***** PRELIMINARY DRAFT *****

Estimates of the Probable Costs and Benefits of the Proposed Rule Amendments to the Model Toxics Control Act Cleanup Regulation Chapter 173-340 WAC

Prepared by:

Washington State Department of Ecology
Toxics Cleanup Program

October 12, 2000

Publication 00-09-903

Table of Contents

Chapter 1 Introduction **1**
1.1 PURPOSE 1
1.2 BACKGROUND 1
1.3 SCOPING OF THE ANALYSIS 2
Chapter 2 Evaluation of the Proposed Amendments **3**
2.1 METHOD A CLEANUP LEVELS FOR SOIL AND GROUND WATER 3
2.1.1 Summary of Proposed Rule Amendment *3*
2.1.2 Analysis of Probable Costs *5*
2.1.3 Analysis of Probable Benefits *6*
2.2 SOIL CLEANUP LEVELS – CONSIDERATION OF LAND USE 7
2.2.1 Summary of Proposed Rule Amendment *7*
2.2.2 Analysis of Probable Costs *7*
2.2.3 Analysis of Probable Benefits *9*
2.3 SOIL CLEANUP LEVELS – CONSIDERATION OF THE LEACHING PATHWAY 9
2.3.1 Summary of Proposed Rule Amendment *9*
2.3.2 Analysis of Probable Costs *10*
2.3.3 Analysis of Probable Benefits *10*
2.4 SOIL CLEANUP LEVELS – CONSIDERATION OF THE DERMAL PATHWAY 12
2.4.1 Summary of Proposed Rule Amendment *12*
2.4.2 Analysis of Probable Costs *12*
2.4.3 Analysis of Probable Benefits *14*
2.5 SOIL CLEANUP LEVELS – CONSIDERATION OF THE VAPOR PATHWAY 14
2.5.1 Summary of Proposed Rule Amendment *15*
2.5.2 Analysis of Probable Costs *16*
2.5.3 Analysis of Probable Benefits *17*
2.6 SOIL CLEANUP LEVELS – CONSIDERATION OF TERRESTRIAL ECOLOGICAL RECEPTORS 18
2.6.1 Summary of Proposed Amendments *18*
2.6.2 Analysis of Probable Costs *20*
2.6.3 Analysis of Probable Benefits *22*
2.7 FINANCIAL ASSURANCES 24
2.7.1 Summary of the Proposed Rule Amendment *24*
2.7.2 Analysis of Probable Costs *25*
2.7.3 Analysis of Probable Benefits *26*
2.8 CITIZEN TECHNICAL ADVISOR 27
2.8.1 Summary of Proposed Rule Amendment *27*
2.8.2 Analysis of Probable Costs *27*
2.8.3 Analysis of Probable Benefits *28*
Chapter 3 Technical Analysis – Probable Costs of the Proposed Method A Soil and Ground Water Cleanup Levels **29**
3.1 INTRODUCTION 29
3.2 IMPACT OF PROPOSED METHOD A SOIL CLEANUP LEVELS 29
3.2.1 Methodology *29*
3.2.2 Description of Model Site *30*
3.2.3 Cost of Soil Cleanup *31*
3.2.4 Avoided Cost of Ground Water Cleanup *32*
3.3 IMPACT OF PROPOSED METHOD A GROUND WATER CLEANUP LEVELS 33
3.3.1 Methodology *34*
3.3.2 Description of Model Site *34*
3.3.3 Cost of Ground Water Cleanup *34*
3.4 CONCLUSION 36
3.5 CALCULATIONS 36
Chapter 4 Technical Analysis – Probable Benefits of the Proposed Method A Soil and Ground Water Cleanup Levels **53**

4.1 INTRODUCTION 53
4.2 LESS STRINGENT CLEANUP LEVELS 53
4.2.1 Soil Cleanup Levels *53*
4.2.2 Ground Water Cleanup Levels *53*
4.3 MORE STRINGENT CLEANUP LEVELS 54
4.3.1 Avoided Cost of Ground Water Cleanup – Soil Cleanup Levels ONLY *54*
4.3.2 Avoided Municipal Ground Water Treatment Costs *54*
4.3.3 Avoided Reduction in Value of Ground Water *54*
4.3.4 Health Benefits *55*
4.3.5 Other Benefits *59*
4.4 CONCLUSION 60
4.5 CALCULATIONS 61
Chapter 5 Technical Analysis – Probable Cost Impact on Petroleum Contaminated Sites 103
5.1 INTRODUCTION 103
5.1.1 Conceptual Approach *103*
5.1.2 Study Design *103*
5.2 STATEWIDE LEAKING FUEL TANK STUDY 104
5.2.1 Methodology *104*
5.2.2 Study Results *105*
5.2.3 Conclusions *106*
5.3 SITE "A" – COMMERCIAL GAS STATION WITH CONTAMINATED SOIL AND NO GROUND WATER CONTAMINATION 106
5.3.1 Site "A" Description *106*
5.3.2 Site "A" Analysis *106*
5.3.3 Site "A" Summary *109*
5.4 SITE "B" – COMMERCIAL GAS STATION WITH SOIL AND GROUND WATER CONTAMINATION 109
5.4.1 Site "B" Description *109*
5.4.2 Site "B" Analysis *110*
5.4.3 Site "B" Summary *113*
5.5 SITE "C" – INDUSTRIAL FACILITY WITH SOIL AND NON-POTABLE GROUND WATER CONTAMINATION 113
5.5.1 Site "C" Description *113*
5.5.2 Site "C" Analysis *114*
5.5.3 Site "C" Summary *116*
5.6 CONCLUSION 116
5.7 CALCULATIONS 116
Chapter 6 Technical Analysis – Probable Costs of Conducting a Terrestrial Ecological Evaluation 137
6.1 INTRODUCTION 137
6.2 CASE STUDIES 137
6.2.1 Commercial Gas Station *137*
6.2.2 Industrial Site *138*
6.2.3 City Park Site *141*
6.3 CONCLUSION 143
Chapter 7 Technical Analysis – Probable Cost Impact of Financial Assurances 145
7.1 INTRODUCTION 145
7.2 COVERAGE 145
7.3 COST OF COVERAGE 146
7.3.1 Methodology for Estimating Costs *146*
7.3.2 Cost Estimates *147*
7.4 HIGH-END COST ESTIMATE 149
7.5 CONCLUSION 150
Chapter 8 References 151

List of Tables

Table 2-1: Proposed Changes to Method A Ground Water Cleanup Levels 3
Table 2-2: Proposed Changes to Method A Soil Cleanup Levels for Unrestricted Land Use 4
Table 2-3: Proposed Changes to Method A Soil Cleanup Levels for Industrial Properties 5
Table 2-4: Comparison of Soil Direct Contact Concentrations for Petroleum Mixtures under the Current and Proposed Rules 13
Table 2-5: Comparison of Soil Direct Contact Concentrations and Soil Cleanup Levels for Petroleum Mixtures under the Proposed Rule 13
Table 3-1: Summary of Method A Soil Cleanup Levels for Unrestricted Land Use 37
Table 3-2: Summary of Method A Soil Cleanup Levels for Industrial Land Use 38
Table 3-3: Method A Soil Cleanup Levels for Unrestricted Land Use - Calculation of Change in Mass Removed . 39
Table 3-4: Method A Soil Cleanup Levels for Industrial Land Use – Calculation of Change in Mass Removed 40
Table 3-5: Method A Soil Cleanup Levels for Unrestricted Land Use – Calculation of Change in Cost of Cleanup 41
Table 3-6: Method A Soil Cleanup Levels for Industrial Land Use – Calculation of Change in Cost of Cleanup 43
Table 3-7: Cost of Soil Vapor Extraction (SVE) – Compiled from Federal Cleanup Sites 45
Table 3-8: Cost of Soil Cleanup Using Low Temperature Thermal Desorption – Compiled from Federal Cleanup Sites 46
Table 3-9: Cost of Soil Cleanup Using Soil Washing – Compiled from Federal Cleanup Sites 47
Table 3-10: Cost of Soil Cleanup Using Excavation and Off-Site Disposal in a Landfill – Compiled from Ecology Bid Data 48
Table 3-11: Cost of Ground Water Cleanup Using Pump and Treat Systems – Compiled from Federal Cleanup Sites 49
Table 3-12: Summary of Method A Ground Water Cleanup Levels 51
Table 3-13: Method A Ground Water Cleanup Levels – Calculation of Change in Cleanup Costs 52
Table 4-1: Capital and Operating Costs for Contaminated Municipal Well Treatment Systems 61
Table 4-2: Calculation of Value of Ground Water Based on Value of Water Right 62
Table 4-3: Calculation of Value of Ground Water Based on Water Rates 63
Table 4-4: Number of Persons with Potential to Contract Cancer due to Ground Water Ingestion 64
Table 4-5: Method A Soil Cleanup Levels for Unrestricted Land Use – Summary of Change in Health Risk 65
Table 4-6: Method A Soil Cleanup Levels for Industrial Land Use – Summary of Change in Health Risk 67
Table 4-7: Calculation of Predicted Ground Water Concentration Resulting from Current Method A Soil Cleanup Levels for Unrestricted Land Use using the 3-Phase Model 69
Table 4-8: Calculation of Predicted Ground Water Concentration Resulting from Proposed Method A Soil Cleanup Levels for Unrestricted Land Use using the 3-Phase Model 72
Table 4-9: Calculation of Predicted Ground Water Concentration Resulting from Current Method A Soil Cleanup Levels for Industrial Land Use using the 3-Phase Model 75
Table 4-10: Calculation of Predicted Ground Water Concentration Resulting from Proposed Method A Soil Cleanup Levels for Industrial Land Use using the 3-Phase Model 78
Table 4-11: Ground Water Concentration Using the 4-Phase Model and BP Gasoline Composition #4 Using 100 PPM in Soil (Current TPH-G Method A Soil Cleanup Level) 81
Table 4-12: Ground Water Concentration Using the 4-Phase Model and BP Gasoline Composition #4 Using 30 PPM in Soil (Proposed TPH-G Method A Soil Cleanup Level) 82
Table 4-13: Ground Water Concentration Using the 4-Phase Model and ARCO Gasoline Composition #5 Using 100 PPM in Soil (Current TPH-G Method A Soil Cleanup Level) 83
Table 4-14: Ground Water Concentration Using the 4-Phase Model and ARCO Gasoline Composition #5 Using 30 PPM in Soil (Current TPH-G Method A Soil Cleanup Level) 84
Table 4-15: Calculation of Ground Water Hazard Quotient Resulting from Current Method A Soil Cleanup Levels for Unrestricted Land Use 85
Table 4-16: Calculation of Ground Water Hazard Quotient Resulting from Proposed Method A Soil Cleanup Levels for Unrestricted Land Use 87
Table 4-17: Calculation of Ground Water Cancer Risk Resulting from Current Method A Soil Cleanup Levels for Unrestricted Land Use 89

Table 4-18: Calculation of Ground Water Cancer Risk Resulting from Proposed Method A Soil Cleanup Levels for Unrestricted Land Use 91
Table 4-19: Calculation of Ground Water Hazard Quotient Resulting from Current Method A Soil Cleanup Levels for Industrial Land Use 93
Table 4-20: Calculation of Ground Water Hazard Quotient Resulting from Proposed Method A Soil Cleanup Levels for Industrial Land Use 95
Table 4-21: Calculation of Ground Water Cancer Risk Resulting from Current Method A Soil Cleanup Levels for Industrial Land Use 97
Table 4-22: Calculation of Ground Water Cancer Risk Resulting from Proposed Method A Soil Cleanup Levels for Industrial Land Use 99
Table 4-23: Estimated Cost of Adverse Health Effects 101
Table 4-24: Estimated Incremental Value of a Statistical Life 102
Table 5-1: Leaking Fuel Tank Site Study – Residual Soil Concentrations (12 of 29 Sites) 119
Table 5-2: Gasoline Composition Derivation – Fuel Compositions 120
Table 5-3: Gasoline Composition Derivation – Soil BTEX Composition Ratios 121
Table 5-4: Site "A" – Hypothetical Soil Data 125
Table 5-5: Site "A" – Cost Estimates for Excavation of Soil to Method A Cleanup Levels 128
Table 5-6: Existing Ground Water Concentrations based on NEAT (Pure) Gasoline Composition 129
Table 5-7: Site "B" – Soil and Ground Water Cleanup Levels 130
Table 5-8: Site "B" – Protective Soil Concentrations: Direct Contact Pathway 130
Table 5-9: Site "B" – Protective Soil Concentrations: Leaching Pathway 130
Table 5-10: Site "B" – Calculation of Ground Water Cleanup Levels (Proposed Rule) 131
Table 5-11: Site "B" – Protective Soil Concentrations: Leaching Pathway Calculations #1 132
Table 5-12: Site "B" – Protective Soil Concentrations: Leaching Pathway Calculations #2 133
Table 5-13: Site "B" – Protective Soil Concentrations: Leaching Pathway Calculations #3 134
Table 5-14: Site "B" – Mass and Cleanup Cost Calculations: TPH-G 135
Table 5-15: Site "B" – Unit Cost of Dual-Phase Extraction 136
Table 7-1: Estimated Cost of Selecting a Financial Assurance Mechanism 147
Table 7-2: Estimated Cost of Establishing a Financial Assurance Mechanism 147
Table 7-3: Estimated Cost of Financial Assurance Mechanisms 148

List of Figures

Figure 5-1: Leaking Fuel Tank Study – Impact of Current Method A Soil Cleanup Levels 117
Figure 5-2: Leaking Fuel Tank Study – Impact of Proposed Method A Soil Cleanup Levels 118
Figure 5-3: Gasoline Composition Derivation – Gasoline Weathering Profile 122
Figure 5-4: Gasoline Composition Derivation – Measured vs. Predicted Soil BTEX Composition Ratios 123
Figure 5-5: Site "A" – Measured Gasoline Soil Concentrations vs. Depth 124
Figure 5-6: Site "A" – Gasoline and Benzene Soil Concentrations vs. Depth 126
Figure 5-7: Site "A" – Toluene, Ethylbenzene & Xylene Soil Concentrations vs. Depth 127

Chapter 1 Introduction

1.1 Purpose

The Washington Administrative Procedure Act requires that significant legislative rules be evaluated to "[d]etermine that the probable benefits of a rule are greater than its probable costs, taking into account both quantitative and qualitative benefits and costs and the specific directives of the statute being implemented." RCW 34.05.328(1)(c). This determination must be documented prior to final rule adoption and included in the rulemaking record. This report summarizes Ecology's analysis of the probable costs and probable benefits of the proposed amendments to the MTCA Cleanup Regulation (Chapter 173-340 WAC) and explains how the estimates of those costs and benefits were generated.

1.2 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. Effective 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 declaration of policy, the Model Toxics Control Act (MTCA) 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.

RCW 70.105D.010(1).

MTCA requires the Washington State Department of Ecology (Ecology) to adopt and enforce implementing regulations. The implementing regulation, Chapter 173-340 WAC, Model Toxics Control Act Cleanup Regulation, was developed in two phases and adopted in 1990 and 1991 respectively.

Ecology is proposing to adopt amendments to the MTCA Cleanup Regulation. These amendments reflect changes developed through a negotiated rulemaking process that began in 1997. The purpose of the proposed rule amendments is to update the rule based on new scientific information, to make the rule reflect department policy, and to make the rule easier to understand. More specifically, the proposed rule amendments were developed in response to the need to:

- Implement the recommendations of the MTCA Policy Advisory Committee (PAC);[1]
- Implement the recommendations of the MTCA Science Advisory Board;

[1] Established by the legislature in 1995, the MTCA Policy Advisory Committee (PAC) was directed to provide advice to the legislature and Ecology on administrative and legislative actions to implement MTCA more effectively. The PAC provided its final report containing its recommendations in December 1996.

- Meet the regulatory requirement in WAC 173-340-702(3) that Ecology review and, as appropriate, update cleanup standards every five years based on new scientific information and changes in other state and federal laws;
- Incorporate existing Department policies into the rule, as required by the Administrative Procedure Act (RCW 34.05.230(8)); and
- Clarify and improve the readability of the rule.

The proposed rule amendments were developed in accordance with the specific directives of the Model Toxics Control Act (Chapter 70.105D RCW), the MTCA Cleanup Regulation (Chapter 173-340 WAC), and the Administrative Procedure Act (Chapter 34.05 RCW).

1.3 Scoping of the Analysis

Ecology conducted a comprehensive review of the proposed amendments to the MTCA Cleanup Regulation (Chapter 173-340 WAC) to identify those amendments that required further evaluation to determine whether the probable benefits of the proposed rule amendments exceed the probable costs. The review undertaking by Ecology considered several factors, including whether the amendment may have a significant economic impact, whether the amendment establishes requirements under optional methodologies, and whether the amendment only clarifies existing requirements. Based on this review, Ecology determined that the following amendments may have significant economic impacts and should be subject to further analysis.

- Changes to the Method A soil and ground water cleanup levels.
- Establishment of soil cleanup levels – consideration of land use.
- Establishment of soil cleanup levels – evaluation of the soil-to-ground water pathway.
- Establishment of soil cleanup levels – evaluation of the dermal exposure pathway.
- Establishment of soil cleanup levels – evaluation of the vapor exposure pathway.
- Establishment of soil cleanup levels – conducting a terrestrial ecological evaluation.
- Requirement of financial assurances.
- Creation of a citizen technical advisor.

Chapter 2 Evaluation of the Proposed Amendments

The primary impact of the proposed rule amendments on costs and benefits is expected to result from changes in the cleanup levels established for a site. Costs and benefits, though, are not directly related to the establishment of cleanup levels. Rather, the ultimate impact on costs and benefits of any change in cleanup levels is dependent on several site-specific factors, including (most importantly) the remedy selected. More permanent cleanup actions that remove contaminants from the soil or ground water typically cost more than less permanent cleanup actions that leave contamination at the site and rely on engineered and institutional controls. Consequently, the proposed rule amendments that affect the establishment of cleanup levels are expected to have a greater impact if a more permanent remedy that removed contaminants were selected than if a less permanent remedy that contained contamination were selected.

2.1 Method A Cleanup Levels for Soil and Ground Water

The primary impact of the proposed rule amendments on costs and benefits is expected to result from the proposed changes to the soil and ground water Method A cleanup levels. The impact of the proposed Method A soil cleanup levels also reflects the impact of the proposed amendments regarding the evaluation of the leaching pathway **(see Section 2.3)** and the dermal pathway **(see Section 2.4)**.

2.1.1 Summary of Proposed Rule Amendment

The proposed rule amendments include changes to some of the Method A cleanup levels for soil and ground water. These changes are identified in WAC 173-340-900 in Tables 720-1, 740-1, and 745-1. The basis for each of these changes and the resulting cleanup levels are provided in the applicable footnotes located at the end of each Method A table.

Table 2-1 below identifies the Method A ground water cleanup levels that have changed or been added as part of the proposed rule amendments. See Table 720-1 in WAC 173-340-900 for the complete Method A table and associated explanatory footnotes.

Table 2-1: Proposed Changes to Method A Ground Water Cleanup Levels

Hazardous Substance	Cleanup Level (ug/liter)		Basis for Change*
	Current Rule	Proposed Rule	
PAHs / Benzo(a)pyrene	0.1	0.1	See Table 720-1 footnote.
DDT	0.1	0.3	Equation 720-2
Lead	5	15	See Table 720-1 footnote.
TPH Mixtures			
Gasoline Range Organics			
• Benzene not present	1,000	1,000	See Table 720-1 footnote.
• Benzene present	1,000	800	See Table 720-1 footnote.
Diesel Range Organics	1,000	500	See Table 720-1 footnote.
Heavy Oils	1,000	500	See Table 720-1 footnote.
Mineral Oil	1,000	1,000	See Table 720-1 footnote.

TPH Components			
Toluene	40	1,000	See Table 720-1 footnote.
Ethylbenzene	30	700	See Table 720-1 footnote.
Xylenes	20	1,000	See Table 720-1 footnote.
MTBE	N/A	20	See Table 720-1 footnote.
Naphthalenes	N/A	5	Equation 720-1

Table 2-2 below identifies the Method A soil cleanup levels for unrestricted land uses that have changed or been added as part of the proposed rule amendments. See Table 740-1 in WAC 173-340-900 for the complete Method A table and associated explanatory footnotes.

Table 2-2: Proposed Changes to Method A Soil Cleanup Levels for Unrestricted Land Use

Hazardous Substance	Cleanup Level (mg/kg)		Exposure Pathway of Concern	Basis for Change**
	Current Rule	Proposed Rule		
Benzo(a)pyrene	N/A	0.1	Ground Water	3-Phase Model
Chromium (Total)	100			
• Chromium VI		19	Ground Water	3-Phase Model
• Chromium III		2,000	Ground Water	3-Phase Model
DDT	1	3	Direct Contact	
EDB	0.001	0.005	Ground Water	3-Phase Model + PQL
Lindane	1.0	0.01	Ground Water	3-Phase Model + PQL
Methylene chloride	0.5	0.02	Ground Water	3-Phase Model
Mercury (inorganic)	1	2	Ground Water	3-Phase Model
PAHs (carcinogenic)	1.0	N/A		
Tetrachloroethylene	0.5	0.05	Ground Water	3-Phase Model
1,1,1 Trichloroethane	20	2	Ground Water	3-Phase Model
Trichloroethylene	0.5	0.03	Ground Water	3-Phase Model
TPH Mixtures				
Gasoline Range Organics				
• Conditional	100	100	Ground Water	4-Phase Model
• Default	100	30	Ground Water	4-Phase Model
Diesel Range Organics	200	2,000	Ground Water	Residual Saturation
Heavy Oils	200	2,000	Ground Water	Residual Saturation
Mineral Oil	200	4,000	Ground Water	Residual Saturation
TPH Components				
Benzene	0.5	0.03	Ground Water	3- & 4-Phase Models
Toluene	40	7	Ground Water	3-Phase Model
Ethylbenzene	20	6	Ground Water	3-Phase Model
Xylenes	20	9	Ground Water	3-Phase Model
MTBE	N/A	0.1	Ground Water	3-Phase Model
Naphthalenes	N/A	5	Ground Water	3-Phase Model

** Please refer to Table 740-1 in WAC 173-340-900 for a more detailed description of the basis for the change. The 3-Phase Model and the 4-Phase Model refer the methods described in WAC 173-340-747 for establishing soil concentrations protective of ground water. "PQL" means that the cleanup level was adjusted based on the practical quantitation limit.

Table 2-3 below identifies the Method A soil cleanup levels for industrial properties that have changed or been added as part of the proposed rule amendments. See Table 745-1 in WAC 173-340-900 for the complete Method A table and associated explanatory footnotes.

Table 2-3: Proposed Changes to Method A Soil Cleanup Levels for Industrial Properties

Hazardous Substance	Cleanup Level (mg/kg)		Exposure Pathway of Concern	Basis for Change**
	Current Rule	Proposed Rule		
Arsenic	200	20	Ground Water	3-Phase Model + NB
Benzo(a)pyrene	N/A	2	Ground Water	3-Phase Model
Cadmium	10	2	Ground Water	3-Phase Model + PQL
Chromium (Total)	500			
• Chromium VI		19	Ground Water	3-Phase Model
• Chromium III		2,000	Ground Water	3-Phase Model
DDT	5	4	Ground Water	3-Phase Model
EDB	0.001	0.005	Ground Water	3-Phase Model + PQL
Lindane	1.0	0.01	Ground Water	3-Phase Model + PQL
Methylene chloride	0.5	0.02	Ground Water	3-Phase Model
Mercury (inorganic)	1	2	Ground Water	3-Phase Model
PAHs (carcinogenic)	20	N/A		
Tetrachloroethylene	0.5	0.05	Ground Water	3-Phase Model
1,1,1 Trichloroethane	20	2	Ground Water	3-Phase Model
Trichloroethylene	0.5	0.03	Ground Water	3-Phase Model
TPH Mixtures				
Gasoline Range Organics				
• Conditional	100	100	Ground Water	4-Phase Model
• Default	100	30	Ground Water	4-Phase Model
Diesel Range Organics	200	2,000	Ground Water	Residual Saturation
Heavy Oils	200	2,000	Ground Water	Residual Saturation
Mineral Oil	200	4,000	Ground Water	Residual Saturation
TPH Components				
Benzene	0.5	0.1	Ground Water	4-Phase Model
Toluene	40	7	Ground Water	3-Phase Model
Ethylbenzene	20	6	Ground Water	3-Phase Model
Xylenes	20	9	Ground Water	3-Phase Model
MTBE	N/A	0.1	Ground Water	3-Phase Model
Naphthalenes	N/A	5	Ground Water	3-Phase Model

** Please refer to Table 745-1 in WAC 173-340-900 for a more detailed description of the basis for the change. The 3-Phase Model and the 4-Phase Model refer the methods described in WAC 173-340-747 for establishing soil concentrations protective of ground water. "PQL" means that the cleanup level was adjusted based on the practical quantitation limit. "NB" means that the cleanup level was adjusted based on the natural background concentration.

2.1.2 Analysis of Probable Costs

The impact of these proposed rule amendments on costs depends on whether the proposed Method A cleanup levels will increase or decrease the costs of site remediation. Whether the proposed Method A cleanup levels will increase or decrease the costs of site remediation depends on several factors.

First, the impact depends on whether the proposed Method A cleanup levels are more stringent or less stringent than under the current rule. More stringent cleanup levels may increase the total cost of site remediation while less stringent cleanup levels may decrease the total cost of site remediation (avoided cost).

Second, the impact depends on several site-specific factors, including the type of contaminants present, which contaminants are contaminants of concern, the type of media contaminated, the extent of contamination, and the physical properties of the site. These factors determine the nature and scope of the cleanup and whether the proposed cleanup levels have an impact.

Third, the impact depends on the remedy selected. More permanent cleanup actions that remove contaminants from the soil or ground water typically cost more than less permanent cleanup actions that leave contamination at the site and rely on engineered and institutional controls. The impact of the proposed cleanup levels would have the greatest impact on costs if a more permanent cleanup were selected because the proposed levels would require a change in the amount of contaminants requiring removal. However, the proposed cleanup levels might not have any impact on cleanup costs if a less permanent remedy were selected that left contamination at the site because the proposed levels might not require a change in the amount of contaminants requiring removal.

The impact of the proposed Method A soil and ground water cleanup levels on cleanup costs were estimated using two methodologies. First, the impact of the proposed Method A soil and ground water cleanup levels were estimated by applying those levels to a model site representative of most sites that use Method A to establish cleanup levels. **See Chapter 3.** Second, the particular impact of the proposed Method A soil and ground water cleanup levels on petroleum contaminated sites was estimated by applying those levels to a model site representative of a commercial gas station. **See Chapter 5**. The analysis of the impact of the proposed Method A soil cleanup levels also reflects the impact of the proposed amendments regarding the evaluation of the leaching pathway **(see Section 2.3)** and the dermal pathway **(see Section 2.4)**.

2.1.3 Analysis of Probable Benefits

The impact of the proposed rule amendments on benefits also depends on several factors. First, as discussed above, the impact depends on whether the proposed Method A cleanup levels are more stringent or less stringent than under the current rule. More stringent cleanup levels would quantitatively reduce the risk of adverse health effects.

Second, the impact depends on several site-specific factors, including the type of contaminants present, which contaminants are contaminants of concern, the type of media contaminated, the extent of contamination, and the physical properties of the site. These factors determine the nature and scope of the cleanup and whether the proposed cleanup levels have an impact.

Third, the impact depends on the remedy selected. More permanent cleanup actions that remove contaminants from the soil or ground water typically would quantitatively reduce the risk of

adverse health effects. Less permanent cleanup actions that leave contamination at the site and rely on engineered and institutional controls might not result in additional contaminant removal and thereby reduce the risk of adverse health effects.

The probable benefits of the proposed Method A soil and ground water cleanup levels are discussed in **Chapter 5**.

2.2 Soil Cleanup Levels – Consideration of Land Use

2.2.1 Summary of Proposed Rule Amendment

The current rule allows soil cleanup levels to be established using land uses other than residential and industrial as the basis for a reasonable maximum exposure (RME) scenario under certain limited circumstances specified in the rule. Other land uses that could be considered included commercial, recreational, and agricultural. WAC 173-340-740(1).

The proposed rule amendments allow soil cleanup levels to be established using only residential and industrial land uses as the basis for a RME scenario. Although other land uses (such as commercial, recreational, and agricultural) may not be used to establish cleanup levels, these other land uses may be used to establish remediation levels as part of remedy selection. WAC 173-340-708(3)(d)(ii); 173-340-740(1)(a). For example, if containment is the proposed remedy for contaminated soil at a commercial site, the RME scenario for evaluating the protectiveness of the containment system for the direct contact pathway could be changed from a child living on the site to a maintenance worker or child trespasser. See WAC 173-340-708(3)(d)(ii), (iii).

2.2.2 Analysis of Probable Costs

The impact of this proposed amendment on costs depends on whether the amendment would increase the cleanup costs. The proposed rule amendment is not expected to result in any additional cleanup costs. This projection is based on several factors.

First, based on a comparison of the current and proposed rules, the proposed rule amendment is not expected to result in additional cleanup costs. Although land uses other than residential (such as commercial, recreational, and agricultural) may not be used to establish cleanup levels, these other land uses may be used to evaluate the protectiveness of remediation levels as part of remedy selection. WAC 173-340-708(3)(d)(ii); 173-340-740(1)(a). Ecology expects that if less stringent cleanup levels could have been established under the current rule using land uses other than residential and industrial as the basis for a reasonable maximum exposure (RME) scenario, then remediation levels based on those same scenarios could also be justified. Accordingly, while the proposed rule amendment could result in more stringent soil cleanup levels based on residential land use at a few sites, the amendment is not expected to result in additional cleanup actions at those sites.

Furthermore, if an alternative RME scenario (based on a commercial, recreational, or agricultural land use) was used under the current rule to establish soil cleanup levels, then institutional controls would be required. WAC 173-340-440(1); 173-340-740(1)(c)(iii) and (d)(ii)(C).

Similarly, under the proposed rule amendments, if remediation levels based on those same RME scenarios were justified for a site, then institutional controls would also be required. WAC 173-340-440(2). Accordingly, the requirement of institutional controls under the proposed rule amendments would also not result in additional cleanup costs.

Second, the establishment of soil cleanup levels less stringent than residential soil cleanup levels under the current rule is limited in application and rarely used in practice. For commercial land uses, the current rule specifically provides that "soil cleanup levels **shall** be established in accordance with residential areas unless it can be clearly demonstrated that this is inappropriate." WAC 173-340-740(1)(c). To demonstrate that this is inappropriate, it must be clearly demonstrated that:

(A) [t]he property is currently zoned for or otherwise officially designated for industrial/commercial use;
(B) [t]he property is currently used for industrial/commercial purposes or has a history of use for industrial/commercial purposes;
(C) [the] properties adjacent to and in the general vicinity of the property are used or are designated for use for industrial/commercial purposes; **and**
(D) [t]he property and properties adjacent to and in the general vicinity are expected to be used for industrial/commercial purposes for the foreseeable future due to site zoning, statutory or regulatory restrictions, comprehensive plans, adjacent land use, and other relevant factors."

WAC 173-340-740(1)(c)(i) (emphasis added). Furthermore, as emphasized in the current rule "[Ecology] expects that only industrial/commercial properties located in the interior portion of a large industrial/commercial area will qualify for other than method A or method B cleanup levels...." WAC 173-340-740(1)(c)(v). Because most sites cannot make these demonstrations, most properties are precluded from using land uses other than residential as the basis for a RME scenario. Even if a property qualifies, the current rule requires that "soil cleanup levels be established as close as practicable to the method B soil cleanup levels...and shall be at least as stringent as method C soil cleanup levels." WAC 173-340-740(1)(c)(ii).

Third, even if a property qualifies for an alternative RME scenario, soil cleanup levels that are established for a site must be protective of the underlying ground water and must not cause an exceedance of the ground water cleanup level. Ground water cleanup levels are based on the potential productivity of the aquifer underlying a site, independent of the surface land use. Many commercial and industrial areas throughout the state are underlain by highly productive aquifers. Examples include the Airdustrial Park area in Tumwater, the Nalley Valley in Tacoma, Ponders Corner in Lakewood, the Spokane Valley sole source aquifer, and municipal water supply wells for the Cities of Vancouver, Richland and Union Gap. This is also apparent from the number of public water systems that have become contaminated by nearby industrial and commercial sites. Since most sites are underlain by aquifers that are classified as drinking water aquifers under MTCA, soil cleanup levels would often be established that are equivalent to the Method B cleanup level.

