish soil cleanup levels for PAH mixtures (sum of the toxic equivalent concentrations of the seven PAH compounds identified in the MTCA rule) using a target cancer risk 10-6.	Yes.	Yes.	Increased.
Option 6 – "Expanded List of PAH Compounds": Ecology would require cleanup proponents to analyze soil samples to determine the concentrations of all 25 carcinogenic PAHs identified by the California EPA. Cleanup proponents would be required to establish cleanup levels for PAH mixtures using a target cancer risk of 10^{-6}.	Yes.	Yes.	Increased.
Option 7 – "Early Life Stage Adjustment to Cancer Slope Factor": Ecology would require cleanup proponents to adjust the cancer slope factor for benzo[a]pyrene using EPA's current guidance materials. Soil cleanup levels would be based on the adjusted cancer slope factor	Yes.	Yes.	Increased.

Description of Rulemaking Alternatives

Ecology reviewed the range of policy options and identified three rulemaking alternatives:

- **Final Rule Changes**. Under this alternative, soil cleanup levels would be established for PAH mixtures as a whole, using a target cancer risk of one-in-one million and the updated California EPA 2005 TEF values. The cleanup level for the mixture would be based on the seven PAH compounds identified in the MTCA rule. This alternative is a combination of policy options 3 and 5.

- **"No Action" Alternative (Previous Rule)**. Under this alternative, soil cleanup levels could be established for individual PAH compounds using a target cancer risk level of one-in-one million and the California EPA 1994 TEF values. The "no action" alternative is the previous rule.

- **"More Protective" Alternative**. Under this alternative, soil cleanup levels would be established for PAH mixtures as a whole, using a target cancer risk of one-in-one million, cancer slope factors that have been adjusted for early-life stage exposure, and updated California EPA 2005 TEF values. The cleanup level for the mixture would be based on all twenty-five PAH compounds listed by California EPA. Ecology would also require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels. This alternative is a combination of policy options 2, 3, 5, 6 and 7.

Evaluation of Rulemaking Alternatives

Ecology evaluated the three rulemaking alternatives to determine whether the final rule represents the least burdensome alternative that achieves the general goals and specific objectives of the MTCA. As described in Section 8.2, Ecology considered two main factors when performing this evaluation:

- Does the rulemaking alternative achieve the goals and objectives of the MTCA?
- Does the final rule represent the least burdensome alternative for achieving those goals and objectives?

The evaluation results are presented in Table 17 and the following paragraphs.

Table 17: Rulemaking Alternatives for Method B Soil Cleanup Levels for PAH Mixtures

Table 17: Rulemaking Alternatives for Method B Soil Cleanup Levels for PAH Mixtures

Rulemaking Alternatives	Meets Statutory Goals & Objectives		Least Burdensome Alternative
	Level of Protection	Scientific Information	
Final Rule Changes. Under this alternative, soil cleanup levels would be established for PAH mixtures as a whole, using a target cancer risk of one-in-one million and the updated California EPA 2005 TEF values. The cleanup level for the mixture would be based on the seven PAH compounds identified in the MTCA rule. This alternative is a combination of policy options 3 and 5.	Yes.	Yes.	Yes.
"No Action" Alternative (Previous Rule). The "no action" alternative is the previous rule. Under this alternative, soil cleanup levels could be established for individual PAH compounds using a target cancer risk level of one-in-one million and the California EPA 1994 TEF values.	No.	No. [But only small difference between old and new TEF values]	Not applicable.

<u>"More Protective" Alternative</u>. Under this alternative, soil cleanup levels would be established for PAH mixtures as a whole, using a target cancer risk of one-in-one million, cancer slope factors that have been adjusted for early-life stage exposure, and updated California EPA 2005 TEF values. The cleanup level for the mixture would be based on all twenty-five PAH compounds listed by California EPA. Ecology would also require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels. This alternative is a combination of policy options 2, 3, 5, 6 and 7.	Yes.	Yes.	No.

Ecology believes the rule revisions are necessary to more effectively establish cleanup levels that protect human health. The revised cancer risk policies provide a margin of safety with respect to the health risks associated with other carcinogenic PAHs not routinely considered during cleanup evaluations and new scientific information on the risks associated with early-life stage exposure. The previous rule provides the flexibility to address these issues on a site-specific basis. However, Ecology believes that the revised rule provides a more effective and less-burdensome approach. The revised rule also incorporates new scientific information on the relative toxicity of PAH compounds. Ecology's decisions on new scientific information are consistent with the determinations and recommendations of the MTCA Science Advisory Board.

Ecology believes that the second or "no action" alternative would not effectively achieve the MTCA goals and objectives. First, this alternative would maintain previous cancer-risk policies. These policies, as applied to mixtures of PAHs, would not provide an adequate margin of safety and would not meet the goals and objectives of MTCA. Further, under this alternative, the health risks associated with other PAH compounds and early-lifestage exposures would have to be addressed on a site-specific basis. Ecology believes this approach is less effective and more burdensome than the final rule. Second, this alternative does not incorporate new scientific information on the relative toxicity of PAH compounds. This type of new scientific information could also be considered on a site-specific basis. However, Ecology believes that this approach is less effective and more burdensome than the proposed rule revisions. Ecology recognizes, though, that the small differences between the 1994 and 2005 California EPA values are unlikely to result in significant differences in cleanup requirements.

Ecology believes that the third or "more protective" alternative meets the MTCA goals and objectives. Soil cleanup levels would protect human health and incorporate new scientific information (e.g. more recent California EPA values). However, Ecology also believes this alternative would be more burdensome than the final rule because:

(1) Ecology would require cleanup proponents to analyze a broader range of contaminants using special analytical methods that are not routinely used at cleanup sites.

(2) Cleanup levels would generally be set at concentrations that are at or below concentrations commonly found in urban areas.

Conclusion

Ecology believes that the final rule is the least burdensome alternative that will achieve the general goals and objectives of MTCA.

7.6 Soil Cleanup Levels for Unrestricted Land Uses – PCB Mixtures

The final rule revisions do not significantly change the Method B soil cleanup levels for PCB-contaminated soils. However, Ecology considered several options and issues when preparing the rule revisions.

Comparison of the Baseline and the Final Rule

Under the baseline, soil cleanup levels for PCB mixtures are based on the soil ingestion pathway using measurements of total PCBs the soil. Soil cleanup levels for the whole PCB mixture are based on a target cancer risk of one-in-one million and the cancer slope factor for PCB mixtures published in the Integrated Risk Information System (IRIS) database. Under the baseline, Ecology may approve less stringent cleanup levels based on site-specific evaluations of the bioavailability of soil-bound PCBs. Ecology may also require more stringent cleanup levels based on a site-specific evaluation of other soil-related exposure pathways.

Under the final rule, soil cleanup levels for PCB mixtures can still be based on total PCB measurements using a target cancer risk of one-in-one million (10^{-6}) for the whole mixture. Under the final rule, cleanup proponents will also have the option of using congener-specific information to establish soil cleanup levels. If the TEF option is chosen, cleanup proponents must use the WHO-2005 TEF values to characterize the mixture. Cleanup levels for the mixture will be established using the cancer slope factor for 2,3,7,8 TCDD and a target cancer risk level of one-in-one million (10^{-6}).

Description of the Policy Options

In addition to maintaining the previous rule language (no action alternative), Ecology considered several technical and policy options during the rulemaking process:

- Option 1 – Arochlor-Based Approach: Ecology would continue to require that cleanup levels be established using measurements of total PCBs, a target cancer risk of 10^{-6} (applied to the whole mixture) and the cancer slope factor for PCBs that is published in the Integrated Risk Information System.

- Option 2 – “Site-Specific Exposure Analyses”. Ecology would require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels.

- Option 3 – “World Health Organization TEF Values” With Target Cancer Risk (10^{-6}) Applied to Each PCB Congener”: Ecology would require cleanup proponents to use the World Health Organization TEF values when establishing cleanup levels for PCB mixtures. Under this alternative, cleanup levels would be established for each dioxin-like PCB congener using a cancer risk of 10^{-6}. The total site risk could not exceed one-in-a-hundred thousand (10^{-5}).

- Option 4 – "World Health Organization TEF Values" With Target Cancer Risk (10^{-6}) Applied to the Whole PCB Mixture": Ecology would require cleanup proponents to use the World Health Organization TEF values when establishing cleanup levels for PCB mixtures. Under this alternative, cleanup levels would be established for the whole PCB mixture (characterized by the sum of the toxic equivalent concentrations for the dioxin-like PCB congener) using a cancer risk of 10^{-6}.

- Option 5– Integrated Evaluation: Ecology would require cleanup proponents to consider the health risks of both dioxin-like PCBs and non-dioxin-like PCBs when establishing cleanup levels for PCB mixtures.

- Option 6 – "Target Cancer Risk Level for Dioxin-Like Congeners": Ecology would set soil cleanup levels for mixtures of dioxin-like congeners (dioxins, furans and PCBs) using a cancer risk of 10^{-6}.

Evaluation of Policy Options

Ecology evaluated the six policy options using three evaluation criteria:

- Does the policy option result in rule requirements that protect human health and the environment?
- Is the policy option consistent with current scientific information?
- Would the policy option result in rule requirements that are more or less burdensome than previous rule requirements?

The evaluation results are presented in Table 18.

Table 18: Policy Options for Method B Soil Cleanup Levels for PCB Mixtures

Table 18: Policy Options for Method B Soil Cleanup Levels for PCB Mixtures

Policy Options	Protection of Human Health & the Environment	Consistent With Current Scientific Information	Burden on Persons Required to Comply
Option 1 – Arochlor Approach: Ecology would continue to require that cleanup levels be established using measurements of total PCBs, a target cancer risk of 10^{-6} (applied to the whole mixture) and the cancer slope factor for PCBs that is published in the Integrated Risk Information System.	Yes.	Yes.	Previous rule requirement.
Option 2 – "Site-Specific Exposure Analyses". Ecology would require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when	Yes.	Yes.	Increased.

establishing soil cleanup levels.			
Option 3 – "World Health Organization TEF Values" With Target Cancer Risk (10-6) Applied to Each PCB Congener": Ecology would require cleanup proponents to use the World Health Organization TEF values when establishing cleanup levels for PCB mixtures. Under this alternative, cleanup levels would be established for each dioxin-like PCB congener using a cancer risk of 10^{-6}. The total site risk could not exceed one-in-a-hundred thousand (10^{-5}).	Reduced level of protection.	Yes.	Decreased. Reduction in cleanup costs balanced by increased in analytical costs.
Option 4 – "World Health Organization TEF Values" With Target Cancer Risk (10-6) Applied to the Whole PCB Mixture": Ecology would require cleanup proponents to use the World Health Organization TEF values when establishing cleanup levels for PCB mixtures. Under this alternative, cleanup levels would be established for the PCB mixture using a cancer risk of 10^{-6}.	Yes.	Yes.	Increased.
Option 5– Integrated Evaluation: Ecology would require cleanup proponents to consider the health risks of both dioxin-like PCBs and non-dioxin-like PCBs when establishing cleanup levels for PCB mixtures.	Yes.	Yes.	Increased.
Option 6 – "Target Cancer Risk Level for Dioxin-Like Congeners": Ecology would set soil cleanup levels for mixtures of dioxin-like congeners (dioxins, furans and PCBs) using a cancer risk of 10^{-6}.	Yes.	Yes.	Increased.

Description of Rulemaking Alternatives

Ecology reviewed the range of policy options and identified four rulemaking alternatives:

- **Final Rule Changes**. Ecology will provide cleanup proponents with the option of establishing cleanup levels using either measurements of total PCBs or dioxin-like PCB congeners. Ecology will continue to require that soil cleanup levels be based on a target cancer risk level of one-in-a-million independent of which method is chosen. The alternative is a combination of policy options 1, 4 and 5.

- **"No Action" Alternative (Previous Rule)**. The "no action" alternative is the previous rule (policy option 1). Soil cleanup levels are established for PCB mixtures using a target cancer risk level of one-in-one million and the EPA cancer slope factors for PCBs.

- **"Less Protective" Alternative.** Under this alternative, soil cleanup levels would be established for individual PCB congeners using a target cancer risk level of one-in-one million and the WHO 2005 TEF values. This alternative is policy option 3.

- **"More Protective" Alternative**. Under this alternative, soil cleanup levels would be established for mixtures of dioxin-like compounds, using a target cancer risk of one-in-one million and the WHO-2005 TEF values. Ecology would also require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels. This alternative is a combination of policy options 2, 5 and 6.

Evaluation of Rulemaking Alternatives

Ecology evaluated the four rulemaking alternatives to determine whether the final rule represents the least burdensome alternative that achieves the general goals and specific objectives of the MTCA. As described in Section 8.2, Ecology considered two main factors when performing this evaluation:

- Does the rulemaking alternative achieve the goals and objectives of the MTCA?
- Does the final rule revision represent the least burdensome alternative for achieving those goals and objectives?

The evaluation results are presented in Table 19 and the following paragraphs.

Table 19: Rulemaking Alternatives for Method B Soil Cleanup Levels for PCB Mixtures

Table 19: Rulemaking Alternatives for Method B Soil Cleanup Levels for PCB Mixtures

Rulemaking Alternatives	Meets Statutory Goals & Objectives		Least Burdensome Alternative
	Level of Protection	Scientific Information	
Final Rule Changes. Ecology will provide cleanup proponents with the option of establishing cleanup levels using either measurements of total PCBs or dioxin-like PCB congeners. Ecology will continue to require that soil cleanup levels be based on a target cancer risk level of one-in-a-million independent of which method is chosen. The alternative is a combination of policy options 1, 4 and 5.	Yes.	Yes.	Yes.
"No Action" Alternative (Previous Rule). The "no action" alternative is the previous rule (policy option 1). Soil cleanup levels would be established for PCB mixtures using a target cancer risk level of one-in-one million and the EPA cancer slope factors.	Yes.	Yes.	No.
"Less Protective" Alternative. Under this alternative, soil cleanup levels would be established for individual PCB congeners, using a target cancer risk level of one-in-one million and the WHO 2005 TEF values. This alternative is policy option 3.	No.	No.	Not applicable.
"More Protective" Alternative. This alternative is a combination of policy options 2, 3, 5 and 7. Ecology would require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels. Ecology would require cleanup proponents to establish soil cleanup levels for mixtures of dioxin-like compounds using a target cancer risk of one-in-one million and the WHO-2005 TEF	Yes.	Yes.	No.

values.			

Ecology believes the **rule revisions** are necessary to more effectively establish cleanup levels that protect human health. The final rule does not modify the previous procedures for establishing Method B soil cleanup levels based on total PCB levels. However, Ecology recognizes that some cleanup proponents elect to perform congener-specific analyses at individual sites. Consequently, the revised rule provides the option for using congener-specific analyses to establish soil cleanup levels with a comparable level of protection. Ecology also recognizes that the previous rule provides the flexibility to establish site-specific cleanup levels using congener-specific analyses. Ecology believes that developing site-specific policies and procedures would be less efficient and more burdensome than the final rule. The revised rule incorporates new scientific information on the relative toxicity of dioxin-like congeners and the bioavailability of soil-bound dioxins. Ecology's decisions on new scientific information are consistent with the determinations and recommendations of the MTCA Science Advisory Board.

Ecology believes that the **second or "no action" alternative** would achieve the MTCA goals and objectives. However, determinations on the use and application of congener-specific analyses would continue to be made on a site-specific basis. As discussed above, Ecology believes that developing site-specific policies and procedures would be less efficient and more burdensome than the final rule.

Ecology believes that the **third or "less protective" alternative** would not effectively achieve the MTCA goals and objectives. Ecology believes this approach is less protective than the final rule and the previous rule because it uses a target risk level of one-in-one million (10^{-6}) for individual PCB congeners instead of the whole PCB mixture. Ecology also believes this approach is more burdensome than the final rule because congener-specific analyses are more expensive than Arochlor-based analytical procedures.

Ecology believes that the **fourth or "more protective" alternative** meets the MTCA goals and objectives. Ecology believes this approach has a sound scientific foundation and the resulting soil cleanup levels would protect human health. However, Ecology also believes this alternative would be more burdensome than the final rule because:

(1) Congener-specific analyses would be required at all sites.

(2) Cleanup levels may be set at concentrations that are at or below concentrations commonly found in urban areas.

Conclusion

Ecology believes that the final rule is the least burdensome alternative that will achieve the general goals and objectives of MTCA.

7.7 Industrial Soil Cleanup Levels – Dioxin Mixtures

The final rule revisions do result in changes to industrial soil cleanup levels for dioxin and furan mixtures based on human cancer risks.

Comparison of the Baseline and the Final Rule

Under the baseline, industrial soil cleanup levels for dioxin mixtures are generally based on the soil ingestion pathway. Soil cleanup levels for individual congeners and the whole mixture are based on a target cancer risk of one-in-one hundred thousand (10^{-5}) and a relative bioavailability of 100%. Cleanup proponents may establish cleanup levels for individual congeners using (1) the EPA 1989 Toxic Equivalency Factors (TEF) values or (2) an approach that assumes all congeners are equally toxic as 2,3,7,8 TCDD. Ecology may approve less stringent cleanup levels based on site-specific evaluations of the bioavailability of soil-bound dioxins. Ecology may also require more stringent cleanup levels based on a site-specific evaluation of other soil-related exposure pathways.

Under the final rule, industrial soil cleanup levels for dioxin mixtures will continue to be based on the soil ingestion pathway using a target cancer risk of one-in-one hundred thousand (10^{-5}). However, soil cleanup levels for dioxin mixtures will be established using the WHO-2005 TEF values and a relative bioavailability of 60%. Ecology also eliminated the option to establish cleanup levels based on the assumption that all congeners are as toxic as 2,3,7,8 TCDD.

Description of the Policy Options

In addition to maintaining the previous rule language (no action alternative), Ecology considered several technical and policy options during the rulemaking process:

- Option 1 – No TEF: Ecology would require cleanup proponents to establish cleanup levels for individual dioxin and furan congeners using the cancer slope factor for 2,3,7,8 TCDD. Under this alternative, all dioxin and furan congeners would be considered equally toxic to the reference congener (2,3,7,8 TCDD).

- Option 2 – "Site-Specific Exposure Analyses": Ecology would require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels.

- Option 3 – "World Health Organization TEF Values": Ecology would require cleanup proponents to use the World Health Organization TEF values when establishing cleanup levels for dioxin mixtures.

- Option 4 – "Lower Gastro-Intestinal Absorption Fraction (AB1)": Under this alternative, Ecology would revise the default AB1 from 100% (1.0) to 60% (0.6). This modification would account for the reduced bioavailability of soil-bound dioxins and furans.

- Option 5 – "Revised Target Cancer Risk Level for all Dioxin-Like Congeners": Ecology would establish soil cleanup levels for mixtures of dioxin-like congeners (dioxins, furans and PCBs) using a target cancer risk of 10-6.

Evaluation of Policy Options

Ecology evaluated the seven policy options using three evaluation criteria:

- Does the policy option result in rule requirements that protect human health and the environment?
- Is the policy option consistent with current scientific information?
- Would the policy option result in rule requirements that are more or less burdensome than previous rule requirements?

The evaluation results are presented in Table 20.

Table 20: Policy Options for Industrial Soil Cleanup levels for Dioxin Mixtures

Table 20: Policy Options for Industrial Soil Cleanup Levels for Dioxin Mixtures			
Policy Options	Protection of Human Health & the Environment	Consistent With Current Scientific Information	Burden on Persons Required to Comply
Option 1 – No TEF: Ecology would require cleanup proponents to establish cleanup levels for individual dioxin and furan congeners using the cancer slope factor for 2,3,7,8 TCDD. Under this option, all dioxin and furan congeners would be considered equally toxic to the reference congener (2,3,7,8 TCDD).	Yes.	No.	Increased.
Option 2 – "Site-Specific Exposure Analyses". Ecology would require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels.	Yes.	Yes.	Increase.
Option 3 – "World Health Organization TEF Values": Ecology would require cleanup proponents to use the WHO TEF values when establishing cleanup levels for dioxin mixtures.	Yes.	Yes.	Similar to previous rule.
Option 4 – "Lower Absorption Fraction (AB1)": Ecology would revise the default AB1 from 100% (1.0) to 60% (0.6). This modification would account for the reduced bioavailability of soil-bound dioxins and furans.	Yes.	Yes.	Decreased.
Option 5 – "Target Cancer Risk Level for Dioxin-Like Congeners": Ecology would set soil cleanup levels for mixtures of dioxin-like congeners (dioxins, furans and PCBs) using a cancer risk of 10-5.	Yes.	Yes.	Increased.

Description of Rulemaking Alternatives

Ecology reviewed the range of policy options and identified three rulemaking alternatives:

- **Final Rule**. Under this alternative, soil cleanup levels will be established for dioxin mixtures as a whole, using a target cancer risk of one-in-one hundred thousand, the WHO-2005 TEF values and an AB1 value of 60%. This alternative is a combination of policy options 3 and 4.

- **"No Action" Alternative (Previous Rule)**. The "no action" alternative is the previous rule. Under this alternative, soil cleanup levels could be established for individual congeners and the whole mixture using a target cancer risk level of one-in-one hundred thousand, the EPA 1989 TEF values, and an AB1 value of 100%.

- **"More Protective" Alternative**. Under this alternative, soil cleanup levels would be established for mixtures of dioxin-like compounds as a whole, using a target cancer risk of one-in-one hundred thousand, the WHO-2005 TEF values and an AB1 value of 100%. Ecology would require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels. This alternative is a combination of policy options 2, 3 and 5.

Evaluation of Rulemaking Alternatives

Ecology evaluated the three rulemaking alternatives to determine whether the final rule represents the least burdensome alternative that achieves the general goals and specific objectives of the MTCA. As described in Section 8.2, Ecology considered two main factors when performing this evaluation:

- Does the rulemaking alternative achieve the goals and objectives of the MTCA?

- Does the final rule represent the least burdensome alternative for achieving those goals and objectives?

The evaluation results are presented in Table 21 and the following paragraphs.

Table 21: Rulemaking Alternatives for Industrial Soil Cleanup Levels for Dioxin Mixtures

Table 21: Rulemaking Alternatives for Industrial Soil Cleanup Levels for Dioxin Mixtures

Rulemaking Alternatives	Meets Statutory Goals & Objectives		Least Burdensome Alternative
	Level of Protection	Scientific Information	
Final Rule. Under this alternative, soil cleanup levels would be established for dioxin mixtures as a whole, using a target cancer risk of one-in-one hundred thousand, the WHO-2005 TEF values, and an AB1 value of 60%. This alternative is a combination of policy options 3 and 4.	Yes.	Yes.	Yes.