2.2.3 Analysis of Probable Benefits

The impact of this proposed rule amendment on benefits depends on whether the amendment would result in a cleanup that is more protective of human health and the environment. The protectiveness of a cleanup is based on both the established cleanup standards and the selected cleanup actions. While the proposed rule amendment could result in more stringent soil cleanup levels at a few sites, the amendment is not expected to result in additional cleanup actions at those sites. First, as discussed above, even though land uses other than residential (such as commercial, recreational, and agricultural) may not be used to establish less stringent soil cleanup levels, these other land uses may be used to establish remediation levels as part of remedy selection. WAC 173-340-708(3)(d)(ii); 173-340-740(1)(a). Second, as discussed above, the establishment of soil cleanup levels less stringent than residential soil cleanup levels under the current rule is limited in application and rarely used in practice. Third, even if a property qualifies for an alternative RME scenario under the current rule, soil cleanup levels that are established for a site must still be protective of the underlying ground water and must not cause an exceedance of the ground water cleanup level. However, while the proposed rule amendment is not expected to result in additional cleanup actions, the amendment is expected to provide greater assurance that the cleanups actions selected for a site are protective of human health and the environment.

2.3 Soil Cleanup Levels – Consideration of the Leaching Pathway

2.3.1 Summary of Proposed Rule Amendment

Evaluation of the leaching pathway (soil-to-ground water pathway) requires a determination that the soil concentration will not cause an exceedance of the ground water cleanup level established under WAC 173-340-720. Under the current rule, soil concentrations that meet this requirement are determined by multiplying the ground water cleanup level by 100. Under the proposed rule amendments, Ecology replaced this methodology with fate and transport models. WAC 173-340-747. The following discussion provides a brief overview of the proposed rule amendment.

WAC 173-340-747(2) sets forth the general requirements (criteria) that soil concentrations must meet for those concentrations to be considered protective of human health. First, the soil concentrations must not cause an exceedance of the ground water cleanup levels established under WAC 173-340-720. To determine if this criterion is met, one of the methodologies specified in subsections (4) through (9) must be used. Second, to ensure that the first criterion is met, the soil concentration must not result in the accumulation of free product on or in ground water. To determine if this criterion is met, one of the methodologies specified in subsection (10) must be used.

WAC 173-340-747(3) provides an overview of the methods specified in subsections (4) through (10) for deriving soil concentrations that meet the criteria specified in subsection (2). Certain methods are tailored for particular types of hazardous substances or sites. Certain methods are more complex than others and certain methods require the use of site-specific data. The specific requirements for deriving a soil concentration under a particular method may also depend on the

hazardous substance. Note, however, that the proposed rule amendment does not mandate the use of any particular methodology.

WAC 173-340-747(4) through (10) specifies the procedures and requirements for establishing soil concentrations that meet the criteria specified in subsection (2) under each of the specified methodologies.

The proposed Method A soil cleanup levels were established by evaluating each of the exposure pathways, including the soil-to-ground water pathway. The Method A soil cleanup levels that are based on the protection of ground water are identified in **Tables 2-2 and 2-3**. Derivation of these cleanup levels was based on the application of the three-phase and the four-phase equilibrium partitioning models and on the consideration of residual saturation. As indicated by **Tables 2-2 and 2-3**, each of the proposed changes to the Method A soil cleanup levels is based on protection of ground water, except for one – DDT for industrial properties, which is based on direct contact.

2.3.2 Analysis of Probable Costs

The impact of this proposed rule amendment on costs depends on whether the soil cleanup level is established based on the leaching pathway and, if so, whether evaluation of the leaching pathway results in a less or more stringent soil cleanup level.

This proposed rule amendment has resulted in a different Method A soil cleanup level for many hazardous substances. These hazardous substances are identified in **Tables 2-2 and 2-3**. Some of these hazardous substances have become more stringent and some have become less stringent. This proposed rule amendment may also result in different Method B or Method C soil cleanup levels.

More stringent cleanup levels may increase the total cost of site remediation while less stringent cleanup levels may decrease the total cost of site remediation (avoided cost). As discussed previously, the cost impact also depends on whether the hazardous substance(s) at issue will determine the nature and scope of the cleanup (i.e., whether the hazardous substance(s) are contaminants of concern at a site) and the remedy selected for the site.

The impact of the proposed leaching pathway amendment on cleanup costs was evaluated as part of the evaluation of the impact of the proposed Method A cleanup levels. **See Chapter 3**. The impact of the proposed leaching pathway amendment on cleanup costs was also evaluated as part of the evaluation of the impact of the proposed rule on petroleum contaminated sites. **See Chapter 5.**

2.3.3 Analysis of Probable Benefits

2.3.3.1 Health Benefits

The impact of the proposed rule amendment on benefits also depends on several factors. First, as discussed above, the impact depends on whether the soil cleanup level is established based on the leaching (soil-to-ground water) pathway and, if so, whether evaluation of this pathway results in

a less or more stringent soil cleanup level. While more stringent cleanup levels would quantitatively reduce the risk of adverse health effects, less stringent cleanup levels would quantitatively increase the risk of adverse health effects.

Second, the impact depends on whether the hazardous substance(s) at issue will determine the nature and scope of the cleanup (i.e., whether the hazardous substance(s) are contaminants of concern at a site) and the remedy selected for the site.

The probable benefits of the proposed leaching pathway amendment was evaluated as part of the evaluation of the impact of the proposed Method A cleanup levels. **See Chapter 5.**

2.3.3.2 Other Benefits

The methodology proposed by Ecology more accurately quantifies the risk posed to ground water by hazardous substances within the soil and hence more accurately ensures the protection of human health and the environment. This amendment attempts to combine the goals advanced by the MTCA Policy Advisory Committee of creating a rule that achieves a level of simplicity combined with a level of human health and environmental protection consistent with advances in scientific information.

The proposal to replace the old "100 X ground water" model with the more accurate chemical and site-specific fate and transport models is based on an extensive review of new scientific and technical information. Although the 100 X ground water model was based on the best scientific and technical information available at the time, the old model does not adequately account for site or chemical-specific factors that control the movement of hazardous substances from soil into water. The movement of hazardous substances from soil into water is primarily controlled by two factors: the soil properties and the hazardous substance water solubility.

For example, some hazardous substances like benzene are relatively soluble in water. When gasoline is released to the soil, benzene will immediately start to partition from the gasoline into water that is held within the soil pores and then flow to the ground water. The 100 X ground water model does not adequately account for this mobility. All hazardous substances are treated the same, even if some are more mobile than others. Consequently, for hazardous substances that are highly mobile (e.g., benzene, gasoline and chlorinated organics), the 100 X model will predict a soil concentration that is too high and consequently not sufficiently protective of human health. Conversely, for hazardous substances that are less mobile (e.g., PCBs, metals and heavier petroleum products), the 100 X model will predict a soil concentration that is too low.

Based on new scientific and technical information developed since the adoption of the 100 X ground water methodology in 1991, Ecology developed two fate and transport models to account for the way hazardous substances behave when they are released to the soil. These models apply the same principle of equilibrium partitioning used for evaluating the leaching pathway in the ASTM Risk-Based Corrective Action protocol and the U.S. Environmental Protection Agency's Soil Screening Guidance. The three-phase model accounts for partitioning of hazardous substances between the water, air and solid phases of a soil. The four-phase model accounts for partitioning between these same phases plus includes a non-aqueous liquid phase, a phase that commonly occurs when organic chemicals such as petroleum products are released to soils.

Both of these models were subject to rigorous review by the MTCA Science Advisory Board and it's Fate and Transport Subcommittee, which included members from the private consulting community and the University of Washington and Washington State University. Assumptions used in these models include extensive information extracted from the literature as well as information from contaminated sites in Washington State.

2.4 Soil Cleanup Levels – Consideration of the Dermal Pathway

2.4.1 Summary of Proposed Rule Amendment

The current rule does not require the evaluation of the dermal exposure pathway for the establishment of soil cleanup levels.

The proposed rule requires the evaluation of the dermal exposure pathway, concurrent with the ingestion exposure pathway, for certain hazardous substances and for other hazardous substances under certain conditions. Specifically, the dermal exposure pathway must be evaluated concurrently with the ingestion exposure pathway for all sites contaminated with petroleum mixtures. WAC 173-340-740(3)(b)(iii)(B)(III) and 173-340-745(5)(b)(iii)(B)(III). For all other contaminated sites, a concurrent exposure evaluation (dermal + ingestion) must be conducted only if the proposed changes to the default assumptions in the standard Method B or standard Method C equations "would result in a significantly higher soil cleanup level than would be calculated without the proposed changes." WAC 173-340-740(3)(c)(iii) and 173-340-745(5)(c)(iii).

2.4.2 Analysis of Probable Costs

The impact of this proposed rule amendment on costs depends on whether the dermal exposure pathway would be analyzed under the amendment and, if so, whether that analysis would result in a more stringent soil cleanup level than would otherwise have been established if that pathway had not been analyzed.

This proposed rule amendment did not result in any changes to the Method A soil cleanup levels.

This proposed rule amendment could result in changes to standard Method B or standard Method C soil cleanup levels for petroleum mixtures. As described previously, the dermal exposure pathway must be evaluated concurrently with the ingestion exposure pathway for all sites contaminated with petroleum mixtures. WAC 173-340-740(3)(b)(iii)(B)(III) and 173-340-745(5)(b)(iii)(B)(III). The actual impact of the proposed rule amendment on standard Method B and C cleanup levels, however, depends on several factors.

First, the impact depends on whether an evaluation of the dermal exposure pathway concurrent with the ingestion exposure pathway results in lower soil concentration than would have been derived by evaluation of the ingestion exposure pathway alone. As can be seen in **Table 2-4**, inclusion of the dermal pathway in the direct contact soil calculation, using the default assumptions in the proposed rule amendments, has only a minor effect on soil concentrations for unrestricted land use. For industrial land use, including the dermal pathway decreases the soil

concentration more, although the amount of difference varies considerably between hazardous substances.

Table 2-4: Comparison of Soil Direct Contact Concentrations for Petroleum Mixtures under the Current and Proposed Rules

Hazardous Substance	Soil Direct Contact Concentrations (mg/kg)			
	Unrestricted Land Use		Industrial Land Use	
	Current Rule (Ingestion)	Proposed Rule (Dermal + Ingest)	Current Rule (Ingestion)	Proposed Rule (Dermal + Ingest)
TPH Mixtures				
Gasoline Range Organics	4,700	4,700	210,000	150,000
Diesel Range Oragnics	3,900	3,000	170,000	39,000
Heavy Oils	3,900	3,000	170,000	39,000
Mineral Oil	7,800	5,800	340,000	70,000
TPH Components*				
Benzene	34	34	4,526	2,627
Toluene	16,000	15,000	700,000	297,309
Ethylbenzene	8,000	7,400	350,000	148,665
Xylenes	160,000	150,000	N/A	N/A
MTBE	N/A	N/A	N/A	N/A
Naphthalenes	1,600	1,200	70,000	16,613

* For the TPH components listed in this table, the assumption is that these occur as pure substances, not as a mixture. If they occur as a mixture, the individual TPH component cleanup levels must be adjusted downward for additive risk.

Second, the impact depends on whether direct contact pathway determines the soil cleanup levels or whether some other exposure pathway determines the soil cleanup level. If an exposure pathway other than direct contact determines the soil cleanup level, then the proposed rule amendment will have no impact, irrespective of whether the proposed rule amendment results in a more stringent direct contact soil concentration. As can be seen in **Table 2-5**, for sites where protection of ground water is a concern, none of the soil cleanup levels for petroleum mixtures and components is determined by the direct contact pathway. Rather, they are determined by the leaching pathway.

Table 2-5: Comparison of Soil Direct Contact Concentrations and Soil Cleanup Levels for Petroleum Mixtures under the Proposed Rule

Hazardous Substance	Soil Direct Contact Concentrations and Soil Cleanup Levels (mg/kg)			
	Unrestricted Land Use		Industrial Land Use	
	Direct Contact Concentration	Soil Cleanup Level	Direct Contact Concentration	Soil Cleanup Level
TPH Mixtures				
Gasoline Range Organics	4,700	100 or 30	150,000	100 or 30
Diesel Range Oragnics	3,000	2,000	39,000	2,000
Heavy Oils	3,000	2,000	39,000	2,000
Mineral Oil	5,800	4,000	70,000	4,000
TPH Components*				
Benzene	34	0.03	2,627	0.1
Toluene	15,000	7	297,309	7
Ethylbenzene	7,400	6	148,665	6
Xylenes	150,000	9	N/A	9

MTBE		N/A	0.1		N/A	0.1
Naphthalenes		1,200	5		16,613	5

* For the TPH components listed in this table, the assumption is that these occur as pure substances, not as a mixture. If they occur as a mixture, the individual TPH component cleanup levels must be adjusted downward for additive risk.

The impact of the proposed dermal pathway amendment on cleanup costs was evaluated as part of the evaluation of the impact of the proposed rule on petroleum contaminated sites. **See Chapter 5.**

As with standard Method B and C, this proposed rule amendment could result in changes to modified Method B or modified Method C cleanup levels. Again, however, the impact of the proposed rule amendment on costs depends on several factors. In addition to the factors discussed above for petroleum mixtures, the impact also depends on whether an evaluation of the dermal pathway would even be required under the proposed rule amendment. As described previously, an evaluation would only be required if the proposed changes to the default assumptions in the standard Method B or standard Method C equations "would result in a significantly higher soil cleanup level than would be calculated without the proposed changes." WAC 173-340-740(3)(c)(iii) and 173-340-745(5)(c)(iii). Since the establishment of site-specific soil cleanup levels under modified Method B or modified Method C is optional, further evaluation of the potential impact of this amendment on such site-specific cleanup levels has not been conducted.

2.4.3 Analysis of Probable Benefits

2.4.3.1 Health Benefits

The impact of the proposed rule amendment on benefits also depends on several factors. First, as discussed above, the impact depends on whether the soil cleanup level is established based on the direct contact pathway and, if so, whether evaluation of this pathway results in a more stringent soil cleanup level. More stringent cleanup levels would quantitatively reduce the risk of adverse health affects. Second, the impact depends on whether the hazardous substance(s) at issue will determine the nature and scope of the cleanup (i.e., whether the hazardous substance(s) are contaminants of concern at a site) and the remedy selected for the site.

2.4.3.2 Other Benefits

Evaluation of the dermal exposure pathway ensures that the soil cleanup levels and the remedy established for a site are sufficiently protective of human health. This amendment attempts to combine the goals advanced by the MTCA Policy Advisory Committee of creating a rule that achieves a level of simplicity combined with a level of human health and environmental protection consistent with advances in scientific information. Review of new scientific and technical information demonstrates that soil cleanup levels established without evaluating the dermal pathway concurrently with the ingestion pathway may not always be protective of human health. The proposed rule amendment takes into account current technical information and guidance and is consistent with current trends across both state and federal agencies.

2.5 Soil Cleanup Levels – Consideration of the Vapor Pathway

2.5.1 Summary of Proposed Rule Amendment

The current rule requires the evaluation of the vapor exposure pathway for protection of both ambient and indoor air under certain circumstances. WAC 173-340-740(3)(a)(iv) and (4)(b)(iv) and WAC 173-340-740(3)(b)(iv) and (4)(b)(iv).

The proposed rule amendments do not change how the pathway is evaluated; rather, the proposed amendments only change the circumstances for requiring an evaluation of the pathway. Furthermore, the proposed amendments do not mandate the use of any particular methodology for evaluating the pathway, if an evaluation is required.

The proposed rule amendments set forth the criteria for determining when to conduct an evaluation of the vapor exposure pathway. In general, the criteria identify those situations where the vapor pathway, rather than the direct contact or the leaching pathways, becomes the most significant exposure pathway (the exposure pathway of concern). The following discussion provides an overview of those criteria.

For standard Method B (soil cleanup levels for unrestricted land use) and for standard Method C (soil cleanup levels for industrial land use), the applicability of the vapor pathway evaluation is defined in WAC 173-340-740(3)(b)(iii)(C) and WAC 173-340-745(5)(b)(iii)(C) respectively. Specifically, the proposed rule amendments provide the following:

> The soil to vapor pathway shall be evaluated whenever one of the methods specified in WAC 173-340-747(5) through (9) is used to derive a soil concentration that is protective of ground water and that concentration is significantly higher than a concentration derived under the method specified in WAC 173-340-747(4).

For modified Method B (soil cleanup levels for unrestricted land use) and for modified Method C (soil cleanup levels for industrial land use), the applicability of the vapor pathway evaluation is defined in WAC 173-340-740(3)(c)(iv)(A) and WAC 173-340-745(5)(c)(iv)(A) respectively. Specifically, the proposed rule amendments provide the following:

> The soil to vapor pathway shall be evaluated whenever the proposed changes to the [standard equations] or default values would result in a significantly higher soil cleanup level than would be calculated without the proposed changes. The soil to vapor pathway shall also be evaluated whenever one of the methods specified in WAC 173-340-747(5) through (9) is used to derive a soil concentration that is protective of ground water and that concentration is significantly higher than a concentration derived under the method specified in WAC 173-340-747(4). Evaluation of soil vapors shall also be required under the following specific situations:
>
> (I) For petroleum distillates containing less than eight percent (8%) volatile constituents by weight (such as diesel range organics), the indoor air pathway shall be evaluated whenever soil cleanup levels exceed 10,000 mg/kg within one foot of: The wall of a structure; bottom slab of a structure; or, conduit that could facilitate transport to a structure.

(II) When the soil cleanup level for a volatile hazardous substance is based on protection of ground water for nonpotable use and the ground water cleanup level is established using a site-specific risk assessment under WAC 173-340-720(6)(c).

WAC 173-340-740(3)(c)(iv)(A) and 173-340-745(5)(c)(iv)(A).

2.5.2 Analysis of Probable Costs

The impact of this proposed rule amendment on costs depends on whether the vapor exposure pathway would be analyzed under the amendment (but not under the current rule) and, if so, whether that analysis would result in a more stringent soil cleanup level than would otherwise have been established if that pathway had not been analyzed.

This proposed rule amendment did not result in any changes to the Method A soil cleanup levels.

This proposed rule amendment could result in more stringent standard Method B or standard Method C soil cleanup levels. The actual impact of the proposed rule amendment on costs, however, depends on several factors. First, the impact depends on whether an evaluation would be required under the proposed rule amendment. As described previously, the proposed rule amendment requires the following under standard Method B and standard Method C:

> The soil to vapor pathway shall be evaluated whenever one of the methods specified in WAC 173-340-747(5) through (9) is used to derive a soil concentration that is protective of ground water and that concentration is significantly higher than a concentration derived under the method specified in WAC 173-340-747(4).

WAC 173-340-740(3)(b)(iii)(C) and WAC 173-340-745(5)(b)(iii)(C). Under this proposed rule amendment, the vapor pathway would not be evaluated if the method specified in WAC 174-340-747(4) is used to derive a soil concentration that is protective of ground water or if one of the methods specified in WAC 173-340-747(5) through (9) is used but does not result in a concentration that is significantly higher than a concentration derived under the method specified in WAC 173-340-747(4). Determination of significance is itself based on several factors.

Second, the impact depends on whether an evaluation of the vapor pathway would have been conducted under the current rule. If an evaluation of the vapor pathway would be conducted under both the current and proposed rules, then there would be no impact. This conclusion is based on the fact that the proposed rule does not change how the pathway is evaluated and does not mandate the use of any particular methodology for evaluating the pathway.

Third, the impact depends on whether an evaluation of the vapor exposure pathway would result in a lower soil cleanup level than would have been established without that evaluation. In other words, even if an evaluation were conducted under the proposed rule (but not under the current rule), the evaluation might not result in a more stringent soil cleanup level.

Therefore, only if an evaluation were conducted under the proposed rule (but not under the current rule) and that evaluation resulted in a more stringent soil cleanup level than would have been established without that evaluation could the proposed rule amendment have an impact on costs.

The impact of the proposed dermal pathway amendment on cleanup costs was evaluated as part of the evaluation of the impact of the proposed rule on petroleum contaminated sites. **See Chapter 5**.

As with standard Method B and C, this proposed rule amendment could also result in more stringent modified Method B or modified Method C soil cleanup levels. Again, however, the actual impact of the proposed rule amendment on costs depends on several factors. First, the impact depends on whether an evaluation would be required under the proposed rule amendment. Second, the impact depends on whether an evaluation of the vapor pathway would have been conducted under the current rule. Third, the impact depends on whether an evaluation of the vapor exposure pathway would result in a lower soil cleanup level than would have been established without that evaluation. Only if an evaluation were conducted under the proposed rule (but not under the current rule) and that evaluation resulted in a more stringent soil cleanup level than would have been established without that evaluation could the proposed rule amendment have an impact on costs. Since the establishment of site-specific soil cleanup levels under modified Method B or modified Method C is optional, further evaluation of the potential impact of this amendment on such site-specific cleanup levels has not been conducted.

2.5.3 Analysis of Probable Benefits

2.5.3.1 Health Benefits

The impact of this proposed rule amendment on benefits also depends on several factors. First, as discussed above, the impact depends on whether the vapor exposure pathway would be analyzed under the amendment (but not under the current rule) and, if so, whether that analysis would result in a more stringent soil cleanup level than would otherwise have been established if that pathway had not been analyzed. More stringent cleanup levels would quantitatively reduce the risk of adverse health affects. Second, the impact depends on whether the hazardous substance(s) at issue will determine the nature and scope of the cleanup (i.e., whether the hazardous substance(s) are contaminants of concern at a site) and the remedy selected for the site.

2.5.3.2 Other Benefits

Evaluation of the vapor exposure pathway ensures that the soil cleanup levels and the remedy established for a site are sufficiently protective of human health. This amendment attempts to combine the goals advanced by the MTCA Policy Advisory Committee of creating a rule that achieves a level of simplicity combined with a level of human health and environmental protection consistent with advances in scientific information. Review of new scientific and technical information demonstrates that under certain circumstances, soil cleanup levels established without evaluating the vapor pathway may not always be protective of human health. The proposed rule amendment takes into account current technical information and guidance and is consistent with current trends across both state and federal agencies.

2.6 Soil Cleanup Levels – Consideration of Terrestrial Ecological Receptors

2.6.1 Summary of Proposed Amendments

Under the current rule, all cleanup actions must meet certain minimum requirements, including protection of human health and the environment. WAC 173-340-360(2). "Environment" is broadly defined in the rule to mean "any plant, animal, natural resource, surface water (including underlying sediments), ground water, drinking water supply, land surface (including tidelands and shorelands) or subsurface strata, or ambient air within the state of Washington or under jurisdiction of the state of Washington." WAC 173-340-200.

The current rule requires, as appropriate, an investigation of the current and potential threats to plants and animals that may be posed by hazardous substances. Specifically, the current rule requires as part of the remedial investigation and feasibility study, as appropriate, "sufficient investigations to characterize the distribution of hazardous substances present at the site, and threat to human health **and the environment**," including, as applicable to the site:

> Information to determine the impact or potential impact of the hazardous substance from the facility on the natural resources and Ecology of the area such as: Sensitive environment, plant and animal species, and other environmental receptors.

WAC 173-340-350(6)(c) and (6)(c)(vi) (emphasis added). The current rule also requires, as appropriate, that the remedial investigation and feasibility study include:

> A risk assessment characterizing the current and potential threats to human health **and the environment** that may be posed by hazardous substances. This assessment may not be required when [Ecology] determines that proposed cleanup standards are obvious and undisputed and allow an adequate margin of safety for protection of human health **and the environment**.

WAC 173-340-350(6) and (6)(d) (emphasis added).

Under the current rule, Ecology may also establish cleanup levels more stringent than those otherwise required by the rule when, based on a site-specific evaluation, Ecology determines that such levels are necessary to protect human health and the environment. With respect to the terrestrial environment in particular, the current rule authorizes the following:

> [Ecology] may establish method B cleanup levels that are more stringent than those required under (a) of this subsection, when, based on a site-specific evaluation, [Ecology] determines that such levels are necessary to protect human health or environment, including the following:
>
> (i) Concentrations which eliminate or substantially reduce the potential for food chain contamination;

(ii) Concentrations which eliminate or substantially reduce the potential for damage to soils or biota in the soils which could impair the use of soils for agricultural or silvicultural purposes;

(iii) Concentrations which eliminate or substantially reduce the potential for adverse effects on vegetation or wildlife;

...

WAC 173-340-740(3)(b). The current rule provides Ecology the same authority to establish more stringent soil cleanup levels under Method C. WAC 173-340-740(4)(c).

However, the current rule does not indicate how this site-specific evaluation should be conducted.

In summary, under the current rule, terrestrial ecological impacts are evaluated on a case-by-case basis. The current rule does not specify criteria for ecological protectiveness, whether a terrestrial ecological evaluation is required, or how a terrestrial ecological evaluation should be conducted.

The proposed rule amendments, in comparison, establish criteria for ecological protectiveness and define a tiered process for evaluating threats from soil contamination to terrestrial ecological receptors. The requirements and procedures for determining whether a simplified or site-specific terrestrial ecological evaluation is required (exclusions) and, where an evaluation is required, how a simplified or site-specific evaluation may be conducted are set forth in WAC 173-340-7490 through 173-340-7494. The amendment provides significant flexibility in determining the type of ecological evaluation that is required for a particular site. In particular, the amendment provides significant flexibility in how one may conduct a site-specific evaluation. The amendment does not require the use of any particular methodology for conducting a site-specific evaluation.

Based on a comparison of the current rule and the proposed rule amendments, Ecology has made the following determinations regarding the impact of the proposed rule amendments:

- Both the current rule and the proposed rule require all cleanup actions to protect human health and the environment. See WAC 173-340-360.
- Both the current rule and the proposed rule require, as appropriate, an investigation of the current and potential threats to terrestrial ecological receptors that may be posed by hazardous substances. See WAC 173-340-350.
- Under both the current rule and the proposed rule, Ecology may establish more stringent cleanup levels, including soil cleanup levels, to protect the environment. See WAC 173-340-720 through 173-340-750.
- The current rule does not provide clear direction as to when a terrestrial ecological evaluation is required or how an evaluation should be conducted. The proposed rule amendments specify those situations where a simplified or site-specific terrestrial ecological evaluation is not required (exclusions) and, where such an evaluation is required, how such an evaluation may be conducted. See WAC 173-340-350, 173-340-740 and 173-340-745 under both rules and WAC 173-340-7490 through 173-340-7494 under the proposed rule amendments.

- Neither the current rule nor the proposed rule requires the use of any particular methodology for conducting an evaluation.
- Under both the current rule and the proposed rule, a site-specific terrestrial ecological evaluation may not be required.
- Under both the current rule and the proposed rule, even if a site-specific terrestrial ecological evaluation is conducted, it may not result in lower soil cleanup levels or additional remedial actions.

2.6.2 Analysis of Probable Costs

The impact of the proposed rule amendment on costs depends on several factors. These factors include the following:

- First, whether a terrestrial ecological evaluation would be required under the proposed rule, but not under the current rule;
- Second, whether the site would qualify for an exclusion from conducting a simplified or site-specific terrestrial ecological evaluation under the proposed rule;
- Third, the type of terrestrial ecological evaluation conducted under the proposed rule;
- Fourth, whether the terrestrial ecological evaluation conducted under the proposed rule would result in lower soil cleanup levels or additional remedial actions;

The probable costs associated with this amendment include both the cost of any more thorough terrestrial ecological evaluation and the costs of any additional cleanup actions required based on such evaluations.

2.6.2.1 Is a terrestrial ecological evaluation required under the proposed rule, but not current rule?

First, the probable costs of the proposed rule amendment is dependent on whether a terrestrial ecological evaluation would be required under the proposed rule, but not under the current rule. If an evaluation were conducted under both the current and proposed rules, then no additional evaluation or cleanup costs would be expected. This conclusion is based in part on the assumption that the same analysis would be conducted under both rules. This assumption is based on the fact that neither the current nor the proposed rule mandates the use of any particular methodology for conducting the evaluation.

Ecology does not expect that for most sites a simplified or site-specific terrestrial ecological evaluation would be required under the proposed rule, but not under the current rule. This conclusion is based on a comparative analysis of the requirements of the current and proposed rules. This conclusion is also based on the expectation that most sites will obtain an exclusion from conducting a simplified or site-specific terrestrial ecological evaluation under the proposed rule. See the discussion below under **Section 2.6.2.2** and the Terrestrial Environmental Evaluation Pilot Study Report (Ecology, 1999). If a simplified or site-specific evaluation were not required under the proposed rule, the expectation is that such an evaluation would also not be required or conducted under the current rule.

2.6.2.2 Does the site qualify for an exclusion from conducting a simplified or site-specific terrestrial ecological evaluation under the proposed rule?

Second, the probable cost of the proposed rule amendment is dependent on whether a simplified or site-specific terrestrial ecological evaluation is even required. The proposed rule specifies those situations where a simplified or site-specific terrestrial ecological evaluation is not required (exclusions). WAC 173-340-7491. If a site qualifies for an exclusion, then further terrestrial ecological evaluations would not be required and additional site remediation would not be required to protect terrestrial ecological receptors. Accordingly, neither the costs of conducting an evaluation nor the costs of additional cleanup actions would be incurred.

Ecology expects that most sites will be able to obtain an exclusion from conducting a simplified or site-specific terrestrial ecological evaluation. This conclusion is based in part on the results of the Terrestrial Environmental Evaluation Pilot Study Report (Ecology, 1999). Of the 39 Voluntary Cleanup Program Sites selected for evaluation, ninety-five percent (95%) obtained an exclusion. Five percent (5%) were evaluated using a simplified evaluation. None were evaluated using a site-specific evaluation.

Even if a site qualifies for an exclusion, additional costs may be incurred. Qualifying for an exclusion requires some analysis, resulting in minor costs. Based on the results of the Terrestrial Environmental Evaluation Pilot Study (Ecology, 1999), conducting such an analysis would most likely require less than an hour.

Additional institutional controls may also be required to obtain an exclusion. This may increase the cost of cleanup. However, this additional cleanup cost would only be incurred if those institutional controls would not otherwise be required as part of the cleanup to protect human health. For example, if the selected cleanup action includes leaving residual contamination under a containment barrier (such as paving), then institutional controls would already be required. In addition, obtaining an exclusion is optional. Institutional controls and the associated cost could be avoided by conducting a site-specific terrestrial ecological evaluation.

Again, as discussed under **Section 2.6.2.1**, if a simplified or site-specific evaluation is not required under the proposed rule, the expectation is that an evaluation would also not be required under the current rule.

2.6.2.3 What type of evaluation is conducted?

Third, the probable cost of the proposed rule amendment is dependent on the type or method of evaluation conducted. The amendment provides significant flexibility in determining the type of ecological evaluation that is required for a particular site. In addition, the amendment provides significant flexibility in how one may conduct a site-specific evaluation. The proposed rule amendment does not mandate how a site-specific terrestrial ecological evaluation may be conducted. Consequently, the cost of conducting an evaluation may vary greatly from site to site.

2.6.2.4 Does the evaluation result in lower soil cleanup levels and additional remedial actions?

Fourth, the probable costs of the proposed rule amendment depends on whether the evaluation would result in lower cleanup levels and additional remedial actions. Conducting a simplified or site-specific terrestrial ecological evaluation may not result in lower soil cleanup levels or additional remedial actions. Either the existing soil concentrations or the soil cleanup levels based on human health may already be protective of terrestrial ecological receptors. If additional remedial actions would not be required, then no additional cleanup costs would be incurred. Only if the terrestrial ecological evaluation resulted in additional remedial actions would additional cleanup costs be incurred.

2.6.2.5 Summary

In summary, only if a simplified or site-specific terrestrial ecological evaluation were required under the proposed rule, but not under the current rule, and that evaluation resulted in additional remedial actions would the proposed rule result in additional cleanup costs. Considering the factors discussed above, Ecology does not expect that the proposed rule amendments will result in lower soil cleanup levels or additional cleanup actions being required at most sites. Consequently, Ecology does not expect that the proposed rule will result in additional cleanup costs at most sites. However, Ecology does expect that for a few sites, additional evaluation costs may be incurred as a consequence of conducting more involved terrestrial ecological evaluations than would have been conducted under the current rule. Most of these evaluations are expected to be simplified evaluations as opposed to site-specific evaluations. Ecology also expects that a few sites, additional cleanup costs may be incurred as a consequence of the proposed rule. Those costs that are incurred are not expected to be significant.

The impact of the proposed rule amendment on costs was also evaluated as part of the evaluation of the impact of the proposed rule on petroleum contaminated sites. **See Chapter 5.** To further estimate the impact of the proposed rule amendment on evaluation costs, as well as cleanup costs, three case studies were also developed and evaluated. **See Chapter 6.**

2.6.3 Analysis of Probable Benefits

The impact of the proposed rule amendment is based on several considerations. First, whether the proposed rule amendment increases the protection of the environment from either a quantitative or qualitative perspective. Second, whether the proposed rule amendment reduces the regulatory burden, from a qualitative perspective, of ensuring the protection of the environment.

2.6.3.1 Protection of the Environment

The impact of the proposed rule amendment on the protection of the environment is based on the same factors considered under **Section 2.6.2** to analyze the impact on costs. If a terrestrial ecological evaluation were required under the proposed rule, but not the current rule, and the terrestrial ecological evaluation resulted in additional remedial actions, then the proposed rule

amendment would result in additional protection of the environment. Based on the factors discussed under **Section 2.6.2**, Ecology does not expect that the proposed rule amendment will result in lower soil cleanup levels or additional cleanup actions at most sites. Consequently, Ecology does not expect that the proposed rule amendment will provide additional environmental protection (in the form of additional cleanup actions) at most sites. However, by ensuring that those sites that may pose a threat to the environment undergo a terrestrial ecological evaluation, the proposed rule amendment is expected to ensure that cleanup actions are protective not only of human health but also of the environment. At a few sites, though, Ecology does expect that additional cleanup actions may be required. For those sites, the proposed rule amendment will provide additional environmental protection (in the form of additional cleanup actions).

For those sites where a simplified or site-specific terrestrial ecological evaluation is conducted, Ecology expects that the proposed rule amendment to expedite and facilitate cleanups by providing a clear and consistent process for ensuring the potential ecological threats from soil contamination are adequately considered in site cleanups. While the current rule results in uncertainty regarding the criteria for ecological protectiveness, when an ecological risk assessment should be conducted, and how an ecological risk assessment should be conducted, the proposed rule provides considerably more specificity. In particular, the proposed rule amendment establishes criteria for ecological protectiveness and defines a tiered process for evaluating potential threats from soil contamination to terrestrial ecological receptors.

2.6.3.2 Cost-Effectiveness of the Evaluation

By establishing criteria for ecological protectiveness and defining a tiered process for evaluating potential threats from soil contamination to terrestrial ecological receptors, the proposed rule amendment is expected to reduce the regulatory burden and costs of conducting an evaluation at many sites. This analysis is qualitative in nature.

Examples of measures that may reduce the regulatory burden of protecting terrestrial ecological receptors include the following:

(1) Site-specific terrestrial ecological evaluations may not be required if soil concentrations at a site do not exceed specified criteria. The proposed rule specifies soil concentrations for hazardous substances (Table 749-3) that Ecology considers highly likely to be safe at any site without any further evaluation of site conditions. If these concentrations are not exceeded, then these concentrations can be used to show, without any further site-specific evaluation, that there is no potential threat to terrestrial plants and animals. If only some hazardous substances exceed these concentrations, the table can also be used to exclude the remaining substances from further consideration and thus narrow the focus of the evaluation.

(2) Site-specific terrestrial ecological evaluations may not be required if it is known that planned future actions to be taken at a site will eliminate exposure pathways (WAC 173-340-7493(1)(d)(i) and 173-340-7493(2)(a)(ii)).

(3) Site-specific terrestrial ecological evaluations may not be required if a site qualifies for an exclusion under WAC 173-340-7491(1). The proposed rule amendment sets forth criteria for determining whether a site qualifies for an exclusion. These criteria rely on readily available information and do not require specialized expertise to evaluate. Consequently, these criteria can be applied to a site with minor evaluation costs.

(4) A site-specific terrestrial ecological evaluation may not be required if the site qualifies for a simplified evaluation under WAC 173-340-7492. This "simplified evaluation procedure" is based on a higher level of acceptable risk and consequently expected to be easier and less costly. For example:

- Soil concentrations considered safe without further evaluation of the site (Table 749-2) are higher than those used in the site-specific evaluation procedure (Table 749-3).
- Only those substances listed in Table 749-2 need be considered in a simplified evaluation. At a site where TCE is the only hazardous substance, for example, the evaluation could be terminated because this substance is not listed in the table.
- Specialized expertise in ecology and toxicology is not required to perform a simplified evaluation.
- Ecology staff need not be involved in conducting a simplified evaluation because the procedure is more prescriptive. This is expected to facilitate voluntary cleanups, since most sites that do not qualify for an exclusion under WAC 173-340-7491(1) are expected to be eligible for a simplified evaluation.
- Allowance for a higher level of acceptable risk is based on the principle that the consequences of an underprotective cleanup are constrained by excluding sites from using this procedure where there are potential threats to more important ecological communities or species. The determination of whether a simplified evaluation may be conducted relies on criteria using readily available information and does not require specialized expertise to apply (WAC 173-340-7491(2)).

(5) Land use may be used to limit the range of terrestrial species to be considered in a simplified or site-specific evaluation (WAC 173-340-7490(3)(b)). Threats from contaminated soil to plants and soil biota need not be evaluated at industrial or commercial sites.

2.7 Financial Assurances

2.7.1 Summary of the Proposed Rule Amendment

Under the current rule, Ecology may require the potentially liable person to provide financial assurances under certain circumstances and using specified or approved mechanisms. See WAC 173-340-440(7) under the current rule.

The proposed rule amendments on financial assurances revise the current rule in the following ways:

- First, the proposed rule changes Ecology's authority and duty to require the potentially liable person to provide financial assurances. See WAC 173-340-440(11). Based on this amendment, Ecology expects that financial assurances will be required in practice under the proposed rule where they may not have been required under the current rule.

- Second, the proposed rule provides potentially liable persons increased flexibility in the selection of financial assurance mechanisms that meet the requirements of the rule. See WAC 173-340-440(11)(a).

- Third, the proposed rule provides a specific exemption for financial hardship. See WAC 173-340-440(11)(b).

- Fourth, the proposed rule provides a specific exemption for potentially liable persons that can demonstrate that sufficient financial resources are available and in place to provide for the long-term effectiveness of engineered and institutional controls adopted. See WAC 173-340-440(11).

2.7.2 Analysis of Probable Costs

The impact of the proposed rule amendment on costs depends on each of the four factors discussed above. Most notably, the impact depends on whether and to what extent financial assurances will be required in practice under the proposed rule where they may not have been required under the current rule. If financial assurances were required under both the current and proposed rules, a potentially liable person would not incur additional costs as a consequence of the proposed rule amendment. Overall, though, Ecology expects that financial assurances will be required in practice under the proposed rule where they may not have been required under the current rule. However, the number of sites and potentially liable persons that may be impacted is uncertain.

Even if financial assurances will be required in practice under the proposed rule where they may not have been required under the current rule, other factors may mitigate the impact on costs. First, the impact depends on whether a potentially liable person would qualify for an exemption based on financial hardship. Second, the impact depends on whether a potentially liable person would qualify for an exemption based on a demonstration that sufficient financial resources are available and in place to provide for the long-term effectiveness of engineered and institutional controls adopted. Third, even if the potentially liable person does not qualify for an exemption, the impact may be mitigated by the increased flexibility provided by the proposed rule in the selection of financial assurance mechanisms that meet the requirements of the rule.

The selection of cleanup actions under the MTCA Cleanup Regulation may also limit the impact of the proposed rule amendment. If a less permanent remedy requiring financial assurances is more costly than a more permanent remedy that would not require financial assurances, then the more permanent remedy will be selected, thereby limiting the total impact of the proposed rule amendment. The disproportionate cost analysis, conducted as part of the remedy selection process, accounts for the total cost of the cleanup action, including any long-term costs such as

operation and maintenance costs, monitoring costs, equipment replacement costs, and the cost of maintaining institutional controls. WAC 173-340-360(3).

To the extent that the proposed rule amendment even has an impact, the amendment is expected to impact larger, more complex sites (industrial site) rather than smaller, less complex sites (commercial gas station). Smaller, less complex sites (e.g., commercial gas stations) are less likely to require institutional or engineered controls that would require financial assurances. Such sites typically use Method A to establish cleanup levels and use permanent remedies to cleanup the site. As reflected by Ecology's Statewide Leaking Fuel Tank Study **(see Chapter 5)**, over 60% of commercial gas stations sites cleanup to below applicable cleanup levels. Even if such sites were impacted, the financial assurances required would reflect the simplicity of the site. Larger, more complex sites are more likely to contain multiple contaminants, to involve multiple pathways, to use site-specific information to develop modified Method B or C cleanup levels and/or remediation levels, and to use more complex, less-permanent remedies requiring long-term maintenance and monitoring.

In summary, based on the factors discussed above, the proposed rule amendment is not expected to impact most sites. Those sites that are impacted are expected to be the larger, more complex sites instead of the smaller, less complex sites. For those sites that may be impacted, Ecology estimated the potential cost of financial assurances. That analysis is presented in **Chapter 7**. That analysis is based on a larger, more complex site and, accordingly, represents an upper-bound estimate on costs.

2.7.3 Analysis of Probable Benefits

The impact of this proposed rule amendment on benefits also depends on each of the four factors discussed above. Most notably, the impact depends on whether and to what extent financial assurances will be required in practice under the proposed rule where they may not have been required under the current rule. To the extent that financial assurances will be required in practice under the proposed rule where they may not have been required under the current rule, the proposed rule amendment will increase the protectiveness of the cleanup. The increased protection of human health and the environment is difficult to estimate quantitatively.

Financial assurances are safeguards (an insurance policy) to ensure the protectiveness of the cleanup over the long-term. More specifically, financial assurances may be required to cover the long-term operation and maintenance costs, long-term monitoring costs, equipment replacement costs, and the long-term cost of maintaining institutional controls. Financial assurances may also be required to cover any failure of the implemented remedy.

Financial assurances also ensure that the potentially liable persons, not the taxpayers, are required to pay for the cleanup, as directed by the Model Toxics Control Act. Ensuring that the potentially liable persons, not the taxpayers, are required to pay for the cleanup is an issue of fairness and equity. Without such financial assurances, taxpayers would be required to pay for the long-term operation and maintenance of a less than permanent remedy. Without such financial assurances, taxpayers would be subsidizing the selection and implementation of less permanent cleanups.

Note that both the proposed and current rules provide a person conducting the cleanup with the option of conducting a more permanent cleanup action that does not require financial assurances. For site cleanups that are dependent upon financial assurances for long-term protectiveness of the final remedy, the person conducting the cleanup derives an economic benefit by either delaying, or avoiding, the costs associated with meeting cleanup standards.

In conclusion, considering the probable impacts on costs and benefits of this proposed rule amendment as discussed in this section (Section 2.7) and in Chapter 7, Ecology has determined that the probable benefits of this proposed rule amendment exceed the probable costs.

2.8 Citizen Technical Advisor

2.8.1 Summary of Proposed Rule Amendment

The proposed rule amendments include a funding mechanism for the addition of a citizen technical advisor position at the Department of Ecology. WAC 173-340-550. The citizen technical advisor will increase the resources available to citizens, enabling citizens to more effectively participate in the cleanup process. The proposed rule amendment includes the cost of the citizen technical advisor as an overhead program support cost. As a type of remedial action cost, program support costs are recoverable from a potentially liable person.

2.8.2 Analysis of Probable Costs

The impact of this proposed amendment on costs is based on any increase in the program support costs that are recoverable due to the addition of the citizen technical advisor.

Program support costs (PSC) are established by multiplying the direct staff costs (DSC) by the program support cost multiplier (PSCM).

$$PSC = DSC \times PSCM$$

The program support cost multiplier (PSCM) is established by dividing the program support costs (PSC) by the direct staff costs (DSC).

$$PSCM = PSC / DSC$$

The MTCA Cleanup Regulation limits program support costs to the amount of direct staff costs by providing that the program support cost multiplier (PSCM) "shall not exceed 1.0 (one)." WAC 173-340-550(2)(c). The regulation further provides that this multiplier shall be evaluated at least biennially. Biennial audit results since the establishment of the multiplier have not resulted in any adjustments (increases) to the multiplier since program support costs already exceed direct staff costs, resulting in a multiplier greater than 1.0. Under the most recent audit in 1998, the program support cost multiplier was calculated to be 1.37.

The cost of the citizen technical advisor is estimated to be $95,480 per year, based on the projected cost of one FTE (Full Time Equivalent). However, since the current multiplier (1.37) already exceeds 1.0 (i.e., program support costs > direct staff costs), additional program support costs, including those attributable to the citizen technical advisor, cannot be recovered. Based on its experience since the inception of the cost multiplier, Ecology further anticipates that current program support costs will not decrease. Therefore, the program support costs recoverable under the proposed rule amendments is estimated to be the same as under the current rule.

2.8.3 Analysis of Probable Benefits

The probable benefits associated with the availability of a citizen technical advisor are not quantifiable. Nevertheless, the benefits associated with the establishment of a citizen technical advisor are significant. The citizen technical advisor will help citizens participate more effectively in the cleanup process by enhancing their understanding of the Model Toxics Control Act and the implementing regulations, as well as site investigations and feasibility studies. The citizen technical advisor is intended to augment, not replace, resources available to citizens now provided by Ecology site staff. Effective citizen participation contributes to efficient and protective cleanups by helping decision-makers develop remedies that consider community values. Effective citizen participation also enhances the protectiveness of a remedy by increasing the knowledge and understanding of citizens of the cleanup and the risks associated with any residual contamination.

Ecology anticipates that the duties of the citizen technical advisor will include the following:

- Help the public identify and focus on key issues at a site and to understand the implications of assumptions in site-specific risk assessments, at the request of citizens or Ecology.
- Answer questions from the public related to risk assessment, remedial actions, and site cleanup processes.
- Explain technical documents, including site-specific risk assessments, in non-technical language at the request of citizens.
- Prepare generic explanatory documents and presentations.
- Track contacts and resulting referrals/actions (for program evaluation).

In conclusion, considering the probable impacts on costs and benefits of this proposed rule amendment as discussed in this section (Section 2.8), Ecology has determined that the probable benefits of this proposed rule amendment exceed the probable costs. In fact, the proposed rule amendment is not expected to result in any additional cost for the potentially liable person.

Chapter 3 Technical Analysis – Probable Costs of the Proposed Method A Soil and Ground Water Cleanup Levels

3.1 Introduction

The primary impact of the proposed rule amendments on cost results from the proposed changes to the soil and ground water cleanup levels in the Method A tables. The proposed changes to the Method A soil cleanup levels, and the basis for those changes, are described in **Table 3-1 and Table 3-2**. The proposed changes to the Method A ground water cleanup levels, and the basis for those changes, are described in **Table 3-12**. Further description of the proposed changes and the potential impact of those proposed changes is presented in **Chapter 2**.

The potential impact of the proposed Method A cleanup levels on costs depends on whether the proposed Method A cleanup levels will increase or decrease the cleanup cost at a site. Whether the proposed Method A cleanup levels will increase or decrease the cleanup cost at a site depends on several factors. First, the impact depends on whether the proposed Method A cleanup levels are more stringent or less stringent than under the current rule. More stringent cleanup levels may increase the total cleanup cost while less stringent cleanup levels may decrease the total cleanup cost. Second, the impact depends on several site-specific factors, including the type of contaminants present, the type of media contaminated, the extent of contamination, the contaminants of concern, and the physical properties of the site. Third, the impact depends on the remedy selected.

3.2 Impact of Proposed Method A Soil Cleanup Levels

3.2.1 Methodology

To estimate the potential impact of the proposed Method A soil cleanup levels on cleanup costs, the proposed cleanup levels were applied to a model site that is representative of most sites that use Method A to establish cleanup levels. Description of that model site is provided in **Section 3.2.2.**

The impact of the proposed Method A soil cleanup levels on soil cleanup costs depends on whether the proposed levels are more stringent or less stringent than under the current rule and on the type of remedy selected. For this analysis, Ecology assumed that a more permanent cleanup action that removes contaminants from the soil was selected. Based on this assumption, the estimated change in cost of contaminant removal (soil cleanup) for each contaminant was calculated by multiplying the unit cost of contaminant removal by the change in the amount of contaminants requiring removal. While more stringent cleanup levels are expected to increase soil cleanup costs, less stringent cleanup levels are expected to decrease soil cleanup costs (avoided cost). **See Section 3.2.3.**

Even if the more stringent Method A soil cleanup levels result in an increase in soil cleanup costs, those cleanup costs may be offset by a corresponding decrease in ground water cleanup

costs. For this analysis, Ecology assumed that because the more stringent Method A soil cleanup levels are based on protection of ground water, the removal of additional contaminants from the soil will reduce the amount of contaminants reaching and requiring removal from the ground water. The estimated avoided cost of contaminant removal (ground water cleanup) for each contaminant was calculated by multiplying the unit cost of contaminant removal by the differential amount of contaminants requiring removal. **See Section 3.2.4.**

3.2.2 Description of Model Site

The model site is based on the following basic assumptions:

- The extent of contamination at the site is ¼ acre to a depth of 25 feet.
- Soil contamination is uniform across the site and at depth.
- The soil density at the site is 1.5 kilograms per liter or 42.45 kilograms per cubic foot.
- Potable ground water is present at a depth of 25 feet below the ground surface.
- Each contaminant is a contaminant of concern at the site driving the nature and scope of the cleanup.

The size of the area of contamination is based on a review of site files, the lot size of small commercial properties, and the scope of cleanups typical for such sites. The ¼ acre size is on the upper end of the size of many Method A cleanups and thus should provide a conservative (high) estimate of increased soil cleanup costs.

The soil density of 1.5 kilograms per liter is the default density used in the three- and four-phase equilibrium partitioning models that are used to derive soil concentrations protective of ground water under WAC 173-340-747. The value is based on the EPA soil screening guidance (U.S. EPA, 1995) and published information on soil density.

The depth to ground water of 25 feet was based on a review of site files. This value is expected to be representative of sites both west and east of the Cascades. Shallow ground water is common at west-side contaminated sites due to the high annual amount of precipitation. In the dryer areas of the state, primarily east of the Cascades, most contaminated sites are located in urbanized areas that developed near surface water or are in heavily irrigated areas and thus tend to also have relatively shallow ground water. Also, in both areas of the state, the source of the contamination is often buried at depth beneath the ground surface. Thus, the estimate of 25 feet is probably a reasonable upper bound estimate of the depth to ground water at most Method A sites and should result in a conservative (high) estimate of cleanup costs.

This analysis assumes that each of the proposed Method A cleanup levels is the contaminant of concern at the model site and, thus, determines the nature and scope of the cleanup. This assumption is based on the fact that Method A sites tend to be smaller sites with only a few or only one contaminant driving the cleanup. However, the assumption is a conservative assumption since the hazardous substances may not be contaminants of concern at a particular site. For example, other contaminants whose cleanup levels have not changed could actually drive the cleanup at a site.

3.2.3 Cost of Soil Cleanup

The cost of soil cleanup depends on the remedy selected. More permanent cleanup actions that remove contaminants from the soil typically cost more than less permanent cleanup actions that leave contamination at the site and rely on engineered and institutional controls. For this analysis, Ecology assumed that a more permanent cleanup action that removes contaminants from the soil was selected. This assumption is a conservation assumption that provides a high bound estimate of the potential differential in cleanup costs under the current and proposed rules. Assumption of a less permanent remedy that leaves contamination at the site might not result in any additional cleanup or cost.

3.2.3.1 Estimated Differential Mass of Contaminant Removal (kg)

To estimate the change in the cost of soil cleanup, Ecology first calculated the change in the amount of contamination requiring removal from the soil at the model site for each contaminant. These calculations were based on the change in the Method A soil cleanup levels and the model site assumptions regarding the area and depth of contamination. More stringent cleanup levels require an increase in the amount of contaminant removal. Less stringent cleanup levels allow for a reduction in the amount of contaminant removal. The change in the mass of soil contaminants requiring removal is presented in **Table 3-3** for unrestricted land use and in **Table 3-4** for industrial land use.

3.2.3.2 Estimated Unit Cost for Contaminant Removal ($/kg)

To estimate the change in the cost of soil cleanup, Ecology next estimated the unit cost of removing an additional kilogram of contaminant from the soil. The estimated unit cost of soil cleanup depends on the remedial technology used to remove the soil contamination. The remedial technology selected depended on the type of contaminant and the available technologies for treating those contaminants. The selection was based on review of federal reports and on the best professional judgment of environmental engineers. The estimated unit cost for each of the treatment technologies was based on actual data from reports available from the federal government (Federal Remediation Technologies Roundtable: Cost and Performance Reports, http://clu-in.org/remed1.htm), the only readily available source found for this type of information. The cost estimates include both capitol and operating expenses. The estimated unit costs of soil cleanup are expressed as the cost per kilogram of contamination removed ($/kg). The unit cost estimates can be thought of as the increase (or decrease) in the operating costs for a treatment remedy at a site.

- For volatile hazardous substances, soil vapor extraction (SVE) was selected. The unit cost is based on the median cost at 13 sites. **See Table 3-7.**

- For semi-volatile hazardous substances and pesticides, excavation and treatment using low temperature thermal desorption was selected. The unit cost is based on the median cost at 15 sites. **See Table 3-8.**

- For metals, excavation and treatment using soil washing was selected. The unit cost is based on the cost at one site. **See Table 3-9.**

- For all hazardous substances, for comparison purposes, the cost of excavating and off-site disposal was calculated based on bids and actual invoices from sites in Washington State. **See Table 3-10.**

3.2.3.3 Results – Estimated Differential Cost of Contaminant Removal ($)

The estimated change in the cost of contaminant removal (soil cleanup) for each contaminant was calculated by multiplying the unit cost of contaminant removal by the change in the amount of contaminants requiring removal. More stringent cleanup levels require an increase in the amount of contaminant removal, resulting in an increase in cleanup costs. Less stringent cleanup levels allow for a reduction in the amount of contaminant removal, resulting in a decrease in cleanup costs. These calculations are presented in **Table 3-5** for unrestricted land use and in **Table 3-6** for industrial land use.

- **Increased Cost for More Stringent Soil Cleanup Levels**

  As illustrated in **Tables 3-5 and 3-6**, adopting more stringent soil cleanup levels could result in small increases in soil cleanup costs for sites contaminated with benzene, cPAHs, cadmium, DDT, ethylbenzene, methylene chloride, tetrachloroethylene, trichloroethylene, or xylene. The increased costs ranged from about **$250 to $8,000**.

  Adopting more stringent soil cleanup levels could result in moderate increases in soil cleanup costs for sites contaminated with lindane, toluene, 1,1,1 TCE and fresh and weathered gasoline. The increased costs ranged from about **$11,000 to $50,000**.

  Adopting more stringent soil cleanup levels could result in substantial increases in soil cleanup costs for sites contaminated with hexavalent chromium and for industrial properties contaminated with arsenic. The increased costs ranged from about **$50,000 to $300,000**.

- **Decreased (Avoided) Cost for Less Stringent Soil Cleanup Levels**

  As also illustrated in **Tables 3-5 and 3-6**, adopting less stringent soil cleanup levels could result in small decreases (savings) in soil cleanup costs for sites contaminated with with DDT (unrestricted land use), EDB, mercury, or naphthalene. The decreased costs ranged from about **$2 to $3,000**.

  Adopting less stringent soil cleanup levels could result in substantial decreases (savings) in soil cleanup costs for sites contaminated with trivalent chromium, diesel fuel, heavy oils or electrical insulating mineral oil. The decreased costs range from about **$900,000 to $2 million**.

3.2.4 Avoided Cost of Ground Water Cleanup

Even if the more stringent Method A soil cleanup levels result in an increase in soil cleanup costs, those cleanup costs may be offset by a corresponding decrease in ground water cleanup costs. For this analysis, Ecology assumed that because the more stringent Method A soil cleanup levels are based on protection of ground water, the removal of additional contaminants from the soil will reduce the amount of contaminants reaching and requiring removal from the ground water.

3.2.4.1 Estimated Reduction in Mass of Contaminant Removal (kg)

To estimate the reduction in ground water cleanup costs, Ecology first calculated the change in the amount of contamination requiring removal from the ground water at the model site for each contaminant. To make this calculation, Ecology first determined the reduction in the soil concentration under the proposed rule. This concentration was then converted to a mass based on site size, depth to ground water, and soil density. This is the mass that, if not removed from the soil, would eventually reach the ground water and require removal. These calculations are provided in **Table 3-3** for unrestricted land use and **Table 3-4** for industrial land use.

3.2.4.2 Estimated Unit Cost of Contaminant Removal ($/kg)

To estimate the reduction in ground water cleanup costs, Ecology next estimated the unit cost of removing an additional kilogram of contaminant from the ground water. The estimated unit cost of ground water cleanup depends on the remedial technology used to remove the ground water contamination. The remedial technology selected for all of the contaminants was a pump and treat system. To determine the unit cost of a pump and treat system, cost information was compiled from an EPA report on 28 ground water pump and treat systems (U.S. EPA, 1999), the only readily available source found for this type of information. The median of this data, expressed as a cost per kilogram of contamination removed from the ground water, was used as the unit cost. Universal application of this unit cost estimate is considered reasonable because these sites represent a wide range of site conditions and contaminants and no pattern, based on type of contamination, could be discerned from the data. **See Table 3-11.**

3.2.4.3 Results – Estimated Avoided Cost of Contaminant Removal ($)

The estimated avoided cost of contaminant removal (ground water cleanup) for each contaminant was calculated by multiplying the unit cost of contaminant removal by the change in the amount of contaminants requiring removal. These calculations are presented in **Table 3-5** for unrestricted land use and in **Table 3-6** for industrial land use.

As illustrated in these tables, the savings in ground water remediation costs could be substantial, from about **$10,000 to over $10 million**. These savings more than offset any increase in soil remediation costs. This confirms what is common knowledge in site remediation – it is substantially less expensive to remove contamination from the soil before it reaches the ground water than it is to remove the contamination from the ground water.

3.3 Impact of Proposed Method A Ground Water Cleanup Levels

3.3.1 Methodology

To estimate the potential impact of the proposed Method A ground water cleanup levels on cleanup costs, the proposed cleanup levels were applied to a model site that is representative of most sites that use Method A to establish cleanup levels. Description of that model site is provided in **Section 3.3.2**.

The impact of the proposed Method A ground water cleanup levels on ground water cleanup costs depends on whether the proposed levels are more stringent or less stringent than under the current rule and on the type of remedy selected. For this analysis, Ecology assumed that a more permanent cleanup action that removes contaminants from the ground water was selected. Based on this assumption, the estimated differential cost of contaminant removal (ground water cleanup) for each contaminant was calculated by multiplying the unit cost of contaminant removal by differential amount of contaminants requiring removal. While more stringent cleanup levels are expected to increase ground water cleanup costs, less stringent cleanup levels are expected to decrease ground water cleanup costs (avoided cost). **See Section 3.3.3.**

3.3.2 Description of Model Site

The model site is based on the following basic assumptions:

- The extent of ground water contamination is one acre to a depth of 20 feet.
- The contamination is uniform across the site and at depth.
- The soil porosity at the site is 0.43.
- Each contaminant is a contaminant of concern at the site driving the nature and scope of the cleanup.

The extent of ground water contamination is based on a review of site files and the scope of ground water cleanups typical for Method A sites. The soil porosity of 0.43 is the default porosity used in the three- and four-phase equilibrium partitioning models that are used to derive soil concentrations protective of ground water under WAC 173-340-747. The value is based on the EPA soil screening guidance (U.S. EPA, 1995) and experience at sites in Washington State.

This analysis assumes that each of the proposed Method A cleanup levels is the contaminant of concern at the model site and, thus, determines the nature and scope of the cleanup. This assumption is based on the fact that Method A sites tend to be smaller sites with only a few or only one contaminant driving the cleanup. However, the assumption is a conservative assumption since the hazardous substances may not be contaminants of concern at a particular site. For example, other contaminants whose cleanup levels have not changed could actually drive the cleanup and cost at a site.

3.3.3 Cost of Ground Water Cleanup

The cost of ground water cleanup depends on the remedy selected. More permanent cleanup actions that remove contaminants from the ground water typically cost more than less permanent cleanup actions that leave contamination at the site and rely on engineered and institutional

controls. For this analysis, Ecology assumed that a more permanent cleanup action that removes contaminants from the ground water was selected. This assumption is a conservation assumption that provides a high bound estimate of the potential differential in cleanup costs under the current and proposed rules. Assumption of a less permanent remedy that leaves contamination at the site might not result in any additional cleanup or cost.

3.3.3.1 Estimated Differential in Mass of Contaminant Removal (kg)

To estimate the change in ground water cleanup costs, Ecology first calculated the change in the amount of contamination requiring removal from the ground water at the model site for each contaminant. These calculations were based on the change in the Method A ground water cleanup levels and the model site assumptions regarding the area and depth of contamination. More stringent cleanup levels require an increase in the amount of contaminant removal. Less stringent cleanup levels allow for a reduction in the amount of contaminant removal. The change in the mass of contaminants requiring removal from the ground water for each contaminant are presented in **Table 3-13**.

3.3.3.2 Estimated Unit Cost of Contaminant Removal ($/kg)

To estimate the change in ground water cleanup costs, Ecology next estimated the unit cost of removing an additional kilogram of contaminant from the ground water for each contaminant. The estimated unit cost of ground water cleanup depends on the remedial technology used to remove the ground water contamination. The remedial technology selected was a pump and treat system. To determine the unit cost of a pump and treat system, cost information was compiled from an EPA report on 28 ground water pump and treat systems (U.S. EPA, 1999), the only readily available source found for this type of information. The median of this data, expressed as a cost per kilogram of contamination removed from the ground water, was used as the unit cost. Universal application of this unit cost estimate is considered reasonable because these sites represent a wide range of site conditions and contaminants and no pattern, based on type of contamination, could be discerned from the data. **See Table 3-11.**

3.3.3.3 Estimated Differential Cost of Contaminant Removal ($)

The estimated change in cost of contaminant removal (ground water cleanup) for each contaminant was calculated by multiplying the unit cost of contaminant removal by the change in the amount of contaminants requiring removal. More stringent cleanup levels require an increase in the amount of contaminant removal, resulting in an increase in cleanup costs. Less stringent cleanup levels allow for a reduction in the amount of contaminant removal, resulting in a decrease in cleanup costs. The calculations are presented in **Table 3-13**.

- **Increased Cost for More Stringent Ground Water Cleanup Levels**

  As illustrated in **Table 3-13**, adopting more stringent cleanup levels could result in moderate increases in ground water cleanup costs for sites contaminated with gasoline range organics with benzene, diesel range organics, and heavy oils. The increased costs ranged from about **$4,500 to $11,000**.

- **Decreased (Avoided) Cost for Less Stringent Ground Water Cleanup Levels**

  As illustrated in **Table 3-13**, adopting less stringent cleanup levels could result in small decreases (savings) in ground water cleanup costs ranging from about **$2 to $3,600** for sites contaminated with for benzo(a)pyrene, trivalent chromium, DDT, lead, MTBE, and naphthalene.

  Adopting less stringent cleanup levels could result in moderate decreases (savings) in ground water cleanup costs ranging from about **$15,000 to $22,000** for sites contaminated with ethylbenzene, toluene, and xylene.

3.4 Conclusion

In summary, adopting more stringent Method A soil cleanup levels could result in small increases in soil cleanup costs ranging from about **$250 to $300,000**, depending on the hazardous substance. **See Tables 3-5 and 3-6**. Even if the more stringent soil cleanup levels resulted in an increase in soil cleanup costs, those cleanup costs may be offset by a corresponding decrease in ground water cleanup costs. Specifically, the avoided cost of ground water cleanup could be substantial, ranging from about **$10,000 to over $10 million**. **See Table 3-13**. These savings more than offset any increase in soil cleanup costs. This confirms what is common knowledge in site remediation – it is substantially less expensive to remove contamination from the soil before it reaches the ground water than it is to remove the contamination from the ground water.

Adopting more stringent Method A ground water cleanup levels could result in moderate increases in ground water cleanup costs for sites contaminated with gasoline range organics with benzene, diesel range organics, and heavy oils. The increased costs ranged from **about $4,500 to $11,000**, depending on the hazardous substance. **See Table 3-13**.

Adopting less stringent Method A soil cleanup levels could result in small to more substantial decreases in soil cleanup costs ranging from only a **few dollars to $2 million**, depending on the hazardous substance. **See Tables 3-5 and 3-6**. Adopting less stringent Method A ground water cleanup levels could result in small to moderate decreases in ground water cleanup costs ranging from only a **few dollars to $22,000**, depending on the hazardous substance. **See Table 3-13**.