<u>"No Action" Alternative (Previous Rule)</u>. The "no action" alternative is the previous rule. Under this alternative, soil cleanup levels could be established for individual congeners and the whole mixture using a target cancer risk level of one-in-one hundred thousand, the EPA 1989 TEF values and an AB1 value of 100%.	Yes. On a site-specific basis.	Yes. On a site-specific basis.	No.
<u>"More Protective" Alternative</u>. Under this alternative, soil cleanup levels would be established for mixtures of dioxin-like compounds as a whole, using a target cancer risk of one-in-one hundred thousand, the WHO-2005 TEF values and an AB1 value of 100%. Ecology would require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels. This alternative is a combination of policy options 2, 3 and 5.	Yes.	Yes.	No.

Ecology believes the **rule revisions** achieve the MTCA goals and objectives. The revised rule incorporates new scientific information on the relative toxicity of dioxin-like congeners and the bioavailability of soil-bound dioxins. Ecology's decisions on new scientific information are consistent with the determinations and recommendations of the MTCA Science Advisory Board. Ecology believes that the revised rule provides a more effective and less-burdensome approach because:

(1) The revised procedures result in higher soil cleanup standards.

(2) Use of the revised default AB1 value will reduce the need to perform site-specific studies.

Ecology believes that the **second or "no action" alternative** achieves the MTCA goals and objectives. However, Ecology believes it is more burdensome than the final rule (see previous paragraph).

Ecology believes that the **third or "more protective" alternative** meets the MTCA goals and objectives. This approach has a solid scientific foundation and results in soil cleanup levels that protect human health. However, Ecology also believes this alternative would be more burdensome than the final rule because congener-specific PCB analyses would be required at all sites. Given the MTCA policies and procedures for establishing industrial soil cleanup levels, it is unclear whether the additional costs would result in lower (more protective) cleanup levels.

<u>Conclusions</u>

The final rule will effectively achieve these objectives. Ecology believes the amendment is necessary to more effectively protect human health.

7.8 Industrial Soil Cleanup Levels – PAH Mixtures

The final rule revisions will <u>not</u> change industrial soil cleanup levels for carcinogenic PAHs. However, the change in the TEF value for dibenz(a,h)anthracene from 0.4 to 0.1 will result in approximately five percent higher mixture concentrations meeting the industrial soil cleanup level (five percent less stringent cleanup requirements).

Comparison of the Baseline and the Proposed Rule Amendment

Under the baseline, industrial soil cleanup levels for carcinogenic PAH mixtures are generally based on the soil ingestion pathway. Soil cleanup levels for individual PAH compounds and the whole mixture are based on a target cancer risk of one-in-one hundred thousand (10^{-5}) and a relative bioavailability of 100%. Cleanup proponents may establish cleanup levels for individual PAH compounds using (1) the California EPA 1994 Potency Equivalency Factors (PEF) values or (2) an approach that assumes all PAH compounds are equally toxic as benzo[a]pyrene. Ecology may approve less stringent cleanup levels based on site-specific evaluations of the bioavailability of soil-bound PAH compounds. Ecology may also require more stringent cleanup levels based on a site-specific evaluation of other soil-related exposure pathways.

Under the final rule, industrial soil cleanup levels for carcinogenic PAH mixtures will continue to be based on the soil ingestion pathway using a target cancer risk of one-in-one hundred thousand (10^{-5}). However, soil cleanup levels for carcinogenic PAHs will be established using the updated California EPA 2005 PEF values. Ecology also eliminated the option to establish cleanup levels based on the assumption that all PAH compounds are as toxic as benzo[a]pyrene.

Description of the Policy Options

In addition to maintaining the previous rule language (no action alternative), Ecology considered several technical and policy options during the rulemaking process:

- Option 1 – No TEF: Ecology would require cleanup proponents to establish cleanup levels for individual PAH compounds using the cancer slope factor for benzo[a]pyrene. Under this alternative, all PAH compounds would be considered equally toxic to the reference compound (benzo[a]pyrene).

- Option 2 – "Site-Specific Exposure Analyses": Ecology would require cleanup proponents to evaluate other soil-related exposure pathways (e.g. dermal contact) and consider the results of those evaluations when establishing soil cleanup levels.

- Option 3 – "Updated California PEF Values": Ecology would require cleanup proponents to use the most current California EPA PEF values when establishing cleanup levels for PAH mixtures.

- Option 4 – "EPA Relative Potency Factors (RPF) Values": Ecology would require cleanup proponents to use the EPA Relative Potency Factors (EPA 1993) when establishing cleanup levels for PAH mixtures.

- Option 5 – "Expanded List of PAH Compounds": Ecology would require cleanup proponents to analyze environmental samples to determine the concentrations of all

25 carcinogenic PAHs identified by the California EPA. Cleanup proponents would be required to establish cleanup levels for PAH mixtures using a target cancer risk of 10^{-5}.

Evaluation of Policy Options

Ecology evaluated the seven policy options using three evaluation criteria:

- Does the policy option result in rule requirements that protection human health and the environment?
- Is the policy option consistent with current scientific information?
- Would the policy option result in rule requirements that are more or less burdensome than previous rule requirements?

The evaluation results are presented in Table 22.

Table 22: Policy Options for Industrial Soil Cleanup Levels for PAH Mixtures

Table 22: Policy Options for Industrial Soil Cleanup Levels for PAH Mixtures

Policy Options	Protection of Human Health & the Environment	Consistent With Current Scientific Information	Burden on Persons Required to Comply
Option 1 – No TEF: Ecology would require cleanup proponents to establish cleanup levels for all PAH compounds using the cancer slope factor for benzo[a]pyrene. Under this option, all PAH compounds would be considered equally toxic to the reference compound (benzo[a]pyrene).	Yes.	No.	Increased.
Option 2 – "Site-Specific Exposure Analyses". Ecology would require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels.	Yes.	Yes.	Increased.
Option 3 – "Updated California PEF Values": Ecology would require cleanup proponents to use the most current California EPA PEF values when establishing cleanup levels for PAH mixtures.	Yes. Values are similar to previous rule.	Yes.	Slight Decrease.
Option 4 – "EPA Relative Potency Factors (RPF) Values": Ecology would require cleanup proponents to use the EPA Relative Potency Factors (EPA 1993) when establishing cleanup levels for PAH mixtures.	Yes. Values are similar to previous rule.	Yes. Values are consistent with more recent values.	Slight Increase.
Option 5 – "Expanded List of PAH Compounds": Ecology would require cleanup proponents to analyze environmental samples to determine the concentrations of all 25 carcinogenic PAHs identified by the California EPA. Cleanup proponents would be required to establish cleanup levels for PAH mixtures using a target cancer risk of 10^{-5}.	Yes.	Yes.	Increased.

Description of Rulemaking Alternatives

Ecology reviewed the range of policy options and identified three rulemaking alternatives:

- **Proposed Rule Revision**. Under this alternative, soil cleanup levels would be established for PAH mixtures as a whole, using a target cancer risk of one-in-one hundred thousand and the updated California EPA 2005 TEF values. The cleanup level for the mixture would be based on the seven PAH compounds identified in the MTCA rule. This alternative is policy option 3.

- **"No Action" Alternative (Previous Rule)**. Under this alternative, soil cleanup levels could be established for individual PAH compounds using a target cancer risk level of one-in-one hundred thousand and the California EPA 1994 TEF values. The "no action" alternative is the previous rule.

- **"More Protective" Alternative**. Under this alternative, soil cleanup levels would be established for PAH mixtures as a whole, using a target cancer risk of one-in-one hundred thousand and updated California EPA 2005 TEF values. The cleanup level for the mixture would be based on all twenty-five PAH compounds listed by California EPA. Ecology would also require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels. This alternative is a combination of policy options 2, 3 and 5.

Evaluation of Rulemaking Alternatives

Ecology evaluated the three rulemaking alternatives to determine whether the final rule represents the least burdensome alternative that achieves the general goals and specific objectives of the MTCA. As described in Section 8.2, Ecology considered two main factors when performing this evaluation:

- Does the rulemaking alternative achieve the goals and objectives of the MTCA?
- Does the final rule represent the least burdensome alternative for achieving those goals and objectives?

The evaluation results are presented in Table 23.

Table 23: Policy Options for Industrial Soil Cleanup Levels for PAH Mixtures

Table 23: Rulemaking Alternatives for Industrial Soil Cleanup Levels for PAH Mixtures			
Rulemaking Alternatives	Meets Statutory Goals & Objectives		Least Burdensome Alternative
	Level of Protection	Scientific Information	

Final Rule. Under this alternative, soil cleanup levels would be established for PAH mixtures as a whole, using a target cancer risk of one-in-one hundred thousand (10^{-5}) and the updated California EPA 2005 TEF values. The cleanup level for the mixture would be based on the seven PAH compounds identified in the MTCA rule. This alternative is policy option 3.	Yes.	Yes.	Yes. [Very little difference between the baseline and final rules.]
"No Action" Alternative (Previous Rule). Under this alternative, soil cleanup levels could be established for individual PAH compounds using a target cancer risk level of one-in-one hundred thousand (10^{-5}) and the California EPA 1994 TEF values. The "no action" alternative is the previous rule.	No. [But only small difference because the target risk of 10-5 also applies to the mixture as a whole.	No. [But only small difference between old and new TEF values]	Not applicable.
"More Protective" Alternative. Under this alternative, soil cleanup levels would be established for PAH mixtures as a whole, using a target cancer risk of one-in-one hundred thousand (10^{-5}) and updated California EPA 2005 TEF values. The cleanup level for the mixture would be based on all twenty-five PAH compounds listed by California EPA. Ecology would also require cleanup proponents to evaluate other soil-related exposure pathways and consider the results of those evaluations when establishing soil cleanup levels. This alternative is a combination of policy options 2, 3 and 5.	Yes.	Yes.	No.

Ecology believes the **rule revisions** achieve the MTCA goals and objectives. The revised rule incorporates new scientific information on the relative toxicity of PAH compounds. Ecology's decisions on new scientific information are consistent with the determinations and recommendations of the MTCA Science Advisory Board. From a practical standpoint, the final rule will not result in significant changes to industrial soil cleanup levels for PAH mixtures. As noted above, the change in the PEF value for dibenz(a,h)anthracene from 0.4 to 0.1 will result in approximately five percent higher mixture concentrations meeting the industrial soil cleanup level. In other words, the revised rule will result in slightly less stringent cleanup requirements.

Ecology believes that the **second or "no action" alternative** would largely, but not entirely achieve the MTCA goals and objectives. As discussed above, Ecology believes that the small differences between the 1994 and 2005 California EPA PEF values will result in slightly higher cleanup standards for PAH mixtures at industrial sites. It is unclear whether such changes would significantly alter the types of cleanup actions performed at sites. However, Ecology believes the final rule is less burdensome than the previous rule requirements.

Ecology believes that the **third or "more protective" alternative** would meet the MTCA goals and objectives. However, Ecology also believes this alternative would be more burdensome than the final rule because:

(1) Ecology would require cleanup proponents to analyze a broader range of

contaminants using special analytical methods that are not routinely used at cleanup sites.

(2) Cleanup levels would be significantly lower than cleanup levels established under the final rule and may approach concentrations commonly found in urban areas.

Conclusions

The final rule will effectively achieve these objectives. Ecology believes the amendment is necessary to more effectively protect human health.

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APPENDICES

Appendix A: Cleanup Level Methodology

Ecology performed calculations for baseline and final rule cleanup levels.

Past Practice Cleanup Level Calculation
Using the standard formula exposure assumptions, Ecology calculated the cleanup value (Method B) using 2,3,7,8-TCDD as equipotent to the entire mixture. This resulted in a cleanup level of 6.7 ppt for dioxin/furan mixtures.

The Baseline Calculation:
Using the standard formula exposure assumptions, the soil cleanup value (Method B) was calculated for the baseline as follows:

- Compiled data from dioxin contaminated sites in WA State.
- For each sample analyzed, calculated a concentration that meets the 10^{-6} standard for individual congeners and a 10-5 standard for the total mixture, using the standard Method B direct contact (soil ingestion) assumption and standard Method B assumptions and the 2005 TEFs.
- Calculated the average cleanup level for each site

This resulted in a cleanup level of 16-24 ppt for dioxin/furan mixtures at several sites in Washington State, with the value depending on the mixture composition.

It is important to this calculation, that for existing site data, a single congener tends to drive cleanup on a site. This means that, rather than cleanup equivalent to a theoretical 67ppt, actual cleanup performed on sites under the baseline would meet a more stringent overall standard, in order to remediate a particular congener of the overall congener mix to the 10^{-6} standard.

Final Rule Calculation:
Using the standard formula exposure assumptions, the soil cleanup value (Method B) was calculated for the final rule revisions as follows:

- Standard formula based Method B assumptions except for 60% bioavailability
- The cleanup level was calculated using the 2005 TEFs for each of the 17 dioxin/furan congeners

This resulted in a cleanup level of 11 ppt for dioxin/furan mixtures.

Appendix B: Potentially Affected Standard Industry Classifications (SIC)

Table K-1: Suspected and Confirmed Dioxin-Contaminated Sites in Washington State

COUNTY	COMMON NAME	ADDRESS	CITY	SIC	SIC DESCRIPTION
CLARK	Pacific Wood Treating Corp	111 W DIVISION ST	RIDGEFIELD	2421	SAWMILLS AND PLANING MILLS, GENERAL
				2439	STRUCTURAL WOOD MEMBERS, NEC
				2491	WOOD PRESERVING
				2499	WOOD PRODUCTS, NEC
				3069	FABRICATED RUBBER PRODUCTS, NEC
				9199	GENERAL GOVERNMENT, NEC
COWLITZ	MT SOLO LANDFILL	4646 MT SOLO RD	LONGVIEW	4953	LANDFILL
	INTERNATIONAL PAPER LONGVIEW	10 INTERNATIONAL WAY	LONGVIEW	2411	LOGGING
				26	PAPER & ALLIED PRODUCTS
				4225	GENERAL WAREHOUSING AND STORAGE
				4953	REFUSE SYSTEMS
FRANKLIN	Pasco Landfill NPL Site	KAHLOTUS RD & HWY 12	PASCO	4953	LANDFILL
				9511	AIR, WATER, & SOLID WASTE MANAGEMENT
GRAYS HARBOR	RAYONIER INC	400 AIRPORT WAY	HOQUIAM	2491	WOOD PRESERVING
				24	LUMBER AND WOOD PRODUCTS
				2421	SAWMILLS AND PLANING MILLS, GENERAL
	RICHARDSON CUSTOM AUTO	136 HWY 101 N	HOQUIAM	75	AUTO REPAIR, SERVICES, AND PARKING
ISLAND	US NAVY WHIDBEY OU2	AULT FIELD NAS WHIDBEY ISLAND	OAK HARBOR	9711	NATIONAL SECURITY
	US NAVY WHIDBEY OU3	AULT FIELD NAS WHIDBEY ISLAND	OAK HARBOR	4953	HAZARDOUS WASTE MATERIAL DISPOSAL SI
KING	Seattle Port Terminal 117	8700 DALLAS AVE S	SEATTLE	2952	ASPHALT FELTS &COATINGS
	JH BAXTER & CO INC	5015 LAKE WASHINGTON BLVD N	RENTON	24	LUMBER AND WOOD PRODUCTS
				2491	WOOD PRESERVING
	HARBOR ISLAND	HARBOR ISLAND	SEATTLE	2999	PETROLEUM & COAL PRODUCTS
				3341	SECONDARY SMELTING & REFINING OF NON
				3731	SHIP BUILDING AND REPAIRING

	RAVENNA LANDFILL UNION BAY	NE 45TH & MONTLAKE	SEATTLE	4953	LANDFILL
	BOEING NORTH FIELD	7370 E MARGINAL WAY S	SEATTLE	372	AIRCRAFT & PARTS
				3721	AIRCRAFT
	Seattle City Light South Service Center	3613 4TH AVE S	SEATTLE	4911	ELECTRIC SERVICES
	King Cnty Regional Justice	421 6TH AVE N	KENT	2431	MILLWORK (INCL. WINDOW FRAMES)
				2499	WOOD PRODUCTS, NEC
KITSAP	US NAVY SUBASE	US HWY 99	SILVERDALE	4953	HAZARDOUS WASTE MATERIAL DISPOSAL SI
				9711	NATIONAL SECURITY
	WA ECY Manchester Lab	7411 BEACH DR E ECY LAB	PORT ORCHARD	4953	LANDFILL
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	EAGLE HARBOR WYCKOFF	CREOSOTE PL NE	BAINBRIDGE ISLAND	2491	WOOD PRESERVING
	US NAVY PSNS OUB	1400 FARRAGUT AVE	BREMERTON	9711	NATIONAL SECURITY
	Wileys Body Shop Inc	1344 COLCHESTER DR SE	PORT ORCHARD	7532	TOP & BODY REPAIR & PAINT SHOPS
LEWIS	AMERICAN CROSSARM & CONDUIT	100 CHEHALIS AVE SW	CHEHALIS	24	LUMBER AND WOOD PRODUCTS
				4953	LANDFILL
				9511	AIR, WATER, & SOLID WASTE MANAGEMENT
	ROSS ELECTRIC OF WA COAL CREEK	346 COAL CREEK RD	CHEHALIS	3629	ELECTRICAL INDUSTRIAL APPARATUS, NOT
				9999	NONCLASSIFIABLE ESTABLISHMENTS
MASON	SIMPSON TIMBER COMPANY	215 N 3RD ST	SHELTON	24	LUMBER AND WOOD PRODUCTS
				2421	SAWMILLS AND PLANING MILLS, GENERAL
				2436	SOFTWOOD VENEER AND PLYWOOD
	SHELTON LANDFILL	C ST	SHELTON	4953	LANDFILL
PIERCE	US ARMY FORT LEWIS MULTI SITE	FORT LEWIS	TACOMA	3482	SMALL ARMS AMMUNITION
				4953	LANDFILL
	Marine VW Drums	1900 MARINE VIEW DR NE	TACOMA	9999	NONCLASSIFIABLE ESTABLISHMENTS
	REICHHOLD CHEM INC	2340 TAYLOR WAY	TACOMA	2672	COATED & LAMINATED PAPER

	Tacoma Landfill	3510 S MULLEN	TACOMA	4212	LOCAL TRUCKING, WITHOUT STORAGE
				4953	LANDFILL
				9199	GENERAL GOVERNMENT, NEC
SKAGIT	Scott Paper Mill Former	17TH-22ND ST & R AVE	ANACORTES	261	PULP MILLS
	IMPACT INDUSTRIES SULPHUR PILE	1325 HWY 237	MOUNT VERNON	2819	INDUSTRIAL INORGANIC CHEMICALS
	MJB PROPERTIES	17TH-30TH ST & T AVE	ANACORTES	2611	PULP MILLS
				4493	MARINAS
	PORT OF ANACORTES	Q AVE & 15TH ST	ANACORTES	2611	PULP MILLS
SNOHOMISH	US NAVY Station Everett	2000 W MARINE VIEW DR	EVERETT	3731	SHIP BUILDING AND REPAIRING
				9199	GENERAL GOVERNMENT, NEC
				9711	NATIONAL SECURITY
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	Sultan Post & Pole	124 FOUNDRY DR	SULTAN	2429	SPECIAL PRODUCT SAWMILLS, NEC
				2491	WOOD PRESERVING
				2851	PAINTS AND ALLIED PRODUCTS
THURSTON	CASCADE POLE INC MCFARLAND	1100 WASHINGTON ST	OLYMPIA	2491	WOOD PRESERVING
	BRIGGS NURSERY	4407 HENDERSON BLVD SE	OLYMPIA	0181	ORNAMENTAL NURSERY PRODUCTS
WHATCOM	RG HALEY INTL CORP	CORNWALL AVE N	BELLINGHAM	24	LUMBER AND WOOD PRODUCTS
	WILDER LANDFILL	N OF 1524 SLATER RD	FERNDALE	4953	REFUSE SYSTEMS
YAKIMA	Cameron Yakima Inc	1414 S 1ST ST	YAKIMA	28	CHEMICALS AND ALLIED PRODUCTS
				2819	INDUSTRIAL INORGANIC CHEMICALS, NEC
				3564	BLOWERS AND FANS
				3569	GENERAL INDUSTRIAL MACHINERY, NEC
				3589	SERVICE INDUSTRY MACHINERY, NEC
				4953	INCINERATOR OPERATION
	Bay Zinc Co Inc	301 W CHARRON RD	MOXEE CITY	2879	AGRICULTURAL CHEMICALS, NEC

Table K-2: Suspected and Confirmed PAH-Contaminated Sites in Washington State

COUNTY	COMMON NAME	ADDRESS	CITY	SIC	SIC DESCRIPTION
ADAMS	BURLINGTON NORTHERN OTHELLO	BROADWAY & MAIN	OTHELLO	4011	RAILROADS, LINE HAUL OPERATING
				4013	SWITCHING AND TERMINAL SERVICES
CHELAN	Unocal Svs Sta 4942	405 S WENATCHEE AVE	WENATCHEE	7538	GENERAL AUTOMOTIVE REPAIR SHOPS
CLALLAM	FREDS AUTO	262 MT PLEASANT RD	PORT ANGELES	5093	SCRAP AND WASTE MATERIALS
	JONATHAN SHOTWELL CORPORATION	484 ECLIPSE PKWY	PORT ANGELES	1442	CONSTRUCTION SAND AND GRAVEL
				1459	CLAY AND RELATED MINERALS NEC
				2951	ASPHALT PAVING MIXTURES AND BLOCKS
				3273	READY-MIXED CONCRETE
	QUALITY 4 X 4	2509 EDDY LN	PORT ANGELES	55	AUTOMOTIVE DEALERS & SERVICE STATION
				75	AUTO REPAIR, SERVICES, AND PARKING
CLARK	AC SPECIALTY	13917 NE FOURTH PLAIN RD	VANCOUVER	75	AUTO REPAIR, SERVICES, AND PARKING
	BATTLE GROUND PLAZA MINI MA	717 MAIN ST	BATTLE GROUND	554	GASOLINE SERVICE STATIONS
				594	MISCELLANEOUS SHOPPING GOODS STORES
	CARBORUNDUM FILL	3103 LOWER RIVER RD	VANCOUVER	4953	LANDFILL
	CHERRY GROVE DUMP	PENDER RD & NE 249TH	BATTLE GROUND	4953	LANDFILL
	EXXON GAS STATION 2422	604 NE 179TH ST	RIDGEFIELD	2999	PETROLEUM & COAL PRODUCTS
				55	AUTOMOTIVE DEALERS & SERVICE STATION
	Fort Vancouver Plywood	W 8TH ST	VANCOUVER	2436	SOFTWOOD VENEER AND PLYWOOD
	KINGSBURY TERRACE APTS	2011 E BRANDT RD	VANCOUVER	9999	NONCLASSIFIABLE ESTABLISHMENTS
	LEWIS RIVER RANCH A	11001 NE 269TH ST	BATTLE GROUND	02	AGRICULTURAL PRODUCTION-LIVESTOCK
	LEWIS RIVER RANCH C	ACCESS RD	BATTLE GROUND	02	AGRICULTURAL PRODUCTION-LIVESTOCK
	MCCALL OIL	1309 W MCLOUGHLIN AVE	VANCOUVER	2999	PETROLEUM & COAL PRODUCTS
	OFFICER PROPERTY OIL PITS	2505 NE 134TH ST	VANCOUVER	9999	NONCLASSIFIABLE ESTABLISHMENTS
	Pacific Wood Treating Corp	111 W DIVISION ST	RIDGEFIELD	2421	SAWMILLS AND PLANING MILLS, GENERAL
				2439	STRUCTURAL WOOD MEMBERS, NEC

				2491	WOOD PRESERVING
				2499	WOOD PRODUCTS, NEC
				3069	FABRICATED RUBBER PRODUCTS, NEC
				9199	GENERAL GOVERNMENT, NEC
	PRI NORTHWEST INC VANCOUVER	1300 W 8TH ST	VANCOUVER	2951	ASPHALT PAVING MIXTURES AND BLOCKS
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	SPRAGUE & FJERMESTAD	4206 NE 239TH ST	RIDGEFIELD	5015	MOTOR VEHICLE PARTS, USED
				5093	SCRAP AND WASTE MATERIALS
	ST Services Vancouver	5420 NW FRUIT VALLEY RD	VANCOUVER	5171	PETROLEUM BULK STATIONS & TERMINALS
	Toftdahl Drum Site	22033 NE 189 ST	BRUSH PRAIRIE	9511	AIR, WATER, & SOLID WASTE MANAGEMENT
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	VANCOUVER ICE & FUEL OIL	1112 W 7TH ST	VANCOUVER	2951	ASPHALT PAVING MIXTURES AND BLOCKS
				2999	PETROLEUM & COAL PRODUCTS
				5171	PETROLEUM BULK STATIONS & TERMINALS
	WOODYS 4X4	6408 NE ST JOHNS RD	VANCOUVER	75	AUTO REPAIR, SERVICES, AND PARKING
COWLITZ	CLIFF KOPPE METALS	1610 S RIVER RD	KELSO	3449	MISCELLANEOUS METAL WORK
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	INTERNATIONAL PAPER LONGVIEW	10 INTERNATIONAL WAY	LONGVIEW	2411	LOGGING
				26	PAPER & ALLIED PRODUCTS
				4225	GENERAL WAREHOUSING AND STORAGE
				4953	REFUSE SYSTEMS
	KALAMA FALLS HATCHERY	3900 KALAMA RIVER RD	KALAMA	0921	FISH HATCHERIES AND PRESERVES
	LONGVIEW FIRE DEPT	740 COMMERCE	LONGVIEW	9224	FIRE PROTECTION
	United Rentals NW Inc Longview	1002 TENNANT WAY	LONGVIEW	7359	EQUIPMENT RENTAL & LEASING, NEC
				7532	TOP & BODY REPAIR & PAINT SHOPS
				7538	GENERAL AUTOMOTIVE REPAIR SHOPS
FRANKLIN	Pasco Bulk Fuel Terminal Site	AINSWORTH & W 9TH	PASCO	2999	PETROLEUM & COAL PRODUCTS
GRAYS HARBOR	FRIENDLY AUTO SALES & SALVAGE	150 US HWY 101	HOQUIAM	5015	MOTOR VEHICLE PARTS, USED
	HILLIARD PROPERTY	323 W MARKET ST	ABERDEEN	75	AUTO REPAIR, SERVICES, AND PARKING
				7991	PHYSICAL FITNESS FACILITIES

	Little Hoquiam Boat Shop 1	119 ENDRESEN AVE	HOQUIAM	373	SHIP & BOATBUILDING AND REPAIRING
				3732	BOAT BUILDING AND REPAIRING
	LITTLE HOQUIAM BOAT SHOP 2	825 QUEEN AVE	HOQUIAM	373	SHIP & BOATBUILDING AND REPAIRING
				3732	BOAT BUILDING AND REPAIRING
	RODERICK TIMBER CO	712 HAGARA ST	JUNCTION CITY	24	LUMBER AND WOOD PRODUCTS
	SIERRA PACIFIC	301 HAGARA ST	JUNCTION CITY	24	LUMBER AND WOOD PRODUCTS
				2421	SAWMILLS & PLANNING MILLS, GEN
				4911	ELECTRIC SERVICES
				4953	LANDFILL
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	VIRGIL FOSTER	254-19 MONTE ELMA RD	MONTESANO	24	LUMBER AND WOOD PRODUCTS
				2491	WOOD PRESERVING
ISLAND	HOLMES HARBOR ROD & GUN CLUB	3634 BROOKS HILL RD	LANGLEY	3484	SMALL ARMS
				7997	MEMBERSHIP SPORTS & RECREATION CLUBS
	ISLAND RECYCLING	20014 HWY 525	FREELAND	3714	MOTOR VEHICLE PARTS AND ACCESSORIES
				5093	SCRAP AND WASTE MATERIALS
				8999	SERVICES, NEC
	US NAVY Air Station Whidbey Island Ault	AULT FIELD BASE	OAK HARBOR	9711	NATIONAL SECURITY
	US NAVY WHIDBEY OU1	AULT FIELD NAS WHIDBEY ISLAND	OAK HARBOR	4953	HAZARDOUS WASTE MATERIAL DISPOSAL SI
	US NAVY WHIDBEY OU2	AULT FIELD NAS WHIDBEY ISLAND	OAK HARBOR	9711	NATIONAL SECURITY
	US NAVY WHIDBEY OU3	AULT FIELD NAS WHIDBEY ISLAND	OAK HARBOR	4953	HAZARDOUS WASTE MATERIAL DISPOSAL SI
	US NAVY WHIDBEY OU4	NAS WHIDBEY ISLAND	OAK HARBOR	9711	NATIONAL SECURITY
JEFFERSON	Jefferson County Transit Authority	1615 SIMS WAY	PORT TOWNSEND	4111	LOCAL AND SUBURBAN TRANSIT
				47	TRANSPORTATION SERVICES
	RURAL GARBAGE SERVICE	NEWBERRY HILL RD NW & SESAME ST NW	SILVERDALE	4953	REFUSE SYSTEMS
KING	Aesquivel Property	14325 35TH AVE NE	SEATTLE	88	PRIVATE HOUSEHOLDS
	AFFORDABLE AUTO WRECKING	9802 MARTIN LUTHER KING JR WAY S	SEATTLE	5015	MOTOR VEHICLE PARTS, USED
				5093	SCRAP AND WASTE MATERIALS
	Associated Grocers Inc Kent	7890 S 188TH	KENT	5141	GROCERIES, GENERAL LINE
	BALLARD PARTNERS PROPERTY	1455 NW LEARY WAY	SEATTLE	752	AUTOMOBILE PARKING

	BELLEFIELD OFFICE PARK BLDG N & O	1756-1800 114TH AVE SE BLDG N & O	BELLEVUE	9111	EXECUTIVE OFFICES
	Belshaw Brothers Inc	1750 22ND AVE S	SEATTLE	1541	INDUSTRIAL BUILDINGS AND WAREHOUSES
				3556	FOOD PRODUCTS MACHINERY
	BLACKBURN PROPERTY	31411 169TH AVE SE	AUBURN	75	AUTO REPAIR, SERVICES, AND PARKING
				7538	GENERAL AUTOMOTIVE REPAIR SHOPS
	BNRR QUENDALL LOADING RACKS	E OF RR TRACKS & 4503 LK WASHINGTON BLVD	RENTON	4011	RAILROADS, LINE-HAUL OPERATING
	BNRR SWITCHING YARD CEDAR FALLS	SE OF RATTLESNAKE LAKE & CEDAR FALLS RD	CEDAR FALLS	4013	SWITCHING AND TERMINAL SERVICES
	BNSF Railway Co Skykomish	RAILROAD AVE 5TH ST	SKYKOMISH	40	RAILROAD TRANSPORTATION
				4011	RAILROADS, LINE-HAUL OPERATING
				4013	SWITCHING AND TERMINAL SERVICES
				4785	INSPECTION & FIXED FACILITIES
	BOEING AUBURN GOVERNMENT CANAL	15TH ST SW	AUBURN	3471	ELECTROPLATING, PLATING, POLISHING,A
	BOEING ELECTRONIC MFG	7300 PERIMETER RD S	SEATTLE	5065	ELECTRONIC PARTS AND EQUIPMENT
	Boeing Plant 2	7755 E MARGINAL WAY S	SEATTLE	3721	AIRCRAFT
				3728	AIRCRAFT PARTS AND EQUIPMENT, NEC
				3761	GUIDED MISSILES AND SPACE VEHICLES
	Boeing Renton	800 N 6TH ST	RENTON	372	AIRCRAFT & PARTS
				3721	AIRCRAFT
	BOW LAKE LANDFILL	S 188TH ST & MILITARY RD S	TUKWILA	4953	LANDFILL
	BP West Coast Products	1652 SW LANDER	SEATTLE	29	PETROLEUM AND COAL PRODUCTS
				3533	OIL AND GAS FIELD MACHINERY
				5171	PETROLEUM BULK STATIONS & TERMINALS
				5172	PETROLEUM PRODUCTS, NEC
	BUDGET RENT A CAR BELLEVUE	111 108TH NE	BELLEVUE	7514	PASSENGER CAR RENTAL
	Burlington Environmental Inc Georgetown	734 S LUCILE ST	SEATTLE	4953	REFUSE SYSTEMS
	CADMAN PREMIX CO INC	1605 130TH AVE NE	BELLEVUE	177	CONCRETE WORK
	Coleman Creosoting Works	333 ELLIOTT AVE W	SEATTLE	2491	WOOD PRESERVING

				5171	PETROLEUM BULK STATIONS & TERMINALS
	DARIGOLD ELLIOTT AVENUE	635 ELLIOTT AVE W	SEATTLE	2026	FLUID MILK
	DELTA TRAIN CORP	209 41ST ST SE	AUBURN	5088	TRANSP. EQUIP. (WHOLESALE)
	DUWAMISH FILL SITE DOT	S 124TH ST & SR 99	SEATTLE	4953	LANDFILL
				3599	INDUSTRIAL MACHINERY, NEC
				3731	SHIP BUILDING AND REPAIRING
				3732	BOAT BUILDING AND REPAIRING
	EASTGATE ABANDONED LANDFILL	2805 160TH AVE SE	BELLEVUE	4953	LANDFILL
	Eat Em Up Hut	12640 RENTON AVE S	SEATTLE	554	GASOLINE SERVICE STATIONS
	ENUMCLAW LANDFILL	29000 SE 440TH ST	ENUMCLAW	4953	LANDFILL
	EVERGREEN MARINE LEASING PARCEL E	7343 E MARGINAL WAY S	SEATTLE	2491	WOOD PRESERVING
				4491	MARINE CARGO HANDLING
	FEDERAL COURTHOUSE	700 STEWART ST	SEATTLE	921	COURTS
	FIELDS CORP KENT	710 S RAILROAD AVE	KENT	2952	ASPHALT FELTS AND COATINGS
				5211	LUMBER & OTHER BLDG. MATERIALS DEALE
	Fishing Vessel Owners Marine Ways Inc	1511 W THURMAN	SEATTLE	3731	SHIP BUILDING AND REPAIRING
				3732	BOAT BUILDING AND REPAIRING
	Foss Maritime Co	660 W EWING ST	SEATTLE	3731	SHIP BUILDING AND REPAIRING
				3732	BOAT BUILDING AND REPAIRING
				4493	MARINAS
	Fox Ave Bldg	6900 FOX AVE S	SEATTLE	5169	CHEM. & ALLIED PRODUCTS (WHOLESALE)
	FREASE PROPERTY	1330 S 343RD ST	FEDERAL WAY	753	AUTOMOTIVE REPAIR SHOPS
	Fremont Bridge Approach	FREMONT AVE N & 4TH AVE N	SEATTLE	1622	BRIDGE, TUNNEL, & ELEVATED HIGHWAY
	GAS WORKS PARK WA NATURAL GAS	2000 N NORTHLAKE WAY	SEATTLE	1311	CRUDE PETROLEUM AND NATURAL GAS
				49	ELECTRIC, GAS, AND SANITARY SERVICES
	GATX Facility	1733 ALASKAN WAY S	SEATTLE	4226	SPECIAL WAREHOUSING AND STORAGE, NEC
				5171	PETROLEUM BULK STATIONS & TERMINALS
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	GENESEE LANDFILL	GENESEE ST & 43RD AVE S	SEATTLE	4953	LANDFILL

	GRIFFITH PROPERTY	19 W GRIFFIN CREEK RD	CARNATION	88	PRIVATE HOUSEHOLDS
	HANGAR HOLDINGS INC	7675 PERIMETER RD S	SEATTLE	9999	NONCLASSIFIABLE ESTABLISHMENTS
	HARBOR ISLAND	HARBOR ISLAND	SEATTLE	2999	PETROLEUM & COAL PRODUCTS
				3341	SECONDARY SMELTING & REFINING OF NON
				3731	SHIP BUILDING AND REPAIRING
	Industrial Container Services WA LLC	7152 1ST AVE S	SEATTLE	3412	METAL SHIPPING BARRELS, DRUMS, KEGS,
				7699	REPAIR SERVICES, NEC
	INTERBAY BNR	1809 W EMERSON	SEATTLE	4013	RAILROAD SWITCHING & TERMINAL ESTABL
	INTERBAY OLD LANDFILL	W WHEELER ST & 15TH AVE W	SEATTLE	4953	LANDFILL
	JC Commercial Properties LLC	2955 WESTLAKE AVE N	SEATTLE	7521	AUTOMOBILE PARKING
	JH BAXTER & CO INC	5015 LAKE WASHINGTON BLVD N	RENTON	24	LUMBER AND WOOD PRODUCTS
				2491	WOOD PRESERVING
	John Dunato & Co Inc	2309 N NORTHLAKE WY	SEATTLE	3732	BOAT BUILDING AND REPAIRING
	JOSEPH SIMON & SONS KENT	1025 S CENTRAL AVE	KENT	5093	SCRAP AND WASTE MATERIALS
	JSWJ Property Former	301 1ST AVE N	KENT	5084	INDUSTRIAL MACHINERY AND EQUIPMENT
	JSWJ Property Former	301 1ST AVE N	KENT	752	AUTOMOBILE PARKING
	KENMORE IND PARK	6423 NE 175TH ST	KENMORE	2951	PAVING MIXTURES AND BLOCKS
				3531	CONSTRUCTION MACHINERY & EQUIPMENT
				4953	LANDFILL
	Kentwood Industrial Bldg	20215 84TH AVE S	KENT	9999	NONCLASSIFIABLE ESTABLISHMENTS
	Kinder Morgan Tank Farm	2720 13TH AVE SW	SEATTLE	5171	PETROLEUM BULK STATIONS & TERMINALS
	King Cnty DOT Metro Transit Lake Union	1602 N NORTHLAKE WY	SEATTLE	4111	LOCAL AND SUBURBAN TRANSIT
				4173	BUS TERMINAL AND SERVICE FACILITIES
				4225	GENERAL WAREHOUSING AND STORAGE
				5171	PETROLEUM BULK STATIONS & TERMINALS
	King Cnty Solid Waste	11724 NE 60TH ST	KIRKLAND	4953	LANDFILL

	Houghton			9511	AIR, WATER, & SOLID WASTE MANAGEMENT
	King Cnty Solid Wst Cedar Hills Landfill	16645 228TH AVE SE	MAPLE VALLEY	4911	ELECTRIC SERVICES
				4953	LANDFILL
	KING COUNTY STREET SWEEPING SITE	16TH AVE S & HWY 518	SEATTLE	4581	AIRPORTS, FLYING FIELDS, & SERVICES
	LAKE UNION STEAM PLANT	1179 EASTLAKE AV E	SEATTLE	4961	STEAM & AIR-CONDITIONING SUPPLY
	Lake Washington School Dist 414	6505 176TH NE MARYMOOR ANNEX	REDMOND	376	GUIDED MISSILES, SPACE VEHICLES, PAR
			REDMOND	8222	JUNIOR COLLEGES
			REDMOND	9999	NONCLASSIFIABLE ESTABLISHMENTS
	LAKE YOUNGS SUPPLY LINE	SE PETROVITSY & CEDAR RIVER PLN RD	MAPLE VALLEY	4941	WATER SUPPLY
	LAKESIDE INDUSTRIES EASTGATE	13620 SE EASTGATE WY	BELLEVUE	1611	HIGHWAY AND STREET CONSTRUCTION
	LAKESIDE INDUSTRIES KENT	19601 FRONTAGE RD	KENT	2951	PAVING MIXTURES AND BLOCKS
				7699	REPAIR SHOPS & RELATED SERVICES-MISC
	Lithia Lot A Car of Renton	700 S GRADY WAY	RENTON	55	AUTOMOTIVE DEALERS & SERVICE STATION
	LITTLE ETHELS AUTO WRECKING	13301 MARTIN LUTHER KING JR WAY S	SEATTLE	5093	SCRAP & WASTE MATERIALS
	LOCKHEED SHIPBLDG CO YARD 1	2929 16TH AV SW	SEATTLE	3731	SHIP BUILDING AND REPAIRING
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	Longview Fibre Paper & Packaging Inc	5901 E MARGINAL WAY S	SEATTLE	2653	CORRUGATED AND SOLID FIBER BOXES
	Lous Chevron	1531 BROADWAY	SEATTLE	5499	MISCELLANEOUS FOOD STORES
				5541	GASOLINE SERVICE STATIONS
	Madrona Elementary	1121 33RD AVE	SEATTLE	5983	FUEL OIL DEALERS
	MANAGAN PROPERTY	19040 MAXWELL RD SE	MAPLE VALLEY	283	DRUGS
				5015	MOTOR VEHICLE PARTS, USED
	MARSHALL RESIDENCE	2909 MOUNTAIN VIEW AVE N	RENTON	88	PRIVATE HOUSEHOLDS
	MAUST TERMINAL	1762 6TH AVE S	SEATTLE	4214	LOCAL TRUCKING WITH STORAGE
	Maxines Floral & Gifts Inc	8811 ROOSEVELT WAY NE	SEATTLE	7216	DRYCLEANING PLANTS, EXCEPT RUG
	MC TERMINALS	40 S SPOKANE ST	SEATTLE	5153	GRAIN & FIELD BEANS

	Mercer Island Cleaners	7652 SE 27TH ST	MERCER ISLAND	7216	DRYCLEANING PLANTS, EXCEPT RUG
	MERIDIAN LANDFILL	170TH N & MERIDIAN AV	SEATTLE	4953	LANDFILL
	METRO EAST BASE	1975 124TH AVE NE	BELLEVUE	4111	LOCAL AND SUBURBAN TRANSIT
				417	BUS TERMINAL AND SERVICE FACILITIES
	METRO NORTH BUS BASE	N 165 ST & 1ST AV NE	SEATTLE	4953	LANDFILL
	MOBIL OIL CANAL BULK PLANT	1101 NW 45TH ST	SEATTLE	29	PETROLEUM AND COAL PRODUCTS
				5171	PETROLEUM BULK STATIONS & TERMINALS
	NEWCASTLE COAL CREEK LANDFILL	NEWCASTLE COAL CR RD SECT 26	ISSAQUAH	4953	REFUSE SYSTEMS
	NORTAR INC	1700 N NORTHLAKE WY	SEATTLE	2952	ASPHALT FELTS &COATINGS
	NORTH COAST CHEMICAL CO	6300 17TH AV S	SEATTLE	28	CHEMICALS AND ALLIED PRODUCTS
				2842	POLISHES AND SANITATION GOODS
				28	CHEMICALS AND ALLIED PRODUCTS
				2842	POLISHES AND SANITATION GOODS
	North Winds Weir Intertidal Restoration	2724 S 112TH ST	TUKWILA	5015	MOTOR VEHICLE PARTS, USED
				5015	MOTOR VEHICLE PARTS, USED
	Nucor Steel Seattle Inc	2424 SW ANDOVER ST	SEATTLE	3295	MINERALS, GROUND OR TREATED
				33	PRIMARY METAL INDUSTRIES
				3312	BLAST FURNACES AND STEEL MILLS
				3399	PRIMARY METAL PRODUCTS, NEC
	OLYMPIC HOME CARE PRODUCTS	1141 NW 50TH	SEATTLE	2865	CYCLIC COAL TAR CRUDES,DYES, PIGMENT
	PACCAR Inc	1400 N 4TH ST	RENTON	3325	STEEL FOUNDRIES, UNCLASSIFIED
				3462	IRON AND STEEL FORGINGS
				3531	CONSTRUCTION MACHINERY & EQUIPMENT
				4213	TRUCKING, EXCEPT LOCAL
				7374	DATA PROCESSING AND PREPARATION
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	Pace International LP	500 7TH AVE S	KIRKLAND	28	CHEMICALS AND ALLIED PRODUCTS
				2841	SOAP AND OTHER DETERGENTS
				2842	POLISHES AND SANITATION GOODS
				2873	NITROGENOUS FERTILIZERS
				2879	AGRICULTURAL CHEMICALS, NEC