3.5 Calculations

Table 3-1: Summary of Method A Soil Cleanup Levels for Unrestricted Land Use

Hazardous Substance	CAS Number	Current Method A Cleanup Level (mg/kg)	Proposed Method A Cleanup Level (mg/kg)	Basis for Standard
Arsenic	7440-38-2	20.0	20	Soil ingestion using equation 740-2, and leaching using 3-phase model, adjusted for natural background (1).
Benzene	71-43-2	0.5	0.03	Protection of drinking water -- based on both 3 and 4 phase models.
Benzo(a)Pyrene	50-32-8	none	0.1	Soil ingestion using equation 740-2. Can also be used as the total toxic equivalents for all cPAHs. See WAC 173-340-708(8).
Cadmium	7440-43-9	2	2	Protection of drinking water, adjusted for PQL.
Chromium (total)	7440-47-3	100.0	none	Replaced by values for Cr III and Cr VI.
Chromium VI	18540-29-9		19	Protection of drinking water--3 phase model.
Chromium III	16065-83-1		2000	Protection of drinking water--3 phase model.
DDT	50-29-3	1	3	Soil ingestion using equation 740-2.
Ethylbenzene	100-41-4	20.0	6	Protection of drinking water--3 phase model.
Ethylene dibromide (EDB)	106-93-4	0.001	0.005	Protection of drinking water--3 phase model, adjusted for PQL.
Lead	7439-92-1	250.0	250	Soil ingestion. See 1991 responsiveness summary for explaination of calculation. (1)
Lindane	58-89-9	1	0.01	Protection of drinking water--3 phase model, adjusted for PQL.
Methylene chloride	75-09-2	0.5	0.02	Protection of drinking water--3 phase model.
Mercury (inorganic)	7439-97-6	1	2	Protection of drinking water--3 phase model.
MTBE	1634-04-4	none	0.1	Protection of drinking water--3 phase model.
Naphthalenes	91-20-3	none	5	Protection of drinking water--3 phase model. Total of all naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.
PAHs (carcinogenic)		1.0	none	Replaced by Benzo(a)Pyrene, above.
PCB Mixtures	1336-36-3	1	1	ARAR. This is a total value for all PCBs in the soil sample.
Tetrachloroethylene	127-18-4	0.5	0.05	Protection of drinking water--3 phase model.
Toluene	108-88-3	40.0	7	Protection of drinking water--3 phase model.
1,1,1 Trichloroethane	71-55-6	20	2	Protection of drinking water--3 phase model.
Trichloroethylene	79-01-5	0.5	0.03	Protection of drinking water--3 phase model.
Xylenes	1330-20-7	20.0	9	Protection of drinking water--3 phase model. Total of all m, o & p xylene.
GRO with benzene		100	30	Protection of drinking water--4 phase model, assuming weathered gasoline composition.
GRO w/o benzene		100	100 (3)	Protection of drinking water--4 phase model, assuming highly weathered gasoline composition.
Diesel Range Organics		200	2000	Protection of drinking water--residual saturation
Heavy Oils		200	2000	Protection of drinking water--residual saturation for diesel.
Mineral Oil		200 (2)	4000	Protection of drinking water--residual saturation

(1) Ecology decision not to change at this time. Ecology intends to review and, if appropriate, update these values in a future rulemaking.
(2) Ecology has also issued a fact sheet (#95-157-TCP) allowing the use of 2000 mg/kg at electrical substations and switchyards.
(3) To use this value no benzene must be present in the soil and the aromatic EC 8 to EC 16 fractions must be less than 20% of the gasoline mixture.

Table 3-2: Summary of Method A Soil Cleanup Levels for Industrial Land Use

Hazardous Substance	CAS Number	Current Method A Cleanup Level mg/kg	Proposed Method A Cleanup Level (mg/kg)	Basis for Standard
Arsenic	7440-38-2	200	20	Protection of drinking water, adjusted for background (1)
Benzene	71-43-2	0.5	0.03	Protection of drinking water--based on both 3 and 4 phase models.
Benzo(a)Pyrene	50-32-8	none	2	Protection of drinking water--3 phase model.
Cadmium	7440-43-9	10	2	Protection of drinking water, adjusted for background
Chromium (total)	7440-47-3	500.0	none	Replaced by values for Cr III and Cr VI.
Chromium VI	18540-29-9		19	Protection of drinking water--3 phase model.
Chromium III	16065-83-1		2000	Protection of drinking water--3 phase model.
DDT	50-29-3	5	4	Protection of drinking water--3 phase model.
Ethylbenzene	100-41-4	20	6	Protection of drinking water--3 phase model.
Ethylene dibromide (EDB)	106-93-4	0.001	0.005	Protection of drinking water, adjusted for PQL
Lead	7439-92-1	1000.0	1000	Ingestion (3)
Lindane	58-89-9	20	0.01	Protection of drinking water, adjusted for PQL
Methylene chloride	75-09-2	0.5	0.02	Protection of drinking water--3 phase model.
Mercury (inorganic)	7439-97-6	1	2	Protection of drinking water--3 phase model.
MTBE	1634-04-4	none	0.1	Protection of drinking water--3 phase model.
Naphthalenes	91-20-3	none	5	Protection of drinking water--3 phase model. Total of naphthalene, 1-methyl naphthalene & 2-methyl naphthalene
PAHs (carcinogenic)		20	none	Replaced by benzo(a)pyrene.
PCB Mixtures	1336-36-3	10.0	10	ARAR. This is a total value for all PCBs in the soil sample.
Tetrachloroethylene	127-18-4	0.5	0.05	Protection of drinking water--3 phase model.
Toluene	108-88-3	40	7	Protection of drinking water--3 phase model.
1,1,1 Trichloroethane	71-55-6	20	2	Protection of drinking water--3 phase model.
Trichloroethylene	79-01-5	0.5	0.03	Protection of drinking water--3 phase model.
Xylenes	1330-20-7	20	9	Protection of drinking water--3 phase model. Total of all m, o & p xylene.
GRO with benzene		100	30	Protection of drinking water--4 phase model, assuming weathered gasoline composition.
GRO w/o benzene		100	100 (5)	Protection of drinking water--4 phase model, assuming highly weathered gasoline composition.
Diesel Range Organics		200	2000	Protection of drinking water--residual saturation
Heavy Oils		200	2000	Protection of drinking water--residual saturation for diesel.
Mineral Oil		200 (4)	4000	Protection of drinking water--residual saturation

(1) Based on background value in table 740-1. Ecology intends to review and, if appropriate, update this value in a future rulemaking.
(2) This can also be used as the total toxic equivalents for all cPAHs. See WAC 173-340-708(8).
(3) Ecology decision not to change at this time. Ecology intends to review and, if appropriate, update this value in a future rulemaking.
(4) Ecology has also issued a fact sheet (#95-157-TCP) allowing the use of 2000 mg/kg at electrical substations and switchyards.
(5) To use this value no benzene must be present in the soil and the aromatic EC 8 to EC 16 fractions must be less than 20% of the gasoline mixture.

Table 3-3: Method A Soil Cleanup Levels for Unrestricted Land Use - Calculation of Change in Mass Removed

Hazardous Substance	CAS Number	Current Method A Cleanup Level (mg/kg) (1)	Proposed Method A Cleanup Level (mg/kg) (2)	Difference (mg/kg) (3)	Change in mass removed from soil at a site (kg) (4)	Change in mass needing removal from GdH2O at site (kg) (5)
Arsenic	7440-38-2	20.0	20	0	0.0	0.0
Benzene	71-43-2	0.5	0.03	0.47	5.4	-5.4
Benzo(a)Pyrene	50-32-8	0.1	0.1	0.0	0.0	0.0
Cadmium	7440-43-9	2	2	0	0.0	0.0
Chromium (total)	7440-47-3	100.0	none			
Chromium VI	18540-29-9		19	81	936	-936
Chromium III	16065-83-1		2,000	-1,900	-21,958	0.0
DDT	50-29-3	1	3	-2	-23	0.0
Ethylbenzene	100-41-4	20.0	6	14	162	-162
Ethylene dibromide (EDB)	106-93-4	0.001	0.005	-0.004	-0.046	0.0
Lead	7439-92-1	250.0	250	0	0.0	0.0
Lindane	58-89-9	1	0.01	0.99	11	-11
Methylene chloride	75-09-2	0.5	0.02	0.48	5.5	-5.5
Mercury (inorganic)	7439-97-6	1	2	-1	-11.6	0.0
MTBE	1634-04-4	0.005 & 2.0	0.1	(-0.095) & 1.9	(-1.1) & 22	0 & -22
Naphthalene	91-20-3	0.5 & 0.4	5	(-4.5) & -4.6	(-52) & -53	0
PAHs (carcinogenic)		1.0	none	see B(a)P		
PCB Mixtures	1336-36-3	1	1	0	0.0	0.0
Tetrachloroethylene	127-18-4	0.5	0.05	0.45	5.2	-5.2
Toluene	108-88-3	40.0	7	33	381	-381
1,1,1 Trichloroethane	71-55-6	20	2	18	208	-208
Trichloroethylene	79-01-5	0.5	0.03	0.47	5.4	-5.4
Xylenes	1330-20-7	20.0	9	11	127	-127
GRO with benzene		100	30	70	809	-809
GRO w/o benzene		100	100	0	0.0	0.0
Diesel Range Organics		200	2000	-1800	-20,803	0.0
Heavy Oils		200	2000	-1800	-20,803	0.0
Mineral Oil		200	4000	-3800	-43,917	0.0

Footnotes:

(1) From current MTCA table 2. Exceptions: B(a)P = cPAH total divided by 7 (number of cPAHs). For MTBE first value assumes MTBE = PQL as per WAC 173-340-704(2)(c) ; second value assumes MTBE resent at 2% in gas* and a cleanup level of 100 mg/kg. For naphthalene first value assumes naphthalene = PQL as per WAC 173-340-740(2)(c); second value assumes present in diesel fuel at 0.2%** and a cleanup level of 200 mg/kg).

(2) From table 740-1 in MTCA rule revisions proposed in August 2000.

(3) Column 1 minus column 2.

(4) Mass calculated assuming 1/4 acre site with uniform contamination, 25 feet between source of release and ground water and soil dry density of 1.5 kg/l or 42.45 kg/cf. This is the change in mass of contamination that would have to be removed from the soil at a site to meet the proposed cleanup level. Equals [10890 (ft^2) * 25 (ft) * 42.45 (kg/ft^3) * value in column 3 (mg/kg)] / [1,000,000 (mg/kg)].

(5) Decrease in mass needing removal from ground water to achieve ground water cleanup level as a result of new soil cleanup levels. For sites with the more stringent soil cleanup levels being driven by ground water protection concerns, this is equal to the additional mass of contamination needing removal from the soil. A value of zero means no ground water remediation would be needed for either soil cleanup level as ground water would meet drinking water standard under both cleanup levels.

* Source: Oregon DEQ

** Source: TPH-National Criteria Working Group; Ecology site files.

Table 3-4: Method A Soil Cleanup Levels for Industrial Land Use – Calculation of Change in Mass Removed

Hazardous Substance	CAS Number	Current Method A Cleanup Level (mg/kg) (1)	Proposed Method A Cleanup Level (mg/kg) (2)	Difference (mg/kg) (3)	Change in mass removed from soil at a site (kg) (4)	Change in mass needing removal from GdH2O at a site (kg) (5)
Arsenic	7440-38-2	200	20	180	2,080	-2080.3
Benzene	71-43-2	0.5	0.03	0.47	5.4	-5.4
Benzo(a)Pyrene (3)	50-32-8	2.8	2	0.8	9.2	-9.2
Cadmium	7440-43-9	10	2	8	92.5	-92.5
Chromium (total)	7440-47-3	500.0	none			
Chromium VI	18540-29-9		19	481	5,559	-5,559
Chromium III	16065-83-1		2,000	-1,500	-17,336	0.0
DDT	50-29-3	5	4	1	12	-12
Ethylbenzene	100-41-4	20	6	14	162	-162
Ethylene dibromide (EDB)	106-93-4	0.001	0.005	-0.004	-0.046	0.0
Lead	7439-92-1	1000.0	1000	0	0.0	0.0
Lindane	58-89-9	20	0.01	19.99	231	-231
Methylene chloride	75-09-2	0.5	0.02	0.48	5.5	-5.5
Mercury (inorganic)	7439-97-6	1	2	-1	-11.6	0.0
MTBE (4)	1634-04-4	0.005 & 2.0	0.1	(-0.095) & 1.9	(-1.1) & 22	0 & -22
Naphthalene (5)	91-20-3	0.5 & 0.4	5	(-4.5) & -4.6	(-52) & -53	0
PAHs (carcinogenic)		20	none	see B(a)P		
PCB Mixtures	1336-36-3	10.0	10	0	0.0	0.0
Tetrachloroethylene	127-18-4	0.5	0.05	0.45	5.2	-5.2
Toluene	108-88-3	40	7	33	381	-381
1,1,1 Trichloroethane	71-55-6	20	2	18	208	-208
Trichloroethylene	79-01-5	0.5	0.03	0.47	5.4	-5.4
Xylenes	1330-20-7	20	9	11	127	-127
GRO with benzene		100	30	70	809	-809
GRO w/o benzene		100	100	0	0.0	0.0
Diesel Range Organics		200	2,000	-1,800	-20,803	0.0
Heavy Oils		200	2,000	-1,800	-20,803	0.0
Mineral Oil		200	4,000	-3,800	-43,917	0.0

Footnotes:

(1) From current MTCA table 2. Exceptions: B(a)P = cPAH total divided by 7 (number of cPAHs). For MTBE first value assumes MTBE = PQL as per WAC 173-340-704(2)(c); second value assumes MTBE resent at 2% in gas* and a cleanup level of 100 mg/kg. For naphthalene first value assumes naphthalene = PQL as per WAC 173-340-740(2)(c); second value assumes present in diesel fuel at 0.2%** and a cleanup level of 200 mg/kg).

(2) From table 740-1 in MTCA rule revisions proposed in August 2000.

(3) Column 1 minus column 2.

(4) Mass calculated assuming 1/4 acre site with uniform contamination, 25 feet between source of release and ground water and soil dry density of 1.5 kg/l or 42.45 kg/cf. This is the change in mass of contamination that would have to be removed from the soil at a site to meet the proposed cleanup level. Equals [10890 (ft^2) * 25 (ft) * 42.45 (kg/ft^3) * value in column 3 (mg/kg)] / [1,000,000 (mg/kg)].

(5) Decrease in mass needing removal from ground water to achieve ground water cleanup level as a result of new soil cleanup levels. For sites with the more stringent soil cleanup levels being driven by ground water protection concerns, this is equal to the additional mass of contamination needing removal from the soil. A value of zero means no ground water remediation would be needed for either soil cleanup level as ground water would meet drinking water standard under both cleanup levels.

* Source: Oregon DEQ

** Source: TPH-National Criteria Working Group; Ecology site files.

Table 3-5: Method A Soil Cleanup Levels for Unrestricted Land Use – Calculation of Change in Cost of Cleanup

Hazardous Substance	CAS Number	Current Method A Cleanup Level (mg/kg) (1)	Proposed Method A Cleanup Level (mg/kg) (2)	Difference (mg/kg) (3)	Change in Mass removed from soil (kg) (4)	Unit Cost of Soil Treatment ($/kg) (5)	Difference in Cost of Soil Remediation ($) (6)	Unit Cost of Soil Excav. & Off-Site Disposal ($/kg) (7)	Difference in Cost of Soil Remediation ($) (8)	Δ Mass needing Removal From GW (kg) (9)	Unit Cost of GW Remediation ($/kg) (10)	Difference in Cost of GW Remediation ($) (11)
Arsenic	7440-38-2	20.0	20	0	0	238.96	$0	51.64	$0	0	2108.27	$0
Benzene	71-43-2	0.5	0.03	0.47	5.4	16.58	$90	51.64	$280	-5.4	2108.27	-$11,452
Benzo(a)Pyrene	50-32-8	0.1	0.1	0.0	0	186.04	$0	51.64	$0	0	2108.27	$0
Cadmium	7440-43-9	2	2	0	0	238.96	$0	51.64	$0	0	2108.27	$0
Chromium (total)	7440-47-3	100.0	none									
Chromium VI	18540-29-9		19	81	936	238.96	$223,695	51.64	$48,341	-936	2108.27	-$1,973,590
Chromium III	16065-83-1		2,000	-1,900	-21,958	238.96	-$5,247,161	51.64	-$1,133,928	0	2108.27	$0
DDT	50-29-3	1	3	-2	-23.1	186.04	-$4,300	51.64	-$1,194	0	2108.27	$0
Ethylbenzene	100-41-4	20.0	6	14	162	16.58	$2,683	51.64	$8,355	-162	2108.27	-$341,114
Ethylene dibromide (EDB)	106-93-4	0.001	0.005	-0.004	-0.046	16.58	-$1	51.64	-$2	0	2108.27	$0
Lead	7439-92-1	250.0	250	0	0	238.96	$0	51.64	$0	0	2108.27	$0
Lindane	58-89-9	1	0.01	0.99	11.4	186.04	$2,129	51.64	$591	-11.4	2108.27	-$24,122
Methylene chloride	75-09-2	0.5	0.02	0.48	5.5	16.58	$92	51.64	$286	-5.5	2108.27	-$11,695
Mercury (inorganic)	7439-97-6	1	2	-1	-11.6	238.96	-$2,762	51.64	-$597	0	2108.27	$0
MTBE	1634-04-4	0.005 & 2.0	0.1	(-0.095) to 1.9	(-1.1) to 22	16.58	$-18 to $32	51.64	$-56.8 to $1136	up to -22	2108.27	up to -$46,382
Naphthalene	91-20-3	0.5 & 0.4	5	(-4.5) to -4.6	(-52) to -53	16.58	(-$862) to -$879	51.64	(-$2685) to -$2737	0	2108.27	$0
PAHs (carcinogenic)		1.0	none	see B(a)P		186.04	$0	51.64	$0	0	2108.27	$0
PCB Mixtures	1336-36-3	1	1	0	0	186.04	$0	51.64	$0	0	2108.27	$0
Tetrachloroethylene	127-18-4	0.5	0.05	0.45	5.2	16.58	$86	51.64	$269	-5.2	2108.27	-$10,964
Toluene	108-88-3	40.0	7	33	381	16.58	$6,323	51.64	$19,695	-381	2108.27	-$804,055
1,1,1 Trichloroethane	71-55-6	20	2	18	208	16.58	$3,449	51.64	$10,742	-208	2108.27	-$438,575
Trichloroethylene	79-01-5	0.5	0.03	0.47	5.4	16.58	$90	51.64	$280	-5.4	2108.27	-$11,452
Xylenes	1330-20-7	20.0	9	11	127	16.58	$2,108	51.64	$6,565	-127	2108.27	-$268,018
GRO with benzene		100	30	70	809	16.58	$13,413	51.64	$41,776	-809	2108.27	-$1,705,571
GRO w/o benzene		100	100	0	0	16.58	$0	51.64	$0	0	2108.27	$0
Diesel Range Organics		200	2,000	-1,800	-20,803	16.58	-$344,907	51.64	-$1,074,247	0	2108.27	$0
Heavy Oils		200	2,000	-1,800	-20,803	186.04	-$3,870,120	51.64	-$1,074,247	0	2108.27	$0
Mineral Oil		200	4,000	-3,800	-43,917	186.04	-$8,170,253	51.64	-$2,267,856	0	2108.27	$0

Table 3-5 Footnotes.

(1) From current MTCA table 2. Exceptions: B(a)P = cPAH total divided by 7 (number of cPAHs). For MTBE first value assumes MTBE = PQL as per WAC 173-340-704(2)(c); second value assumes MTBE resent at 2% in gas and a cleanup level of 100 mg/kg. For naphthalene first value assumes naphthalene = PQL as per WAC 173-340-704(2)(c); second value assumes present in diesel fuel at 0.2% and a cleanup level of 200 mg/kg).

(2) From table 740-1 in MTCA rule revisions proposed in August 2000.

(3) Column 1 minus column 2.

(4) Mass calculated assuming 1/4 acre contaminated area with uniform contamination extenting 25 feet to ground water and soil dry density of 1.5 kg/l or 42.45 kg/cf. This is the change in mass of contamination that would have to be removed from the soil at a site to meet the proposed cleanup level (see Table 3-3).

(5) For volatile organics based on median cost of soil vapor extraction reported at 13 federal cleanup sites (see Table 3-7). For metals based on cost of soil washing reported at 1 federal cleanup site (see Table 3-9). For semi volatile organics and pesticides based on the median cost of thermal desorption at 15 federal cleanup sites (see Table 8).

(6) Change in mass removed from soil (column 4) times unit cost of cleanup (column 5). Positive number is increase in soil cleanup costs, negative number is savings in soil cleanup costs.

(7) Disposal at a landfill based on data from Ecology site files (Table 3-10).

(8) Change in mass removed from soil (column 4) times unit cost of cleanup (column 7). Positive number is increase in soil cleanup costs, negative number is savings in soil cleanup costs.

(9) Decrease in mass needing removal from ground water to achieve ground water cleanup level as a result of new soil cleanup levels (see Table 3-3).

(10) Based on median cost of ground water cleanup at 26 sites, expressed as a cost per kg of contaminants removed (see Table 3-11).

(11) Change in mass removed from ground water times unit cost of cleanup. This is the savings in ground water cleanup costs.

Table 3-6: Method A Soil Cleanup Levels for Industrial Land Use – Calculation of Change in Cost of Cleanup

Hazardous Substance	CAS Number	Current Method A Cleanup Level (mg/kg)	Proposed Method A Cleanup Level (mg/kg)	Difference (mg/kg)	Change in Mass removed from Soil in Kg (kg) (1)	Unit Cost of Soil Remediation ($/kg) (2)	Difference in Cost of Soil Remediation ($) (3)	Unit Cost of Soil Excav. & Off-Site Disposal ($/kg) (7)	Difference in Cost of Soil Remediation ($) (8)	Change in Mass needing Removal from GW (kg) (4)	Unit Cost of GW Remediation ($/kg) (5)	Difference in Cost of GW Remediation ($) (6)
Arsenic	7440-38-2	200	20	180	2,080	238.96	$497,099	51.64	$107,425	-2,080	2108.27	-$4,385,754
Benzene	71-43-2	0.5	0.03	0.47	5.4	16.58	$90	51.64	$280	-5.4	2108.27	-$11,452
Benzo(a)Pyrene	50-32-8	2.8	2	0.8	9.2	186.04	$1,720	51.64	$477	-9.2	2108.27	-$19,492
Cadmium	7440-43-9	10	2	8	92	238.96	$22,093	51.64	$4,774	-92	2108.27	-$194,922
Chromium (total)	7440-47-3	500.0	none									
Chromium VI	18540-29-9		19	481	5,559	238.96	$1,328,360	51.64	$287,063	-5,559	2108.27	-$11,719,711
Chromium III	16065-83-1		2,000	-1,500	-17,336	238.96	-$4,142,496	51.64	-$895,206	0	2108.27	$0
DDT	50-29-3	5	4	1	11.6	186.04	$2,150	51.64	$597	-11.6	2108.27	-$24,365
Ethylbenzene	100-41-4	20	6	14	162	16.58	$2,683	51.64	$8,355	-162	2108.27	-$341,114
Ethylene dibromide	106-93-4	0.001	0.005	-0.004	0.0	16.58	-$1	51.64	-$2	0	2108.27	$0
Lead	7439-92-1	1000.0	1000	0	0	238.96	$0	51.64	$0	0	2108.27	$0
Lindane	58-89-9	20	0.01	19.99	231	186.04	$42,980	51.64	$11,930	-231.0	2108.27	-$487,062
Methylene chloride	75-09-2	0.5	0.02	0.48	5.5	16.58	$92	51.64	$286	-5.5	2108.27	-$11,695
Mercury (inorganic)	7439-97-6	1	2	-1	-11.6	238.96	-$2,762	51.64	-$597	0	2108.27	$0
MTBE	1634-04-4	0.005 & 2.0	0.1	(-0.095) & 1.9	(-1.1) & 22	16.58	$-18 to $32	51.64	$-56.8 to $1136	up to -22	2108.27	up to -$46,382
Naphthalene	91-20-3	0.5 & 0.4	5	(-4.5) & -4.6	(-52) & -53	16.58	(-$862) to -$879	51.64	(-$2685) to -$2737	0	2108.27	$0
PAHs (carcinogenic)		20	none	see B(a)P		186.04	$0	51.64	$0	0	2108.27	$0
PCB Mixtures	1336-36-3	10.0	10	0	0	186.04	$0	51.64	$0	0	2108.27	$0
Tetrachloroethylene	127-18-4	0.5	0.05	0.45	5.2	16.58	$86	51.64	$269	-5.2	2108.27	-$10,964
Toluene	108-88-3	40	7	33	381	16.58	$6,323	51.64	$19,695	-381	2108.27	-$804,055
1,1,1 Trichloroethane	71-55-6	20	2	18	208	16.58	$3,449	51.64	$10,742	-208	2108.27	-$438,575
Trichloroethylene	79-01-5	0.5	0.03	0.47	5.4	16.58	$90	51.64	$280	-5.4	2108.27	-$11,452
Xylenes	1330-20-7	20	9	11	127	16.58	$2,108	51.64	$6,565	-127	2108.27	-$268,018
GRO with benzene		100	30	70	809	16.58	$13,413	51.64	$41,776	-809	2108.27	-$1,705,571
GRO w/o benzene		100	100	0	0	16.58	$0	51.64	$0	0	2108.27	$0
DRO		200	2,000	-1,800	-20,803	16.58	-$344,907	51.64	-$1,074,247	0	2108.27	$0
Heavy Oils		200	2,000	-1,800	-20,803	186.04	-$3,870,120	51.64	-$1,074,247	0	2108.27	$0
Mineral Oil		200	4,000	-3,800	-43,917	186.04	-$8,170,253	51.64	-$2,267,856	0	2108.27	$0

Table 3-6 Footnotes:

(1) From current MTCA table 3. Exceptions: B(a)P = cPAH total divided by 7 (number of cPAHs). For MTBE first value assumes MTBE = PQL as per WAC 173-340-704(2)(c) ; second value assumes MTBE resent at 2% in gas and a cleanup level of 100 mg/kg. For naphthalene first value assumes naphthalene = PQL as per WAC 173-340-704(2)(c); second value assumes present in diesel fuel at 0.2% and a cleanup level of 200 mg/kg).
(2) From table 745-1 in MTCA rule revisions proposed in August 2000.
(3) Column 1 minus column 2.
(4) Mass calculated assuming 1/4 acre contaminated area with uniform contamination extending 25 feet to ground water and soil dry density of 1.5 kg/l or 42.45 kg/cf. This is the change in mass of contamination that would have to be removed from the soil at a site to meet the proposed cleanup level (see Table 3-3).
(5) For volatile organics based on median cost of soil vapor extraction reported at 13 federal cleanup sites (see Table 3-7). For metals based on cost of soil washing reported at 1 federal cleanup site (see Table 3-9). For semi volatile organics and pesticides based on the median cost of thermal desorption at 15 federal cleanup sites (see Table 3-8).
(6) Change in mass removed from soil (column 4) times unit cost of cleanup (column 5). Positive number is increase in soil cleanup costs, negative number is savings in soil cleanup costs.
(7) Disposal at a landfill based on data from Ecology site files (Table 3-10).
(8) Change in mass removed from soil (column 4) times unit cost of cleanup (column 7). Positive number is increase in soil cleanup costs, negative number is savings in soil cleanup costs.
(9) Decrease in mass needing removal from ground water to achieve ground water cleanup level as a result of new soil cleanup levels (see Table 3-3).
(10) Based on median cost of ground water cleanup at 26 sites, expressed as a cost per kg of contaminants removed (see Table 3-11).
(11) Change in mass removed from ground water times unit cost of cleanup. This is the savings in ground water cleanup costs.

Table 3-7: Cost of Soil Vapor Extraction (SVE) – Compiled from Federal Cleanup Sites

	Site Name & Location	Contaminants	Contaminant Mass Removed (Pounds)	Capitol Cost Dollars	Operating Cost Dollars	Months of Operation	Total Capitol & Operating Costs ($)	Cost per Pound of Mass Removed ($)	Cost per Kilogram of Mass Removed ($)
1	Basket Creek, GA	TCE, PCE, toluene,xylene, methyl ethyl ketone, methyl isobutyl ketone	1,571	na	na	6	660,000	9.20	4.17
2	Davis-Monthan AFB, AZ	JP-4	585,700	162,000	45,000	16	207,000	0.35	0.16
3	Fairchild Semiconductor, CA	TCA, 1,1,1 TCE, 1,1,DCE, PCE, xylene, freon 113, acetone, isopropyl alcohol	16,000	2,100,000	1,800,000	16	3,900,000	243.75	110.56
4	Hastings Well #3, NB	Carbon Tet	600	210,378	159,250	12	369,628	616.05	279.43
5	Hill AFB, UT	JP-4	211,000	335,000	132,000	24	335,024	1.59	0.72
6	Intersil/Siemens, CA	TCE	3,000	550,000	220,000	60	770,000	256.67	116.42
7	Luke AFB, AZ	TPH (JP-4 and lub oils), BTEX, MEK	12,000	297,017	210,168	6	507,185	42.27	19.17
8	Rocky Mt Arsenal, OU 18	TCE, PCE, toluene,xylene, methyl ethyl ketone, methyl isobutyl ketone	70	75,600	88,490	5	164,090	2,344.14	1,063.29
9	Sacramento Army Depot, CA	TCE,PCE, 1,2 DCE	138	231,127	439,384	14	670,511	4,858.78	2,203.91
10	Sand Creek, CO	Chloroform, methylene chloride, TCE, PCE, TPH	176,500	na	na	6	2,058,000	11.70	5.31
11	Shaw AFB, SC	JP-4, BTEX	518,000	1,800,000	568,500	19	2,368,500	4.57	2.07
12	Texas Tower Site, Fort Greely, AK	Diesel	1,300	178,530	117,230	24	295,760	227.51	103.20
13	Verona Well Field, MI	19 contaminants including 1,1,1 TCE, PCE	45,000	na	na	54	1,645,281	36.56	16.58
	All projects		**Median**	264,072		16	**Median**	42.27	19.17
	All projects		**Average**	593,965		20	**Average**	665.63	301.92
							Without projects 8 & 9 (1) **Median**	36.56	16.58
							Without projects 8 & 9 (1) **Average**	131.84	59.80
							TPH sites only (8, 11, 17, 18) **Median**	3.08	1.40
							TPH sites only (8, 11, 17, 18) **Average**	58.51	26.54

Source:
Federal Remediation Technologies Roundtable: Cost and Performance Reports. Web-Site: Http//clu-in.org/remed1.htm

Footnote:
(1) Projects 8 & 9 appear to be outliers. This median value was used in subsequent calculations. Note that TPH only projects have a much lower cost.

Table 3-8: Cost of Soil Cleanup Using Low Temperature Thermal Desorption – Compiled from Federal Cleanup Sites

	Site Name & Location	Contaminants	Soil or Waste Treated Tons	Capitol Cost	Operating Cost	Total Costs	Cost per Ton of Soil or Waste	Notes
1	Arlington Blending and Packaging, TN	pesticides, PCP, arsenic	41,431	$4,293,893	$62,351	$4,356,244	$105.14	1996
2	FCX Washington, NC	pesticides	13,591			$1,696,800	$124.85	1995-96
3	Ft. Lewis Coal Pilot Plant, WA	cPAHs	104,336			$7,100,000	$68.05	1996
4	Letterkenny Army Depot, PA	VOCs, metals, heavy TPH	22,378			$5,402,801	$241.43	1993-94 Results reported as 13,986 cy. Converted using 1.6 ton/cy.
5	Longhorn Army Ammo Plant, TX	Methylene Chloride, TCE	51,669			$4,886,978	$94.58	1997 Reported soil density of 1.6 ton/cy.
6	McKin Company, ME	BTEX, PAHs	18,400			$2,900,000	$157.61	1986-87 Results reported as 11,500 cy. Converted using 1.6 ton/cy.
7	NAS Cecil Field, FL	BTEX, TPH	11,768			$1,986,122	$168.77	1995
8	Outboard Marine, IL	PCB s	12,755			$2,474,000	$193.96	1992
9	Port Moller, AK	BTEX, GRO, DRO	15,200			$3,325,000	$218.75	1995 Results reported as 9,500 cy. Converted using 1.6 ton/cy.
10	Re-Solve, MA	PCBs	44,000			$6,800,000	$154.55	1993-94 Reported soil density of 1.2 ton/cy.
11	Rocky Flats Trenchs T-3 & T-4, CO	VOCs, BTEX, ketones	6,074			$1,328,600	$218.74	1996 Results reported as 3,796 cy. Converted using 1.6 ton/cy.
12	Sand Creek, CO	pesticides	13,000	$1,804,337	$191,144	$1,995,481	$153.50	1994 Reported soil density of 1.6 ton/cy.
13	TH Agriculture & Nutrition, GA	pesticides	4,300			$849,996	$197.67	1993 Reported soil density of 1.7 tons/cy.
14	Waldrick Aerospace, NJ	BTEX, VOCs, TPH	5,520			$3,610,086	$654.00	1993 Results reported as 3,450 cy. Converted using 1.6 ton/cy.
15	Wide Beach, NY	PCBs	42,000			$11,600,000	$276.19	1991
						Median	**$168.77**	**Per ton of soil**
						Average	**$201.85**	**Per ton of soil**
						Median	**$186.04**	**Per kg of contamination (1)**
						Average	**$222.50**	**Per kg of contamination (1)**

Source:
Federal Remediation Technologies Roundtable: Cost and Performance Reports. Web-Site: Http//clu-in.org/remed1.htm

Footnote:
(1) Assuming contaminant concentration is 1000 mg/kg, a typical average concentration based on available data at these and other federal sites.

Table 3-9: Cost of Soil Cleanup Using Soil Washing – Compiled from Federal Cleanup Sites

	Site Name & Location	Contaminants	Soil or Waste Treated (Tons)	Mass Treated (Kg)	Total Costs ($)	Cost per Ton of Soil or Waste ($/ton)	Cost per Kg of Contaminants ($/kg)	Notes
1	King of Prussia, NJ	Metals (avg. total metals 1,850 mg/kg)	19,200	32,223	$7,700,000	$401.04	$238.96	1993

Source:
Federal Remediation Technologies Roundtable: Cost and Performance Reports. Web-Site: http//clu-in.org/remed1.htm

Table 3-10: Cost of Soil Cleanup Using Excavation and Off-Site Disposal in a Landfill – Compiled from Ecology Bid Data

Site Name & Location	Contaminants	Cost per Ton of Soil $/Ton	Cost per Kg of Contaminants $/kg (2)	Notes
Asarco Everett (1)	Metals (arsenic & lead)			
Bidder #1		$38.00	$41.89	
Bidder #2		$44.06	$48.57	
Bidder #3		$46.85	$51.64	
Bidder #4		$40.00	$44.09	
Bidder #5		$52.50	$57.87	
Bidder #6		$47.97	$52.88	
Bidder #7		$39.00	$42.99	
Bidder #8		$60.00	$66.14	
Bidder #9		$51.67	$56.96	
	Median	$46.85	$51.64	
	Average	$46.67	$51.45	
Other Sites (3)				
K Mart, Everett	TPH	$30.28		
Vilander Property, Battleground	TPH	$47.00		
Sequim Bay State Park	TPH	$45.00		

Footnotes:
(1) Source: Year 2000 bids on Asarco Everett soil excavation and disposal, Everett WA.
(2) Assuming 1000 mg/kg, a typical average contaminant concentration at the federal cleanup sites reported in previous tables.
(3) Ecology site files. Based on this data the Everett bid median appears appropriate to use for a cost estimate.

Table 3-11: Cost of Ground Water Cleanup Using Pump and Treat Systems – Compiled from Federal Cleanup Sites

	Site Name & Location	Contaminants	Volume of GW Extracted (Million Gallons)	Contaminant Mass Removed Pounds	Capitol Cost Dollars	Annual Operating Cost Dollars	Years of Operation	Total Operating Costs Dollars
1	Baird and McGuire, MA	VOCs, SVOCs, Pesticides, metals	80	2,100	11,000,000	2,000,000	3.8	7,600,000
2	City Industries, FL	VOCs	151.7	2,700	1,200,000	170,000	3.0	510,000
3	Des Moines, IA	VOCs	4900	30,000	1,600,000	110,000	8.8	968,000
4	Firestone, CA	VOCs	1800	500	4,100,000	1,300,000	6.8	8,840,000
5	French Ltd. TX	VOCs	306	510,000	15,000,000	3,400,000	4.0	13,600,000
6	Gold Coast, FL	VOCs	80	2,000	250,000	120,000	3.7	444,000
7	Intersil, CA	VOCs	36	120	330,000	140,000	7.3	1,022,000
8	JMT Facility RCRA, NY	VOCs	50.1	840	880,000	150,000	9.6	1,440,000
9	Keefe, NH	VOCs	46	68	1,600,000	240,000	4.1	984,000
10	King of Prussia, NJ	VOCs, Metals	151.5	5,400	2,000,000	390,000	2.7	1,053,000
11	La Salle, IL	VOCs, PCBs	23	130	5,300,000	190,000	4.4	836,000
12	Libby, MT	VOCs, SVOCs	15.1	37,000	3,000,000	500,000	5.3	2,650,000
13	Moffett, CA	VOCs	0.284	?				
14	MSWP, AR	VOCs, SVOCs	100.6	800	470,000	91,000	8.3	755,300
15	Mystery Bridge, WY	VOCs	192.8	21	310,000	170,000	3.6	612,000
16	Odessa I, TX	Metals	125	1,100	2,000,000	190,000	4.2	798,000
17	Odessa IIS, TX	Metals	121	130	2,000,000	140,000	4.1	574,000
18	Old Mill, OH	VOCs	13	120	210,000	210,000	7.8	1,638,000
19	SCRDI Dixiana, SC	VOCs	20.6	7	94,000	94,000	4.6	432,400
20	Site A, NY	VOCs	8.4	5,300	290,000	290,000	1.3	377,000
21	Sol Lynn, TX	VOCs	13	5,000	150,000	150,000	3.0	450,000
22	Solid State, MO	VOCs	257	2,700	370,000	370,000	4.2	1,554,000
23	Solvent Recovery Service, CT	VOCs, Metals	32.5	4,300	400,000	400,000	2.9	1,160,000
24	Sylvester/Gilson Road, NH	VOCs, Pesticides, Metals	1200	430,000	1,900,000	1,900,000	9.5	18,050,000
25	US Aviex, MI	VOCs	329	660	180,000	180,000	3.4	612,000
26	United Chrome, OR	Metals	62	31,000	3,300,000	96,000	8.6	825,600
27	USCG Center, NC	VOCs, Metals	2.6	?				
28	Western Processing, WA	VOCs, Metals	974	100,000	15,000,000	4,400,000	8.2	36,080,000

Source:
Groundwater Cleanup: Overview of Operating Experience at 28 Sites. EPA 542-R-99-006, September 1999.

Table 3-11: Cost of Ground Water Cleanup Using Pump and Treat Systems – Compiled from Federal Cleanup Sites (continued)

	Site Name & Location	Total Capitol & Operating Costs ($)	Cost per Pound of Mass Removed ($)	Cost per Kg of Mass Removed ($)
1	Baird and McGuire, MA	18,600,000	$8,857.14	$19,526.63
2	City Industries, FL	1,710,000	$633.33	$1,396.26
3	Des Moines, IA	2,568,000	$85.60	$188.72
4	Firestone, CA (1)	12,940,000	$25,880.00	$57,055.57
5	French Ltd. TX	28,600,000	$56.08	$123.63
6	Gold Coast, FL (1)	694,000	$347.00	$765.00
7	Intersil, CA	1,352,000	$11,266.67	$24,838.72
8	JMT Facility RCRA, NY	2,320,000	$2,761.90	$6,088.95
9	Keefe, NH	2,584,000	$38,000.00	$83,775.56
10	King of Prussia, NJ	3,053,000	$565.37	$1,246.43
11	La Salle, IL	6,136,000	$47,200.00	$104,058.06
12	Libby, MT	5,650,000	$152.70	$336.65
13	Moffett, CA			
14	MSWP, AR	1,225,300	$1,531.63	$3,376.65
15	Mystery Bridge, WY	922,000	$43,904.76	$96,793.32
16	Odessa I, TX	2,798,000	$2,543.64	$5,607.75
17	Odessa IIS, TX	2,574,000	$19,800.00	$43,651.48
18	Old Mill, OH	1,848,000	$15,400.00	$33,951.15
19	SCRDI Dixiana, SC	526,400	$75,200.00	$165,787.42
20	Site A, NY	667,000	$125.85	$277.45
21	Sol Lynn, TX	600,000	$120.00	$264.55
22	Solid State, MO	1,924,000	$712.59	$1,571.00
23	Solvent Recovery Service, CT	1,560,000	$362.79	$799.82
24	Sylvester/Gilson Road, NH	19,950,000	$46.40	$102.28
25	US Aviex, MI	792,000	$1,200.00	$2,645.54
26	United Chrome, OR	4,125,600	$133.08	$293.40
27	USCG Center, NC			
28	Western Processing, WA	51,080,000	$510.80	$1,126.12
		Median	**$956.30**	**$2,108.27**
		Average	**$11,438.36**	**$25,217.24**

Table 3-12: Summary of Method A Ground Water Cleanup Levels

Hazardous Substance	CAS No.	Method A Cleanup Level (ug/l) Current	Proposed	Basis for Proposed Cleanup Level
Arsenic	7440-38-2	5	5	Natural background--MCL exceeds allowable risk.
Benzene	71-43-2	5	5	MCL
Benzo(a)Pyrene	50-32-8	none	0.1	MCL adjusted to 1 X 10-5 risk. This can also be used as the total toxic equivalents for all cPAHs. See WAC 173-340-708(8).
Cadmium	7440-43-9	5	5	MCL
T Chromium	7440-47-3	50	50	Method B--based on Chromium VI. (1)
Chromium VI	18540-29-9	none	none	
Chromium III	16065-83-1	none	none	
DDT	50-29-3	0.1	0.3	Method B (current Method A value appears to be in error)
1,2 Dichloroethane	107-06-2	5	5	MCL
Ethylbenzene	100-41-4	30	700	MCL
Ethylene dibromide	106-93-4	0.01	0.01	Method B adjusted to PQL--MCL exceeds allowable risk.
Lead	7439-92-1	5	15	MCL
Lindane	58-89-9	0.2	0.2	MCL
Methylene chloride	75-09-2	5	5	MCL
Mercury (inorganic)	7439-97-6	2	2	MCL
MTBE	1634-04-4	none	20	Lower limit of EPA Advisory level
Naphthalenes	91-20-3	none	160	Method B for naphthalene. This is a total of all naphthalene, 1-Methyl naphthalene & 2-Methyl Naphthalene in the water.
PAHs(carcinogenic)(1)	na	0.1	none	Replaced by Benzo(a)Pyrene, above.
PCB mixtures	1336-36-3	0.1	0.1	Method B adjusted to PQL (MCL exceeds MTCA allowable HQ and cancer risk). This is a total for all PCBs.
Tetrachloroethylene	127-18-4	5	5	MCL
Toluene	108-88-3	40	1000	MCL
TPH (total)	14280-30-9	1,000	none	Replaced with TPH for specific products.
Gasoline	6842-59-6			
GRO w/o benzene			1,000	Equation 720-3, assuming no benzene is present in gasoline contaminated water.
GRO with benzene			800	Equation 720-3, assuming benzene restored to 5 ug/l.
Diesel			500	Equation 720-3.
Heavy Oils			500	Equation 720-3.
Electrical Insulating Oil			1,000	Equation 720-3.
1,1,1 Trichloroethane	71-55-6	200	200	MCL
Trichloroethylene	79-01-6	5	5	MCL
Vinyl Chloride	75-01-4	0.2	0.2	MCL adjusted to 1 X 10-5 risk.
Xylene (total)	1330-20-7	20	1000	Not to exceed total TPH for gasoline & aesthetic considerations (odor)
Gross Alpha Particle Act.		15 pCi/l	15 pCi/l	MCL.
Gross Beta Particle Act.		4 mrem/yr	4 mrem/yr	MCL (4 mrem/yr equals 50 pCi/l)
Radium 226 & 228		5 pCi/l	5 pCi/l	MCL
Radium 226		3 pCi/l	3 pCi/l	MCL

(1) If just chromium III is present at site, may use MCL of 100 ug/l.

Table 3-13: Method A Ground Water Cleanup Levels – Calculation of Change in Cleanup Costs

Hazardous Substance	CAS Number	Method A Cleanup Levels (ug/l) Current Rule	Proposed Rule	Difference (ug/l)	Change in Mass Removed from GW at a site (kg) (1)	Unit Cost of GW Remediation ($/kg) (2)	Increase in Cost OR (Savings) for GW Remediation ($) (3)
Arsenic	7440-38-2	5.0	5	0	0	2,108.27	-
Benzene	71-43-2	5	5	0	0	2,108.27	-
Benzo(a)Pyrene (4)	50-32-8	0.01	0.1	0.09	-0.00095	2,108.27	(2.01)
Cadmium	7440-43-9	5	5	0	0	2,108.27	-
Chromium (total)	7440-47-3	50.0	50	0	0	2,108.27	-
Chromium VI	18540-29-9	None	50	0	0	2,108.27	-
Chromium III	16065-83-1	None	100	50	-0.53	2,108.27	(1,118.22)
DDT	50-29-3	0.1	0.3	0.2	-0.0021	2,108.27	(4.47)
1,2 Dichlorothane	107-06-2	5	5	0	0	2,108.27	-
Ethylbenzene	100-41-4	30.0	700	670	-7.11	2,108.27	(14,984.16)
Ethylene dibromide (EDB)	106-93-4	0.01	0.01	0	0	2,108.27	-
Lead	7439-92-1	5.0	15	10	-0.106	2,108.27	(223.64)
Lindane	58-89-9	0.2	0.2	0	0	2,108.27	-
Methylene chloride	75-09-2	5	5	0	0	2,108.27	-
Mercury (inorganic)	7439-97-6	2	2	0	0	2,108.27	-
MTBE (5)	1634-04-4	1	20	19	-0.20	2,108.27	(424.92)
Naphthalene (6)	91-20-3	1	160	159	-1.69	2,108.27	(3,555.94)
PAHs (carcinogenic)		0.1	none	see B(a)P			
PCB Mixtures	1336-36-3	0.1	0.1	0	0	2,108.27	-
Tetrachloroethylene	127-18-4	5.0	5	0	0	2,108.27	-
Toluene	108-88-3	40.0	1000	960	-10.18	2,108.27	(21,469.84)
TPH (total)	14280-30-9	1000	none	see below			
Gasoline range organics	6842-59-6						
GRO with benzene		1000	800	-200	2	2,108.27	4,472.88
GRO w/o benzene		1000	1000	0	0.00	2,108.27	-
Diesel Range Organics		1000	500	-500	5.30	2,108.27	11,182.21
Heavy Oils		1000	500	-500	5.30	2,108.27	11,182.21
Electrical Insulating Mineral Oil		1000	1000	0	0	2,108.27	-
1,1,1 Trichloroethane	71-55-6	200	200	0	0	2,108.27	-
Trichloroethylene	79-01-5	5.0	5	0	0	2,108.27	-
Vinyl Chloride		0.2	0.2	0	0	2,108.27	-
Xylenes	1330-20-7	20.0	1000	980	-10.40	2,108.27	(21,917.12)
Gross Alpha Particle Activity		15 pCi/l	15 pCi/l	0	0	2,108.27	-
Gross Beta Particle Activity		4 mrem/yr	4 mrem/yr	0	0	2,108.27	-
Radium 226 & 228		5 pCi/l	5 pCi/l	0	0	2,108.27	-
Radium 226		3 pCi/l	3 pCi/l	0	0	2,108.27	-

Footnotes:

(1) Mass calculated assuming 1 acre site with uniform ground water contamination, an aquifer thickness of 20 ft. and soil porosity of 0.43. This is the change in mass of contamination that would have to be removed from the ground water at a site to meet the proposed cleanup level.

(2) Source: Ground Water Cleanup: Overview of Operating Experience at 28 Sites, EPA 542-R-99-006, September 1999.

(3) Current concentration is PAH value of 1 divided by 7 (number of cPAHs).

(4) Current concentration is based on PQL as per WAC 173-340-704(1)(c).

(5) Current concentration is based on PQL as per WAC 173-340-704(1)(c).

Chapter 4 Technical Analysis – Probable Benefits of the Proposed Method A Soil and Ground Water Cleanup Levels

4.1 Introduction

The primary impact of the proposed rule amendments on benefits results from the proposed changes to the soil and ground water cleanup levels in the Method A tables. The proposed changes to the Method A soil cleanup levels, and the basis for those changes, are described in **Table 3-1 and Table 3-2**. The proposed changes to the Method A ground water cleanup levels, and the basis for those changes, are described in **Table 3-12**. Further description of the proposed changes and the potential impact of those proposed changes is presented in **Chapter 2**.

The impact of the proposed rule amendments on benefits depends on several factors. First, the impact depends on whether the proposed Method A cleanup levels are more stringent or less stringent than under the current rule. Less stringent cleanup levels are expected to reduce the cost of cleanup. **See Section 4.2**. More stringent cleanup levels are expected to improve the quality of ground water and, thereby, enhance the value of the ground water (maintain the most beneficial uses) and reduce the risk of adverse health effects associated with exposure to contaminated ground water. **See Section 4.3**.

Second, the impact is dependent on the remedy selected. Neither the costs nor the benefits of cleanup are directly related to the establishment of cleanup levels. Rather, the costs and benefits of cleanup are dependent on the remedy selected. For this analysis, as with the cost analysis, Ecology assumed that a more permanent cleanup action that removes contaminants from the soil or ground water was conducted. This assumption is a conservative assumption that provides a high bound estimate of the potential differential in the costs and benefits of cleanup.

4.2 Less Stringent Cleanup Levels

The primary benefit of less stringent soil and ground water cleanup levels is the expected reduction in the cost of cleanup. Less stringent cleanup levels are expected to require less contaminant removal, resulting in a decrease in the cost of cleanup. This decrease is an avoided cost or savings.

4.2.1 Soil Cleanup Levels

Less stringent soil cleanup levels are expected to require less contaminant removal, resulting in a decrease in the cost of soil cleanup. This decrease is an avoided cost or savings. The impact of less stringent Method A soil cleanup levels on cleanup costs was analyzed **Chapter 3**. The results of this analysis are presented in **Section 3.2.3.3**.

4.2.2 Ground Water Cleanup Levels

Less stringent ground water cleanup levels are expected to require less contaminant removal, resulting in a decrease in the cost of ground water cleanup. This decrease is an avoided cost or savings. The impact of less stringent Method A ground water cleanup levels on cleanup costs was analyzed **Chapter 3**. The results of this analysis are presented in **Section 3.3.3.3**.

4.3 More Stringent Cleanup Levels

The primary benefit of more stringent soil and ground water cleanup levels is the expected reduction in the amount of contaminants in the ground water. Several independent approaches were used to quantify the probable benefits of the more stringent cleanup levels. First, because more stringent soil cleanup levels could result in less ground water cleanup, the potential avoided cost or savings in ground water cleanup was calculated. **See Section 4.3.1**. Second, the benefit of less ground water contamination was estimated by calculating the potential avoided cost of municipal ground water treatment. **See Section 4.3.2**. Third, the benefit of less ground water contamination was estimated by calculating the value of ground water based on water rates charged by municipalities and the value of the water rights. **See Section 4.3.3**. Fourth, the health benefit of less ground water contamination was estimated by calculating the reduced risk of adverse health effects (including cancer) and the avoided costs associated with avoiding those adverse health effects. **See Section 4.3.4**.

4.3.1 Avoided Cost of Ground Water Cleanup – Soil Cleanup Levels ONLY

The impact of more stringent Method A soil cleanup levels on cleanup costs may be offset by a corresponding decrease in the cost of ground water cleanup. For this analysis, Ecology assumed that because the more stringent Method A soil cleanup levels are based on protection of ground water, the removal of additional contaminants from the soil will reduce the amount of contaminants reaching and requiring removal from the ground water. The impact of more stringent soil cleanup levels on the costs of ground water cleanup was analyzed in **Chapter 3**. The results of this analysis are presented in **Section 3.2.4.3**.

4.3.2 Avoided Municipal Ground Water Treatment Costs

Another approach to quantifying the benefits of less ground water contamination is to estimate the avoided cost of ground water treatment at municipal water wells. To estimate the potential avoided cost, Ecology considered the cost of ground water treatment at three municipal water treatment systems found in Washington State. **See Table 4-1**. Using this approach, it appears a reasonable range of capitol costs for such systems is between **$2 million and $4 million** with annual operating expenses expected to be about **$100,000 per year**. This estimate of probable benefits exceeds the increased probable cost of soil cleanup described in **Section 3.2** and the increased probable cost of ground water cleanup described in **Section 3.3**.

4.3.3 Avoided Reduction in Value of Ground Water

Another approach to quantifying the benefits of less ground water contamination is to estimate the avoided reduction in the value of ground water. To estimate the potential avoided reduction in value, water rates charged by municipalities and the value of the water rights were examined.

See Tables 4-2 and 4-3. The same model site described under **Section 3.3** and used to evaluate the cost of ground water cleanup was used for this calculation.

Based on water rates charged by municipalities, the **annual** value or benefit of the ground water would be **$7,800** for this model site. Based on the value of water rights, the **annual** value or benefit of the ground water would be **$10,320 to $12,900** for this model site.

The total value or benefit is based on the value lost during the restoration time. Experience to date has shown that it can take 10 to 20 years or longer to restore ground water once it has become contaminated. Based on this time estimate for ground water restoration, the value or benefit of ground water lost during this restoration time would be in the range **of $78,000 to $258,000** at the model site. This range of probable benefits exceeds the estimated increased probable cost of soil cleanup described in **Section 3.2** and the increased probable cost of ground water cleanup described in **Section 3.3**.

4.3.4 Health Benefits

Another approach to quantifying the benefits of less ground water contamination is to estimate the benefits of a reduction in the risk of adverse health effects associated with exposure to contaminated ground water. To quantify the health benefits, Ecology calculated the reduced risk of adverse health effects (including cancer) for each hazardous substance of concern, determined the range of adverse health effects attributable to those hazardous substances, and calculated the cost of a single incidence (unit cost) of those adverse health effects. Based on assumptions regarding the exposed population, Ecology also attempted to calculate the number of avoided incidences of cancer and, thereby, the total avoided cost for cancer. Based on the same assumptions, Ecology also attempted to calculate the number of avoided cancer deaths and the value of a statistical life.

4.3.4.1 Estimates of Reduced Health Risks

For Method A soil cleanup levels, ground water contaminant concentrations resulting from the current and proposed Method A soil cleanup levels were first predicted for both unrestricted land use and industrial land use using the methods described in WAC 173-340-747 of the proposed rule. **See Tables 4-7 through 4-14**.

The hazard quotient and cancer risk at these concentrations were then calculated. This calculation assumes that the ground water is used or has the potential to be used as a source of drinking water. **See Tables 4-15 through 4-22**.

The reduction in cancer risks and hazard quotients resulting from the adoption of the more stringent soil cleanup levels were then calculated. See **Table 4-5** for unrestricted land use and **Table 4-6** for industrial land use.

The proposed Method A ground water cleanup level for several hazardous substances also result in significant reductions in the risk of non-cancer health effects. These include gasoline with benzene, diesel range organics, and heavy oils.

4.3.4.2 Estimates of Reduced Morbidity: Cancer Health Effects

For carcinogens, the calculations show that adopting the proposed more stringent soil cleanup levels will decrease the risk of cancer incidence by anywhere from **0.3 x 10^{-6} to 5,283 x 10^{-6}. See Table 4-4.** In other words, adoption of the more stringent soil cleanup levels will increase the margin of safety and reduce the potential that a person drinking ground water will contract cancer.

The reduction in risk is significant because in Washington State an estimated **3.1 million persons** rely on ground water as their source of drinking water (OFM, 1999a). Based on the assumption that 3.1 million persons have the potential to be exposed to contaminated drinking water during a portion of their lifetime, the reduction in risk could result in anywhere from about **21 to 1,469 fewer persons** contracting some form of cancer, depending on the hazard substance. **See Table 4-4.** This estimate is based on the assumption that most sites establish cleanup levels based on unrestricted land use instead of industrial land use.

The assumption that 3.1 million persons have the potential to be exposed to contaminated ground water during a portion of their lifetime is based on several considerations. First, 3.1 million persons already rely on ground water as their source of drinking water and a certain percentage of them are exposed to contaminated ground water. Second, exposure to contaminated ground water is expected to increase as the population of the state increases. Third, exposure to contaminated ground water is expected to increase as development density increases, resulting in more water supply wells being subjected to an increased risk of contamination. Fourth, exposure to contaminated ground water is impacted by the mobility of an increasing population over time.

The range of adverse health effects or cancers attributable to exposure to the hazardous substances with more stringent cleanup levels is significant. **See Table 4-23.** The estimated **cost of a single incidence** is about **$22,000** for all cancers (non-fatal) and **$41,000** for lung cancer (non-fatal).

4.3.4.3 Estimates of Reduced Morbidity: Non-Cancer Health Effects

For non-carcinogens, the calculations show that adopting the proposed more stringent soil cleanup levels will significantly decrease the risk of non-cancer health effects (hazard quotient). **See Tables 4-5 and 4-6.** The proposed Method A ground water cleanup level for several hazardous substances also result in significant reductions in the risk of non-cancer health effects.

In other words, adoption of the more stringent soil cleanup levels will increase the margin of safety and reduce the potential that a person drinking ground water will experience adverse health effects. The reduction in risk is significant because in Washington State an estimated **3.1 million persons** rely on ground water as their source of drinking water (OFM, 1999a).

The range of adverse health effects attributable to exposure to the hazardous substances with more stringent cleanup levels is significant. Attributable adverse health effects include adverse

effects on the nervous system, respiratory system, cardiovascular system, liver, and kidney. **See Table 4-23.**

The estimated **cost of a single incidence** of these adverse health effects ranges from about **$6,000 to $200,000**. Two methods were used to estimate the avoided cost of the identified adverse health effects – the cost of illness approach and the willingness to pay or contingent valuation approach. **See Table 4-23.**

The cost of illness (COI) approach accounts for the direct costs of medical treatment and the foregone output (measured by income) of affected persons who are unable to work due to illness. This approach has the advantage of utilizing regularly collected and available data, but tends to underestimate the total avoided cost by either underestimating or failing to account for several costs. The costs not accounted for include the following:

- The COI approach underestimates the cost of illness for persons not conventionally employed (e.g., housekeepers, the young, retired persons and others not earning income from current economic activity).
- The COI approach does not account foe the "disutility of illness" (i.e., pain and suffering).
- The COI approach does not account for averting or defensive expenditures (e.g., home water filtration systems).
- The COI approach does not account for productivity losses (e.g., affected person goes to work but is not as efficient as when healthy).
- The COI approach does not account for "quality of life" effects. These effects may include reduced ability to engage in occupational or recreational activities or reductions in general enjoyment of leisure time.

The willingness to pay approach, by contrast, elicits or infers values for reductions in or avoidance of ill health in ways that – in principle – incorporate some or all of the above. Methods used typically include surveys, labor market studies, and others.

4.3.4.4 Estimates of Reduced Mortality – Cancer

Many of the adverse health effects attributable to the hazardous substances of concern could result in death. Principally among those is cancer. Based on statistics obtained from the National Cancer Institute, the overall mortality rate of a person who has contracted cancer is 43% (NCI, 2000). Consequently, to quantify the benefits of less ground water contamination, Ecology also estimated the societal benefits of projected reductions in cancer mortality resulting from the reduced risks of cancer incidence attributable to the hazardous substances of concern. To quantify those societal benefits, Ecology attempted to calculate the incremental value of a statistical life. This calculation is based on information obtained from several sources, including application of the results of a previously published contingent valuation study. Based on this information, the estimated incremental value of a statistical life saved (or benefit) is **$18.1 million**. **See Table 4-24.**

The following discussion provides a summary of the methodology used and assumptions made in calculating the incremental value of a statistical life saved.

(1) **Exposed Population:** Ecology assumed that 3.1 million persons have the potential to be exposed to contaminated drinking water during a portion of their lifetime. This assumption is based on several considerations. **See Section 4.3.4.2.**

(2) **Reduction in Cancer Risk:** The reduction in cancer risk for each hazardous substance of concern was calculated by determining the cancer risk at the current and proposed cleanup levels. **See Tables 4-5 and 4-6.** The calculations show that adopting the proposed more stringent cleanup levels will decrease the risk of cancer incidence by anywhere from 0.3×10^{-6} to $5{,}283 \times 10^{-6}$. **See Table 4-4.** In other words, adoption of the more stringent cleanup levels will increase the margin of safety and reduce the potential that a person drinking ground water will contract cancer.

(3) **Reduction in Cancer Incidence:** The reduction in cancer incidence for each hazardous substance of concern was calculated by multiplying the exposed population (3.1 million persons) by the cancer risk at the current and proposed cleanup levels. The calculations show that the reduction in the number of persons contracting cancer ranged from 21 to 1,469 (based on the changes to the soil cleanup levels for unrestricted land use) and 0.8 to 16,377 (based on the changes to the soil cleanup levels for industrial land use). **See Table 4-4.**

(4) **Mortality Rate:** The overall mortality rate of a person who has contracted cancer (all sites/both sexes/all races) is estimated to be 43%. This estimate is based on cancer incident and mortality statistics obtained from the National Cancer Institute (NCI, 2000). Other studies have cited cancers of the colon, rectum, and bladder as most likely outcomes from consumption of contaminated ground water. However, the conditional mortality rates for these cancers are very close to the overall rate (weighted average of 36.9 percent), and it was judged that the small difference versus the overall rate would serve to pick up other cancer sites not covered by colo/rectal and bladder cancers.

(5) **Reduction in Cancer Mortality:** The reduction in cancer mortality was calculated by multiplying the number of cancer incidences by the mortality rate of 43%. Since most sites establish soil cleanup levels based on unrestricted instead of industrial land use, estimates of cancer incidence used in this calculation were based only on the proposed soil cleanup levels for unrestricted land use. **See Table 4-24.**

(6) **Cumulative and Incremental Death Rates:** The calculated reductions in excess deaths were then converted to cumulative and incremental death rates per 100,000 relevant to the potentially exposed population of 3.1 million in order to facilitate application of the a contingent valuation study.

The study by duVair and Loomis, entitled "Household's Valuation of Alternative Levels of Hazardous Waste Risk Reduction: An Application of the Referendum Format Contingent Valuation Method," (duVair and Loomis, 1993) used a referendum format in which survey respondents registered a "yes" or "no" response to payment of a preselected amount for a specified result. The study used a single class of pollutant exposure (heavy

metals) as the contingent event. The reported results also allowed for the derivation of a (theoretically well-behaved) "willingness to pay" function generalizable to excess death reductions other than those specifically considered in their analysis. However, the current analysis considers several different pollutant substances and associated death rate reductions simultaneously. Application of the duVair/Loomis results required development of an **incremental** deaths approach in order to avoid double counting.

(7) **Application of the Contingent Valuation Study:** The incremental approach referred to above consisted of utilizing the willingness-to-pay (WTP) function derived from the deVair/Loomis research to value increments in excess death reduction rates successively. That is, the smallest death reduction was evaluated first. Then the **second** smallest reduction in excess deaths was combined with the smallest value and the cumulative reduction was evaluated using the WTP function. The **difference** between these two values is taken to be the **incremental** value attributable to the second smallest estimated reduction in excess death rates. This process was repeated for each substance considered in ascending order of excess death rate reduction.

The resulting incremental values were adjusted to the value of a single (statistical) life and for inflation over the time interval since the duVair/Loomis research was conducted and extrapolated to all Washington households (1999). Summation of the resultant values provides the overall, total estimated societal benefit for excess cancer death rate reductions attributable to the hazardous substances of concern.

4.3.4.5 Conclusions

Based on quantitative estimates of (1) the reduction in risk of adverse health effects, (2) the range of adverse health effects attributable to the hazardous substances of concern, (3) the cost of even a single incidence of these adverse health effects, and (4) the exposed population, Ecology has determined that the probable benefits of adopting the more stringent cleanup levels are significant in comparison with the probable costs. The probable avoided cost of even a single incidence of these adverse health effects range from **$6,000 to $200,000**. If these adverse health effects should result in even a single death, the probable avoided cost increases to about **$18.1 million**, the value of a statistical life.

4.3.5 Other Benefits

In addition to the health-related benefits considered previously, additional benefits potentially accrue to the proposed more stringent cleanup levels. Although these were not quantified in monetary terms in this analysis, it is useful to be aware of their existence. Examples (but far from an exhaustive listing) include:

- Protection of fish and other aquatic life – especially when ground and surface waters are connected – as well as terrestrial wildlife.
- Property values – the market values of property in proximity to contaminated sites may be adversely affected and, conversely enhanced when sites are cleaned up.
- Active use values – protection/enhancement of general recreational use of water and land.

- Aesthetics – elimination of adverse sensory effects of contamination.
- "Bequest" benefits – satisfaction of knowing that the environment is protective of current generations and protected for future generations.
- Passive use values – option value, etc. (in addition to benefits accruing to active use).

4.4 Conclusion

The primary benefit of less stringent soil and ground water cleanup levels is the expected reduction in the cost of cleanup. Less stringent cleanup levels are expected to require less contaminant removal, resulting in a decrease in the cost of cleanup. This decrease is an avoided cost or savings. **See Section 4.2.** Adopting less stringent Method A soil cleanup levels could result in small to more substantial decreases in soil cleanup costs ranging from only a **few dollars to $2 million**, depending on the hazardous substance. **See Tables 3-5 and 3-6.** Adopting less stringent Method A ground water cleanup levels could result in small to moderate decreases in ground water cleanup costs ranging from only a **few dollars to $22,000**, depending on the hazardous substance. **See Table 3-13.**

The primary benefit of more stringent soil and ground water cleanup levels is the expected reduction in the amount of contaminants in the ground water. Several independent approaches were used to quantify the probable benefits of the more stringent cleanup levels. First, because more stringent soil cleanup levels could result in less ground water cleanup, the potential avoided cost or savings in ground water cleanup was calculated. **See Section 4.3.1.** Second, the benefit of less ground water contamination was estimated by calculating the potential avoided cost of municipal ground water treatment. **See Section 4.3.2.** Third, the benefit of less ground water contamination was estimated by calculating the value of ground water based on water rates charged by municipalities and the value of the water rights. **See Section 4.3.3.** Fourth, the health benefit of less ground water contamination was estimated by calculating the reduced risk of adverse health effects (including cancer) and the avoided costs associated with avoiding those adverse health effects. **See Section 4.3.4.** Based on each of these approaches, Ecology determined that the probable benefits of the more stringent cleanup levels exceeded the probable costs.