				2899	CHEMICAL PREPARATIONS, NEC
	Pacific City Park	3RD AVE SE & WHITE RIVER	PACIFIC	4953	LANDFILL
	PIER 1	2130 HARBOR AVE SW	SEATTLE	3731	SHIP BUILDING AND REPAIRING
	PILLON PROPERTY	15753 SE RENTON ISSAQUAH RD	RENTON	5015	MOTOR VEHICLE PARTS, USED
				5093	SCRAP AND WASTE MATERIALS
	PIONEER LUMBER & TREATING CO	1080 W EWING	SEATTLE	2491	WOOD PRESERVING
				4226	SPECIAL WAREHOUSING & STORAGE
	PUGET POWER AUBURN SERV CTR	33940 WEYERHAEUSER WAY S	AUBURN	7538	GENERAL AUTOMOTIVE REPAIR SHOPS
	PUYALLUP KIT CORNER LANDFILL	S 352ND & I5 PUYALLUP CUTOFF RD	FEDERAL WAY	4953	REFUSE SYSTEMS
	QUENDALL TERMINALS	4503 LAKE WASHINGTON BLVD N	RENTON	2411	LOGGING
				5169	CHEM. & ALLIED PRODUCTS (WHOLESALE)
	RAINIER BEACH AUTOMOTIVE	9479 RAINIER AVE S	SEATTLE	753	AUTOMOTIVE REPAIR SHOPS
				7532	TOP & BODY REPAIR & PAINT SHOPS
	Rainier Court	RAINIER AVE S	SEATTLE	01	AGRICULTURAL PRODUCTION - CROPS
	Rainier Precision LLC	1150 EASTLAKE AVE E	SEATTLE	3089	PLASTICS PRODUCTS, NEC
				3449	MISCELLANEOUS METAL WORK
				3451	SCREW MACHINE PRODUCTS
				8734	TESTING LABORATORIES
	RAVENNA LANDFILL UNION BAY	NE 45TH & MONTLAKE	SEATTLE	4953	LANDFILL
	Rexam Beverage Can Co	1220 2ND AVE N	KENT	3411	METAL CANS
				3441	FABRICATED STRUCTURAL METAL
	RICKS AUTO WRECKING	12621 STONE AV N	SEATTLE	5015	MOTOR VEHICLE PARTS, USED
	Salmon Bay Steel Ballard	4315 9TH AVE NW	SEATTLE	3312	BLAST FURNACES AND STEEL MILLS
				3325	STEEL FOUNDRIES, UNCLASSIFIED
				3399	PRIMARY METAL PRODUCTS, NEC
		1 MILES OFF HWY 2 NEAR MP 55.3	SKYKOMISH	283	DRUGS
				5015	MOTOR VEHICLE PARTS, USED
	Seattle City Dexter Horton Building	710 2ND AVE	SEATTLE	9111	EXECUTIVE OFFICES
	Seattle City DOT Maintenance Yard	2940 WESTLAKE AVE N	SEATTLE	379	MISCELLANEOUS TRANSPORTATION EQUIPME
				5198	PAINTS, VARNISHES, AND SUPPLIES
	Seattle City DOT Ship Canal Trail	6TH AVE W & EMERSON ST VIADUCT	SEATTLE	401	RAILROADS

	Seattle City Parks & Rec Magnuson Park	6500 SANDPOINT WAY NE	SEATTLE	9999	NONCLASSIFIABLE ESTABLISHMENTS
	SEATTLE IRON & METALS MAIN YRD	2955 11TH AVE SW	SEATTLE	33	PRIMARY METAL INDUSTRIES
				5093	SCRAP AND WASTE MATERIALS
	SEATTLE LIGHTING STA	1177 ELLIOTT AVE W	SEATTLE	1311	COAL GASIFICATION
	Seattle Port Terminal 117	8700 DALLAS AVE S	SEATTLE	2952	ASPHALT FELTS &COATINGS
	SEATTLE PORT TERMINAL 91	2001 W GARFIELD ST	SEATTLE	4222	REFRIGERATED WAREHOUSING AND STORAGE
				4449	WATER TRANSPORTATION OF FREIGHT, NEC
				9199	GENERAL GOVERNMENT, NEC
	SEATTLE PORT TERMINAL 91 TANK FARM	2001 W GARFIELD ST	SEATTLE	4953	RECYCLE OPERATION
				5171	PETROLEUM BULK STATIONS & TERMINALS
	SEATTLE STEAM CO WESTERN AV	1319 WESTERN AV	SEATTLE	4961	STEAM AND AIR-CONDITIONING SUPPLY
	Shell 120764	17010 PACIFIC HWY S	SEATAC	5541	GASOLINE SERVICE STATIONS
	SHELL OIL PRODUCT SEATTLE TERMINAL	2555 13TH AVE SW	SEATTLE	29	PETROLEUM AND COAL PRODUCTS
				2992	LUBRICATING OILS AND GREASES
				5171	PETROLEUM BULK STATIONS & TERMINALS
	SOUTHPARK LANDFILL	8200 2ND AVE S	SEATTLE	4953	LANDFILL
				5421	MEAT AND FISH MARKETS
				7692	WELDING REPAIR
	SR 519 Street Improvement	ALASKAN WAY S	SEATTLE	1611	HIGHWAY AND STREET CONSTRUCTION
	ST CHARLES HOTEL	619 3RD AVE	SEATTLE	6513	APARTMENT BUILDING OPERATORS
	STERNOFF METALS CORPORATION	1600 SW 43RD ST	RENTON	3449	MISCELLANEOUS METAL WORK
	SUNSET PARK & TUB LAKE DUMP	S 136TH ST & 18TH AV S	SEATAC	4953	REFUSE SYSTEMS
	SUNSET VIEW APARTMENTS	2101 SW SUNSET BLVD	RENTON	6513	APARTMENT BUILDING OPERATORS
	SW HARBOR PROJ BN BUCKLEY YD	26TH AV SW & SW SPOKANE ST	SEATTLE	4013	RAILROAD SWITCHING & TERMINAL ESTABL
	SW HARBOR PROJ LOCKHEED YD 2	2330 SW FLORIDA ST	SEATTLE	3731	SHIP BUILDING AND REPAIRING
	SW HARBOR PROJ WYCKOFF	W MARGINAL WY SW & FLORIDA ST SW	SEATTLE	2491	WOOD PRESERVING

	ToxGon Corp Seattle	631 S 96TH ST	SEATTLE	3567	INDUSTRIAL PROCESS FURNACES & OVENS
	UNION STATION SITE	JACKSON ST & 4TH AV	SEATTLE	1311	COAL GASIFICATION
				332	IRON & STEEL FOUNDRIES
	UNOCAL 4704	15623 1ST AVE S	BURIEN	5541	GASOLINE SERVICE STATIONS
	UNOCAL SEATTLE MARKET LOWER	BN ELLIOTT RR BAY & BROAD	SEATTLE	5171	PETROLEUM BULK STATIONS & TERMINALS
	UNOCAL SEATTLE MARKETING TERM	BROAD ST & WESTERN AV & BAY ST	SEATTLE	5171	PETROLEUM BULK STATIONS & TERMINALS
	US NAVY STATION PUGET SOUND	7500 SANDPOINT WAY NE	SEATTLE	9711	NATIONAL SECURITY
	WA ARMY National Guard OMS 6	1601 W ARMORY WAY	SEATTLE	4785	INSPECTION AND FIXED FACILITIES
				9711	NATIONAL SECURITY
	WA DSHS Fircrest School	15230 15TH AVE NE	SHORELINE	8052	INTERMEDIATE CARE FACILITIES
				8361	RESIDENTIAL CARE
	WA UW 815 Mercer	815 MERCER ST	SEATTLE	4924	NATURAL GAS DISTRIBUTION
	Washington Cedar Supply	223 W SMITH ST	KENT	752	AUTOMOBILE PARKING
				9999	NONCLASSIFIABLE ESTABLISHMENTS
				5093	SCRAP AND WASTE MATERIALS
	Westbridge Building	4201 W MARGINAL WAY SW	SEATTLE	9999	NONCLASSIFIABLE ESTABLISHMENTS
	Western Processing	7215 S 196TH ST	KENT	4953	RECYCLE OPERATION
	Weyerhaeuser Enumclaw Millpond	31002 CHINOOK PASS HWY	ENUMCLAW		SAWMILLS & PLANNING MILLS, GEN
				2421	SAWMILLS AND PLANING MILLS, GENERAL
				4212	LOCALTRUCKING WITHOUT STORAGE
				5031	LUMBER, PLYWOOD, MILLWORK (WHOLESALE
				7699	REPAIR SERVICES, NEC
	Wycoff Co West Seattle	2801 SW FLORIDA ST	SEATTLE	2491	WOOD PRESERVING
				9199	GENERAL GOVERNMENT, NEC
KITSAP	ACE PAVING MAINTENANCE SHOP	DICKEY RD	SILVERDALE	7542	CARWASHES
				7699	REPAIR SHOPS & RELATED SERVICES-MISC
	AIRPORT AUTO WRECKING I	6504 SW OLD CLIFTON RD	PORT ORCHARD	5093	SCRAP & WASTE MATERIALS
	AIRPORT AUTO WRECKING II	4275 HWY 3 SW	PORT ORCHARD	5015	MOTOR VEHICLE PARTS, USED

	ARPER DICKEY ROAD LANDFILL	9546 DICKEY RD NW	SILVERDALE	4953	REFUSE SYSTEMS
	BAINBRIDGE ISLAND LANDFILL	VINCENT RD	BAINBRIDGE ISLAND	4953	LANDFILL
	BATTLE POINT SITE	VENICE LOOP RD & KIRK ST	BAINBRIDGE ISLAND	4953	REFUSE SYSTEMS
	BREMERTON AUTO WRECKING LANDFILL	4275 SR 3 SW	PORT ORCHARD	4953	REFUSE SYSTEMS
	CONSTITUTION AVE LANDFILL	CONSTITUTION AVE & PORTER	BREMERTON	4953	LANDFILL
	EAGLE HARBOR	CREOSOTE PL NE	BAINBRIDGE ISLAND	2491	WOOD PRESERVING
	EAGLE HARBOR WYCKOFF	CREOSOTE PL NE	BAINBRIDGE ISLAND	2491	WOOD PRESERVING
	EGLON DUMP	SOUTH OF HANSVILLE RD & OLD HANSVILLE RD	HANSVILLE	4953	REFUSE SYSTEMS
	HEAD OF BAY	3050 W SR 16	BREMERTON	4953	REFUSE SYSTEMS
	HOLLY DUMP	NW SEABECK HOLLY RD	BREMERTON	4953	REFUSE SYSTEMS
	INDIANOLA DUMP	S KINGSTON RD NE & S MALONE LANE NE	KINGSTON	4953	REFUSE SYSTEMS
	KITSAP CNTY DPW BREIDABLICK PIT	NE CORNER OF PIONEER WAY & LOFALL RD	POULSBO	1442	CONSTRUCTION SAND & GRAVEL (QUARRY)
				3531	CONSTRUCTION MACHINERY & EQUIPMENT
	KITSAP COUNTY SILVERDALE LANDFILL	DICKEY RD NW	SILVERDALE	4953	REFUSE SYSTEMS
	LAMBERTS RADIATOR SHOP	3338 KITSAP WY	BREMERTON	7539	AUTO REPAIR SHOPS, MISCELLANEOUS
	LOVGREN GRAVEL PIT	7500 LOVGREN RD	BAINBRIDGE ISLAND	1442	CONSTRUCTION SAND & GRAVEL (QUARRY)
	Old Bremerton Gasworks & Sesko Property	1725 PENNSYLVANIA AV	BREMERTON	3312	BLAST FURNACES, COKE OVENS
				3499	FABRICATED METAL PRODUCTS, NEC
				5171	PETROLEUM BULK STATIONS & TERMINALS
	PETERSON DUMP	KITSAP WAY & OYSTER BAY AVE	BREMERTON	4953	LANDFILL

	Pope & Talbot Inc Sawmill	VIEW DRIVE	PORT GAMBLE	2421	SAWMILLS AND PLANING MILLS, GENERAL
				2421	SAWMILLS AND PLANING MILLS, GENERAL
	PORT ORCHARD LANDFILL	CLIFTON RD SW & OLD CLIFTON RD SW	PORT ORCHARD	4953	REFUSE SYSTEMS
	Robinson Property	1118 CHARLESTON BEACH RD	BREMERTON	554	GASOLINE SERVICE STATIONS
	RURAL GARBAGE SERVICE WINDJAMMER	NW WINDJAMMER CT	BREMERTON	4953	REFUSE SYSTEMS
	SEBRING PROPERTY	11627 SE SEBRING DR	SOUTHWORTH	249	MISCELLANEOUS WOOD PRODUCTS
				3795	TANKS AND TANK COMPONENTS
				249	MISCELLANEOUS WOOD PRODUCTS
				3795	TANKS AND TANK COMPONENTS
	Seitz Property	BRIAN LN NW	SILVERDALE	5015	MOTOR VEHICLE PARTS, USED
	SKIRVING DUMP	WERNER RD SW	BREMERTON	4953	REFUSE SYSTEMS
	US NAVY JACKSON PARK	UNNAMED RD E OF ROOT RD	BREMERTON	2892	EXPLOSIVES
	US NAVY JACKSON PARK OU 1	ROOT RD	BREMERTON	2892	EXPLOSIVES
	US NAVY JACKSON PARK OU 2	UNNAMED RD E OF ROOT RD	BREMERTON	2892	EXPLOSIVES
	US NAVY KEYPORT	HWY 308	KEYPORT	9711	NATIONAL SECURITY
	US NAVY KEYPORT OU1	610 DOWELL ST	KEYPORT	3471	ELECTROPLATING, PLATING, POLISHING,A
	US NAVY KEYPORT OU1	610 DOWELL ST	KEYPORT	9711	NATIONAL SECURITY
	US NAVY PSNS	1ST ST	BREMERTON	9711	NATIONAL SECURITY
	US NAVY PSNS OUA	1ST ST	BREMERTON	9711	NATIONAL SECURITY
	US NAVY PSNS OUB	1400 FARRAGUT AVE	BREMERTON	9711	NATIONAL SECURITY
	US NAVY SUBASE	US HWY 99	SILVERDALE	4953	HAZARDOUS WASTE MATERIAL DISPOSAL SI
				9711	NATIONAL SECURITY
	VIP LANDFILL	OYSTER BAY AVE	BREMERTON	5093	SCRAP AND WASTE MATERIALS
	VOCKRODT DUMP	W COLUMBIA WAY & NATIONAL AVE	BREMERTON	4953	REFUSE SYSTEMS
	WA ECY Manchester Lab	7411 BEACH DR E ECY LAB	PORT ORCHARD	4953	LANDFILL
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	ZINK DUMP	BONNEVILLE PL SE & PERDEMCO AVE SE	PORT ORCHARD	4953	REFUSE SYSTEMS

KITTITAS	CABIN CREEK PROPERTY	CABIN CREEK RD	EASTON	241	LOGGING
KLICKITAT	COLUMBIA ALUMINUM Corp	HWY 14	GOLDENDALE	3334	PRIMARY PRODUCTION OF ALUMINUM
LEWIS	AMERICAN CROSSARM & CONDUIT	100 CHEHALIS AVE SW	CHEHALIS	24	LUMBER AND WOOD PRODUCTS
				4953	LANDFILL
				9511	AIR, WATER, & SOLID WASTE MANAGEMENT
	COWLITZ STUD CO MORTON	302 SR 7	MORTON	2421	SAWMILLS AND PLANING MILLS, GENERAL
	DEGOEDE BULB FARM INC	409 MOSSYROCK RD	MOSSYROCK	01	AGRICULTURAL PRODUCTION-CROPS
MASON	MASON CNTY SALVAGE YARD	1840 W CLOQUALLUM RD	SHELTON	1795	WRECKING AND DEMOLITION WORK
				5015	MOTOR VEHICLE PARTS, USED
				5093	SCRAP AND WASTE MATERIALS
	SIMPSON TIMBER BUNKER C	700 S 1ST ST	SHELTON	24	LUMBER AND WOOD PRODUCTS
PIERCE	35TH ST LANDFILL CITY FILL	S 35TH ST & PACIFIC AVE	TACOMA	5039	CONSTRUCTION MATERIALS, NEC
	Airo Services Inc	4110 11TH ST E	TACOMA	4789	TRANSPORTATION SERVICES, NEC
				4953	GARBAGE: COLLECTING, DESTROYING, PRO
	ASARCO DEMOLITION	52ND ST & BALTIMORE ST	TACOMA	3331	NONFERROUS METALS, SMELT/ REFINE
				3351	COPPER ROLLING, DRAWING, EXTRUDING
	ASARCO SMELTER	52ND ST & BALTIMORE ST	TACOMA	3331	NONFERROUS METALS, SMELT/ REFINE
				3351	COPPER ROLLING, DRAWING, EXTRUDING
	CAMAS PROPERTY	2926 S M ST	TACOMA	5171	PETROLEUM BULK STATIONS & TERMINALS
	CASCADE TIMBER 2	S TAYLOR WAY	TACOMA	24	LUMBER AND WOOD PRODUCTS
	CLOVER PARK SCHOOL DISTRICT HANGAR BLDG	9219 LAKEWOOD DR SW	LAKEWOOD	415	SCHOOL BUSES
	COSKI INDUSTRIAL DUMP	5403 PENDLE LANGE RD	TACOMA	4953	LANDFILL
	Cummins NW Inc	3701 PACIFIC HWY E	TACOMA	3799	TRANSPORTATION EQUIPMENT, NEC
	D ST PETROLEUM	3RD-7TH & D ST	TACOMA	29	PETROLEUM AND COAL PRODUCTS
	Discount Auto Repair &	1009 S 9TH ST	TACOMA	7532	TOP & BODY REPAIR & PAINT SHOPS

	Bodyworks			9999	NONCLASSIFIABLE ESTABLISHMENTS
	DORMAN TIRE YARD FIRE	35707 KINSMAN RD E	ROY	3011	TIRES & INNER TUBES
	EDDON BOAT PARK	3805 HARBORVIEW DR	GIG HARBOR	3732	BOAT BUILDING AND REPAIRING
	FREDERICKSON INDUSTRIAL PARK	6200 176 ST E & 18300 CANYON RD	PUYALLUP	2421	SAWMILLS & PLANING MILLS, GENERAL
				2491	WOOD PRESERVING
	Glenn Springs Holdings Inc	709 ALEXANDER AVE	TACOMA	29	PETROLEUM AND COAL PRODUCTS
				5171	PETROLEUM BULK STATIONS & TERMINALS
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	HIDDEN VALLEY LANDFILL THUN FLD	17975 MERIDIAN S	PUYALLUP	01	AGRICULTURAL PRODUCTION-CROPS
				4953	LANDFILL
	INS CORRECTIONAL SERVICES CORP	1623 E J ST	TACOMA	9999	NONCLASSIFIABLE ESTABLISHMENTS
	JOHNSONS JEWELRY & GIFTS	103 S MERIDIAN	PUYALLUP	59	MISCELLANEOUS RETAIL
	KAPOWSIN ELEMENTARY SCHOOL	10412 264TH ST	GRAHAM	821	ELEMENTARY AND SECONDARY SCHOOLS
	KLEENBLAST DIVISION	1448 ST PAUL AVE	TACOMA	3291	ABRASIVE PRODUCTS
				5032	BRICK, STONE, & RELATED MATERIALS
				5039	CONSTRUCTION MATERIALS, NEC
	KURT CHRISTIANSEN PROPERTY	4521 PIONEER WAY E	TACOMA	1795	WRECKING AND DEMOLITION WORK
		4521 PIONEER WAY E	TACOMA	75	AUTO REPAIR, SERVICES, AND PARKING
	LEWIS AUTO WRECKING	6012 160TH ST SE	PUYALLUP	9999	NONCLASSIFIABLE ESTABLISHMENTS
	LUCKY LEOS CARWASH	4920 109TH ST SW	LAKEWOOD	7542	CARWASHES
	McFarland Cascade Pole & Lumber Co	1640 E MARC ST	TACOMA	2491	WOOD PRESERVING
	NATIONAL OIL DUMP	25TH & WILKESON	TACOMA	4953	LANDFILL
	Olson Brothers Chevrolet	5502 PT FOSDICK DR NW	GIG HARBOR	5511	NEW AND USED CAR DEALERS
	Pacific Functional Fluids LLC Tacoma	2244 PORT OF TACOMA RD	TACOMA	2911	PETROLEUM REFINING
				5093	SCRAP & WASTE MATERIALS
				5172	PETROLEUM PRODUCTS, NEC
				7389	BUSINESS SERVICES, MISCELLANEOUS
	Petroleum Reclaiming Service Inc	3003 TAYLOR WAY	TACOMA	2999	PETROLEUM AND COAL PRODUCTS, NEC
	PORT OF TACOMA	3400 TAYLOR WAY	TACOMA	3334	PRIMARY PRODUCTION OF ALUMINUM
				3355	ALUMINUM ROLLING & DRAWING, NOT ELSE

	Precision Tune 122nd Puyallup	10212 122ND ST E C	PUYALLUP	9999	NONCLASSIFIABLE ESTABLISHMENTS
	PSE BUCKLEY DEBRIS PILE FILL TERRACE BUR	NE OF BUCKLEY NEAR DIVERSION DAM	BUCKELY	4911	ELECTRIC SERVICES
				7999	AMUSEMENT AND RECREATION, NEC
	PUGET SOUND OIL CO	21716 ORVILLE RD E & FISK RD	ORTING	2999	PETROLEUM & COAL PRODUCTS
	REFLEX RECYCLING	2432 E 11TH ST	TACOMA	2911	PETROLEUM REFINING
				291	PETROLEUM REFINING
	Robert Rosch Property	30220 72ND AVE S	ROY	4953	RUBBISH COLLECTION & DISPOSAL
				9511	AIR, WATER, & SOLID WASTE MANAGEMENT
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	SHEAR TRUCKING	26719 SR 410 E	BUCKLEY	421	TRUCKING & COURIER SERVICES, EX. AIR
				4212	LOCAL TRUCKING, WITHOUT STORAGE
				4214	LOCAL TRUCKING WITH STORAGE
	Shore Terminal LLC Valero LP	250 E D ST	TACOMA	4226	SPECIAL WAREHOUSING AND STORAGE, NEC
				5171	PETROLEUM BULK STATIONS & TERMINALS
				5172	PETROLEUM PRODUCTS, NEC
	SIMON & SONS TARPITS	2200 E RIVER ST	TACOMA	2999	PETROLEUM & COAL PRODUCTS
	SOUND MILL INC	2021 MARC AVE	TACOMA	2421	SAWMILLS & PLANNING MILLS, GEN
	SOUND TRANSIT SUMNER STATION	711 NARROW ST	SUMNER	4011	RAILROADS, LINE-HAUL OPERATING
	Stadium High School	111 N E ST	TACOMA	9999	NONCLASSIFIABLE ESTABLISHMENTS
	STANDARD CHEMICAL CO SITE FORMER	22ND ST & DOCK ST	TACOMA	28	CHEMICALS AND ALLIED PRODUCTS
	SUBURBAN MECHANICAL INC	99TH ST E & 10TH AVE E	TACOMA	1794	EXCAVATION WORK
				3531	CONSTRUCTION MACHINERY
	TACOMA COAL GASIFICATION	22ND ST & A ST	TACOMA	1311	COAL GASIFICATION
				29	PETROLEUM AND COAL PRODUCTS
	TACOMA METALS SITE	1919 PORTLAND AVE	TACOMA	3449	MISCELLANEOUS METAL WORK
				5093	SCRAP AND WASTE MATERIALS
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	TACOMA REDEVELOPMENT PROP	THEA FOSS WATERWAY	TACOMA	2869	INDUS. ORGANIC CHEMICALS
	TRANSMISSION HOUSE	13417 PACIFIC AVE S	TACOMA	7537	AUTOMOTIVE TRANSMISSION REPAIR SHOPS

	Tvetens Lakewood Inc	10002 BRIDGEPORT WAY SW	TACOMA	7538	GENERAL AUTOMOTIVE REPAIR SHOPS
	UNION PACIFIC RR	1119 MILWAUKEE WAY	TACOMA	4011	RAILROADS, LINE HAUL OPERATING
	US ARMY RUSTON WAY MILITARY SITE	3000 N RUSTON WAY	TACOMA	3728	AIRCRAFT PARTS & AUXILIARY EQUIPMENT
	US ARMY WSMC Pier 23	401 ALEXANDER AVE	TACOMA	99	NONCLASSIFIABLE ESTABLISHMENTS
	USAF MAFB MTCA	62 CES CEV	MCCHORD AFB	4581	AIRPORTS, AIRFIELDS, AIR TERMINALS
				9711	NATIONAL SECURITY
	USAF MAFB WASHRACK	62ND CES CEV	MCCHORD AFB	4581	AIRPORTS, AIRFIELDS, AIR TERMINALS
				9711	NATIONAL SECURITY
	WA DOC McNeil Island Corrections Center	MCNEIL ISLAND CC	STEILACOOM	9223	CORRECTIONAL INSTITUTIONS
	WA DOT BRIDGEPORT WAY INTERCHANGE	12320 BRIDGEPORT WAY SW	TACOMA	5541	GASOLINE SERVICE STATIONS
	WA DOT STORAGE	S OF 38TH ST & SR 7	TACOMA	4226	SPECIAL WAREHOUSING AND STORAGE, NEC
	WA NATIONAL GUARD CAMP MURRAY	CAMP MURRAY BLDG 33	TACOMA	9711	NATIONAL SECURITY
	WEYERHAEUSER DUPONT 1	2301 CENTER DR	DUPONT	2892	EXPLOSIVES
				4953	LANDFILL
				6552	SUBDIVIDERS AND DEVELOPERS, NEC
SKAGIT	A Ave Landfill	A AVE & 37TH ST	ANACORTES	5093	SCRAP AND WASTE MATERIALS
				7999	AMUSEMENT AND RECREATION, NEC
	AMERICAN RECYCLING & MANUFACTURING	2045 BROWN RD	FERNDALE	1442	CONSTRUCTION SAND AND GRAVEL
	Anacortes Port	1019 Q AVE	ANACORTES	4491	MARINE CARGO HANDLING
				4493	MARINAS
				4581	AIRPORTS, FLYING FIELDS, & SERVICES
	ARTS AUTO WRECKING	23536 RIVER RD	SEDRO WOOLLEY	5015	MOTOR VEHICLE PARTS, USED
	CUSTOM PLYWOOD MILL	35TH & V ST	ANACORTES	2436	SOFTWOOD VENEER & PLYWOOD
				2436	SOFTWOOD VENEER & PLYWOOD
	FOREST ESTATES LANDFILL	SECTION ST & WOODLAND DR	MOUNT VERNON	4953	REFUSE SYSTEMS
	GLENNS DIESEL	14885 SR 9		7538	GENERAL AUTOMOTIVE REPAIR SHOPS
	HERBS MUFFLER & TUNE UP CENTER	224 W FERRY ST	SEDRO WOOLLEY	5541	GASOLINE SERVICE STATIONS
	His Place Community Church	1480 BURLINGTON BLVD	BURLINGTON	3714	MOTOR VEHICLE PARTS AND ACCESSORIES

				866	RELIGIOUS ORGANIZATIONS
	MARCH POINT LANDFILL	1/4 MI E OF BN WHITMARSH	ANACORTES	4953	LANDFILL
	MJB PROPERTIES	17TH-30TH ST & T AVE	ANACORTES	2611	PULP MILLS
				4493	MARINAS
	Motor Trucks Inc Mount Vernon	2501 HENSON RD	MOUNT VERNON	5511	NEW AND USED CAR DEALERS
				753	AUTOMOTIVE REPAIR SHOPS
	Padilla Heights Rd Property	9655 PADILLA HEIGHTS RD	ANACORTES	283	DRUGS
	PM Northwest Dump	PADILLA HEIGHTS RD OFF HWY 20	ANACORTES	4953	LANDFILL
	PORT OF ANACORTES	Q AVE & 15TH ST	ANACORTES	2611	PULP MILLS
	Scott Paper Mill Former	17TH-22ND ST & R AVE	ANACORTES	261	PULP MILLS
	SINNES ROAD LANDFILL	SINNES RD	MOUNT VERNON	5093	SCRAP AND WASTE MATERIALS
	SKAGIT COUNTY PORT	15400 AIRPORT DR	BURLINGTON	4581	AIRPORTS, FLYING FIELDS, & SERVICES
	TRIDENT SEAFOODS CORP 5TH ST & L AVE	5TH ST & L AVE	ANACORTES	2092	FISH PROCESSING FACILITY
SNOHOMISH	ARLINGTON CITY AIRPORT	18204 59TH AVE NE	ARLINGTON	4581	AIRPORTS, FLYING FIELDS, & SERVICES
				7999	AMUSEMENT AND RECREATION, NEC
	Boeing Everett	3003 W CASINO RD	EVERETT	3721	AIRCRAFT
	Bonneville Power Admin Snohomish	914 AVE D	SNOHOMISH	491	ELECTRIC SERVICES
				4911	ELECTRIC SERVICES
				9199	GENERAL GOVERNMENT, NEC
	Buse Timber & Sales Inc	3812 28TH PL NE	EVERETT	2421	SAWMILLS AND PLANING MILLS, GENERAL
				2491	WOOD PRESERVING
				5211	LUMBER & OTHER BLDG. MATERIALS DEALE
	EDMONDS PORT W DAYTON	120-190 W DAYTON ST	EDMONDS	8999	SERVICES, MISCELLANEOUS
	EVERETT CITY BOND STREET	BOND ST & KROMER AVE	EVERETT	4911	ELECTRIC SERVICES
				493	COMBINATION UTILITY SERVICES
	EVERETT LANDFILL TIRE FIRE	2900 36TH ST	EVERETT	4953	REFUSE SYSTEMS
	Former Bryant Property	MERIDIAN AVE N	ARLINGTON	88	PRIVATE HOUSEHOLDS
	GREAT NORTHERN BNRR TANK FARM	1621 MUKILTEO BLVD	EVERETT	5171	PETROLEUM BULK STATIONS & TERMINALS
	Hansens Towing	3813 & 3827 RUCKER	EVERETT	7532	TOP & BODY REPAIR & PAINT SHOPS

		AVE		5015	MOTOR VEHICLE PARTS, USED
	HOFGESANG PROPERTY	9116 LAKEWOOD RD	STANWOOD	73	BUSINESS SERVICES
				88	PRIVATE HOUSEHOLDS
	HOGLAND TRANSFER CO INC	3221 PAINE AVE	EVERETT	4214	LOCAL TRUCKING WITH STORAGE
	James Auto Service	21000 70TH AVE W	EDMONDS	753	AUTOMOTIVE REPAIR SHOPS
	JH Baxter & Co Arlington	6520 188TH ST NE	ARLINGTON	2491	WOOD PRESERVING
	MARYSVILLE CITY WATERFRONT PARK	SW OF 1ST ST & STATE AVE	MARYSVILLE	35	INDUSTRIAL MACHINERY AND EQUIPMENT
	MCCOLLUM PARK	128TH ST SE & 4TH DR SE	EVERETT	4953	REFUSE SYSTEMS
				7999	AMUSEMENT & RECREATION SERVICES-MISC
	Old Mill Town Mall	201 5TH AVE S	EDMONDS	75	AUTO REPAIR, SERVICES, AND PARKING
	Penske Truck Leasing Co LP Everett	3225 MCDOUGALL AVE	EVERETT	7513	TRUCK RENTAL AND LEASING, NO DRIVERS
	PSE Everett Operating Facility	3630 RAILWAY AV	EVERETT	1311	COAL GASIFICATION
				3312	BLAST FURNACES, COKE OVENS
				4924	NATURAL GAS DISTRIBUTION
	ROTARY PARK	LOWELL SNOHOMISH RIVER RD & S 1ST	EVERETT	2491	WOOD PRESERVING
	SATHER MFG CO INC	3330 MCDOUGALL AVE	EVERETT	3321	GRAY AND DUCTILE IRON FOUNDRIES
	SISCO LANDFILL	7500 WADE RD	ARLINGTON	4953	LANDFILL
	Sno Isle Skills Center	9001 AIRPORT RD	EVERETT	8249	VOCATIONAL SCHOOLS
	Snohomish Cnty Used Oil Collect	11020 19TH AVE SE	EVERETT	599	RETAIL STORES, NEC
				7539	AUTOMOTIVE REPAIR SHOPS, NEC
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	SNYDER ROOFING BROADWAY	20203 BROADWAY AVE	SNOHOMISH	5033	ROOFING, SIDING, & INSULATION
	UNOCAL EDMONDS BULK FUEL TERM 0178	11720 UNOCO RD	EDMONDS	5093	SCRAP AND WASTE MATERIALS
				5171	PETROLEUM BULK STATIONS & TERMINALS
				5541	GASOLINE SERVICE STATIONS
	US DFSP MUKILTEO	1 FRONT ST	MUKILTEO	9711	NATIONAL SECURITY
	US DOJ DEA YTTRI WOZOW PROPERTY	9218 171ST AV SE	SNOHOMISH	9211	COURTS
	US NAVY Station Everett	2000 W MARINE VIEW DR	EVERETT	3731	SHIP BUILDING AND REPAIRING
				9199	GENERAL GOVERNMENT, NEC
				9711	NATIONAL SECURITY
				9999	NONCLASSIFIABLE ESTABLISHMENTS

	WA AIR NATIONAL GUARD PAINE FLD N PARCEL	2701 112TH ST SW	EVERETT	9711	NATIONAL SECURITY
	WA DOT PARCEL 1-15780 LYNNWOOD	BETWEEN SR 525 & LAKE RD	LYNNWOOD	5012	AUTOMOBILES AND OTHER MOTOR VEHICLES
	Weyerhaeuser Paper Co Everett	515 E MARINE VIEW DR	EVERETT	242	SAWMILLS AND PLANING MILLS
	WOLFORD RECYCLING FACILITY	8624 219TH ST SE	WOODINVILLE	4212	LOCALTRUCKING WITHOUT STORAGE
SPOKANE	Appleway Chevrolet Inc	8500 E SPRAGUE AVE	SPOKANE	7538	GENERAL AUTOMOTIVE REPAIR SHOPS
	Avista Corp Dollar Rd	2406 N DOLLAR RD	SPOKANE	4225	GENERAL WAREHOUSING & STORAGE
	Avista Corp Dollar Rd	2406 N DOLLAR RD	SPOKANE	4939	COMBINATION UTILITIES, NEC
	BNSF Hillyard Lead Soil Site	4800 TO 5300 BLOCK N FERRALL ST	SPOKANE	4013	SWITCHING AND TERMINAL SERVICES
	BNSF Railway Black Tank Property	3202 E WELLESLEY	SPOKANE	4011	RAILROADS, LINE-HAUL OPERATING
	BROADWAY TRUCK STOP	6606 E BROADWAY AVE	SPOKANE	5541	GASOLINE SERVICE STATIONS
	Costco Wholesale 670	5601 E SPRAGUE AVE	SPOKANE	5331	VARIETY STORES
	FOUR LAKES TIRE FIRE FLTF	FOUR LAKES	FOUR LAKES	1442	CONSTRUCTION SAND & GRAVEL (QUARRY)
				4953	REFUSE SYSTEMS
	Inland Empire Paper	3320 N ARGONNE RD	SPOKANE	2621	PAPER MILLS
				4953	REFUSE SYSTEMS
	Midwest Pacific Resources	3808 N SULLIVAN RD BLDG N10	SPOKANE	3743	RAILROAD EQUIPMENT
	North Market St	N MARKET ST & FREYA ST	SPOKANE	291	PETROLEUM REFINING
				4613	REFINED PETROLEUM PIPELINES
				5171	PETROLEUM BULK STATIONS & TERMINALS
	SHERATON SPOKANE HOTEL PROPERTY	322 N SPOKANE FALLS CT	SPOKANE	70	HOTELS & OTHER LODGING PLACES
	Spokane City Central Park Maintenace Pro	809 N WASHINGTON ST	SPOKANE	7538	GENERAL AUTOMOTIVE REPAIR SHOPS
	SPOKANE COMMUNITY COLLEGE	2000 N GREEN ST	SPOKANE	8221	COLLEGES, UNIVERSITIES, PROFESSIONAL
	SPOKANE CONCRETE CUTTING INC	4114 E WELLESLEY AVE	SPOKANE	1541	INDUSTRIAL BUILDINGS AND WAREHOUSES

	SPOKANE INDUSTRIAL PARK G	3808 N SULLIVAN RD	SPOKANE	39	MISCELLANEOUS MANUFACTURING INDUSTRI
	Stockland Livestock Exchange	1004 N FREYA ST	SPOKANE	9999	NONCLASSIFIABLE ESTABLISHMENTS
	Texaco Former	322 W 7TH AVE	SPOKANE	5541	GASOLINE SERVICE STATIONS
	Unocal SS 2938	301 1ST ST	CHENEY	5541	GASOLINE SERVICE STATIONS
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	US AF FAIRCHILD AFB	US HWY 2	SPOKANE	4581	AIRPORTS, FLYING FIELDS, & SERVICES
				9199	GENERAL GOVERNMENT, NEC
				9711	NATIONAL SECURITY
	USAF FAFB PR3	US HWY 2	SPOKANE	29	PETROLEUM AND COAL PRODUCTS
				3728	AIRCRAFT PARTS & AUXILIARY EQUIPMENT
				4952	SEWERAGE SYSTEMS
				753	AUTOMOTIVE REPAIR SHOPS
	WA WSU Academic Building Site	310 N RIVERPOINT BLVD	SPOKANE	8221	COLLEGES AND UNIVERSITIES
	Yellowstone Pipeline Otis Orchards	OTIS ORCHARDS	OTIS ORCHARDS	461	PIPELINES, EXCEPT NATURAL GAS
THURSTON	17936 LITTLEROCK ROAD SE DRUG LAB	17936 LITTLEROCK RD SE	ROCHESTER	99	NONCLASSIFIABLE ESTABLISHMENTS
	Aztec Technology Corp	19950 OLD HWY 99 SW	ROCHESTER	3792	TRAVEL TRAILERS AND CAMPERS
				76	MISC. REPAIR SERVICES
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	CASCADE POLE INC MCFARLAND	1100 WASHINGTON ST	OLYMPIA	2491	WOOD PRESERVING
	CEDAR CREEK CORRECTIONS DNR	BORDEAUX RD	LITTLEROCK	2491	WOOD PRESERVING
	CITIFOR Inc	13120 TILLEY RD S	OLYMPIA	2892	EXPLOSIVES
				4953	LANDFILL
	DaPaul Inc	19444 IVAN ST	ROCHESTER	241	LOGGING
				75	AUTO REPAIR, SERVICES, AND PARKING
	FONES ROAD DITCH	1300 BLOCK FONES RD	OLYMPIA	4952	SEWERAGE SYSTEMS
	Hardel Mutual Plywood	1210 W BAY DR NW	OLYMPIA	2436	SOFTWOOD VENEER AND PLYWOOD
	INDUSTRIAL PETROLEUM DISTRIBUTORS	1117 W BAY DR NW	OLYMPIA	5171	PETROLEUM BULK STATIONS & TERMINALS
	JOHNS AUTO WRECKING	411 93RD AVE SE	OLYMPIA	5015	MOTOR VEHICLE PARTS, USED
	MINITRIE TIRE FIRE	16017 CASE RD SW	ROCHESTER	3011	TIRES & INNER TUBES

WALLA WALLA	Walla Walla City Burdine Property	2690 E ISAACS AVE	WALLA WALLA	4953	REFUSE SYSTEMS
WHATCOM	A & H Auto Dismantlers	1887 NEWKIRK RD	FERNDALE	5015	MOTOR VEHICLE PARTS, USED
	ALS SALVAGE	3525 Y RD	BELLINGHAM	5015	MOTOR VEHICLE PARTS, USED
				5093	SCRAP AND WASTE MATERIALS
	BC CORP	4809 GUIDE MERIDIAN	BELLINGHAM	283	DRUGS
				753	AUTOMOTIVE REPAIR SHOPS
	Bellingham Port Harris Ave Shipyard	201 HARRIS AVE	BELLINGHAM	3731	SHIP BUILDING AND REPAIRING
	BELLINGHAM PORT WELDCRAFT SITE	9 SQUALICUM WAY	BELLINGHAM	3732	BOAT BUILDING AND REPAIRING
	Blaine Shipyard	9088 SHIPYARD LANE	BLAINE	4482	FERRIES
	Blaine Shipyard	9088 SHIPYARD LANE	BLAINE	5171	PETROLEUM BULK STATIONS & TERMINALS
	BOULEVARD PARK	BAYVIEW DR	BELLINGHAM	1311	COAL GASIFICATION
				7999	AMUSEMENT & RECREATION SERVICES-MISC
	BURLINGTON NORTHERN RR ACME	BEHIND RESIDENCE AT END OF CHURCH RD	ACME	401	RAILROADS
	CHEVRON BELLINGHAM PORT	1020 C ST	BELLINGHAM	5171	PETROLEUM BULK STATIONS & TERMINALS
				9999	NONCLASSIFIABLE ESTABLISHMENTS
	Everson Cordage Works Inc	7180 EVERSON GOSHEN RD	EVERSON	2298	CORDAGE AND TWINE
				3552	TEXTILE MACHINERY
	EXXON MOBIL OIL CORP	908 10TH ST	BELLINGHAM	5171	PETROLEUM BULK STATIONS & TERMINALS
	FERNDALE LANDFILL	NEILSEN RD	FERNDALE	5093	SCRAP AND WASTE MATERIALS
	HOLLY ST LANDFILL	600 W HOLLY ST	BELLINGHAM	4953	REFUSE SYSTEMS
				7999	AMUSEMENT & RECREATION SERVICES-MISC
	Laurel Street Site	210 E LAUREL ST	BELLINGHAM	99	NONCLASSIFIABLE ESTABLISHMENTS
	Lavergne Property	1469 SUNSET AVE	FERNDALE	598	FUEL DEALERS
				88	PRIVATE HOUSEHOLDS
	Little Squalicum Park	MARINE VIEW DR	BELLINGHAM	494	WATER SUPPLY
	Mountain View Motors	5499 GUIDE MERIDIAN	BELLINGHAM	5093	SCRAP AND WASTE MATERIALS
	MT BAKER PRODUCTS	2929 ROEDER AVE	BELLINGHAM	2435	HARDWOOD VENEER AND PLYWOOD
				2436	SOFTWOOD VENEER AND PLYWOOD
				5031	LUMBER, PLYWOOD, AND MILLWORK

	NW TRANSFORMER HARKNESS	107 S HARKNESS ST	EVERSON	9999	NONCLASSIFIABLE ESTABLISHMENTS
	OLIVINE CORP HILTON AVE	HILTON AVE & ROEDER AVE	BELLINGHAM	3532	MINING MACHINERY & EQUIPMENT, EXCEPT
	RG HALEY INTL CORP	CORNWALL AVE N	BELLINGHAM	24	LUMBER AND WOOD PRODUCTS
	Westman Marine Inc	218 MCMILLAN AVE	BLAINE	373	SHIP AND BOAT BUILDING AND REPAIRING
				3732	BOAT BUILDING AND REPAIRING
WHITMAN	WA WSU LANDFILL	AIRPORT RD .25 MI FROM HWY 270	PULLMAN	4953	LANDFILL
YAKIMA	Tidricks Quality Transmission Inc	1802 S 1ST ST	YAKIMA	9999	NONCLASSIFIABLE ESTABLISHMENTS
	US ARMY Yakima Training Center	DENR BLDG 810	YAKIMA	2992	LUBRICATING OILS & GREASES
				3449	MISCELLANEOUS METAL WORK
				3568	MECHANICAL POWER TRANSMISSION EQUIPM
				3612	POWER, DISTRIBUTION, AND SPECIALTY T
				3621	MOTORS AND GENERATORS
				4953	REFUSE SYSTEMS
				7521	AUTOMOBILE PARKING
				7549	AUTOMOTIVE SERVICES, EXC. REPAIR & C
	YAKAMA JUICE LLC	1 RAILROAD AVE	SELAH	2033	CANNED FRUITS AND VEGETABLES

Appendix C: Estimation on the additional area impacted by air deposition: Air Deposition Modeling of Dioxin/Furan Emissions from a hypothetical pulp and paper mill

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September 7, 2007

To: MTCA Rule Administrative Record File

From: Hun Seak Park, Toxics Cleanup Program
Craig McCormack, Toxics Cleanup Program
Clint Bowman, Air Quality Program

Subject: Calculation of remedial cost increase between two dioxin soil cleanup level alternatives

Objective

The objective of the work described in this memo is to estimate the range of remedial cost increase as a result of the proposed Model Toxics Control Act (MTCA) rule amendments.

As described in the Cost-Benefit Analysis (CBA), the Department of Ecology (Ecology) identified potentially impacted facilities based on a review of facilities listed on Ecology's confirmed and suspected sites database. These are facilities known or suspected to be contaminated with the chemical mixtures the subject of this rulemaking. Ecology also reviewed the standard industrial codes for businesses in Washington State to identify similar businesses.

Based on this review, atmospheric dispersion and the resulting deposition on soil of particulates containing dioxins from stack emissions by hog-fuel boilers burning salt laden wood waste was identified as the most likely to result in potential cost impacts from the proposed rule amendments. Air dispersion modeling was conducted to identify the aerial deposition pattern of dioxins emitted from the stack of a hypothetical hog-fuel boiler at a pulp and paper mill. These modeling results were used to calculate the difference in the soil surface area between two cleanup level alternatives (11 ppt and 20.5 ppt). This information was then used to estimate the difference in soil volume that would potentially need to be cleaned up as a result of this difference in cleanup levels so that Ecology could estimate the range of remedial cost increase as a result of the proposed rule amendments.

Methodology

A. Cleanup level determination

Ecology determined the regulatory baseline and proposed cleanup levels for cost comparison. For a summary of different cleanup levels, see Table 2. See other information in the rule administrative record for a description of the methodology used to develop these cleanup levels. Ecology's past practice of using a cleanup level of 6.7 ppt was not considered for this cost comparison.

Table 2: Soil Cleanup Levels for Typical Dioxin/Furan Mixture

	Regulatory Baseline	Proposed Rule
Cleanup Level (ppt)	20.5*	11

** Median of actual site data ranges from 16 – 24. 20.5 was chosen as a representative value.*

B. Air deposition modeling

The following is a detailed description of the methodology and rationale employed by Ecology for air deposition modeling in support of the proposed rulemaking.