4.5 Calculations

Table 4-1: Capital and Operating Costs for Contaminated Municipal Well Treatment Systems

Site	Contaminant	Treatment Method	Capital Cost ($)	Annual Operating Cost ($)	Year
Well 12 A	VOCs	Air Stripping	1,000,000	100,000	1983
Lakewood	VOCs	Air Stripping	1,290,000	90,000	1985
Tumwater	VOCs	Air Stripping	3,770,478	60,000	1999

Table 4-2: Calculation of Value of Ground Water Based on Value of Water Right

Typical range = $1200 to $1500 per acre-ft/year (1)

Assuming a 1 acre area of ground water contamination and a 20 ft thick aquifer with a porosity of 0.43, the **one year** value of this ground water would be calculated as follows.

1 acre X 20 ft thickness X 0.43 porosity X $1200/acre ft = $10,320/year
1 acre X 20 ft thickness X 0.43 porosity X $1500/acre ft = $12,900/year

Assuming it would take 10 years to restore the ground water to useable quality, the value is:
10 year value: **$103,200 to $129,000**
Assuming it would take 20 years to restore the ground water to useable quality, the value is:
20 year value: **$206,400 to $258,000**

(1) Source: Personnal communication with Kathy Callison, City of Tumwater Public Works Department.

Table 4-3: Calculation of Value of Ground Water Based on Water Rates

Another measure of the value of clean water is how much is charged by water utilities for this water. This includes well development, water treatment, storage and distribution costs as well as administrative costs. Thus, it could be viewed as the value if the water system had to be replaced due to contamination.

Based on the water rates charged in 15 Washington communities (1), this gives the following range of value:

City	Rate / 1000 cf
Aberdeen	$26.80
Bellevue	$21.07
Chehalis	$27.59
Kelso	$21.58
Kirkland	$24.55
Lacey	$15.01
Long Beach	$31.74
Mtlake Terrace	$21.60
Olympia	$16.91
Port Townsend	$23.45
Seattle	$19.30
Shelton	$19.14
Spokane	$9.55
Tacoma	$13.95
Tumwater	$20.15
Average	$20.83
Median	$21.07

(1) Source: City of Tumwater Year 2000 budget report.

Thus, one acre-ft of ground water has an average value of:

(43,560 cf)($20.83)/ 1,000 cf = $907.36

and, one pore volume of ground water at the site has a value of:

(1 acre)(20 ft)(0.43)($907.36/acre-ft) = $7,803.25

Assuming a 10 year ground water restoration timeframe, the value is:

$7,803.25 * 10 = **$78,032**

Assuming a 20 year ground water restoration timeframe, the value is:

$7,803.25 * 20 = **$156,065**

Table 4-4: Number of Persons with Potential to Contract Cancer due to Ground Water Ingestion

Hazardous Substance	CAS No.	Method A Soil Cleanup Levels for Unrestricted Land Use		Method A Soil Cleanup Levels for Industrial Land Use	
		Incremental Cancer Risk @ Predicted Concentration (1) (unitless)	Number of persons in WA with Potential to Contract Cancer (2) (persons)	Incremental Cancer Risk @ Predicted Concentration (1) (unitless)	Number of persons in WA with Potential to Contract Cancer (2) (persons)
Arsenic	7440-38-2			5283	16377
Benzene	71-43-2	55	171	55	171
Cadmium	7440-43-9				
T Chromium	7440-47-3				
Chromium III	16065-83-1				
Chromium VI	18540-29-9				
DDT	50-29-3			0.3	0.8
1,2 Dichloroethane	107-06-2				
Ethylbenzene	100-41-4				
Ethylene dibromide (EDB)	106-93-4				
Lead	7439-92-1				
Lindane	58-89-9	474	1469	474	1469
Methylene chloride	75-09-2	19	58	19	58
MTBE	1634-04-4				
Naphthalene	91-20-3				
cPAH Mixtures	na				
PCB mixtures	1336-36-3				
Tetrachloroethylene (PCE)	127-18-4	49	153	49	153
Toluene	108-88-3				
1,1,1 Trichloroethane	71-55-6				
Trichloroethylene	79-01-6	18	55	18	55
Vinyl Chloride	75-01-4				
Xylenes	1330-20-7				
Gasoline range organics	6842-59-6	7	21	7	21

Calculation made only for carcinogens and for soil cleanup levels proposed to become more stringent due to ground water protection concerns.

Footnotes:

(1) From **Table 4-5**. Expressed in terms of 10-6 risk, that is, a value of 55 is a risk of 55 X 10-6. This is the additional risk posed by drinking ground water beneath a site cleaned up to the current Method A soil cleanup levels instead of the proposed method A soil cleanup levels.

(2) Column 1 multiplied by 3.1 million persons. This is the total excess cancer risk for a population of 3.1 million (the number of persons estimated to rely on ground water for drinking water in WA State*).

(3) From **Table 4-6**. Expressed in terms of 10-6 risk, that is, a value of 55 is a risk of 55 X 10-6. This is the additional risk posed by drinking ground water beneath a site cleaned up to the current Method A soil cleanup levels instead of the proposed Method A soil cleanup levels.

(4) Column 1 multiplied by 3.1 million persons. This is the total excess cancer risk for a population of 3.1 million (the number of persons estimated to rely on ground water for drinking water in WA State*).

*Source: WA State OFM Environmental Chartbook, June 1999.

Table 4-5: Method A Soil Cleanup Levels for Unrestricted Land Use – Summary of Change in Health Risk

Hazardous Substance	CAS Number	Current Method A Cleanup Level (mg/kg) (1)	Proposed Method A Cleanup Level (mg/kg) (2)	Change (mg/kg) (3)	Current Cleanup Levels			Proposed Cleanup Levels			Δ HQ (unitless) (10)	Δ Cancer Risk (unitless) (11)
					Predicted Ground Water Concentration at Current Method A Soil Conc. (ug/l) (4)	HQ at Predicted Ground Water Conc. (unitless) (5)	Cancer Risk at Predicted Ground Water Conc. (unitless) (6)	Predicted Ground Water Concentration at Proposed Method A Soil Conc. (ug/l) (7)	HQ at Predicted Ground Water Conc. (unitless) (8)	Cancer Risk at Predicted Ground Water Conc. (unitless) (9)		
Arsenic	7440-38-2	20.0	20	0.0	-	-	-	-	-	-	-	-
Benzene	71-43-2	0.5	0.03	-0.47	88.80		58.86	5.4		3.58		55.28
Benzo(a)Pyrene	50-32-8	0.1	0.1	0.0	-	-	-	-	-	-	-	-
Cadmium	7440-43-9	2	2	0.0	-	-	-	-	-	-	-	-
Chromium (total)	7440-47-3	100.0	none									
Chromium VI	18540-29-9		19	-81	260.42	5.43	-	50	1.0	-	4.43	-
Chromium III	16065-83-1		2000	1900	-	-	-	-	-	-	-	-
DDT	50-29-3	1	3	2	-	-	-	-	-	-	-	-
Ethylbenzene	100-41-4	20.0	6	-14	2314.80	2.89	-	695	0.9	-	1.99	-
Ethylene dibromide (EDB)	106-93-4	0.001	0.005	0.004	-	-	-	-	-	-	-	-
Lead	7439-92-1	250.0	250	0.0	-	-	-	-	-	-	-	-
Lindane	58-89-9	1	0.01	-0.99	32.22		478.70	0.325		4.83		473.87
Methylene chloride	75-09-2	0.5	0.02	-0.48	114.80		19.68	4.7		0.81		18.87
Mercury (inorganic)	7439-97-6	1	2	1	-	-	-	-	-	-	-	-
MTBE	1634-04-4	0.005 & 2	0.1	up to 1.9	up to 407	20.35	-	23.6	1.2	-	up to 19.1	-
Naphthalene	91-20-3	0.5	5	4.5	-	-	-	-	-	-	-	-
PAHs (carcinogenic)		1.0	none	see B(a)P	-	-	-	-	-	-	-	-
PCB Mixtures	1336-36-3	1	1	0.0	-	-	-	-	-	-	-	-
Tetrachloroethylene	127-18-4	0.5	0.05	-0.45	47.10		54.91	4.7		5.48		49.43
Toluene	108-88-3	40.0	7	-33	5501.00	3.44	-	964	0.6	-	2.84	
1,1,1 Trichloroethane	71-55-6	20	2	-18	2524.60	12.60	-	253	0.04	-	12.56	
Trichloroethylene	79-01-5	0.5	0.03	-0.47	75.60	-	19.01	4.5	-	1.13		17.88
Xylenes	1330-20-7	20.0	9	-11	2187.30	0.14 & 2.2	-	984	0.06 & 1.0	-	0.08 & 1.2	-
Gasoline range organics	6842-59-6											
GRO with benzene		100	30	-70	1584.00	2.50	10.30	744	1.2	3.4	1.3	6.9
GRO w/o benzene		100	100	0	-	-	-	-	-	-	-	-
Diesel Range Organics		200	2000	1800	-	-	-	-	-	-	-	-
Heavy Oils		200	2000	1800	-	-	-	-	-	-	-	-
Mineral Oil		200	4000	3800	-	-	-	-	-	-	-	-

Footnotes for Table 4-5:

(1) From current MTCA table 2. Exceptions: B(a)P = cPAH/7; MTBE first value is PQL and second is assuming 2% MTBE in gasoline contaminated soil cleaned up to 100 mg/kg; naphthalene = PQL as per WAC 173-340-704(2)(c).
(2) From table 740-1 in MTCA rule revisions proposed in August 2000.
(3) Column 1 minus column 2. Further calculations only address contaminants with soil cleanup level proposed to decrease due to ground water considerations.
(4) Predicted using 3 phase model (see **Table 4-7**). For TPH gas, average value predicted using 4-phase model (see **Tables 4-11 and 4-13**)
(5) Hazard quotient of predicted ground water concentration (see **Table 4-15**).
(6) Cancer risk at predicted ground water concentration. Expressed in terms of 10-6 risk, that is, a value of 55 is a risk of 55 X 10-6 (see **Table 4-17**).
(7) Predicted using 3 phase model (see **Table 4-8**). For TPH gas, average value predicted using 4-phase model (see **Tables 4-12 and 4-14**)
(8) Hazard quotient of predicted ground water concentration (see **Table 4-16**).
(9) Cancer risk at predicted ground water concentration. Expressed in terms of 10-6 risk, that is, a value of 55 is a risk of 55 X 10-6 (see **Table 4-18**).
(10) Column 5 minus column 8.
(11) Column 6 minus column 9.

Table 4-6: Method A Soil Cleanup Levels for Industrial Land Use – Summary of Change in Health Risk

Hazardous Substance	CAS Number	Current Method A Cleanup Level (mg/kg) (1)	Proposed Method A Cleanup Level (mg/kg) (2)	Change (mg/kg) (3)	Current Cleanup Levels			Proposed Cleanup Levels			Δ HQ (unitless) (10)	Δ Cancer Risk (unitless) (11)
					Predicted Ground Water Concentration at Current Method A Soil Conc. (ug/l) (4)	HQ at Predicted Ground Water Conc. (unitless) (5)	Cancer Risk at Predicted Ground Water Conc. (unitless) (6)	Predicted Ground Water Concentration at Proposed Method A Soil Conc. (ug/l) (7)	HQ at Predicted Ground Water Conc. (unitless) (8)	Cancer Risk at Predicted Ground Water Conc. (unitless) (9)		
Arsenic	7440-38-2	200.0	20	-180.0	342.47		5870.8	34.30		588		5282.80
Benzene	71-43-2	0.5	0.03	-0.47	88.80		58.9	5.40		3.58		55.28
Benzo(a)Pyrene	50-32-8	2.9	2	-0.9	-	-	-	-	-	-	-	-
Cadmium	7440-43-9	10	2	-8.0	72.5	9.10	-	15.0	1.9	-	7.22	-
Chromium (total)	7440-47-3	500.0	none									
Chromium VI	18540-29-9		19	-481	1302.09	27.10	-	50	1.0	-	26.10	-
Chromium III	16065-83-1		2000	1500	-	-	-	-	-	-	-	-
DDT	50-29-3	5	4	-1	8.0		1.4	0.296		1.15		0.25
Ethylbenzene	100-41-4	20.0	6	-14	2314.80	2.89	-	695	0.9	-	1.99	-
Ethylene dibromide (EDB)	106-93-4	0.001	0.005	0.004	-	-	-	-	-	-	-	-
Lead	7439-92-1	1000.0	1000	0.0	-	-	-	-	-	-	-	-
Lindane	58-89-9	20	0.01	-19.99	644.32		478.70	0.325		4.83		473.87
Methylene chloride	75-09-2	0.5	0.02	-0.48	114.80		19.7	4.7		0.81		18.87
Mercury (inorganic)	7439-97-6	1	2	1	-	-	-	-	-	-	-	-
MTBE	1634-04-4	0.005 & 2	0.1	up to 1.9	up to 407	20.35	-	23.6	1.2	-	19.1	-
Naphthalene	91-20-3	0.5	5	4.5	-	-	-	-	-	-	-	-
PAHs (carcinogenic)		20.0	none	see B(a)P	-	-	-	-	-	-	-	-
PCB Mixtures	1336-36-3	1	1	0.0	-	-	-	-	-	-	-	-
Tetrachloroethylene	127-18-4	0.5	0.05	-0.45	47.10		54.9	4.7		5.48		49.43
Toluene	108-88-3	40.0	7	-33	5501.00	3.44	-	964	0.6	-	2.84	
1,1,1 Trichloroethane	71-55-6	20	2	-18	2524.60	12.60	-	253	0.04	-	12.56	
Trichloroethylene	79-01-5	0.5	0.03	-0.47	75.60	-	19.0	4.5	-	1.13		17.88
Xylenes	1330-20-7	20.0	9	-11	2187.30	0.14 & 2.2	-	984	0.06 & 1.0	-	0.08 & 1.2	-
GRO with benzene		100	30	-70	1584.00	2.50	10.3	744	1.2	3.4	1.30	6.9
GRO w/o benzene		100	100	0	-	-	-	-	-	-	-	-
Diesel Range Organics		200	2000	1800	-	-	-	-	-	-	-	-
Heavy Oils		200	2000	1800	-	-	-	-	-	-	-	-
Mineral Oil		200	4000	3800	-	-	-	-	-	-	-	-

Footnotes for Table 4-6:

(1) From current MTCA table 3. Exceptions: B(a)P = cPAH/7; MTBE first value is PQL and second is assuming 2% MTBE in gasoline contaminated soil cleaned up to 100 mg/kg; naphthalene = PQL as per WAC 173-340-704(2)(c).
(2) From table 745-1 in MTCA rule revisions proposed in August 2000.
(3) Column 1 minus column 2. Further calculations only address contaminants with soil cleanup level proposed to decrease due to ground water considerations.
(4) Predicted using 3 phase model (see **Table 4-9**). For TPH gas, average value predicted using 4-phase model (see **Tables 4-11 and 4-13**)
(5) Hazard quotient of predicted ground water concentration (see **Table 4-19**).
(6) Cancer risk at predicted ground water concentration. Expressed in terms of 10-6 risk, that is, a value of 55 is a risk of 55 X 10-6 (see **Table 4-21**).
(7) Predicted using 3 phase model (see **Table 4-10**). For TPH gas, average value predicted using 4-phase model (see **Tables 4-12 and 4-14**).
(8) Hazard quotient of predicted ground water concentration (see **Table 4-20**).
(9) Cancer risk at predicted ground water concentration. Expressed in terms of 10-6 risk, that is, a value of 55 is a risk of 55 X 10-6 (see **Table 4-22**).
(10) Column 5 minus column 8.
(11) Column 6 minus column 9.

Table 4-7: Calculation of Predicted Ground Water Concentration Resulting from Current Method A Soil Cleanup Levels for Unrestricted Land Use using the 3-Phase Model

3-Phase Model Results	CAS No.	Resulting GW Conc (mg/l) (1)	Bulk Density (g/cc) (2)	Soil Water (cc/cc) (2)	Soil Air (cc/cc) (2)	H' (cc/cc) (3)	Koc (ml/g) (3)	Foc (%) (4)	Kd (cc/g) (5)	Dilution Factor (dimensionless)	Current Soil Cleanup Level (mg/kg) (6)
Arsenic	7440-38-2		1.5	0.3	0.13	0	-	-	29	20	
Benzene	71-43-2	0.0888	1.5	0.3	0.13	0.228	61.7	0.1%	0.062	20	0.500
Cadmium	7440-43-9		1.5	0.3	0.13	0	-	-	6.7	20	
Chromium (total)	7440-47-3										
Chromium VI	18540-29-9	0.260416	1.5	0.3	0.13	0	-	-	19	20	100.000
Chromium III	16065-83-1		1.5	0.3	0.13	0	-	-	1000	20	
DDT	50-29-3		1.5	0.3	0.13	0.000332	677,934	0.1%	678	20	
Ethyl Benzene	100-41-4	2.3148	1.5	0.3	0.13	0.323	204	0.1%	0.204	20	20.000
Ethylene dibromide (EDB)	106-93-4		1.5	0.3	0.13	0.0336	66	0.1%	0.066	20	
Lead	7439-92-1		1.5	0.3	0.13	0	-	-	10000	20	
Lindane	58-89-9	0.03222	1.5	0.3	0.13	0.000574	1,352	0.1%	1.4	20	1.000
Methylene Chloride	75-09-2	0.1148	1.5	0.3	0.13	0.0898	10	0.1%	0.010	20	0.500
Mercury (inorganic)	7439-97-6		1.5	0.3	0.13	0.467	-	-	52	20	
MTBE	1634-04-4	0.4705	1.5	0.3	0.13	0.018	11	0.1%	0.011	20	2.000
Naphthalene	91-20-3		1.5	0.3	0.13	0.0198	1,191	0.1%	1.191	20	
cPAH Mixtures	na										
Benzo[a]anthracene	56-55-3		1.5	0.3	0.13	0.000137	357,537	0.1%	358	20	
Benzo[b]fluoranthene	205-99-2		1.5	0.3	0.13	0.00455	1,230,000	0.1%	1,230	20	
Benzo[k]fluoranthene	207-08-9		1.5	0.3	0.13	0.000034	1,230,000	0.1%	1,230	20	
Benzo[a]pyrene	50-32-8		1.5	0.3	0.13	0.0000463	968,774	0.1%	969	20	
Chrysene	218-01-9		1.5	0.3	0.13	0.00388	398,000	0.1%	398	20	
Dibenzo[a,h]anthracene	53-70-3		1.5	0.3	0.13	6.03E-07	1,789,101	0.1%	1,789	20	
Indeno[1,2,3-cd]pyrene	207-08-9		1.5	0.3	0.13	0.0000656	3,470,000	0.1%	3470.00	20	
PCB Mixtures	1336-36-3										
Arochlor 1016	12674-11-2		1.5	0.3	0.13	0.119	107,285	0.1%	107	20	
Arochlor 1260			1.5	0.3	0.13	0.189	822,422	0.1%	822	20	
Tetrachloroethylene (PCE)	127-18-4	0.0471	1.5	0.3	0.13	0.754	265	0.1%	0.265	20	0.500
Toluene	108-88-3	5.501	1.5	0.3	0.13	0.272	140	0.1%	0.140	20	40.000
1,1,1 Trichloroethane	71-55-6	2.5246	1.5	0.3	0.13	0.705	135	0.1%	0.135	20	20.000
Trichloroethylene	79-01-6	0.0756	1.5	0.3	0.13	0.422	94	0.1%	0.094	20	0.500
Xylenes	1330-20-7	2.1873	1.5	0.3	0.13	0.279	233	0.1%	0.233	20	20.000
m-xylene	108-38-3		1.5	0.3	0.13	0.301	196	0.1%	0.196	20	
o-xylene	95-47-6		1.5	0.3	0.13	0.213	241	0.1%	0.241	20	
p-xylene			1.5	0.3	0.13	0.314	311	0.1%	0.311	20	

Table 4-7 Continued.

3-Phase Model Results	CAS No.	Pore Water Concentration (mg/l) (7)	Solubility (mg/l) (3)	NAPL in Soil? (8)	Csat (mg/kg) (9)	Pore Water Concentration (mg/l) (7)	Water Mass (mg/kg) (10)	Vapor Concentration (mg/m^3) (11)	Vapor Mass (mg/kg) (12)	Soil Conc. (mg/kg) (13)	Soil Mass (mg/kg) (14)	Sum Mass (mg/kg) (15)
Arsenic	7440-38-2											
Benzene	71-43-2	1.78	1,750	No	493	1.78	0.355	404.928	0.0351	0.1096	0.1096	0.500
Cadmium	7440-43-9											
Chromium (total)	7440-47-3											
Chromium VI	18540-29-9	5.2	-	n/a	-	5.2	1.04	-	-	99	99	100
Chromium III	16065-83-1											
DDT	50-29-3											
Ethyl Benzene	100-41-4	46	169	No	73	46	9.3	14953.608	1.30	9.44	9.44	20.00
Ethylene dibromide (EDB)	106-93-4											
Lead	7439-92-1											
Lindane	58-89-9	0.6444	6.8	No	11	0.6444	0.12888	0.3699	3.21E-05	0.8712	0.8712	1.000
Methylene Chloride	75-09-2	2.30	13,000	No	2,831	2.30	0.459	206.2	0.01787	0.0230	0.0230	0.500
Mercury (inorganic)	7439-97-6											
MTBE	1634-04-4	9.41	50,000	No	10,628	9.41	1.882	169.4	0.01468	0.1035	0.1035	2.000
Naphthalene	91-20-3											
cPAH Mixtures	na											
Benzo[a]anthracene	56-55-3											
Benzo[b]fluoranthene	205-99-2											
Benzo[k]fluoranthene	207-08-9											
Benzo[a]pyrene	50-32-8											
Chrysene	218-01-9											
Dibenzo[a,h]anthracene	53-70-3											
Indeno[1,2,3-cd]pyrene	207-08-9											
PCB Mixtures	1336-36-3											
Arochlor 1016	12674-11-2											
Arochlor 1260												
Tetrachloroethylene (PCE)	127-18-4	0.94	200	No	106	0.94	0.188	710	0.0616	0.2496	0.2496	0.500
Toluene	108-88-3	110	526	No	191	110	22.0	29925.44	2.59	15.40	15.40	40.0
1,1,1 Trichloroethane	71-55-6	50.5	1,330	No	527	50.5	10.10	35596.86	3.09	6.82	6.82	20.00
Trichloroethylene	79-01-6	1.51	1,100	No	364	1.51	0.302	638	0.0553	0.1421	0.1421	0.500
Xylenes	1330-20-7	44	171	No	78	44	8.7	12205.134	1.06	10.19	10.19	20.0
m-xylene	108-38-3											
o-xylene	95-47-6											
p-xylene												

Footnotes for Table 4-7:

(1) Predicted ground water concentration from current Method A soil cleanup level. Determined by adjusting value until soil cleanup level matches current rule. No value has been calculated for contaminants with a proposed soil cleanup level that is equal to or higher than the current Method A soil cleanup level.
(2) From equation 747-1. Based on Soil Screening Guidance: Technical Background Document. EPA/540/R-95/12B. May 1996.
(3) Source: Soil Screening Guidance: Technical Background Document. EPA/540/R-95/12B. May, 1996. Exceptions are:
- EDB values from ATSDR Toxicological Profile (TP 91/13);
- MTBE from USGS final draft report on fuel oxygenates (March, 1996)
- Arochlor values for Henry's constant and solubility limit from ATSDR Toxlicological Profile (Dec, 1998); Arochlor Koc from EPA 1994 draft of soil screening guidance
- Values for total xylenes are a weighted average of m,o & p xylene based on gasoline composition data from TPH Criterial Working Group--Volume 2 (May 1998). That is: m = 51% of total xylene; o = 28% of total xylene; and , p = 21% of total xylene.
- H' for all metals except mercury assumed = zero. Mercury H' from EPA Soil Screening Guidance.

(4) Based on review of data available from the literature and WA State sites.
(5) From equation 747-2 for organics. For metals, based on review of data available from the literature and WA State sites.
(6) Current MTCA soil cleanup level. Calculated using equation 747-1 (3-phase model) with model defaults (as shown in this table) and ground water cleanup level shown in this table. For MTBE this is the estimated soil concentration assuming cleanup to 100 ppm TPH-G and 2% MTBE.
(7) Pore water concentration = ground water cleanup level X dilution factor.
(8) There is NAPL in the soil if the pore water concentration exceeds the solubility limit.
(9) C sat is the soil concentration above which there is NAPL in the soil. It is calculated by substituting the solubility limit for the [ground water cleanup level X DF] in equation 747-1.
(10) Water mass = [Pore water concentration X soil water fraction] / soil bulk density. This is the mass of contaminant in the water phase.
(11) Vapor concentration = Pore water concentration X Henry's Constant X 1000.
(12) Vapor mass = [Vapor concentration X soil air fraction] / soil bulk density. This is the mass of contaminant in the vapor phase.
(13) Soil concentration = Pore water concentration X Kd
(14) Soil mass = [Pore water concentration X Kd X soil bulk density] / soil bulk density. This is the mass of contaminant in the soil phase.
(15) Sum mass = water mass + vapor mass + soil mass. This value equals the soil cleanup level.

Table 4-8: Calculation of Predicted Ground Water Concentration Resulting from Proposed Method A Soil Cleanup Levels for Unrestricted Land Use using the 3-Phase Model

3-Phase Model Results	CAS No.	Resulting GW Concentration (mg/l) (1)	Bulk Density (g/cc) (2)	Soil Water (cc/cc) (2)	Soil Air (cc/cc) (2)	H' (cc/cc) (3)	Koc (ml/g) (3)	Foc (%) (4)	Kd (cc/g) (5)	Dilution Factor (dimensionless)		Proposed Soil Cleanup Level (mg/kg) (6)
Arsenic	7440-38-2		1.5	0.3	0.13	0	-	-	29	20		
Benzene	71-43-2	0.0054	1.5	0.3	0.13	0.228	61.7	0.1%	0.062	20		0.030
Cadmium	7440-43-9		1.5	0.3	0.13	0	-	-	6.7	20		
Chromium (total)	7440-47-3											
Chromium VI	18540-29-9	0.05	1.5	0.3	0.13	0	-	-	19	20		19
Chromium III	16065-83-1		1.5	0.3	0.13	0	-	-	1000	20		
DDT	50-29-3		1.5	0.3	0.13	0.000332	677,934	0.1%	678	20		
Ethyl Benzene	100-41-4	0.695	1.5	0.3	0.13	0.323	204	0.1%	0.204	20		6.00
Ethylene dibromide (EDB)	106-93-4		1.5	0.3	0.13	0.0336	66	0.1%	0.066	20		
Lead	7439-92-1		1.5	0.3	0.13	0	-	-	10000	20		
Lindane	58-89-9	0.000325	1.5	0.3	0.13	0.000574	1,352	0.1%	1.4	20		0.0101
Methylene Chloride	75-09-2	0.0047	1.5	0.3	0.13	0.0898	10	0.1%	0.010	20		0.020
Mercury (inorganic)	7439-97-6		1.5	0.3	0.13	0.467	-	-	52	20		
MTBE	1634-04-4	0.0236	1.5	0.3	0.13	0.018	11	0.1%	0.011	20		0.100
Naphthalene	91-20-3		1.5	0.3	0.13	0.0198	1,191	0.1%	1.191	20		
cPAH Mixtures	na											
Benzo[a]anthracene	56-55-3		1.5	0.3	0.13	0.000137	357,537	0.1%	358	20		
Benzo[b]fluoranthene	205-99-2		1.5	0.3	0.13	0.00455	1,230,000	0.1%	1,230	20		
Benzo[k]fluoranthene	207-08-9		1.5	0.3	0.13	0.000034	1,230,000	0.1%	1,230	20		
Benzo[a]pyrene	50-32-8		1.5	0.3	0.13	0.0000463	968,774	0.1%	969	20		
Chrysene	218-01-9		1.5	0.3	0.13	0.00388	398,000	0.1%	398	20		
Dibenzo[a,h]anthracene	53-70-3		1.5	0.3	0.13	6.03E-07	1,789,101	0.1%	1,789	20		
Indeno[1,2,3-cd]pyrene	207-08-9		1.5	0.3	0.13	0.0000656	3,470,000	0.1%	3470.00	20		
PCB Mixtures	1336-36-3											
Arochlor 1016	12674-11-2		1.5	0.3	0.13	0.119	107,285	0.1%	107	20		
Arochlor 1260			1.5	0.3	0.13	0.189	822,422	0.1%	822	20		
Tetrachloroethylene (PCE)	127-18-4	0.0047	1.5	0.3	0.13	0.754	265	0.1%	0.265	20		0.050
Toluene	108-88-3	0.964	1.5	0.3	0.13	0.272	140	0.1%	0.140	20		7.01
1,1,1 Trichloroethane	71-55-6	0.253	1.5	0.3	0.13	0.705	135	0.1%	0.135	20		2.00
Trichloroethylene	79-01-6	0.0045	1.5	0.3	0.13	0.422	94	0.1%	0.094	20		0.030
Xylenes	1330-20-7	0.984	1.5	0.3	0.13	0.279	233	0.1%	0.233	20		9.00
m-xylene	108-38-3		1.5	0.3	0.13	0.301	196	0.1%	0.196	20		
o-xylene	95-47-6		1.5	0.3	0.13	0.213	241	0.1%	0.241	20		
p-xylene			1.5	0.3	0.13	0.314	311	0.1%	0.311	20		

Table 4-8 continued.

3-Phase Model Results	CAS No.	Pore Water Concentration (mg/l) (7)	Solubility (mg/l) (3)	NAPL in Soil? (8)	Csat (mg/kg) (9)	Pore Water Concentration (mg/l) (7)	Water Mass (mg/kg) (10)	Vapor Concentration (mg/m^3) (11)	Vapor Mass (mg/kg) (12)	Soil Conc. (mg/kg) (13)	Soil Mass (mg/kg) (14)	Sum Mass (mg/kg) (15)
Arsenic	7440-38-2	-	-	n/a	-	0.00	0.000	-	-	0.00	0.00	0.00
Benzene	71-43-2	0.11	1,750	No	493	0.11	0.022	24.624	0.0021	0.0067	0.0067	0.030
Cadmium	7440-43-9	0.00	-	n/a	-	0.00	0.000	-	-	0.00	0.00	0.00
Chromium (total)	7440-47-3											
Chromium VI	18540-29-9	1.0	-	n/a	-	1.0	0.20	-	-	19	19	19
Chromium III	16065-83-1	0.0	-	n/a	-	0.0	0.00	-	-	0	0	0
DDT	50-29-3	0.0000	0.0250	No	17	0.0000	0.0000	0.0000	0.00E+00	0.00	0.00	0.00
Ethyl Benzene	100-41-4	14	169	No	73	14	2.8	4489.7	0.39	2.84	2.84	6.00
Ethylene dibromide (EDB)	106-93-4	0.00000	4,000	No	1,076	0.00000	0.000000	0.0000	0.00E+00	0.000000	0.000000	0.000000
Lead	7439-92-1	0.00	-	n/a	-	0.00	0.000	-	-	0	0	0
Lindane	58-89-9	0.0065	6.8	No	11	0.0065	0.00130	0.0037	3.23E-07	0.0088	0.0088	0.010
Methylene Chloride	75-09-2	0.09	13,000	No	2,831	0.09	0.019	8.4	0.00073	0.0009	0.0009	0.020
Mercury (inorganic)	7439-97-6	0.000	-	n/a	-	0.000	0.000	0	0.0000	0.00	0.00	0.00
MTBE	1634-04-4	0.47	50,000	No	10,628	0.47	0.094	8.5	0.00074	0.0052	0.0052	0.100
Naphthalene	91-20-3	0.0	31	No	43	0.0	0.00	0	0.0000	0.00	0.00	0.00
cPAH Mixtures	na											
Benzo[a]anthracene	56-55-3	0.00000	0.0094	No	3.4	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.000	0.00
Benzo[b]fluoranthene	205-99-2	0.00000	0.0015	No	1.8	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.00	0.00
Benzo[k]fluoranthene	207-08-9	0.00000	0.0008	No	1.0	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.00	0.00
Benzo[a]pyrene	50-32-8	0.00000	0.00162	No	1.6	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.00	0.00
Chrysene	218-01-9	0.00000	0.0016	No	0.64	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.000	0.00
Dibenzo[a,h]anthracene	53-70-3	0.00000	0.00249	No	4.5	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.00	0.00
Indeno[1,2,3-cd]pyrene	207-08-9	0.00000	0.0000022	No	0.076	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.00	0.00
PCB Mixtures	1336-36-3											
Arochlor 1016	12674-11-2	0.0000	0.42	No	45	0.0000	0.00000	0.00	0.00E+00	0.00	0.00	0.00
Arochlor 1260		0.0000	0.08	No	66	0.0000	0.00000	0.00	0.00E+00	0.00	0.00	0.00
Tetrachloroethylene (PCE)	127-18-4	0.09	200	No	106	0.09	0.019	71	0.0061	0.0249	0.0249	0.050
Toluene	108-88-3	19	526	No	191	19	3.9	5244.16	0.45	2.70	2.70	7.0
1,1,1 Trichloroethane	71-55-6	5.1	1,330	No	527	5.1	1.01	3567.3	0.31	0.68	0.68	2.00
Trichloroethylene	79-01-6	0.09	1,100	No	364	0.09	0.018	38	0.0033	0.0085	0.0085	0.030
Xylenes	1330-20-7	20	171	No	78	20	3.9	5490.72	0.48	4.59	4.59	9.0
m-xylene	108-38-3	0	161	No	68	0	0.0	0	0.00	0.00	0.00	0.0
o-xylene	95-47-6	0	178	No	82	0	0.0	0	0.00	0.00	0.00	0.0
p-xylene		0	185	No	100	0	0.0	0	0.00	0.00	0.00	0.0

Table 4-8 Footnotes:

(1) Predicted ground water concentration from current Method A soil cleanup level. Determined by adjusting value until soil cleanup level matches current rule. No value has been calculated for contaminants with a proposed soil cleanup level that is equal to or higher than the current Method A soil cleanup level.
(2) From equation 747-1. Based on Soil Screening Guidance: Technical Background Document. EPA/540/R-95/12B. May 1996.
(3) Source: Soil Screening Guidance: Technical Background Document. EPA/540/R-95/12B. May, 1996. Exceptions are:
- EDB values from ATSDR Toxicological Profile (TP 91/13);
- MTBE from USGS final draft report on fuel oxygenates (March, 1996)
- Arochlor values for Henry's constant and solubility limit from ATSDR Toxlicological Profile (Dec, 1998); Arochlor Koc from EPA 1994 draft of soil screening guidance
- Values for total xylenes are a weighted average of m,o & p xylene based on gasoline composition data from TPH Criterial Working Group--Volume 2 (May 1998). That is: m = 51% of total xylene; o = 28% of total xylene; and , p = 21% of total xylene.
- H' for all metals except mercury assumed = zero. Mercury H' from EPA Soil Screening Guidance.