B.1 Air dispersion model used

A steady-state and Gaussian air dispersion-deposition model, ISCST3[52], was run in flat topography with ten-year meteorological data sets from 19 airports in or near Washington State. The ISCST3 model was used to compute the ten-year deposition of dioxins (dioxin/furan mixture) at points within a user-defined domain for each meteorological data set.

B.2 Model input parameters used

- Composition ratio of dioxin congeners in stack emissions: A fixed congener ratio for 17 dioxin and furan congeners was used to define the emission source strength. This composition ratio was estimated using 20 dioxin soil samples collected from off property but near the Rayonier Pt. Angeles mill to define the physical characteristics of the emissions. This data set was used because it represented the most comprehensive dioxin congener data set available at the time the modeling was conducted. The congener pattern in this data set is also very similar to the congener pattern found on the Rayonier property and matches well with congener patterns for emissions from paper mills in published literature. The weighted-average proportion for each of the 17 congeners used to define the stack emission source strength is

[52] Industrial Source Complex 3 Short Term

shown in Table 3. The TEQ deposition rate of dioxins was calculated using the World Health Organization (WHO) TEFs (2005) and relative emission rates for the congeners for a typical pulp and paper mill[53]. Using the WHO 2005 TEFs and the fixed congener composition ratio described above, 1 pg TEQ of dioxins was determined to be approximately equivalent to 45 pg of dioxins as a measured total concentration.

- Stack source emission rates: Soil concentrations resulting from air deposition are based on various assumed stack source emission rates. Although there are several references[54] that report the current level of dioxins released into the air from a hog-fuel boiler of a typical paper and pulp mill, this data does not reflect emission rates prior to the installation of air pollution control equipment. This is confirmed by data from EPA's Toxics Release Inventory[55] which shows that the yearly total amount of dioxin released to air was reduced almost 10 times between 1987 and 2000. This was similarly reflected in the Rayonier Port Angeles atmospheric deposition modeling done as part of that site's Remedial Investigation.

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[53] The equivalency ratio calculation was based on the 20 off-site soil dioxin data from Figure 5-24 contained in "Former Rayonier Mill Site Uplands Environment RI- Agency Review Draft" dated 11/10/2004 and Table 6-14 and Appendix D contained in "Rayonier Pulp Mill Expanded Site Investigation" dated 10/1998.

[54] For example, refer to Department of Ecology 2000, "Chemicals in Washington State Summary Report: Toxic Release Inventory and Tier Two-Emergency and Hazardous Chemical Inventory, Pub No 02-04-020.

[55] Table 1-7, Inventory of Contemporary Releases (g TEQ/yr) of TEQ_{DF}-WHO_{98} from known sources in the United States for reference years 2000, 1995, and 1987 (Columns A, B & C) and preliminary release estimates for 2000 (Column D), US EPA 2005, "The inventory of Sources and Environmental Release of Dioxin-like Compounds in the United States: The Year 2000 Update (External Review Draft, March 2005: EPA/600/p-03/002A); http://www.epa.gov/ncea/pdfs/dioxin/2k-update/

Table 3: Dioxin Congener's Weighted-Average Composition

Congener	Average (% Mass)
2,3,7,8-TCDD	0.38%
1,2,3,7,8-PeCDD	0.77%
1,2,3,4,7,8-HxCDD	0.89%
1,2,3,6,7,8-HxCDD	1.58%
1,2,3,7,8,9-HxCDD	1.71%
1,2,3,4,6,7,8-HpCDD	13.51%
1,2,3,4,6,7,8,9-OCDD	70.84%
2,3,7,8-TCDF	1.16%
1,2,3,7,8-PeCDF	0.37%
2,3,4,7,8-PeCDF	0.59%
1,2,3,4,7,8-HxCDF	0.44%
1,2,3,6,7,8-HxCDF	0.62%
2,3,4,6,7,8-HxCDF	0.12%
1,2,3,7,8,9-HxCDF	0.27%
1,2,3,4,6,7,8-HpCDF	2.22%
1,2,3,4,7,8,9-HpCDF	0.14%
1,2,3,4,6,7,8,9-OCDF	4.39%
sum	100.0%

The current air pollution regulations found in chapter 173-400 WAC[56] were written in the early 1970s. Little documentation exists to estimate the exact stack emission rate from the hog-fuel boiler from a typical mill in Washington State prior to the installation of major air pollution control equipment. Ecology[57] found that as of 1997, 12% of hog-fuel boilers had no air pollution control equipment, while an additional 13% had relatively inefficient "mechanical collection." The range of dioxin air emission rates used in the model was selected to reflect Ecology's best estimate of air emissions prior to the installation of air pollution control equipment. This was done to represent a worst-case scenario of the maximum area of soil potentially impacted.

There are two types of ash produced by incinerators and industrial boilers: fly ash (air pollution control residues) and bottom ash. Bottom ashes are generally a mixture of grate ash and grate siftings. These materials fall to the bottom of the boiler and are mechanically removed. Without air pollution control devices (cyclones, scrubbers, etc.), most[58] ash produced by a hog-boiler mill would have been released into the atmosphere. Essentially all the dioxin ash load is associated with fly ash rather than grate ash. Since air pollution control equipment that removes the fly ash before discharge to the air was not required and not used before the 1970s, all ash generated from the hog-fuel boiler was assumed to be emitted from the stack and eventually deposited on the ground.

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[56] General regulations for air pollution sources.

[57] Ecology 1997, Wood Waste boiler survey, April 1997, Air Quality Program, Pub No 97-204.

[58] Refer to Table 6 of Ecology, 1998, Washington State Dioxin Source Assessment, July 1998, Pub No 98-320.

Four different emission rates were used to represent a range of operating conditions: 5, 10, 20, and 50 ug/s of dioxin. As illustrated by Equation 1, a source emission rate of one ug/s of dioxin per each facility is equivalent to approximately 1.9 mg TEQ/d per each facility, using the fixed congener composition ratios described in section B.2.

Equation 1:

$$1ug/s * \frac{60s}{\min} * \frac{60\min}{hr} * \frac{24hr}{d} * \frac{ugTEQ}{45ug} * \frac{mg}{1000ug} = 1.9mgTEQ/d$$

These four established stack emission rates (ranging from 9.6 to 96 mg TEQ/d) fall within the range of total ash[59] produced by a typical paper mill. In 1998, Ecology[60] conducted a study on dioxin source strength from four pulp and paper mills located in Washington State. This study found a range of source strengths from 0.012 to 69 mg TEQ/day. The stack emission rates used in the model are relatively conservative compared to these values. Using a larger emission rate produces a larger area affected by aerial deposition and results in a higher additional remedial cost differential between the two dioxin cleanup level alternatives. It is believed that the four source strengths used for the air deposition model are well within the range of historical stack emission patterns in Washington State.

- Total duration of depositing from the stack emission: The ISCST3 model computed the ten-year deposition of the dioxin/furan mixture at points within a user-defined domain for each meteorological data set. Total dioxin air deposition was calculated by multiplying the modeled ten-year deposition by three to simulate a 30-year deposition pattern.

- Meteorological data simulated: Because meteorological data were not readily available at every mill site, meteorological data for 19 airports (see Table 4) were obtained from the archives of the Atmospheric Sciences Department at the University of Washington for use in the modeling. Using a large number of reporting sites helps identify the variability in deposition produced by the different climatic conditions across the state.

  The archived observations report the daily total precipitation once every 24 hours. Because deposition modeling requires an hourly precipitation amount, the precipitation was allocated equally to those hours with a relative humidity greater than 90 percent or to the hour with the highest relative humidity if no observations were greater than 90 percent. Dispersion modeling also requires estimates of mixing height. Since this exercise was for a hypothetical mill and was to apply generally for all 19 mills in the state, Spokane climatological mixing heights from the report by

[59] Total dioxin ash load produced by Rayonier mill was estimated ranging from 1.2 to 69 mg TEQ/d.
[60] Department of Ecology, 1998, Washington State Dioxin Source Assessment, July 1998, Publication No. 98-320.

Holzworth (1971) were used. These mixing heights tend to be lower than heights reported for Seattle during winter days and spring, summer, and autumn mornings and will tend to produce somewhat higher values of deposition.

Table 4: Name of Air Station for Meteorological Data Used for Air Deposition Modeling

Airport name	State	ID	Latitude	Longitude	Elevation, ft	WMO ID
WALLA WALLA RGN	WA	KALW	46.1	-118.28	1204	72788
ASTORIA/CLATSOP	OR	KAST	46.15	-123.88	23	72791
ARLINGTON	WA	KAWO	48.17	-122.16	135	99999
SEATTLE/BOEING	WA	KBFI	47.53	-122.3	16	99999
BELLINGHAM INTL	WA	KBLI	48.8	-122.53	157	99999
PORT ANGELES IN	WA	KCLM	48.12	-123.5	289	99999
WENATCHEE/PANGB	WA	KEAT	47.4	-120.2	1243	99999
SPOKANE INTL AR	WA	KGEG	47.63	-117.53	2365	72785
KELSO-LONGVEIW	WA	KKLS	46.12	-122.9	16	99999
EVERETT/PAINE F	WA	KPAE	47.9	-122.28	607	99999
PENDLETON MUNIC	OR	KPDT	45.68	-118.85	1496	72688
PORTLAND INTL A	OR	KPDX	45.6	-122.6	39	72698
PASCO/TRI-CITIE	WA	KPSC	46.27	-119.12	407	99999
BREMERTON NTNL	WA	KPWT	47.5	-122.75	482	99999
SEATTLE-TACOMA	WA	KSEA	47.45	-122.3	449	72793
STAMPEDE PASS A	WA	KSMP	47.28	-121.33	3966	99999
MCCHORD AFB	WA	KTCM	47.15	-122.48	322	74206
PORTLAND/TROUTD	OR	KTTD	45.55	-122.4	36	99999
QUILLAYUTE STAT	WA	KUIL	47.95	-124.55	203	72797

- Other model inputs used: Table 5 shows other key parameters to estimate air deposition rate for area around the stack emission source. These are listed below:

  - Stack descriptors (stack height, exit temperature, etc.)
  - Atmospheric transport parameters (particle size distributions, dry deposition velocity, etc.)
  - Detailed meteorological data (hourly rainfall, wind speeds, etc.)
  - Terrain descriptions

B.3 Uncertainties associated with the ISCST3 model

There is uncertainty and variability with the model input parameters and assumptions used for the air dispersion/deposition model used by Ecology. Some of the model attributes and assumptions that contribute to uncertainty and variability are as follows:

- This analysis assumes no degradation of dioxins that are deposited on the soil. The assumption of no degradation for the soil contamination source, stack emissions, is reasonable with moderate, but unquantifiable uncertainty. Dioxins are persistent organics that do not readily degrade. For example, the half-life of 2,3,7,8-TCDD in soil is estimated[61] to vary from 25 to 100 years. Processes such as wind and soil

[61] McLachlan et. al., 1996. McLachlan, M.S.; Sewart, A. P.; Bacon, J.R.; Jones, K.C. (1996), Persistence of PCDD/Fs in a Sludge-Amended Soil. Environmental Science and Technology 30:2567-2571;

erosion may deplete the contamination. However, this assumption results in a conservative (higher) estimate of the impacted area of soil and thus a conservative cost estimate.

- Most of the physical-chemical properties needed for the ISCST3 model inputs are specific to 2,3,7,8-TCDD. Uncertainty is introduced into parameter assignment when information specific to one congener is assumed to apply to all dioxin-like congeners. However, because dioxin-like congeners have similar chemical structures, the physical-chemical properties are also similar, so this is not anticipated to introduce significant errors in the analysis.

- The input parameters related to dioxins/furans for the ISCST3 Model are based on estimates obtained from the technical literature usually specific to 2,3,7,8-TCDD. These values can vary depending on the source of information used. This may introduce some variability and uncertainty in the analysis but this is believed to be minimal.

Paustenbach et. al., 1992. Paustenbach, D.; Wenning, R.; Lau, V.; Harrington, N.; Rennix, D.; Parsons, A. (1992), Recent Developments on Hazards Posed by 2378-TCDD in Soil: Implications for setting Risk-Based Cleanup Goals at Residential and Industrial Sites. Journal of Toxicology and Environmental Health, 36: 103-149; Young, 1983. Young, A.L. (1983), Long term studies on the persisitence and movement of TCDD in a natural ecosystem. In: Human and Environmental Risks of Chloronated Dioxins and Related Compounds, Eds. Tucker, R.E., A.L. Young, A.P. Gray, Plenum Press, New York, NY.

Table 5: Parameters Used in the ISCST3 Modeling of Dioxins Emission from a Hypothetical Stack

Air pollution control system and particle reduction rate: Not installed and zero % reduction rate
Model Options: Terrain adjustments: None Building wake effects: None, stack assumed to be greater than GEP height
Stack information: Stack height: 35 m; Stack diameter: 2.45 m; Anemometer height: 10 m Terrain: flat; Stack temperature: 470 K; Stack exit velocity: 15.6 m/s Source elevation: 0 m
Exponent for power law wind increase with height: Default, varies by stability
Particle size categories for dry/wet deposition analysis: 0.7, 1.1, 2.0, 3.6, 5.5, 8.1, 12.5, 15.0 μm
Fraction of dioxin particle bound emissions by particle size category: 0.6536, 0.129, 0.0915, 0.0499, 0.0231, 0.0224, 0.0146, 0.0149
Deposition scavenging coefficients (liquid): .43e-4, .43e-4, .43e-4, .46e-3, .46e-3, .46e-3, .66e-3, .66e-3

C. Conversion of air deposition model output to ground soil dioxin concentration

The air deposition model produces a dioxin flux, which is the mass deposited per unit area over the 30-year air deposition period. The unit conversion from flux to ground soil concentration was made assuming a soil mixing depth of three inches (≈ 8cm). This is based on sampling typically conducted at contaminated sites. The total dioxin mass deposited on the ground over 30-year period is assumed to be evenly mixed within the three inch depth soil layer. Assuming a soil density of 1.5kg/L and using Equation 2 results in this mass flux being converted to a ground surface concentration.

Equation 2:

$$1 pgTEQ/m^2 * (\frac{m^2}{(100cm)^2}) * (\frac{1}{8cm}) * (\frac{L}{1.5kg}) * (\frac{10^3 cm^3}{L}) * (\frac{kg}{10^3 g}) = 8.3x10^{-6} pgTEQ/g$$

Thus, as indicated by Equation 2, one pg TEQ/m^2 is equivalent to $8.3x10^{-6}$ pg TEQ/g of soil.

D. Calculation of incremental acreage for additional cleanup

The total aerial coverage was integrated using the dioxin cleanup level contour line of 11 (proposed) and 20.5 ppt (regulatory baseline). The modeling results are calculated for each 25 meter x 25 meter grid spaced over an area 2 kilometers on a side centered at the point of emission. Table 6 shows the actual acreage covered by these two dioxin contour lines (alternative soil cleanup levels).

E. Discussion of modeling results

The ISCST3, dispersion-deposition model was used to estimate the atmospheric transport and the pattern of deposition of dioxins/furans attributable to smokestack emissions from a hypothetical pulp and paper mill. The concentration and deposition isopleths of the dioxin/furan discharges from the stack are computed at specified distances from the smokestack. Incremental acreage changes were computed between the proposed cleanup level (11 ppt) and the regulatory baseline cleanup level (20.5 ppt). Statistics were used to develop an estimate of the incremental acreage impacted due to the proposed rule amendments.

A total of 76 model runs were made (19 modeling runs for each of 4 emission rates). See Table 6. For each model run, the incremental area of additional clean-up potentially needed for an 11 ppt vs 20.5 ppt cleanup level was calculated.

Table 6: Area Covered by Different Contour Lines (Unit is Acre)

stack source emission rate	Meteorological station ID	Area covered >1 ppt	Area covered >11ppt	Area covered >20.5 ppt	Incremental acreage between 11 and 20.5 ppt contour lines
5ug/s	KALW	25.2	1.35	0.75	0.6
	KAST	119.1	1.8	0.9	0.9
	KAWO	29.7	0.9	0.45	0.45
	KBFI	77.55	0.9	0.15	0.75
	KBLI	33	1.35	0.6	0.75
	KCLM	20.55	0.15	0	0.15
	KEAT	51	1.5	0.9	0.6
	KGEG	85.8	1.5	0.45	1.05
	KKLS	38.7	1.35	0.45	0.9
	KPAE	113.85	1.35	0.3	1.05
	KPDT	2.1	0	0	0
	KPDX	32.25	1.95	0.75	1.2
	KPSC	83.85	0.75	0.45	0.3
	KPWT	15	0.9	0.45	0.45
	KSEA	106.2	1.2	0.6	0.6
	KSMP	114.15	0.45	0.15	0.3
	KTCM	52.2	0.3	0	0.3
	KTTD	16.35	0.3	0.3	0
	KUIL	28.2	0.9	0.15	0.75
10ug/s	KALW	100.35	3.45	1.5	1.95
	KAST	248.4	3.75	1.8	1.95
	KAWO	286.35	2.85	1.2	1.65
	KBFI	172.35	1.95	0.9	1.05
	KBLI	188.25	3.6	1.5	2.1
	KCLM	176.4	0.75	0.15	0.6
	KEAT	160.65	4.05	1.65	2.4
	KGEG	150.15	4.05	1.5	2.55
	KKLS	105.75	2.55	1.5	1.05
	KPAE	113.85	1.35	0.3	1.05
	KPDT	93.75	0	0	0
	KPDX	113.85	3.9	2.1	1.8
	KPSC	141.3	2.4	1.05	1.35
	KPWT	121.05	2.1	1.05	1.05
	KSEA	195.75	2.55	1.35	1.2
	KSMP	221.4	2.1	0.75	1.35
	KTCM	229.05	0.9	0.3	0.6
	KTTD	46.8	1.8	0.45	1.35
	KUIL	111.75	2.55	0.9	1.65
20ug/s	KALW	321.9	4.95	1.8	3.15
	KAST	439.05	5.1	2.25	2.85
	KAWO	535.95	4.35	1.65	2.7
	KBFI	381.15	3.3	1.2	2.1
	KBLI	399.9	5.4	2.1	3.3
	KCLM	453.15	1.2	0.3	0.9
	KEAT	285.75	5.85	2.55	3.3
	KGEG	374.4	6.6	1.95	4.65
	KKLS	607.2	5.25	1.65	3.6
	KPAE	113.85	1.35	0.3	1.05
	KPDT	273.15	0.15	0	0.15
	KPDX	338.55	5.85	2.4	3.45
	KPSC	307.05	4.2	1.5	2.7
	KPWT	390.45	3	1.05	1.95
	KSEA	324.15	3.45	1.5	1.95
	KSMP	463.8	2.85	1.2	1.65
	KTCM	359.1	1.65	0.45	1.2
	KTTD	257.7	2.1	0.9	1.2
	KUIL	406.95	3.9	1.05	2.85
50ug/s	KALW	736.2	22.2	10.8	11.4
	KAST	887.4	104.85	10.5	94.35
	KAWO	803.25	25.8	11.7	14.1
	KBFI	695.1	56.7	6.6	50.1
	KBLI	794.25	28.05	12.75	15.3
	KCLM	852.45	16.2	5.1	11.1
	KEAT	396.45	27.9	13.2	14.7
	KGEG	689.1	76.65	19.95	56.7
	KKLS	917.25	33	13.5	19.5
	KPAE	113.85	1.35	0.3	1.05
	KPDT	475.35	1.8	0.6	1.2
	KPDX	613.95	28.2	13.35	14.85
	KPSC	704.7	74.25	9.75	64.5
	KPWT	848.25	13.65	6.75	6.9
	KSEA	532.35	91.35	7.05	84.3
	KSMP	715.8	90.6	7.2	83.4
	KTCM	467.4	26.1	4.8	21.3
	KTTD	839.85	13.65	6.15	7.5
	KUIL	587.4	24.6	10.2	14.4

Figure 2: Histogram of Incremental Acreage Between 11 and 20.5 ppt Contour Lines

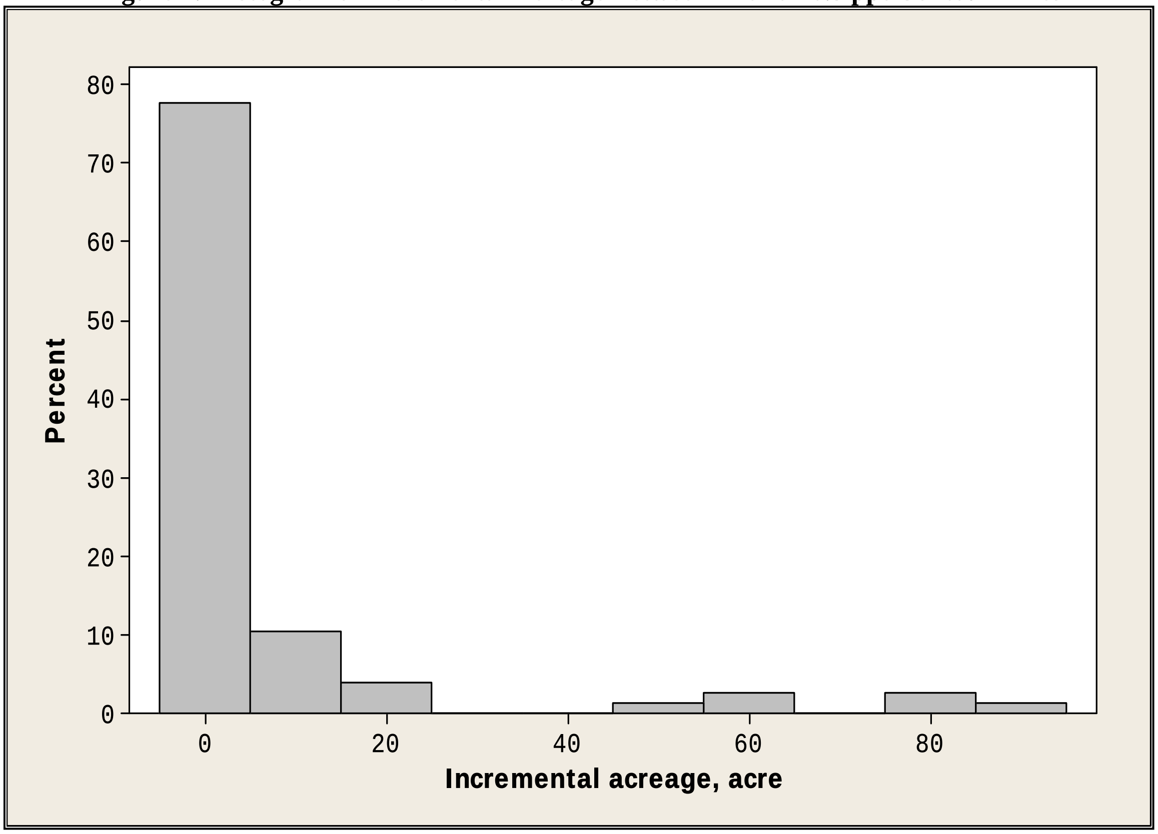

Table 7: Statistics on incremental acreage between two cleanup level alternatives

Statistics	Incremental Acreage
25th%	0.90
50th%	1.65
75th%	3.49
Average	8.80

Figure 2 shows the histogram of calculated incremental acreage between two cleanup level alternatives. Table 7 shows the statistics on the incremental acreage change due to the dioxin soil cleanup level change. From these results it can be concluded that there is a 50% probability that less than 1.7 additional acres per site will require additional cleanup under the proposed regulation (11 ppt) vs. the regulatory baseline cleanup level (20.5 ppt) and a 75% probability that no more than 3.5 acres of additional cleanup will be required.