(4) Based on review of data available from the literature and WA State sites.
(5) From equation 747-2 for organics. For metals, based on review of data available from the literature and WA State sites.
(6) Current MTCA soil cleanup level. Calculated using equation 747-1 (3-phase model) with model defaults (as shown in this table) and ground water cleanup level shown in this table.
(7) Pore water concentration = ground water cleanup level X dilution factor
(8) There is NAPL in the soil if the pore water concentration exceeds the solubility limit.
(9) C sat is the soil concentration above which there is NAPL in the soil. It is calculated by substituting the solubility limit for the [ground water cleanup level X DF] in equation 747-1.
(10) Water mass = [Pore water concentration X soil water fraction] / soil bulk density. This is the mass of contaminant in the water phase.
(11) Vapor concentration = Pore water concentration X Henry's Constant X 1000.
(12) Vapor mass = [Vapor concentration X soil air fraction] / soil bulk density. This is the mass of contaminant in the vapor phase.
(13) Soil concentration = Pore water concentration X Kd
(14) Soil mass = [Pore water concentration X Kd X soil bulk density] / soil bulk density. This is the mass of contaminant in the soil phase.
(15) Sum mass = water mass + vapor mass + soil mass. This value equals the soil cleanup level.

Table 4-9: Calculation of Predicted Ground Water Concentration Resulting from Current Method A Soil Cleanup Levels for Industrial Land Use using the 3-Phase Model

3-Phase Model Results	CAS No.	Resulting GW Conc. (mg/l) (1)	Bulk Density (g/cc) (2)	Soil Water (cc/cc) (2)	Soil Air (cc/cc) (2)	H' (cc/cc) (3)	Koc (ml/g) (3)	Foc (%) (4)	Kd (cc/g) (5)	Dilution Factor (dimensionless)	Current Soil Cleanup Level (mg/kg) (6)
Arsenic	7440-38-2	0.342466	1.5	0.3	0.13	0	-	-	29	20	200.000
Benzene	71-43-2	0.0888	1.5	0.3	0.13	0.228	61.7	0.1%	0.062	20	0.500
Cadmium	7440-43-9	0.07247	1.5	0.3	0.13	0	-	-	6.7	20	10.001
Chromium (total)	7440-47-3										
Chromium VI	18540-29-9	1.30209	1.5	0.3	0.13	0	-	-	19	20	500.003
Chromium III	16065-83-1		1.5	0.3	0.13	0	-	-	1000	20	
DDT	50-29-3	0.0003687	1.5	0.3	0.13	0.000332	677,934	0.1%	678	20	5.001
Ethyl Benzene	100-41-4	2.3148	1.5	0.3	0.13	0.323	204	0.1%	0.204	20	20.000
Ethylene dibromide (EDB)	106-93-4		1.5	0.3	0.13	0.0336	66	0.1%	0.066	20	
Lead	7439-92-1		1.5	0.3	0.13	0	-	-	10000	20	
Lindane	58-89-9	0.64432	1.5	0.3	0.13	0.000574	1,352	0.1%	1.4	20	20.000
Methylene Chloride	75-09-2	0.1148	1.5	0.3	0.13	0.0898	10	0.1%	0.010	20	0.500
Mercury (inorganic)	7439-97-6		1.5	0.3	0.13	0.467	-	-	52	20	
MTBE	1634-04-4	0.471	1.5	0.3	0.13	0.018	11	0.1%	0.011	20	2.000
Naphthalene	91-20-3		1.5	0.3	0.13	0.0198	1,191	0.1%	1.191	20	
cPAH Mixtures	na										
Benzo[a]anthracene	56-55-3		1.5	0.3	0.13	0.000137	357,537	0.1%	358	20	
Benzo[b]fluoranthene	205-99-2		1.5	0.3	0.13	0.00455	1,230,000	0.1%	1,230	20	
Benzo[k]fluoranthene	207-08-9		1.5	0.3	0.13	0.000034	1,230,000	0.1%	1,230	20	
Benzo[a]pyrene	50-32-8	0.0001445	1.5	0.3	0.13	0.0000463	968,774	0.1%	969	20	2.800
Chrysene	218-01-9		1.5	0.3	0.13	0.00388	398,000	0.1%	398	20	
Dibenzo[a,h]anthracene	53-70-3		1.5	0.3	0.13	6.03E-07	1,789,101	0.1%	1,789	20	
Indeno[1,2,3-cd]pyrene	207-08-9		1.5	0.3	0.13	0.0000656	3,470,000	0.1%	3470.00	20	
PCB Mixtures	1336-36-3										
Arochlor 1016	12674-11-2		1.5	0.3	0.13	0.119	107,285	0.1%	107	20	
Arochlor 1260			1.5	0.3	0.13	0.189	822,422	0.1%	822	20	
Tetrachloroethylene (PCE)	127-18-4	0.0471	1.5	0.3	0.13	0.754	265	0.1%	0.265	20	0.500
Toluene	108-88-3	5.501	1.5	0.3	0.13	0.272	140	0.1%	0.140	20	40.000
1,1,1 Trichloroethane	71-55-6	2.5246	1.5	0.3	0.13	0.705	135	0.1%	0.135	20	20.000
Trichloroethylene	79-01-6	0.0756	1.5	0.3	0.13	0.422	94	0.1%	0.094	20	0.500
Xylenes	1330-20-7	2.1873	1.5	0.3	0.13	0.279	233	0.1%	0.233	20	20.000
m-xylene	108-38-3		1.5	0.3	0.13	0.301	196	0.1%	0.196	20	
o-xylene	95-47-6		1.5	0.3	0.13	0.213	241	0.1%	0.241	20	
p-xylene			1.5	0.3	0.13	0.314	311	0.1%	0.311	20	

Table 4-9 Continued.

3-Phase Model Results	CAS No.	Pore Water Concentration (mg/l) (7)	Solubility (mg/l) (3)	NAPL in Soil? (8)	Csat (mg/kg) (9)	Pore Water Concentration (mg/l) (7)	Water Mass (mg/kg) (10)	Vapor Concentration (mg/m^3) (11)	Vapor Mass (mg/kg) (12)	Soil Conc. (mg/kg) (13)	Soil Mass (mg/kg) (14)	Sum Mass (mg/kg) (15)
Arsenic	7440-38-2											
Benzene	71-43-2	1.78	1,750	No	493	1.78	0.355	404.928	0.0351	0.1096	0.1096	0.500
Cadmium	7440-43-9											
Chromium (total)	7440-47-3											
Chromium VI	18540-29-9	26.0	-	n/a	-	26.0	5.21	-	-	495	495	500
Chromium III	16065-83-1											
DDT	50-29-3											
Ethyl Benzene	100-41-4	46	169	No	73	46	9.3	14953.608	1.30	9.44	9.44	20.00
Ethylene dibromide (EDB)	106-93-4											
Lead	7439-92-1											
Lindane	58-89-9	12.8864	6.8	Yes	11	12.8864	2.57728	7.3968	6.41E-04	17.4224	17.4224	20.000
Methylene Chloride	75-09-2	2.30	13,000	No	2,831	2.30	0.459	206.2	0.01787	0.0230	0.0230	0.500
Mercury (inorganic)	7439-97-6											
MTBE	1634-04-4	9.41	50,000	No	10,628	9.41	1.882	169.4	0.01468	0.1035	0.1035	2.000
Naphthalene	91-20-3											
cPAH Mixtures	na											
Benzo[a]anthracene	56-55-3											
Benzo[b]fluoranthene	205-99-2											
Benzo[k]fluoranthene	207-08-9											
Benzo[a]pyrene	50-32-8	0.0029	0.00162	Yes	2	0.0029	0.001	0.00013	1.16E-08	2.7998	2.7998	2.800
Chrysene	218-01-9											
Dibenzo[a,h]anthracene	53-70-3											
Indeno[1,2,3-cd]pyrene	207-08-9											
PCB Mixtures	1336-36-3											
Arochlor 1016	12674-11-2											
Arochlor 1260												
Tetrachloroethylene (PCE)	127-18-4	0.94	200	No	106	0.94	0.188	710	0.0616	0.2496	0.2496	0.500
Toluene	108-88-3	110	526	No	191	110	22.0	29925.44	2.59	15.40	15.40	40.0
1,1,1 Trichloroethane	71-55-6	50.5	1,330	No	527	50.5	10.10	35596.86	3.09	6.82	6.82	20.00
Trichloroethylene	79-01-6	1.51	1,100	No	364	1.51	0.302	638	0.0553	0.1421	0.1421	0.500
Xylenes	1330-20-7	44	171	No	78	44	8.7	12205.134	1.06	10.19	10.19	20.0

Table 4-9 Footnotes:

(1) Predicted ground water concentration from current Method A soil cleanup level. Determined by adjusting value until soil cleanup level matches current rule. No value has been calculated for contaminants with a proposed soil cleanup level that is equal to or higher than the current Method A soil cleanup level.
(2) From equation 747-1. Based on Soil Screening Guidance: Technical Background Document. EPA/540/R-95/12B. May, 1996
(3) Source: Soil Screening Guidance: Technical Background Document. EPA/540/R-95/12B. May 1996. Exceptions are:
- EDB values from ATSDR Toxicological Profile (TP 91/13);
- MTBE from USGS final draft report on fuel oxygenates (March 1996)
- Arochlor values for Henry's constant and solubility limit from ATSDR Toxlicological Profile (Dec, 1998); Arochlor Koc from EPA 1994 draft of soil screening guidance
- Values for total xylenes are a weighted average of m,o & p xylene based on gasoline composition data from TPH Criterial Working Group--Volume 2 (May 1998). That is: m = 51% of total xylene; o = 28% of total xylene; and , p = 21% of total xylene.
- H' for all metals except mercury assumed = zero. Mercury H' from EPA Soil Screening Guidance.

(4) Based on review of data available from the literature and WA State sites.
(5) From equation 747-2 for organics. For metals, based on review of data available from the literature and WA State sites.
(6) Current MTCA soil cleanup level. Calculated using equation 747-1 (3-phase model) with model defaults (as shown in this table) and ground water cleanup level shown in this table. For MTBE this is the estimated soil concentration assuming cleanup to 100 ppm TPH-G and 2% MTBE.
(7) Pore water concentration = ground water cleanup level X dilution factor
(8) There is NAPL in the soil if the pore water concentration exceeds the solubility limit.
(9) C sat is the soil concentration above which there is NAPL in the soil. It is calculated by substituting the solubility limit for the [ground water cleanup level X DF] in equation 747-1.
(10) Water mass = [Pore water concentration X soil water fraction] / soil bulk density. This is the mass of contaminant in the water phase.
(11) Vapor concentration = Pore water concentration X Henry's Constant X 1000.
(12) Vapor mass = [Vapor concentration X soil air fraction] / soil bulk density. This is the mass of contaminant in the vapor phase.
(13) Soil concentration = Pore water concentration X Kd
(14) Soil mass = [Pore water concentration X Kd X soil bulk density] / soil bulk density. This is the mass of contaminant in the soil phase.
(15) Sum mass = water mass + vapor mass + soil mass. This value equals the soil cleanup level.

Table 4-10: Calculation of Predicted Ground Water Concentration Resulting from Proposed Method A Soil Cleanup Levels for Industrial Land Use using the 3-Phase Model

3-Phase Model Results	CAS No.	Resulting GW Conc. (mg/l) (1)	Bulk Density (g/cc) (2)	Soil Water (cc/cc) (2)	Soil Air (cc/cc) (2)	H' (cc/cc) (3)	Koc (ml/g) (3)	Foc (%) (4)	Kd (cc/g) (5)	Dilution Factor (dimensionless)	Current Soil Cleanup Level (mg/kg) (6)
Arsenic	7440-38-2	0.0343	1.5	0.3	0.13	0	-	-	29	20	20.03
Benzene	71-43-2	0.0054	1.5	0.3	0.13	0.228	61.7	0.1%	0.062	20	0.030
Cadmium	7440-43-9	0.015	1.5	0.3	0.13	0	-	-	6.7	20	2.00
Chromium (total)	7440-47-3										
Chromium VI	18540-29-9	0.05	1.5	0.3	0.13	0	-	-	19	20	19
Chromium III	16065-83-1		1.5	0.3	0.13	0	-	-	1000	20	
DDT	50-29-3	0.000296	1.5	0.3	0.13	0.000332	677,934	0.1%	678	20	4.01
Ethyl Benzene	100-41-4	0.695	1.5	0.3	0.13	0.323	204	0.1%	0.204	20	6.00
Ethylene dibromide (EDB)	106-93-4		1.5	0.3	0.13	0.0336	66	0.1%	0.066	20	
Lead	7439-92-1		1.5	0.3	0.13	0	-	-	10000	20	
Lindane	58-89-9	0.000325	1.5	0.3	0.13	0.000574	1,352	0.1%	1.4	20	0.0101
Methylene Chloride	75-09-2	0.0047	1.5	0.3	0.13	0.0898	10	0.1%	0.010	20	0.020
Mercury (inorganic)	7439-97-6		1.5	0.3	0.13	0.467	-	-	52	20	
MTBE	1634-04-4	0.0236	1.5	0.3	0.13	0.018	11	0.1%	0.011	20	0.100
Naphthalene	91-20-3		1.5	0.3	0.13	0.0198	1,191	0.1%	1.191	20	
cPAH Mistures	na										
Benzo[a]anthracene	56-55-3		1.5	0.3	0.13	0.000137	357,537	0.1%	358	20	
Benzo[b]fluoranthene	205-99-2		1.5	0.3	0.13	0.00455	1,230,000	0.1%	1,230	20	
Benzo[k]fluoranthene	207-08-9		1.5	0.3	0.13	0.000034	1,230,000	0.1%	1,230	20	
Benzo[a]pryene	50-32-8		1.5	0.3	0.13	0.0000463	968,774	0.1%	969	20	
Chrysene	218-01-9		1.5	0.3	0.13	0.00388	398,000	0.1%	398	20	
Dibenzo[a,h]anthracene	53-70-3		1.5	0.3	0.13	6.03E-07	1,789,101	0.1%	1,789	20	
Indeno[1,2,3-cd]pyrene	207-08-9		1.5	0.3	0.13	0.0000656	3,470,000	0.1%	3470.00	20	
PCB Mixtures	1336-36-3										
Arochlor 1016	12674-11-2		1.5	0.3	0.13	0.119	107,285	0.1%	107	20	
Arochlor 1260			1.5	0.3	0.13	0.189	822,422	0.1%	822	20	
Tetrachlorothylene (PCE)	127-18-4	0.0047	1.5	0.3	0.13	0.754	265	0.1%	0.265	20	0.050
Toluene	108-88-3	0.964	1.5	0.3	0.13	0.272	140	0.1%	0.140	20	7.01
1,1,1 Trichlorothane	71-55-6	0.253	1.5	0.3	0.13	0.705	135	0.1%	0.135	20	2.00
Trichlorocthylene	79-01-6	0.0045	1.5	0.3	0.13	0.422	94	0.1%	0.094	20	0.030
Xylenes	1330-20-7	0.984	1.5	0.3	0.13	0.279	233	0.1%	0.233	20	9.00
m-xylene	108-38-3		1.5	0.3	0.13	0.301	196	0.1%	0.196	20	
o-xylene	95-47-6		1.5	0.3	0.13	0.213	241	0.1%	0.241	20	
p-xylene			1.5	0.3	0.13	0.314	311	0.1%	0.311	20	

Table 4-10 Continued.

3-Phase Model Results	CAS No.	Pore Water Concentration (mg/l) (7)	Solubility (mg/l) (3)	NAPL in Soil? (8)	Csat (mg/kg) (9)	Pore Water Concentration (mg/l) (7)	Water Mass (mg/kg) (10)	Vapor Concentration (mg/m^3) (11)	Vapor Mass (mg/kg) (12)	Soil Conc. (mg/kg) (13)	Soil Mass (mg/kg) (14)	Sum Mass (mg/kg) (15)
Arsenic	7440-38-2	-	-	n/a	-	0.69	0.137	-	-	19.89	19.89	20.03
Benzene	71-43-2	0.11	1,750	No	493	0.11	0.022	24.624	0.0021	0.0067	0.0067	0.030
Cadmium	7440-43-9	0.29	-	n/a	-	0.29	0.058	-	-	1.94	1.94	2.00
Chromium (total)	7440-47-3											
Chromium VI	18540-29-9	1.0	-	n/a	-	1.0	0.20	-	-	19	19	19
Chromium III	16065-83-1	0.0	-	n/a	-	0.0	0.00	-	-	0	0	0
DDT	50-29-3	0.0059	0.0250	No	17	0.0059	0.0012	0.0020	1.70E-07	4.01	4.01	4.01
Ethyl Benzene	100-41-4	14	169	No	73	14	2.8	4489.7	0.39	2.84	2.84	6.00
Ethylene dibromide (EDB)	106-93-4	0.00000	4,000	No	1,076	0.00000	0.000000	0.0000	0.00E+00	0.000000	0.000000	0.000000
Lead	7439-92-1	0.00	-	n/a	-	0.00	0.000	-	-	0	0	0
Lindane	58-89-9	0.0065	6.8	No	11	0.0065	0.00130	0.0037	3.23E-07	0.0088	0.0088	0.010
Methylene Chloride	75-09-2	0.09	13,000	No	2,831	0.09	0.019	8.4	0.00073	0.0009	0.0009	0.020
Mercury (inorganic)	7439-97-6	0.000	-	n/a	-	0.000	0.000	0	0.0000	0.00	0.00	0.00
MTBE	1634-04-4	0.47	50,000	No	10,628	0.47	0.094	8.496	0.00074	0.0052	0.0052	0.100
Naphthalene	91-20-3	0.0	31	No	43	0.0	0.00	0	0.0000	0.00	0.00	0.00
cPAH Mistures	na											
Benzo[a]anthracene	56-55-3	0.00000	0.0094	No	3.4	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.000	0.00
Benzo[b]fluoranthene	205-99-2	0.00000	0.0015	No	1.8	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.00	0.00
Benzo[k]fluoranthene	207-08-9	0.00000	0.0008	No	1.0	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.00	0.00
Benzo[a]pryene	50-32-8	0.00000	0.00162	No	1.6	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.00	0.00
Chrysene	218-01-9	0.00000	0.0016	No	0.64	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.000	0.00
Dibenzo[a,h]anthracene	53-70-3	0.00000	0.00249	No	4.5	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.00	0.00
Indeno[1,2,3-cd]pyrene	207-08-9	0.00000	0.0000022	No	0.076	0.00000	0.000000	0.00E+00	0.00E+00	0.00	0.00	0.00
PCB Mixtures	1336-36-3											
Arochlor 1016	12674-11-2	0.0000	0.42	No	45	0.0000	0.00000	0.00	0.00E+00	0.00	0.00	0.00
Arochlor 1260		0.0000	0.08	No	66	0.0000	0.00000	0.00	0.00E+00	0.00	0.00	0.00
Tetrachlorothylene (PCE)	127-18-4	0.09	200	No	106	0.09	0.019	71	0.0061	0.0249	0.0249	0.050
Toluene	108-88-3	19	526	No	191	19	3.9	5244.16	0.45	2.70	2.70	7.0
1,1,1 Trichlorothane	71-55-6	5.1	1,330	No	527	5.1	1.01	3567.3	0.31	0.68	0.68	2.00
Trichlorocthylene	79-01-6	0.09	1,100	No	364	0.09	0.018	38	0.0033	0.0085	0.0085	0.030
Xylenes	1330-20-7	20	171	No	78	20	3.9	5490.72	0.48	4.59	4.59	9.0
m-xylene	108-38-3	0	161	No	68	0	0.0	0	0.00	0.00	0.00	0.0
o-xylene	95-47-6	0	178	No	82	0	0.0	0	0.00	0.00	0.00	0.0
p-xylene		0	185	No	100	0	0.0	0	0.00	0.00	0.00	0.0

Table 4-10 Footnotes:

(1) Predicted ground water concentration from current Method A soil cleanup level. Determined by adjusting value until soil cleanup level matches current rule. No value has been calculated for contaminants with a proposed soil cleanup level that is equal to or higher than the current Method A soil cleanup level.
(2) From equation 747-1. Based on Soil Screening Guidance: Technical Background Document. EPA/540/R-95/12B. May, 1996
(3) Source: Soil Screening Guidance: Technical Background Document. EPA/540/R-95/12B. May, 1996. Exceptions are:
- EDB values from ATSDR Toxicological Profile (TP 91/13);
- MTBE from USGS final draft report on fuel oxygenates (March, 1996)
- Arochlor values for Henry's constant and solubility limit from ATSDR Toxlicological Profile (Dec, 1998); Arochlor Koc from EPA 1994 draft of soil screening guidance
- Values for total xylenes are a weighted average of m,o & p xylene based on gasoline composition data from TPH Criterial Working Group--Volume 2 (May 1998). That is: m = 51% of total xylene; o = 28% of total xylene; and , p = 21% of total xylene.
- H' for all metals except mercury assumed = zero. H' for mercury from EPA Soil Screening Guidance.

(4) Based on review of data available from the literature and WA State sites.
(5) From equation 747-2 for organics. For metals, based on review of data available from the literature and WA State sites.
(6) Current MTCA soil cleanup level. Calculated using equation 747-1 (3-phase model) with model defaults (as shown in this table) and ground water cleanup level shown in this table.
(7) Pore water concentration = ground water cleanup level X dilution factor
(8) There is NAPL in the soil if the pore water concentration exceeds the solubility limit.
(9) C sat is the soil concentration above which there is NAPL in the soil. It is calculated by substituting the solubility limit for the [ground water cleanup level X DF] in equation 747-1.
(10) Water mass = [Pore water concentration X soil water fraction] / soil bulk density. This is the mass of contaminant in the water phase.
(11) Vapor concentration = Pore water concentration X Henry's Constant X 1000.
(12) Vapor mass = [Vapor concentration X soil air fraction] / soil bulk density. This is the mass of contaminant in the vapor phase.
(13) Soil concentration = Pore water concentration X Kd
(14) Soil mass = [Pore water concentration X Kd X soil bulk density] / soil bulk density. This is the mass of contaminant in the soil phase.
(15) Sum mass = water mass + vapor mass + soil mass. This value equals the soil cleanup level.

Table 4-11: Ground Water Concentration Using the 4-Phase Model and BP Gasoline Composition #4 Using 100 PPM in Soil (Current TPH-G Method A Soil Cleanup Level)

Solid:	32.9%
Air:	6.4%
Water:	5.5%
NAPL:	55.2%
	100.0%

	Equilibrium Composition %	Soil Concentration ppm		Predicted G.W. ug/l
Aliphatics	BP # 4			
EC >5-6	2.640%	2.64		27.49
EC >6-8	14.131%	14.13		43
EC >8-10	9.935%	9.94		3.0
EC >10-12	13.808%	13.81		0.31
EC >12-16		0.00		0.00
EC >16-21		0.00		0.00
Aromatics				
Benzene	0.127%	0.127		21.09
Toluene	2.003%	2.00		229
Ethylbenzene	1.135%	1.14		81
Xylenes	6.427%	6.43		450
EC >8-10	10.248%	10.25		197
EC >10-12	20.242%	20.24		206
EC >12-16	16.106%	16.11		50
EC >16-21	0.000%	0.00		0
EC >21-35	0.000%	0.00		0
Naphthalene	3.198%	3.20		57
MTBE		0.00		0
Total	100.000%	100.00		1,366

Soil Concentration = 100.00

Total soil porosity: default is 0.43	n	0.430	Unitless
Volumetric water content: default is 0.3	Qw	0.300	Unitless
Initial volumetric air content: default is 0.13	Qa	0.130	Unitless
Soil bulk density measured: default is 1.5	rb	1.500	kg/l
*or, use soil bulk density computed @solid density=2.65kg/l:		1.811	kg/l
Fraction Organic Carbon: default is 0.001	foc	0.0010	Unitless
Dilution Factor: default is 20	DF	20.0	Unitless

Soil Concentration:	**100.00**
Predicted Ground Water TPH (ug/l:	**1,366**
HI @ Predicted G.W. Concentration:	2.60

Volumetric NAPL Content, QNAPL :	0.000099
NAPL Saturation (%), QNAPL/n:	0.02%
Type of model used for computation:	4-Phase Model
Computation completed?	Yes!

NOTE: This is a reprint of summary output only. The complete model run can be found in the rule file.

Table 4-12: Ground Water Concentration Using the 4-Phase Model and BP Gasoline Composition #4 Using 30 PPM in Soil (Proposed TPH-G Method A Soil Cleanup Level)

Solid:	75.4%
Air:	12.1%
Water:	8.8%
NAPL:	3.7%
	100.0%

	Equilibrium Composition %	Soil Concentration ppm		Predicted G.W. ug/l
Aliphatics	**BP # 4**			
EC >5-6	2.640%	0.79		10.23
EC >6-8	14.131%	4.24		24
EC >8-10	9.935%	2.98		3.6
EC >10-12	13.808%	4.14		0.69
EC >12-16		0.00		0.00
EC >16-21		0.00		0.00
Aromatics				
Benzene	0.127%	0.038		6.74
Toluene	2.003%	0.60		82
Ethylbenzene	1.135%	0.34		39
Xylenes	6.427%	1.93		209
EC >8-10	10.248%	3.07		84
EC >10-12	20.242%	6.07		110
EC >12-16	16.106%	4.83		45
EC >16-21	0.000%	0.00		0
EC >21-35	0.000%	0.00		0
Naphthalene	3.198%	0.96		44
MTBE		0.00		0
Total	100.000%	30.00		658

Soil Concentration = 30.00

Total soil porosity: default is 0.43	n	0.430	Unitless
Volumetric water content: default is 0.3	Qw	0.300	Unitless
Initial volumetric air content: default is 0.13	Qa	0.130	Unitless
Soil bulk density measured: default is 1.5	rb	1.500	kg/l
*or, use soil bulk density computed @solid density=2.65kg/l:		1.811	kg/l
Fraction Organic Carbon: default is 0.001	foc	0.0010	Unitless
Dilution Factor: default is 20	DF	20.0	Unitless

Soil Concentration:	**30.00**
Predicted Ground Water TPH (ug/l:	**658**
HI @ Predicted G.W. Concentration:	1.23

Volumetric NAPL Content, QNAPL :	0.000002
NAPL Saturation (%), QNAPL/n:	0.00%
Type of model used for computation:	4-Phase Model
Computation completed?	Yes!

NOTE: This is a reprint of summary output only. The complete model run can be found in the rule file.

Table 4-13: Ground Water Concentration Using the 4-Phase Model and ARCO Gasoline Composition #5 Using 100 PPM in Soil (Current TPH-G Method A Soil Cleanup Level)

Solid:	36.0%
Air:	5.9%
Water:	7.2%
NAPL:	50.9%
	100.0%

	Equilibrium Composition %	Soil Concentration ppm	Predicted G.W. ug/l
Aliphatics	**ARCO # 5**		
EC >5-6	1.36%	1.36	14.29
EC >6-8	13.4%	13.37	42
EC >8-10	12.8%	12.83	4.0
EC >10-12	10.8%	10.77	0.25
EC >12-16		0.00	0.00
EC >16-21		0.00	0.00
Aromatics			
Benzene	0.066%	0.066	11.06
Toluene	2.8%	2.84	328
Ethylbenzene	1.8%	1.82	134
Xylenes	10.0%	10.04	718
EC >8-10	11.6%	11.64	228
EC >10-12	26.3%	26.27	274
EC >12-16	7.7%	7.73	25
EC >16-21		0.00	0
EC >21-35		0.00	0
Naphthalene	1.27%	1.27	24
MTBE		0.00	0
			0
Total	100.00%	100.00	1,801

Soil Concentration = 100.00

Total soil porosity: default is 0.43	n	0.430	Unitless
Volumetric water content: default is 0.3	Qw	0.300	Unitless
Initial volumetric air content: default is 0.13	Qa	0.130	Unitless
Soil bulk density measured: default is 1.5	rb	1.500	kg/l
*or, use soil bulk density computed @solid density=2.65kg/l:		1.811	kg/l
Fraction Organic Carbon: default is 0.001	foc	0.0010	Unitless
Dilution Factor: default is 20	DF	20.0	Unitless

Soil Concentration:	**100.00**
Predicted Ground Water TPH (ug/l:	**1,801**
HI @ Predicted G.W. Concentration:	2.33

Volumetric NAPL Content, QNAPL :	0.000093
NAPL Saturation (%), QNAPL/n:	0.02%
Type of model used for computation:	4-Phase Model
Computation completed?	Yes!

NOTE: This is a reprint of summary output only. The complete model run can be found in the rule file.

Table 4-14: Ground Water Concentration Using the 4-Phase Model and ARCO Gasoline Composition #5 Using 30 PPM in Soil (Current TPH-G Method A Soil Cleanup Level)

Solid:	77.2%
Air:	11.8%
Water:	11.1%
NAPL:	NONE
	100.0%

	Equilibrium Composition %	Soil Concentration @ 30 PPM' ppm	Predicted G.W. ug/l
Aliphatics	**ARCO # 5**		
EC >5-6	1.36%	1.36	5.28
EC >6-8	13.4%	13.37	24
EC >8-10	12.8%	12.83	5.0
EC >10-12	10.8%	10.77	0.62
EC >12-16		0.00	0.00
EC >16-21		0.00	0.00
Aromatics			
Benzene	0.066%	0.066	3.53
Toluene	2.8%	2.84	117
Ethylbenzene	1.8%	1.82	63
Xylenes	10.0%	10.04	330
EC >8-10	11.6%	11.64	96
EC >10-12	26.3%	26.27	145
EC >12-16	7.7%	7.73	22
EC >16-21		0.00	0
EC >21-35		0.00	0
Naphthalene	1.27%	1.27	18
MTBE		0.00	0
Total	100.00%	100.00	829

Soil Concentration = 30.00

Total soil porosity: default is 0.43	n	0.430	Unitless
Volumetric water content: default is 0.3	Qw	0.300	Unitless
Initial volumetric air content: default is 0.13	Qa	0.130	Unitless
Soil bulk density measured: default is 1.5	rb	1.500	kg/l
*or, use soil bulk density computed @solid density=2.65kg/l:		1.811	kg/l
Fraction Organic Carbon: default is 0.001	foc	0.0010	Unitless
Dilution Factor: default is 20	DF	20.0	Unitless
Soil Concentration:	**30.00**		
Predicted Ground Water TPH (ug/l:	**829**		
HI @ Predicted G.W. Concentration:	1.09		
Volumetric NAPL Content, QNAPL :	NAPL phase is not existing!		
NAPL Saturation (%), QNAPL/n:	N/A		
Type of model used for computation:	3-Phase Model		
Computation completed?	Yes!		

NOTE: This is a reprint of summary output only. The complete model run can be found in the rule file.