F. Estimation on unit remediation cost due to the additional area impacted by air deposition

The cost per acre (or per cubic yard) of soil remediation was estimated from information developed for the cleanup of area-wide soil arsenic and lead contamination. This information was used since the sites impacted by area-wide contamination are similar to those that could be impacted by dioxin emissions. A simple model was used to estimate the expected change in additional remediation costs associated with the proposed rule. See Figure 3 for a summary of the expected cost model.

Figure 3: Expected remediation model

$$\text{Expected costs/site} = \Delta SV \times TUC$$

Where:

ΔSV	=	Estimated change in soil volume/acre cleaned up on a representative site (cubic yards, or acre) per site
TUC	=	Unit cost of soil cleanup ($/cubic yard or acre)

The unit cost of soil cleanup was estimated using a weighted average of costs for different remedial methods. The costs for the different remedial methods were developed for Ecology by Landau Associates to estimate the cost of area-wide arsenic and lead-contaminated soil remediation. The similar means of remediation for these sites and dioxin contaminated sites make this information ideal for estimating dioxin/furan soil remediation costs as well.

F.1 Remedial alternatives selected for unit cost estimation

Remedial alternatives selected for estimating unit cost of soil remediation are:

- Protective Measure A: Excavation and Off-site Disposal at a Subtitle D Landfill.
- Protective Measure B: In-Situ Capping with an Engineered Soil Cover.

Because both the baseline and the proposed rule will have the same costs for investigation (except as noted below for sampling), design and planning, oversight and administration, and contingencies, the cost estimates excluded these costs.

Additional sampling cost was included in all cost estimates, assuming:

- $700 cost per sample taken and analyzed.
- Ten samples per acre of land remediated.

This additional cost associated with sampling was equivalent to $1.90 per square yard (or $9,600 per acre).

Unit costs and other assumptions are outlined in Table 8. A weighted average of remedial unit costs was calculated in order to reflect a cleanup strategy involving a mix of several remedies (capping some areas, removal in others, etc.), which is typically done at cleanup sites of this nature. To maintain conservative estimates, the highest weight was placed on excavation and disposal of soils, as this unit cost was the largest.

Table 8: Unit Cost Input and Parameter Summary

Input Values:	
Unit Area of Exposed Dioxin/Furan-Contaminated Soil at the Site (Acres)	1
Depth of Dioxin/Furan Contamination that Exceeds Cleanup Goals (ft)	0.25
Calculated Total Soil Volume (yd^3): density of soil: 1 yd^3=1.5 ton	726
Calculated Total Tonnage (tons)	1,089
Specific Parameters:	
For "Other Post-Development" Management Area, Percent Excavated by Hand	20%
Indirect Costs, Excavation and Tilling Alternatives	42%
Indirect Costs, Capping Alternatives	42%
Mixing Factor (3 inches contamination equals 6 inches cleanup depth)	2

The weighting scheme is assumed based on Toxics Cleanup Program experience applying the MTCA rule to area wide contamination, and is both likely and relatively conservative in placing a higher weight on the most expensive remedial action. The resulting costs for these remedial actions are presented in Table 9, below.

Table 9: Cost estimates by remedial method

Method	Remediation Portion Assumed, %	Cost per acre	Cost per Cubic Yard[62]
A: Excavation and Disposal at a Subtitle D Landfill	50%	$133,000	$183
B: In-Situ Capping with an Engineered Soil Cover	50%	$78,000	$107

The detailed cost break-down for "Excavation and disposal at a subtitle D landfill" and "In-situ capping with an engineered soil cover" are shown in Table 10 and Table 11, respectively. For this analysis, remedies were excluded that were not applicable to all types of remediated land (such as wood-chip surface or gravel surface).

F.2 Unit remedial cost estimate

To incorporate the most conservative (highest) unit cost, the highest per unit remedial cost was used to calculate an upper bound for remedial costs. This upper-bound remedy (complete excavation and disposal) costs $183 per cubic yard (or, $133,000 per acre). To incorporate the lowest-cost alternative remediation, a lower-bound value was used for cleanup per cubic yard. The lower-bound remedy (in-situ capping with an engineered soil cover) costs $107 per cubic yard (or $78,000 per acre). Using a weighted average of remedial options based primarily on excavation of soil with additional capping measures generates a weighted average cost of $145 per cubic yard of soil remediated.

[62] This calculation is based on that remediation of one acre land requires 726 cubic yard of soil treatment.

Table 10: Cost Break-down Details for Excavation and Off-site Disposal

Protective Measure 1A: Excavation and Off-site Disposal at a Subtitle D Landfill

Management Area Type:	1	unit: Acres
Other Post-Development	1	Acres Requiring Treatment

Cost Elements	Unit	Unit Cost	0.5 ft Depth Qty	Total
Minimum Investigation Cost	acre	$9,620	1	$9,620
Excavation	CY	$28	726	$20,328
Transportation	ton	$15	1089	$16,335
Disposal	ton	$20	1089	$21,780
Backfill and Compaction	CY	$15	726	$10,890
Waste Characterization Sampling	CY	$1	726	$726
Confirmation Sampling	SY	$1.9	4840	$9,100
Hydroseeding	SY	$1	4840	$4,840
Subtotal				$93,619
Additional Investigation		2%		$1,872
Design & Planning		15%		$14,043
Oversight & Administrative		15%		$14,043
Contingency		10%		$9,362
Unit Cost of Protective Measure per acre				**$133,000**

EXCAVATION AND OFFSITE DISPOSAL	Unit	Unit Cost $	Notes
Minimum investigation cost	acre	$9,620	Assumed minimum investigation of 10 soil samples for Dioxins congeners samples/analysis ($700/ea) and 2 TCLP test per acre (@$200) plus labor (*1.3).
Excavation by Hand Shovel	CY	$60	RS Means 2001 (normal soil, 17 03 0211); For "Other Post-Development" Management Area, Percent excavated by Hand was assumed 20%.
Excavation by Bobcat	CY	$20	Percent excavated by bobcat was estimated 80%.
Excavation, good site access	CY	$8	Soil excavation, load & haul spoil. RS Means 2001, pg 4-37.
Transportation to Subtitle D landfill	ton	$15	Assume average 5 hour round-trip truck cost at 85/hr (prevailing wage). Quotes from Rabanco and CWM ($80/hr). Average 30 tons per truck and pup (34 max allowed).
Disposal to Subtitle D, no stabilization	ton	$20	$17/ton budget estimate from Rabanco. $79.48/ton estimated by RS Means Env. Unit Cost 2001.
Backfill & compaction, 6" lifts	CY	$15	RS Means 2001 sand = $11.77/CY in level C; experience $15/ton. Some topsoil may be
Waste characterization sampling	CY	$1	Assume $200 TCLP sample plus labor per 500 tons.
Hydroseed	SY	$1	Based on quotation from landscape contractor Van Den Akkers.
Confirmation Sampling	SY	$1.9	Assume 10 Dioxins samples @$700 plus labor per acre
Estimated Indirect Costs	%	42	Default markup 42%. 2% investigation, 15% design, 15% oversight/overhead/markups, 10% contingencies

Table 11: Cost Break-down Details for In-situ Capping with an Engineered Soil Cover

Protective Measure B: In-Situ Capping with an Engineered Soil Cover

Management Area Type:	1	Total Acres
Other Post-Development	1	Acres Requiring Treatment

Cost Elements	Unit	Unit Cost	0.5 ft Depth Qty	Total
Minimum Investigation Cost	acre	$9,620	1	$9,620
Topsoil, 6 inches	SY	$4	4840	$20,812
Hydroseeding	SY	$1	4840	$4,840
Drainage Fabric, Barrier Layer	SY	$1.9	4840	$9,196
Markup for Use of Smaller Equipment	%	30%		$10,454
Subtotal				$54,922
Additional Investigation		2%		$1,098
Design & Planning		15%		$8,238
Oversight & Administrative		15%		$8,238
Contingency		10%		$5,492
Unit Cost of Protective Measure				**$ $78,000**

Engineered soil cover	unit	unit cost, $	Notes
Topsoil, 6 inches	SY	4.3	6" Topsoil, $26/CY RS Means 2001, level D, Pg. 3-40
Hydroseeding	SY	1	Grass hydroseeding, contractor quote @ $3,000/acre
Fill Soil, 24 inches	SY	0	Assumed not needed (If necessary - $8.26/CY RS Means 2001, level D, Pg. 3-40)
Drainage Fabric, barrier layer	SY	1.9	130 mil, RS Means 2001, Pg.3-43
Estimated Indirect Costs	%	42	Default markup 42%. 2% investigation, 15% design, 15% oversight/overhead/markups, 10%

Conclusions: Estimate of total remediation cost increase between two soil dioxin cleanup levels alternatives

The information derived from the modeling was used to calculate the potential remediation cost increase for the two different cleanup levels. This was done by multiplying the area of additional cleanup by a cost per acre (or per cubic yard) of soil remediation.

Ecology estimated the change in impacted soil area using an EPA-approved air deposition model for a hypothetical pulp and paper mill. The simulation found that for soil contaminated with stack emissions, a site may need to clean 1.7 more acres at the median[1]. Based on a depth of six inches, and assuming 10% of the ground is covered by impervious surfaces, this translates to a volume of 1,200 cubic yards of soil. A six inch depth was used to estimate soil volume removed versus the three inch mixing depth to reflect the difficulty for construction equipment to remove a three inch layer of soil.

Note that this is a highly conservative value, given that 10 to 50% of soil at the periphery of

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[1] Assumes contamination has been mixed over a 3-inch depth of surface soil by natural or human influence: 0.9 more acres at the 25th percentile, and 3.5 more acres at the 75th percentile.

existing pulp and paper mills in developed areas are likely to be covered by existing buildings, roads, and other structures and the assumption that six inches will be removed rather than just the three inch contaminated layer. In addition, this estimate does not take into account the potential reduction in industrial properties needing remediation as a result of a higher industrial soil cleanup level under the proposed rule. Taking these factors into account, Ecology believes that the actual change in remediated soil volume will be considerably smaller than the above estimate.

The total per-site expected cost of the proposed rule equals the product of the unit cost of remediation and the increased volume of soil removed under the proposed rule. Ecology expects remediation under the proposed rule to cost $170,000 more per-site, at the weighted average unit cost. As shown in Table 12, depending on the remedial method chosen, this cost can fall in the range of $130,000 to $220,000 more per-site than the regulatory baseline.

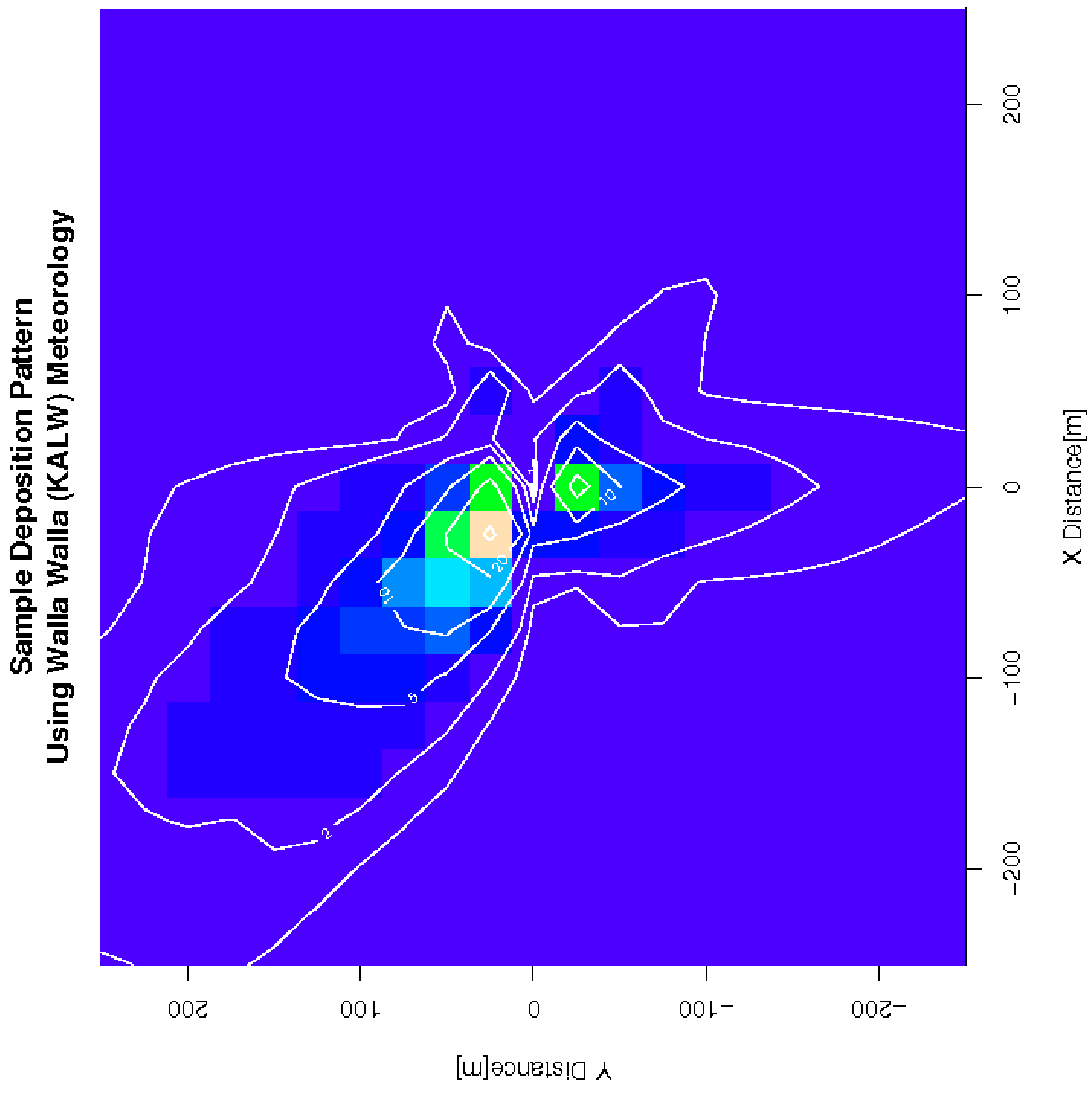
Table 12: Statistics on Remedial Cost Increase Due to the Change in Dioxin Cleanup Level Change

Statistics	Incremental acreage for additional cleanup, acre	Cost increase per site, $		
		Low-bound	Weighted-average	High-bound
25^{th} %	0.9	70,000	95,000	120,000
50^{th} %	1.7	130,000	170,000	220,000
75^{th} %	3.5	270,000	370,000	460,000
Average	8.8	690,000	930,000	1,200,000

Air Dispersion/Deposition Model
Programming and Output Information

```
Files in TCP Cleanup Rule Support 2006 Archive:

./bin/uw_2_isc.pl - reads files as retrieved from
<http://www-k12.atmos.washington.edu/k12/grayskies/nw_weather.html>
and write in form that the (deprecated) dispersion model ISC can use.


./bin/run_isc - file for running ISC
./bin/mak_isc - file for running ISC, makes ISC input deck

./lib/deposition.CO - control inputs for ISC
./lib/deposition.ME - meteorological inputs for ISC
./lib/deposition.OU - output options for ISC
./lib/deposition.RE - receptor locations for ISC
./lib/deposition.SO - source inputs for ISSC


./bin/isc2esri_raster.pl - convert ISC output to a raster form that
ArcInfo can read.

./out/deposition*_period_REWRITE.plt - rewritten ISC output for input
to ArcInfo

./out/Rhistory - R commands to plot postscript images for publication

./out/rule_KALW.p* - sample postscript and png files for publication

./report/ISC_pulp_mills.txt - modeler's description of analysis
----------------------------------------------------------------------

You will find the compressed archive file
toxics_cleanup_rule_support_2006.tar.gz in:

X:\Toxics_cleanup_rule_revision
```

More detailed programming and output information for the Air Dispersion/Deposition Model is available on a CD and is part of the Administrative Record.



Sample Deposition Pattern
Using Walla Walla (KALW) Meteorology
X Distance[m]
Y Distance[m]
−200
−100
0
100
200
2
5
10
20

Appendix D: Cases for Ecological Evaluation

Case 1

Under the baseline, cleanup level is below ecological screening level.

(BL2 < EC)

Under the final rule, cleanup level is below the baseline cleanup level.

(PR < BL2 < EC)

Here, ecological evaluation is not necessary under the baseline or final rule.

Case 2

Under the baseline, cleanup level is above ecological screening level.

(EC < BL2)

Under the final rule, cleanup level is between ecological screening level and the baseline cleanup level.

(EC < PR < BL2)

Here, ecological evaluation is necessary under both the baseline and final rule.

Case 3

Under the baseline, cleanup level is above ecological screening level.

(EC < BL2)

Under the final rule, cleanup level is below the ecological screening level.

(PR < EC < BL2)

Here, ecological evaluation is only necessary under the baseline.

Appendix E: Comments on Cancer and Noncancer Health Effects

A. Disease Incidence and Causality at Hazardous Waste Sites

The National Research Council (NRC) addressed the issue of the inherent difficulties of defining incidence rate or cause and effect relationships of diseases associated with hazardous waste sites (see NRC, 1991).

From NRC (1991), Ecology summarizes the following.

Pages 4 – 5: Environmental epidemiology is the study of the effect on human health of physical, biologic, and chemical factors in the external environment. To make a reasonable inference of causation in environmental epidemiology, eight characteristics of the findings should be considered:

- Strength
- Specificity
- Consistency of the association
- Period of exposure
- Relationship between dose and response
- Effects of the removal of the suggested cause
- Biological plausibility of the association
- Overall coherence of the findings

Page 19: Concluding remarks of the committee: "Whether Superfund and other hazardous-waste programs actually protect human health is a critical question with respect to federal and state efforts to cleanup hazardous wastes. To answer this question requires information on the scope of potential and actual human exposures to hazardous wastes and about the health effects that could be associated with these exposures. Based on its review of the published literature on the subject, the committee find that the question cannot be answered."

Pages 28 – 33: Some of the practical and ethical challenges that studies of hazardous waste sites pose follows:

- Long term cohort studies of continued exposures cannot ethically be conducted on persons who have reasons for assuming they are at risk of chronic disease as a consequence of exposure.
- Drawing inferences about causation is more difficult that it is for those controlled experiments that use random samples and controls because people move around, eat different foods, engage in different social and recreational activities, have different genetic backgrounds, and engage in a variety of different behavior patterns that may or may not be risk related.
- Small numbers, rare events, or small populations are often involved in hazardous-waste sites.

Pages 32 – 34: Hence, the committee does not adhere to conventional approaches to establishing causality, but relies on an inferential approach in developing an understanding of causation in environmental epidemiology. A study of common adverse health outcomes in a small population, as is usually the case for hazardous waste sites, might not achieve a level of statistical significance, even though a causal association may exist. The epidemiological dilemma at hazardous waste sites with multiple chemical and exposures is that the statistical correlation of variables does not necessarily indicate any causal relationship among them, even where tests of statistical significance may be met—i.e., mere coincidence of occurrence says nothing about their essential connection.

Pages 36 – 47: Comments on the eight characteristics discussed above (from pages 4 – 5):

Strength of Association: For diseases with multiple causes, the strength of association depends on many factors:

- Statistical power of the study is the ability to detect an effect; to detect significant disease patterns for rare diseases they are best studied in larger populations
- More common diseases can be studied in smaller populations, however, common diseases have multiple causes and, therefore, also should be studied in larger populations to detect significant results.

Cancer clusters and spontaneous abortion clusters are among the most commonly reported events linked to exposure to hazardous waste sites and are the most difficult adverse outcomes for which causation can be inferred. Both cancer clusters and spontaneous abortions reflect multiple causes and it is difficult to determine a baseline rate. Also, for cancer there may be a long latency period (time between exposure and onset of the disease).

Because of the small populations exposed at many hazardous waste sites, the observed rates of occurrences for diseases studies in a given cluster must be at least 20 times greater than expected to support in inference of causation. One of three people in the US will develop some form of cancer; one in four will die of it; the expected rate of spontaneous abortion is estimated to be one in four of all pregnancies. Hence, clusters of cancer, spontaneous abortion, or other common diseases can arise by chance.

Assessing whether a given cluster of common adverse health effects could be linked to environmental exposure requires the study of very large numbers of people of the finding of extraordinarily high rates. Most hazardous waste sites involve potential or actual exposures of only small numbers of persons, many of whom no longer live in the area of the waste site when the cluster is identified.

For many hazardous waste sites, there usually are not data on relevant exposures that could have occurred years earlier given the long period for development of many forms of cancer.

Hence, the site-specific nature of the analysis precludes Ecology from confidently estimating reductions in incidence of cancer and other disorders that would arise under the final rule, relative to the baseline.

The Cost-Benefit Analysis estimates a representative median of 1.65 additional acres of land area remediated under the final rule. This additional acreage lies at the periphery of land remediated under the baseline, and will likely intersect a small current population, as well as a prospective future population moving in and out of the area, and future development of higher density housing and public buildings associated with a growing population. Based on the information presented above, Ecology cannot estimate changes in disease incidence for these small and changing populations.

B. Noncancer Effects from Exposure to Dioxins and Dioxin-Like Compounds

Margin of Exposure Approach to Evaluate noncancer endpoints

Rather than the traditional U.S. Environmental Protection Agency (EPA) reference dose (RfD) approach to evaluate noncancer effects, for dioxins and dioxin-like compounds (DLCs) EPA chose margin-of-exposure (MOE) to characterize noncancer endpoints. The MOE is the ratio of the human body burden to the effect level, the concentration of a chemical that exhibits an effect, in the comparison species (ED01 or low effect level), in an animal species or human.

$$MOE = \frac{ED_{01} \text{ or Low Effect Level}}{\text{Current Human Body Burden } (\sim 5\text{ng } TEQ_{DFP}\text{-}WHO_{98} \text{ ng/kg})}$$

The MOE approach is used by EPA for DLCs because of the likelihood that noncancer effects may be occurring in the human population at environmental exposure levels. Consistent with EPA practice when considering background exposure or incremental exposure plus background, MOEs in the range of 100 to 1,000 are considered adequate to rule out the likelihood of significant noncancer effects occurring in humans (US EPA, 2000, p107). For sensitive noncancer biological effects, MOEs range from less than one for enzyme induction in mice, through 2.6 to 15 for enzyme induction in rats, < 3 for developmental effects, and 5 for endometriosis in non-human primates (US EPA, 2000).

Endocrine Disruption - Diabetes

Dioxins and dioxin-like compounds are potent endocrine disruptors, resulting in changes in every endocrine system for both steroid and protein hormones. The mode of action resulting from exposure to dioxins and dioxin-like compounds may be at the hormonal receptor level and can include disruption of the synthesis or breakdown of hormones, or disruption of the transport of hormones. Studies have demonstrated an association of elevated levels of dioxin with diabetes in several human populations. Of particular note, occupational exposures and environmental exposures to dioxins and dioxin-like compounds may influence the prevalence of diabetes. The most recent update of studies of Air Force veterans with background levels of exposure to dioxins showed a 47% excess of diabetes in the highly exposed group. Dioxin related alterations in lipid metabolism, glucose transport, and in the insulin signaling pathway contribute to the association of dioxins with diabetes. Most of the data suggest that the diabetes is type II (adult-onset) diabetes. Although other factors such as obesity and aging contribute to type II diabetes, exposure to dioxins shift the distribution of sensitivity, placing younger people or those that are lighter in weight at greater risk for diabetes.

Dose-Response Relationships for Noncancer Endpoints

Body Burden

The term "background" exposure is referred to by the National Academy of Sciences (NAS, 2003 and 2006) and defined by the U.S. Environmental Protection Agency (EPA, 2000 and 2003) as . . . "to describe exposure which regularly occurs to members of the general population form exposure media (food, air, soil, etc.) that have dioxin concentrations within the normal background range. Most (>95%) of background exposure results from the presence of minute amounts of dioxin-like compounds in dietary fat, primarily from the commercial food supply. The origin of this background exposure is from three categories of sources: naturally formed dioxins, anthropogenic dioxins from contemporary sources and dioxins from reservoir sources." (EPA, 2000)

Measure of Background and Dose Metric

The EPA and the National Academy of Sciences have considered the appropriate dose metric for DLCs (EPA, 2000 and NAS, 2003). Although a chemical dose is typically measured as an intake in units of mass per unit of body weight, such as mg of chemical/kg of body weight, for DLCs an internal dose metric is considered appropriate because DLCs are persistent, preferentially bioaccumulate in body fat depots, and are resistant to metabolism and degradation. Body burden concentrations are given in units of mass per mass of lipid because DLCs are preferentially associated with lipids (NAS, 2003).

The EPA's reassessment of dioxin and DLCs did not establish a Reference Dose (RfD, threshold response) approach to evaluate noncancer adverse health effects. Establishing a threshold dose, RfD, for DLCs is complicated by the likelihood that noncancer effects may be occurring in human populations at environmental levels and that background exposures are often a significant component of a person's total exposure to DLCs. For the dioxins and dioxin-like compounds, an EPA derived RfD based on human and animal data including standard uncertainty factors to account for species differences and sensitive populations would result in reference intake levels approximating 10 – 100 times below the current estimates of daily intake in the general population. (US EPA, 2000 and 2003).

The current estimated average dose to the U.S. population of dioxins and dioxin -like compounds (~1 pg TEQ/kg/day) is greater than an RfD value that would be derived by the U.S. EPA. Despite the recognition of that any RfD established by EPA would approximate body burden and intake concentrations, both the EPA Science Advisory Board (US EPA, 1995) and the National Academy of Sciences (NAS, 2006) urged EPA to establish an RfD for noncancer effects to help ensure that proper emphasis was given to noncancer effects and to establish a goal for future exposure reductions.

The effective dose, or EDx, is the exposure dose resulting in excess risk in the studied population and is the dose metric used by EPA for comparison across multiple endpoints, multiple species, and multiple experimental protocols. In consideration of background exposure levels to DLCs and the range of biological endpoints studied in animal experiments, which include the 1% effect level in the experimental range of dosing, EPA has used the effective dose resulting in a 1% effect above controls (ED_{01}) to evaluate the dose-response for DLCs. DLCs which operate through receptor binding mechanisms follow a linear dose-response binding in the 1-10% receptor occupancy region. Empirical data provides dose-response information down to approximately the 1% effect level for many toxic endpoints.

Generally, for noncancer endpoints many dose-response curves are linear over the range of the doses tested. Linearity is particularly true for DLCs when body burdens or exposures at the lower end of the observed dose range are close to body burdens or at the exposures of interest for humans (EPA 2000). Results from analysis of ED01's and examining LOAELs suggest that noncancer effects can occur at body burden levels in animals equal to or less than body burden calculated for tumor induction in animals. The 1% effect level (ED_{01}) is particularly evident when considering biochemical changes which may be on the critical path for both noncancer and cancer effects. The use of ED_{01}s provide a point of departure for a discussion of margins of exposure for a variety of health endpoints. (US EPA, 2000)

Body burden is used as the dose metric to model the dose-response relationships for noncancer effects for the dioxins and dioxin like compounds. In an effort to fit data for over 50 studies to either a linear or a nonlinear model, about half of the studies appeared linear and the other half were best fit by a nonlinear model. The toxic, noncancer, effects were better fit by a nonlinear model, although nearly 40% of the adverse effects appeared to have a linear dose-response relationship. In contrast, the biochemical responses from exposures to dioxins and dioxin-like compounds appeared to be linear. The EPA used a benchmark approach for modeling to incorporate all of the data across the studies. An effective dose to attain a 1% response (ED_{01}) was either close to or within the experimental data.

For the noncancer effects in the animal studies the empirical modeling resulted in ED_{01} values between 1 and 11 ng/kg. Mechanism based modeling showed the lowest ED_{01} of 0.2 ng/kg. ED_{01} values in the range of 1 to 10 ng/kg are in agreement with the low observed adverse effect level (LOAEL) values observed for biochemical effects exhibited from exposure to dioxins and dioxin-like compounds. Similar mechanistic modeling of the liver tumor response in rats resulted in an ED_{01} value of 2.7 ng/kg. The results of animal modeling are in agreement with the estimated ED_{01} values from human occupational data within a range of 6 to 62 ng/kg. (Schecter and Gasiewicz, 2003)

Concluding remarks based on empirical/mechanistic modeling

- Cancer: Based on liver tumors in female rats and the increase in all cancers from occupational exposures, assuming an average body burden of 5 ng TEQ/kg body weight, the excess risk of cancer to the background population may exceed 1/1000 (10^{-3}). (Schecter and Gasiewicz, 2003)
- Noncancer: Again, assuming an average body burden of 5 ng TEQ/kg body weight approximately 5% of the population express body burdens twice the 5 ng TEQ/kg body burden and 1% of the population have body burdens of 15 ng/kg. Biochemical effects (enzyme induction, oxidative stress, cytokine induction) have been observed in animal studies between 3 and 10 ng/kg. Development neurotoxicity, reproductive toxicity and immunotoxicity have been exhibited in animals between 10 and 100 ng/kg. Adult human reproductive and immunological effects have been exhibited at body burdens between 10 and 50 ng/kg. Adverse noncancer effects in animals are expressed within an order of magnitude of the current mean background body burden in people. Type II diabetes and alterations in glucose tolerance and insulin metabolism have been associated with dioxin levels within a factor of 10 of the general population's body burden. Cancer has been seen in people with body burdens between 10 and 100 times those of the background body burdens for dioxins and dioxin-like compounds. (Schecter and Gasiewicz, 2003)

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US EPA, 1995. Letter to the Administrator. Subject: Science Advisory Boards Review of the Draft Dioxin Exposure and Health Effects Reassessment Documents. EPA/SAB/EC/95/021.

US EPA, 2000. Exposure and Human Health Reassessment of 2, 3, 7, 8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds. Part III: Integrated Summary and Risk Characterization for 2, 3, 7, 8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds. EPA/600/P-00/001Bg. September 2000. SAB Review Draft.

Appendix F: Combustion Sources of Dioxin

October 10, 2007

TO: MTCA Rule Administrative File

FROM: Pete Kmet, P.E.

SUBJECT: Combustion Sources of Dioxin and Carcinogenic PAHs-Review

Comments were received on the MTCA rule amendments proposed April 2, 2007 indicating that the cost impact of the rule on a much longer list of facilities needed to be considered. Specifically, Ken Johnson, Weyerhaeuser made the following comment:

> *In Chapter 4 of the Economic Analysis, Ecology's assumptions about the universe of "common" sites potentially affected by the proposed amendments ignore several types of sites that could ultimately be impacted by this proposed rule. A more complete accounting of known sources of chlorinated dioxin/furan or c-PAHs, which informs on possibly contaminated sites, could significantly impact the cost impacts associated with this proposed rule…Overlooked in Ecology's analysis are:*
>
> *wood treating sites with a history of pentachlorophenol or creosote use (note that chlorinated dioxins/furans are a common contaminant associated with the prevalent wood preservative pentachlorophenol, and PAHs are primary components of creosote wood preservatives),*
>
> *sawmills that historically used pentachlorophenol for sapstain control,*
>
> *former pentachlorophenol manufacturers or distributors,*
>
> *publicly- or privately-owned hospital incinerators that burn polyvinyl chloride medical waste, which can contribute both chlorinated dioxins/furans, as well as PAHs, to soil.*
>
> *municipal waste incinerators, operated by local governments or school districts,*
>
> *properties affected by air deposition from wood-fired or combination fuel-fired steam generating units, cement kilns, mortuaries, activated carbon regeneration, municipal treatment sludge incinerators, and other combustion sources.*
>
> *properties that have received land-applied municipal or industrial wastewater treatment solids, or ashes from wood or coal-fired combustion units,*
>
> *"urban areas" (in particular, public parks), state and federal forest ownership (Ken Johnson, Weyerhaeuser, p. 3-4)*

Similar comments were made by Dana Doloff, Rayonier, in written comments and at the Port Angeles public hearing and by Mark E. Madsen from the City of Port Angeles.

Background

As described in the draft Cost-Benefit Analysis, Ecology identified potentially impacted facilities based on a review of facilities listed on Ecology's confirmed and suspected sites database. These are facilities known or suspected to be contaminated with these chemicals. We also reviewed the standard industrial codes for businesses in WA State to identify similar businesses.

Many of the sources identified in the above comments are not currently identified as contaminated sites that would need cleanup under MTCA and would unlikely to ever be identified as such unless cleanup was triggered under MTCA for other reasons. None the less, a literature review was conducted, along with a review of available site-specific test data on potential sources of dioxin and cPAHs in Washington State, to determine the likelihood that these facilities might be considered contaminated under the proposed rule amendments. This memo documents that work. This memo focuses on combustion sources. Other sources identified in these comments are addressed elsewhere in the administrative record.

Municipal Solid Waste and Medical Waste Incinerators

EPA (2005) has conducted several dioxin source assessments. These assessments conclude that nationwide, medical waste incinerators and municipal waste incinerators are one of the top three sources of dioxin (along with backyard burning of refuse).

Ecology (Yake, 1998) conducted a dioxin source assessment that identified 22 active and closed incinerators as the largest potential sources of dioxin in Washington State. These incinerators consisted of four municipal solid waste (MSW) incinerators, sixteen medical waste incinerators, one cogeneration facility and one combined medical/MSW incinerator as potential sources of dioxin in Washington State. The air emission rates from these incinerators were estimated at 0.003 to 4.0 mg TEQ/day.

Comparable studies have not been conducted for carcinogenic PAHs, however combustion is known to be a source of carcinogenic PAH emissions, so it can be anticipated that these same facilities would generate carcinogenic PAHs.

The primary likely impact, if any, of the rule on these facilities, would be the potential cost of cleanup of soils contaminated with dioxins or carcinogenic PAHs by air emissions. Ash from these facilities is disposed of in landfills, where the difference in the cleanup standards as proposed in the rule would not affect the area needing to be capped or otherwise remediated.

To support the draft cost benefit analysis, Ecology conducted air modeling to estimate the potential area impacted by a range of dioxin emissions. The smallest source modeled was a source emitting 5 ug/second or 9.5 mg TEQ/day of dioxins using meteorological data from 19 airports throughout Washington State. The modeling found that the incremental difference in area that would be potentially impacted by the rule for this emission rate was estimated at no difference (0 acres) for some locations up to 1 acre of land, with an average of 0.6 acres. This emission rate is considerably higher than the estimated emission rates for the various incinerators examined in Ecology's dioxin source assessment.

Recomp Incinerator

The highest dioxin emission rate for incinerators reported in Ecology's dioxin source assessment was 4.0 mg TEQ/day from the former Recomp Incinerator in Ferndale, WA (Skagit Co. Incinerator), less than half the smallest modeled emissions rate. Based on a projection from the modeled results, one would expect the incremental difference in impacted area to be less than 0.5 acres for this highest incinerator emission rate.

The Recomp Incinerator operated from 1988 until 1996 burning a combination of municipal solid waste and medical waste. This incinerator was the subject of an extensive study culminating in a report issued in 1993. This included soil testing for dioxins and carcinogenic PAHs at six locations in the vicinity of the incinerator before and 3 years after incineration began. A summary of the test results is attached to this memo. The results indicate dioxin and carcinogenic PAH soil concentrations both before operations began and 3 years afterwards were essentially at background levels with dioxin soil concentrations between 0.1 and 1.5 ppt and cPAH concentrations between 0.002 and 0.02 mg/kg. These concentrations are well below soil cleanup levels under the proposed rule (dioxin cleanup level = 11 ppt and cPAH cleanup level = 0.1 mg/kg).

Spokane Incinerator

An extensive risk assessment was also conducted at the Spokane Incinerator in 2001 that included evaluation of dioxin and carcinogenic PAH soil impacts of extended operation of that facility. This facility has been in operation since 1991 and continues to be the only operational MSW incinerator in Washington State.

Stack testing conducted at the facility resulted in an estimated mean emission rate of 2.1×10^{-9} grams TEQ/second of dioxins & furan or 0.22 mg TEQ/day. This is well below the emission rates Ecology used to project potential impacts of the rule amendments and is the direct result of extensive air pollution control equipment installed at the facility. The resulting soil concentrations were projected to be substantially less than the proposed Method B soil cleanup level of 11 ppt and that it would take over 800,000 years for this level to be exceeded.

Stack testing and modeling was also conducted for carcinogenic PAHs at the Spokane Incinerator. Stack testing conducted at the facility resulted in an estimated mean emission rate of 1.3×10^{-6} grams TEQ/second of carcinogenic PAHs or 0.16 mg TEQ/day. The resulting soil concentrations were projected to be substantially less than the proposed Method B soil cleanup level of 0.1 mg/kg and that it would take over fifty thousand years for this level to be exceeded.

Conclusion—MSW & Medical Waste Incinerators

Based on the above literature review and observations at two facilities which represent the range of conditions expected at MSW and medical waste incinerators in WA State, these types of facilities would not be impacted by the proposed rule amendments.

Burn Barrels

As noted above, residential burn barrels have been identified by EPA as a potentially substantial source of dioxins (EPA, 2005). This is based on testing of emissions from burning of refuse in burn barrels. A burn barrel is typically a 55 gallon drum with its top removed and holes punched in the side to facilitate burning by providing combustion air (oxygen).

Burning of refuse in open barrels has been banned in Washington State since at least the early 1990's. Outdoor burning of brush and garden wastes was prohibited in 2000 within most urban growth areas (WAC 173-425). Many of the more populated areas have banned outdoor burning many years prior to these deadlines.

Lemieux (2000) experimented with burning of refuse made up of two compositions, one representing a family that practices recycling avidly and burns the remainder in a burn barrel and a second representing a family that does not recycle and instead burns their refuse in a burn barrel. The burns were found to emit significant amounts of a wide variety of contaminants, including dioxins and carcinogenic PAHs. However, no prediction of nearby soil concentrations was made nor was nearby soil analyzed as this was a controlled indoor experiment.

The ash from two burns (recycler and non recycler) were analyzed for dioxins and found to contain concentrations well in excess of the MTCA Method B soil cleanup level of 11 ppt. (525 ppt TEQ and 2213 ppt TEQ). The ash was also analyzed from cPAHs. Because of the high detection limits, analyses from only one sample are useable. These analyses indicate the ash TEQ would not exceed the Method B soil cleanup level for cPAHs.

Hedman, et al. (2005) also evaluated emissions from burning of garden waste and refuse in burn barrels. The controlled tests included a wide variety of garden wastes as well as mixtures of garden waste and domestic refuse and refuse alone. The tests were conducted in Sweden.

The two burns with refuse alone that included significant amounts of PVC plastic were found to emit significant amounts of dioxins. The many other burns of garden waste or garden waste mixed with varying amounts of different types of refuse were found to emit much smaller amounts of dioxins.

The ash resulting from these burns was also analyzed for dioxins. The ash from most of the garden wastes and garden waste/refuse mixtures were found to contain less than 1 ppt

TEQ dioxins. However, the ash from one of the garden waste/PVC plastic mixtures was found to contain 510 ppt TEQ of dioxins.

Wevers et al. (in press) conducted a series of open burning experiments in Belgium that included burning of garden waste in barrels and open fires and the burning of household refuse in a barrel. The impact of these burns was then measured on soils in the vicinity of these burns. Burning garden wastes in a barrel or open fire resulted in a total dioxin deposition rate per event of 1 to 2 pg TEQ/m^2 on nearby soils. Burning refuse in a barrel resulted in a total dioxin deposition rate per event of 2 to 3 pg TEQ/m^2 on nearby soils.

At these deposition rates it is estimated it would take over 100,000 burn events or thousands of years to exceed the Method B dioxin soil cleanup level of 11 ppt.

Conclusion—Burn Barrels

Several studies have been done on burn barrel contributions to dioxin emissions. These studies have found burning of refuse, especially refuse with PVC wastes, can result in significant dioxin and cPAH emissions. While burning of refuse has been illegal in Washington State for over a decade, illegal burning likely occurs. Burning of brush and garden wastes generate some dioxin and cPAHs, but at much lower levels. Outdoor burning of these materials has been banned in most urban growth areas for several years. While historic practice and illegal activity has probably contributed to background soil contaminant levels, overall, burn events with individual barrels are small and infrequent enough that they will not result in exceedances of soil dioxin or cPAH cleanup levels.

The ash generated by burning of garden wastes such as brush and leaves will not be significantly contaminated with dioxins and would not be affected by this rule revision. However, the ash generated by burning of refuse with plastics will be highly contaminated with dioxins, well in excess of the cleanup levels considered in this rule revision (11 ppt vs. 16-24 ppt). As such, should cleanup be required of an area where the ash would be disposed of, it would be required regardless of the cleanup level, since the ash concentration is so much greater than the cleanup level.

Wood Waste Boilers

EPA (2005) has identified industrial wood combustion as one of the top 10 sources of dioxin in the nation. Yake (1997) identified hog fuel boilers as the second highest source of dioxins in Washington State. Several other studies by Ecology (Demay, 1997; Kuntz, 2001; Das, 2003) have identified up to 85 active or former wood waste boilers in the State, with as many as 12 burning some salt laden wood waste (hog fuel). These 12 facilities have been identified as the ones most likely to emit higher amounts of dioxins.

The Yake, 1997 study provided estimates of current dioxin emissions from two wood waste boilers at 0.11 and 0.17 mg TEQ/day. This is well below (25 to 30 times lower) the lowest emission rate of 5 mg TEQ/day dioxin used in the cost benefit analysis. This, along with the information on municipal waste incinerators discussed earlier, indicates wood waste boilers with modern emission controls will not significantly impact nearby soils with dioxin contamination from air emissions. However, facilities that historically burned salt laden wood waste prior to the installation of air pollution controls would have likely emitted much greater emissions. These facilities were considered in the modeling conducted for the draft cost-benefit analysis.

Das (2003) summarized available data on the dioxin content of ash from wood waste boilers. Uloth and Heek (2007) also summarized ash dioxin contents based on information from NCASI and extensive testing done under contract to Environment Canada. These sources indicate that fly ash and bottom ash from boilers burning clean wood waste has levels of dioxin generally less than 1 ppt and thus would not be impacted by the proposed rule amendment. However, fly ash captured by air pollution control equipment from boilers burning salt laden wood waste will have very high levels of dioxin (1000 to 5000 ppt). As such, should cleanup be required of an area where the ash would be disposed of, it would be required regardless of the cleanup level, since the ash concentration is so much greater than the cleanup level.

Other Combustion Sources

Any combustion source generates some dioxins and carcinogenic PAHs. Numerous studies have been and continue to be conducted to better understand what factors affect the formation of these hazardous substances. The presence of chlorine in the material being burned is a major factor in generation of dioxin. Combustion temperature and the presence of certain metals that can act as a catalyst in the formation of dioxins are also factors.

The other sources identified in the rule comments are generally considered minor dioxin sources in numerous source inventories that have been done nationally by EPA, Ecology or by other states and countries. In addition, the level of dioxins in the emissions and amount and frequency of emissions are orders of magnitude less than the other sources discussed in this memo. While it is possible an individual facility or situation could arise where emissions from these facilities impact the surrounding area, it is unlikely. Instead, it is probably more appropriate to consider these as contributors to the background concentrations of these chemicals found in the environment.

Where ash is generated by these facilities, it is typically disposed of in a controlled, regulated landfill. Illegal disposal of ash would be captured by the normal solid waste regulatory process or identified as a cleanup site needing to be addressed under MTCA. Where cleanup is required, it generally consists of removal for small amounts of material or containment when larger amounts are involved and removal is not feasible. In these cases, the difference in the cleanup levels affected by the proposed rule revisions would likely not impact the area needing to be addressed by cleanup as other contaminants or the physical extent of waste disposal determine the area needing to be addressed in cleanup.

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Appendix G: Impact of the Proposed Rule on Third-Party Property

Estimation of Relocation Costs for Residential Properties Affected by the Final Rule									
Per-Diem	2-Week Compensation	Properties per Site		Percentage of Properties Relocated	Per-Site Cost		Number of Sites	Total Cost	
		Min.	Max.		Min.	Max.		Min.	Max.
$101.68	$1,423.58	3	7	10%	$427	$997	3	$1,281.22	$2,989.52
							12	$5,124.88	$11,958.06