Table 4-15: Calculation of Ground Water Hazard Quotient Resulting from Current Method A Soil Cleanup Levels for Unrestricted Land Use

Risk Calculations – Noncarcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Reference Dose (1) (mg/kg)	Avg. Body Weight (kg)	Unit Conv. Factor (ug/mg)	Hazard Quotient (unitless)	Drinking H2O Ing. Rate (liters/day)	Inhalation Corr. Factor (unitless)	Drinking H2O Fraction (unitless)	Method B Noncarcin (2) (ug/l)	Predicted Concentration (3) (ug/l)	HQ @ Predicted Concentration (4) (unitless)
Arsenic	7440-38-2	0.0003	16	1,000	1	1.0	1	1.0	4.8		
Benzene	71-43-2	0.003	16	1,000	1	1.0	2	1.0	24	88.8	3.70
Cadmium	7440-43-9	0.0005	16	1,000	1	1.0	1	1.0	8.0		
T Chromium	7440-47-3	not available									
Chromium III	16065-83-1	1.5	16	1,000	1	1.0	1	1.0	24,000		
Chromium VI	18540-29-9	0.003	16	1,000	1	1.0	1	1.0	48	260.416	5.43
DDT	50-29-3	0.0005	16	1,000	1	1.0	1	1.0	8.0		
Ethylbenzene	100-41-4	0.1	16	1,000	1	1.0	2	1.0	800	2314.8	2.89
Ethylene dibromide (EDB)	106-93-4	not available									
Lead	7439-92-1	not available									
Lindane	58-89-9	0.0003	16	1,000	1	1.0	1	1.0	4.8	32.22	6.71
Methylene chloride	75-09-2	0.06	16	1,000	1	1.0	2	1.0	480	114.8	0.24
Mercury (inorganic)	7439-97-6	0.0003	16	1,000	1	1.0	1	1.0	4.8		
MTBE	1634-04-4	not available							20.0	407	20.35
Naphthalene	91-20-3	0.02	16	1,000	1	1.0	2	1.0	160		
cPAH Mixtures	na	not available									
Benzo[a]anthracene	56-55-3	not available									
Benzo[b]fluoranthene	205-99-2	not available									
Benzo[k]fluoranthene	207-08-9	not available									
Benzo[a]pyrene	50-32-8	not available									
Chrysene	218-01-9	not available									
Dibenzo[a,h]anthracene	53-70-3	not available									
Ideno[1,2,3-cd]pyrene	207-08-9	not available									

Footnotes:

(1) Source of RfDs is EPA's IRIS database except for benzene which is from EPA's NCEA.

(2) Value calculated using equation 720-1 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. Bolded values indicate predicted concentration exceeds MTCA requirement that HQ not exceed 1.0. MTBE does not have an RfD or CPF. Value shown is predicted concentration divided by health advisory concentration.

Table 4-15 Continued.

Risk Calculations – Noncarcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Reference Dose (1) (mg/kg)	Avg. Body Weight (kg)	Unit Conv. Factor (ug/mg)	Hazard Quotient (unitless)	Drinking H2O Ing. Rate (liters/day)	Inhalation Corr. Factor (unitless)	Drinking H2O Fraction (unitless)	Method B Noncarcin (2) (ug/l)	Predicted Concentration (3) (ug/l)	HQ @ Predicted Concentration (4) (unitless)
PCB mixtures	1336-36-3	not available									
High Risk & Persistence		not available									
Low Risk & Persistence		not available									
Lowest Risk & Persistence		not available									
Aroclor 1016	12674-11-2	0.00007	16	1,000	1	1.0	1	1.0	1.1		
Arochlor 1248	12672-29-6	not available									
Arochlor 1254	11097-69-1	0.00002	16	1,000	1	1.0	1	1.0	0.32		
Arochlor 1260		not available									
Tetrachloroethylene (PCE)	127-18-4	0.01	16	1,000	1	1.0	2	1.0	80	47.1	0.59
Toluene	108-88-3	0.2	16	1,000	1	1.0	2	1.0	1,600	5,501	3.44
1,1,1 Trichloroethane	71-55-6	0.9	16	1,000	1	1.0	2	1.0	7,200	2524.6	0.35 & 12.6
Trichloroethylene	79-01-6	not available								75.6	
Xylenes	1330-20-7	2.0	16	1,000	1	1.0	2	1.0	16,000	2,187.3	0.14 & 2.2
m-Xylene	108-38-3	not available									
o-xylene	95-47-6	not available									
p-xylene		not available									
Gasoline (5)										1366 & 1801	2.6 & 2.3

Footnotes:

(1) Source of RfDs is EPA's IRIS database except for 1,1,1 TCE, which is from HEAST

(2) Value calculated using equation 720-1 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. For 1,1,1 TCE the first value is the HQ, the second is the ratio of the predicted concentration to the MCL of 200 ug/l. For xylene the first value is the HQ, the second is the ratio of the predicted concentration to odor threshold of 1000 ug/l.

(5) First value for BP composition #4, second value for ARCO composition #5. Both results obtained using 4 phase model to predict ground water impact at a soil gasoline conc. of 100 PPM.

Table 4-16: Calculation of Ground Water Hazard Quotient Resulting from Proposed Method A Soil Cleanup Levels for Unrestricted Land Use

Risk Calculations – Noncarcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Reference Dose (1) (mg/kg)	Avg. Body Weight (kg)	Unit Conv. Factor (ug/mg)	Hazard Quotient (unitless)	Drinking H2O Ing. Rate (liters/day)	Inhalation Corr. Factor (unitless)	Drinking H2O Fraction (unitless)	Method B Noncarcin (2) (ug/l)	Predicted Concentration (3) (ug/l)	HQ @ Predicted Concentration (4) (unitless)
Arsenic	7440-38-2	0.0003	16	1,000	1	1.0	1	1.0	4.8		
Benzene	71-43-2	0.003	16	1,000	1	1.0	2	1.0	24	5.40	0.2
Cadmium	7440-43-9	0.0005	16	1,000	1	1.0	1	1.0	8.0		
T Chromium	7440-47-3	not available									
Chromium III	16065-83-1	1.5	16	1,000	1	1.0	1	1.0	24,000		
Chromium VI	18540-29-9	0.003	16	1,000	1	1.0	1	1.0	48	50	1.0
DDT	50-29-3	0.0005	16	1,000	1	1.0	1	1.0	8.0		
Ethylbenzene	100-41-4	0.1	16	1,000	1	1.0	2	1.0	800	695	0.9
Ethylene dibromide (EDB)	106-93-4	not available									
Lead	7439-92-1	not available									
Lindane	58-89-9	0.0003	16	1,000	1	1.0	1	1.0	4.8	0.325	0.1
Methylene chloride	75-09-2	0.06	16	1,000	1	1.0	2	1.0	480	4.7	0.01
Mercury (inorganic)	7439-97-6	0.0003	16	1,000	1	1.0	1	1.0	4.8		
MTBE	1634-04-4	not available							20.0	23.6	1.2
Naphthalene	91-20-3	0.02	16	1,000	1	1.0	2	1.0	160		
cPAH Mixtures	na	not available									
Benzo[a]anthracene	56-55-3	not available									
Benzo[b]fluoranthene	205-99-2	not available									
Benzo[k]fluoranthene	207-08-9	not available									
Benzo[a]pyrene	50-32-8	not available									
Chrysene	218-01-9	not available									
Dibenzo[a,h]anthracene	53-70-3	not available									
Ideno[1,2,3-cd]pyrene	207-08-9	not available									

Footnotes:

(1) Source of RfDs is EPA's IRIS database except for benzene which is from EPA's NCEA.

(2) Value calculated using equation 720-1 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. Bolded values indicate predicted concentration exceeds MTCA requirement that HQ not exceed 1.0. MTBE does not have an RfD or CPF. Value shown is predicted concentration divided by health advisory concentration.

Table 4-16 Continued.

Risk Calculations – Noncarcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No:	Reference Dose (1) (mg/kg)	Avg. Body Weight (kg)	Unit Conv. Factor (ug/mg)	Hazard Quotient (unitless)	Drinking H2O Ing. Rate (liters/day)	Inhalation Corr. Factor (unitless)	Drinking H2O Fraction (unitless)		Method B Noncarcin (2) (ug/l)		Predicted Concentration (3) (ug/l)	HQ @ Predicted Concentration (4) (unitless)
PCB mixtures	1336-36-3	not available											
High Risk & Persistence		not available											
Low Risk & Persistence		not available											
Lowest Risk & Persistence		not available											
Aroclor 1016	12674-11-2	0.00007	16	1,000	1	1.0	1	1.0		1.1			
Arochlor 1248	12672-29-6	not available											
Arochlor 1254	11097-69-1	0.00002	16	1,000	1	1.0	1	1.0		0.32			
Arochlor 1260		not available											
Tetrachloroethylene (PCE)	127-18-4	0.01	16	1,000	1	1.0	2	1.0		80		4.7	0.1
Toluene	108-88-3	0.2	16	1,000	1	1.0	2	1.0		1,600		964	0.6
1,1,1 Trichloroethane	71-55-6	0.9	16	1,000	1	1.0	2	1.0		7,200		253	0.04
Trichloroethylene	79-01-6	not available											
Xylenes	1330-20-7	2.0	16	1,000	1	1.0	2	1.0		16,000		984	0.06 & 1.0
m-Xylene	108-38-3	not available											
o-xylene	95-47-6	not available											
p-xylene		not available											
Gasoline (5)												658 & 829	1.23 & 1.09

Footnotes:

(1) Source of RfDs is EPA's IRIS database except for 1,1,1 TCE, which is from HEAST.

(2) Value calculated using equation 720-1 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. For xylene the first value is the HQ, the second is the ratio of the predicted concentration to odor threshold of 1000 ug/l.

(5) First value for BP composition #4, second value for ARCO composition #5. Both results obtained using 4 phase model to predict ground water impact at a soil gasoline conc. of 30 PPM.

Table 4-17: Calculation of Ground Water Cancer Risk Resulting from Current Method A Soil Cleanup Levels for Unrestricted Land Use

Risk Calculations – Carcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Risk (unitless)	Avg. Body Weight (kg)	Lifetime (years)	Unit Conv. Factor (ug/mg)	Potency Factor (kg-day/mg)	Drinking H_2O Ing. Rate (liters/day)	Duration of Exposure (years)	Inhalation Corr. Factor (unitless)	Drinking H_2O Fraction (unitless)	Method B Carcinogen (ug/l)	Predicted Concentration (3) (ug/l)	Risk @ Predicted Concentration (4) (unitless)
Arsenic	7440-38-2	1E-06	70	75	1,000	1.5	2.0	30	1	1.0	0.058		
Benzene	71-43-2	1E-06	70	75	1,000	0.029	2.0	30	2	1.0	1.51	88.8	58.86
Cadmium	7440-43-9					not available							
T Chromium	7440-47-3												
Chromium III	16065-83-1					not available							
Chromium VI	18540-29-9					not available						260.416	
DDT	50-29-3	1E-06	70	75	1,000	0.34	2.0	30	1	1.0	0.26		
Ethylbenzene	100-41-4					not available						2314.8	
Ethylene dibromide (EDB)	106-93-4	1E-06	70	75	1,000	85	2.0	30	2	1.0	0.00051		
Lead	7439-92-1					not available							
Lindane	58-89-9	1E-06	70	75	1,000	1.3	2.0	30	1	1.0	0.067	32.22	478.70
Methylene chloride	75-09-2	1E-06	70	75	1,000	0.0075	2.0	30	2	1.0	5.8	114.8	19.68
Mercury (inorganic)	7439-97-6					not available							
MTBE	1634-04-4					not available						3529	
Naphthalene	91-20-3					not available							
cPAH Mixtures	na												
Benzo[a]anthracene	56-55-3					not available							
Benzo[b]fluoranthene	205-99-2					not available							
Benzo[k]fluoranthene	207-08-9					not available							
Benzo[a]pyrene	50-32-8	1E-06	70	75	1,000	7.3	2.0	30	1	1.0	0.012		
Chrysene	218-01-9					not available							
Dibenzo[a,h]anthracene	53-70-3					not available							
Ideno[1,2,3-cd]pyrene	207-08-9					not available							

Footnotes:

(1) Source of Cancer Potency Factor is the oral slope factors from EPA's IRIS database, except for Lindane which is from HEAST.

(2) Value calculated using equation 720-2 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greater than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. This value is expressed in terms of 10-6 risk, that is a value of 58.9 is a risk of 58.9 X 10-6 or 5.89 X 10-5.

Table 4-17 Continued.

Risk Calculations – Carcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Risk (unitless)	Avg. Body Weight (kg)	Lifetime (years)	Unit Conv. Factor (ug/mg)	Potency Factor (kg-day/mg)	Drinking H_2O Ing. Rate (liters/day)	Duration of Exposure (years)	Inhalation Corr. Factor (unitless)	Drinking H_2O Fraction (unitless)		Method B Carcinogen (ug/l)		Predicted Concentration (3) (ug/l)	Risk @ Predicted Concentration (4) (unitless)
PCB mixtures	1336-36-3														
High Risk & Persistence		1E-06	70	75	1,000	2.0	2.0	30	1	1.0		0.044			
Low Risk & Persistence		1E-06	70	75	1,000	0.4	2.0	30	1	1.0		0.22			
Lowest Risk & Persistence		1E-06	70	75	1,000	0.07	2.0	30	1	1.0		1.25			
Aroclor 1016	12674-11-2					not available									
Arochlor 1248	12672-29-6					not available									
Arochlor 1254	11097-69-1					not available									
Arochlor 1260						not available									
Tetrachloroethylene (PCE)	127-18-4	1E-06	70	75	1,000	0.051	2.0	30	2	1.0		0.86		47.1	54.91
Toluene	108-88-3					not available								5,501	
1,1,1 Trichloroethane	71-55-6					not available								2524.6	
Trichloroethylene	79-01-6	1E-06	70	75	1,000	0.011	2.0	30	2	1.0		4.0		75.6	19.01
Xylenes	1330-20-7					not available								2,187.3	
m-Xylene	108-38-3					not available									
o-xylene	95-47-6					not available									
p-xylene						not available									
Gasoline (5)												1.51		11.1 & 20.1	7.35 & 13.31

Footnotes:

(1) Source of Cancer Potency Factor is the oral slope factors from EPA's IRIS database, except for tetrachloroethylene, trichlorothylene and vinyl chloride which are from HEAST.

(2) Value calculated using equation 720-2 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. This value is expressed in terms of 10-6 risk, that is a value of 58.9 is a risk of 58.9 X 10-6 or 5.89 X 10-5.

(5) First value for BP composition #4, second value for ARCO composition #5. Both results obtained using 4 phase model to predict benzene conc. at a soil gasoline conc. of 100 PPM. All values based on benzene. Risk calculated by dividing predicted benzene concentration by Method B benzene value.

Table 4-18: Calculation of Ground Water Cancer Risk Resulting from Proposed Method A Soil Cleanup Levels for Unrestricted Land Use

Risk Calculations – Carcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Risk (unitless)	Avg. Body Weight (kg)	Lifetime (years)	Unit Conv. Factor (ug/mg)	Potency Factor (kg-day/mg)	Drinking H_2O Ing. Rate (liters/day)	Duration of Exposure (years)	Inhalation Corr. Factor (unitless)	Drinking H_2O Fraction (unitless)	Method B Carcinogen (ug/l)	Predicted Concentration (3) (ug/l)	Risk @ Predicted Concentration (4) (unitless)
Arsenic	7440-38-2	1E-06	70	75	1,000	1.5	2.0	30	1	1.0	0.058		
Benzene	71-43-2	1E-06	70	75	1,000	0.029	2.0	30	2	1.0	1.51	5.4	3.58
Cadmium	7440-43-9					not available							
T Chromium	7440-47-3												
Chromium III	16065-83-1					not available							
Chromium VI	18540-29-9					not available							
DDT	50-29-3	1E-06	70	75	1,000	0.34	2.0	30	1	1.0	0.26		
Ethylbenzene	100-41-4					not available							
Ethylene dibromide (EDB)	106-93-4	1E-06	70	75	1,000	85	2.0	30	2	1.0	0.00051		
Lead	7439-92-1					not available							
Lindane	58-89-9	1E-06	70	75	1,000	1.3	2.0	30	1	1.0	0.067	0.325	4.83
Methylene chloride	75-09-2	1E-06	70	75	1,000	0.0075	2.0	30	2	1.0	5.8	4.7	0.81
Mercury (inorganic)	7439-97-6					not available							
MTBE	1634-04-4					not available						23.6	
Naphthalene	91-20-3					not available							
cPAH Mixtures	na												
Benzo[a]anthracene	56-55-3					not available							
Benzo[b]fluoranthene	205-99-2					not available							
Benzo[k]fluoranthene	207-08-9					not available							
Benzo[a]pyrene	50-32-8	1E-06	70	75	1,000	7.3	2.0	30	1	1.0	0.012		
Chrysene	218-01-9					not available							
Dibenzo[a,h]anthracene	53-70-3					not available							
Ideno[1,2,3-cd]pyrene	207-08-9					not available							

Footnotes:

(1) Source of Cancer Potency Factor is the oral slope factors fromEPA's IRIS database, except for Lindane which is from HEAST.

(2) Value calculated using equation 720-2 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. This value is expressed in terms of 10-6 risk, that is a value of 58.9 is a risk of 58.9 X 10-6 or 5.89 X 10-5.

Table 4-18 Continued:

Risk Calculations – Carcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Risk (unitless)	Avg. Body Weight (kg)	Lifetime (years)	Unit Conv. Factor (ug/mg)	Potency Factor (kg-day/mg)	Drinking H_2O Ing. Rate (liters/day)	Duration of Exposure (years)	Inhalation Corr. Factor (unitless)	Drinking H_2O Fraction (unitless)	Method B Carcinogen (ug/l)	Predicted Concentration (3) (ug/l)	Risk @ Predicted Concentration (4) (unitless)
PCB mixtures	1336-36-3												
High Risk & Persistence		1E-06	70	75	1,000	2.0	2.0	30	1	1.0	0.044		
Low Risk & Persistence		1E-06	70	75	1,000	0.4	2.0	30	1	1.0	0.22		
Lowest Risk & Persistence		1E-06	70	75	1,000	0.07	2.0	30	1	1.0	1.25		
Aroclor 1016	12674-11-2					not available							
Arochlor 1248	12672-29-6					not available							
Arochlor 1254	11097-69-1					not available							
Arochlor 1260						not available							
Tetrachloroethylene (PCE)	127-18-4	1E-06	70	75	1,000	0.051	2.0	30	2	1.0	0.86	4.7	5.48
Toluene	108-88-3					not available							
1,1,1 Trichloroethane	71-55-6					not available							
Trichloroethylene	79-01-6	1E-06	70	75	1,000	0.011	2.0	30	2	1.0	4.0	4.5	1.13
Vinyl Chloride	75-01-4	1E-06	70	75	1,000	1.9	2.0	30	2	1.0	0.023		
Xylenes	1330-20-7					not available							
m-Xylene	108-38-3					not available							
o-xylene	95-47-6					not available							
p-xylene						not available							
Gasoline (5)											1.51	6.74 & 3.53	4.5 & 2.3

Footnotes:

(1) Source of Cancer Potency Factor is the oral slope factors from EPA's IRIS database, except for tetrachloroethylene, trichlorothylene and vinyl chloride which are from HEAST.

(2) Value calculated using equation 720-2 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. This value is expressed in terms of 10-6 risk, that is a value of 58.9 is a risk of 58.9 X 10-6 or 5.89 X 10-5.

(5) First value for BP composition #4, second value for ARCO composition #5. Both results obtained using 4 phase model to predict benzene conc. at a soil gasoline conc. of 30 PPM. All values based on benzene. Risk calculated by dividing predicted benzene concentration by Method B benzene value.

Table 4-19: Calculation of Ground Water Hazard Quotient Resulting from Current Method A Soil Cleanup Levels for Industrial Land Use

Risk Calculations – Noncarcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Reference Dose (1) (mg/kg)	Avg. Body Weight (kg)	Unit Conv. Factor (ug/mg)	Hazard Quotient (unitless)	Drinking H2O Ing. Rate (liters/day)	Inhalation Corr. Factor (unitless)	Drinking H2O Fraction (unitless)		Method B Noncarcinogen (2) (ug/l)		Predicted Concentration (3) (ug/l)	HQ @ Predicted Concentration (4) (unitless)
Arsenic	7440-38-2	0.0003	16	1,000	1	1.0	1	1.0		4.8		342.466	71.3
Benzene	71-43-2	0.003	16	1,000	1	1.0	2	1.0		24		88.8	3.7
Cadmium	7440-43-9	0.0005	16	1,000	1	1.0	1	1.0		8.0		72.47	9.1
T Chromium	7440-47-3	not available											
Chromium III	16065-83-1	1.5	16	1,000	1	1.0	1	1.0		24,000			
Chromium VI	18540-29-9	0.003	16	1,000	1	1.0	1	1.0		48		1302.09	27.1
DDT	50-29-3	0.0005	16	1,000	1	1.0	1	1.0		8.0		0.3687	0.05
Ethylbenzene	100-41-4	0.1	16	1,000	1	1.0	2	1.0		800		2314.8	2.9
Ethylene dibromide (EDB)	106-93-4	not available											
Lead	7439-92-1	not available											
Lindane	58-89-9	0.0003	16	1,000	1	1.0	1	1.0		4.8		644.32	134.2
Methylene chloride	75-09-2	0.06	16	1,000	1	1.0	2	1.0		480		114.8	0.2
Mercury (inorganic)	7439-97-6	0.0003	16	1,000	1	1.0	1	1.0		4.8			
MTBE	1634-04-4	not available								20.0		407	20.4
Naphthalene	91-20-3	0.02	16	1,000	1	1.0	2	1.0		160			
cPAH Mixtures	na	not available											
Benzo[a]anthracene	56-55-3	not available											
Benzo[b]fluoranthene	205-99-2	not available											
Benzo[k]fluoranthene	207-08-9	not available											
Benzo[a]pyrene	50-32-8	not available										0.1445	
Chrysene	218-01-9	not available											
Dibenzo[a,h]anthracene	53-70-3	not available											
Ideno[1,2,3-cd]pyrene	207-08-9	not available											

Footnotes:

(1) Source of RfDs is EPA's IRIS database except for benzene which is from EPA's NCEA.

(2) Value calculated using equation 720-1 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. Bolded values indicate MCL exceeds MTCA requirement that HQ not exceed 1.0. MTBE does not have an RfD or CPF. Value shown is predicted concentration divided by health advisory concentration.

Table 4-19 Continued:

Risk Calculations – Noncarcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Reference Dose (1) (mg/kg)	Avg. Body Weight (kg)	Unit Conv. Factor (ug/mg)	Hazard Quotient (unitless)	Drinking H2O Ing. Rate (liters/day)	Inhalation Corr. Factor (unitless)	Drinking H2O Fraction (unitless)		Method B Noncarcinogen (2) (ug/l)		Predicted Concentration (3) (ug/l)	HQ @ Predicted Concentration (4) (unitless)
PCB mixtures	1336-36-3	not available											
High Risk & Persistence		not available											
Low Risk & Persistence		not available											
Lowest Risk & Persistence		not available											
Aroclor 1016	12674-11-2	0.00007	16	1,000	1	1.0	1	1.0		1.1			
Arochlor 1248	12672-29-6	not available											
Arochlor 1254	11097-69-1	0.00002	16	1,000	1	1.0	1	1.0		0.32			
Arochlor 1260		not available											
Tetrachloroethylene (PCE)	127-18-4	0.01	16	1,000	1	1.0	2	1.0		80		47.1	0.6
Toluene	108-88-3	0.2	16	1,000	1	1.0	2	1.0		1,600		5,501	3.4
1,1,1 Trichloroethane	71-55-6	0.9	16	1,000	1	1.0	2	1.0		7,200		2524.6	0.35 & 12.6
Trichloroethylene	79-01-6	not available										75.6	
Xylenes	1330-20-7	2.0	16	1,000	1	1.0	2	1.0		16,000		2,187.3	0.14 & 2.2
m-Xylene	108-38-3	not available											
o-xylene	95-47-6	not available											
p-xylene		not available											
Gasoline (5)												1366 & 1801	2.6 & 2.3

Footnotes:

(1) Source of RfDs is EPA's IRIS database except for 1,1,1 TCE, which is from HEAST.

(2) Value calculated using equation 720-1 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. Bolded values indicate predicted concentration exceeds MTCA requirement that HQ not exceed 1.0. For 1,1,1 TCE the first value is the HQ, the second is the ratio of the predicted concentration to the MCL of 200 ug/l. For xylene the first value is the HQ, the second is the ratio of the predicted concentration to odor threshold of 1000 ug/l.

(5) First value for BP composition #4, second value for ARCO composition #5. Both results obtained using 4 phase model to predict ground water impact at a soil gasoline conc. of 100 PPM.

Table 4-20: Calculation of Ground Water Hazard Quotient Resulting from Proposed Method A Soil Cleanup Levels for Industrial Land Use

Risk Calculations – Noncarcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Reference Dose (1) (mg/kg)	Avg. Body Weight (kg)	Unit Conv. Factor (ug/mg)	Hazard Quotient (unitless)	Drinking H2O Ing. Rate (liters/day)	Inhalation Corr. Factor (unitless)	Drinking H2O Fraction (unitless)	Method B Noncarcinogen (2) (ug/l)	Predicted Concentration (3) (ug/l)	HQ @ Predicted Concentration (4) (unitless)
Arsenic	7440-38-2	0.0003	16	1,000	1	1.0	1	1.0	4.8	34.3	7.1
Benzene	71-43-2	0.003	16	1,000	1	1.0	2	1.0	24	5.40	0.2
Cadmium	7440-43-9	0.0005	16	1,000	1	1.0	1	1.0	8.0	15.0	
T Chromium	7440-47-3	not available									
Chromium III	16065-83-1	1.5	16	1,000	1	1.0	1	1.0	24,000		
Chromium VI	18540-29-9	0.003	16	1,000	1	1.0	1	1.0	48	50	1.0
DDT	50-29-3	0.0005	16	1,000	1	1.0	1	1.0	8.0	0.296	0.04
Ethylbenzene	100-41-4	0.1	16	1,000	1	1.0	2	1.0	800	695	0.9
Ethylene dibromide (EDB)	106-93-4	not available									
Lead	7439-92-1	not available									
Lindane	58-89-9	0.0003	16	1,000	1	1.0	1	1.0	4.8	0.325	0.1
Methylene chloride	75-09-2	0.06	16	1,000	1	1.0	2	1.0	480	4.7	0.01
Mercury (inorganic)	7439-97-6	0.0003	16	1,000	1	1.0	1	1.0	4.8		
MTBE	1634-04-4	not available							20.0	23.6	1.2
Naphthalene	91-20-3	0.02	16	1,000	1	1.0	2	1.0	160		
cPAH Mixtures	na	not available									
Benzo[a]anthracene	56-55-3	not available									
Benzo[b]fluoranthene	205-99-2	not available									
Benzo[k]fluoranthene	207-08-9	not available									
Benzo[a]pyrene	50-32-8	not available									
Chrysene	218-01-9	not available									
Dibenzo[a,h]anthracene	53-70-3	not available									
Ideno[1,2,3-cd]pyrene	207-08-9	not available									

Footnotes:

(1) Source of RfDs is EPA's IRIS database except for benzene which is from EPA's NCEA.

(2) Value calculated using equation 720-1 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. Bolded values indicate predicted concentration exceeds MTCA requirement that HQ not exceed 1.0. MTBE does not have an RfD or CPF. Value shown is predicted concentration divided by health advisory concentration.

Table 4-20 Continued:

Risk Calculations – Noncarcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Reference Dose (1) (mg/kg)	Avg. Body Weight (kg)	Unit Conv. Factor (ug/mg)	Hazard Quotient (unitless)	Drinking H2O Ing. Rate (liters/day)	Inhalation Corr. Factor (unitless)	Drinking H2O Fraction (unitless)		Method B Noncarcinogen (2) (ug/l)		Predicted Concentration (3) (ug/l)	HQ @ Predicted Concentration (4) (unitless)
PCB mixtures	1336-36-3	not available											
High Risk & Persistence		not available											
Low Risk & Persistence		not available											
Lowest Risk & Persistence		not available											
Aroclor 1016	12674-11-2	0.00007	16	1,000	1	1.0	1	1.0		1.1			
Arochlor 1248	12672-29-6	not available											
Arochlor 1254	11097-69-1	0.00002	16	1,000	1	1.0	1	1.0		0.32			
Arochlor 1260		not available											
Tetrachloroethylene (PCE)	127-18-4	0.01	16	1,000	1	1.0	2	1.0		80		4.7	0.1
Toluene	108-88-3	0.2	16	1,000	1	1.0	2	1.0		1,600		964	0.6
1,1,1 Trichloroethane	71-55-6	0.9	16	1,000	1	1.0	2	1.0		7,200		253	0.04
Trichloroethylene	79-01-6	not available											
Xylenes	1330-20-7	2.0	16	1,000	1	1.0	2	1.0		16,000		984	0.06 & 1.0
m-Xylene	108-38-3	not available											
o-xylene	95-47-6	not available											
p-xylene		not available											
Gasoline (5)													

Footnotes:

(1) Source of RfDs is EPA's IRIS database except for 1,1,1 TCE, which is from HEAST

(2) Value calculated using equation 720-1 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. For xylene the first value is the HQ, the second is the ratio of the predicted concentration to odor threshold of 1000 ug/l.

(5) First value for BP composition #4, second value for ARCO composition #5. Both results obtained using 4 phase model to predict ground water impact at a soil gasoline conc. of 30 PPM.

Table 4-21: Calculation of Ground Water Cancer Risk Resulting from Current Method A Soil Cleanup Levels for Industrial Land Use

Risk Calculations – Carcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Risk (unitless)	Avg. Body Weight (kg)	Lifetime (years)	Unit Conv. Factor (ug/mg)	Potency Factor (kg-day/mg)	Drinking H_2O Ing. Rate (liters/day)	Duration of Exposure (years)	Inhalation Corr. Factor (unitless)	Drinking H_2O Fraction (unitless)	Method B Carcinogen (ug/l)	Predicted Concentration (3) (ug/l)	Risk @ Predicted Concentration (4) (unitless)
Arsenic	7440-38-2	1E-06	70	75	1,000	1.5	2.0	30	1	1.0	0.058	342.466	5,870.8
Benzene	71-43-2	1E-06	70	75	1,000	0.029	2.0	30	2	1.0	1.51	88.8	58.9
Cadmium	7440-43-9					not available							
T Chromium	7440-47-3												
Chromium III	16065-83-1					not available							
Chromium VI	18540-29-9					not available							
DDT	50-29-3	1E-06	70	75	1,000	0.34	2.0	30	1	1.0	0.26	0.3687	1.4
1,2 Dichloroethane	107-06-2	1E-06	70	75	1,000	0.091	2.0	30	2	1.0	0.48		
Ethylbenzene	100-41-4					not available						2314.8	
Ethylene dibromide (EDB)	106-93-4	1E-06	70	75	1,000	85	2.0	30	2	1.0	0.00051		
Lead	7439-92-1					not available							
Lindane	58-89-9	1E-06	70	75	1,000	1.3	2.0	30	1	1.0	0.067	644.32	9,572.8
Methylene chloride	75-09-2	1E-06	70	75	1,000	0.0075	2.0	30	2	1.0	5.8	114.8	19.7
Mercury (inorganic)	7439-97-6					not available							
MTBE	1634-04-4					not available						3529	176.5
Naphthalene	91-20-3					not available							
cPAH Mixtures	na												
Benzo[a]anthracene	56-55-3					not available							
Benzo[b]fluoranthene	205-99-2					not available							
Benzo[k]fluoranthene	207-08-9					not available							
Benzo[a]pyrene	50-32-8	1E-06	70	75	1,000	7.3	2.0	30	1	1.0	0.012	0.144500	12.1
Chrysene	218-01-9					not available							
Dibenzo[a,h]anthracene	53-70-3					not available							
Ideno[1,2,3-cd]pyrene	207-08-9					not available							

Footnotes:

(1) Source of Cancer Potency Factor is the oral slope factors fromEPA's IRIS database, except for Lindane which is from HEAST.

(2) Value calculated using equation 720-2 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. This value is expressed in terms of 10-6 risk, that is a value of 19.7 is a risk of 19.7 X 10-6 or 1.97 X 10-5.

Table 4-21 Continued:

Risk Calculations – Carcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Risk (unitless)	Avg. Body Weight (kg)	Lifetime (years)	Unit Conv. Factor (ug/mg)	Potency Factor (kg-day/mg)	Drinking H_2O Ing. Rate (liters/day)	Duration of Exposure (years)	Inhalation Corr. Factor (unitless)	Drinking H_2O Fraction (unitless)	Method B Carcinogen (ug/l)	Predicted Concentration (3) (ug/l)	Risk @ Predicted Concentration (4) (unitless)
PCB mixtures	1336-36-3												
High Risk & Persistence		1E-06	70	75	1,000	2.0	2.0	30	1	1.0	0.044		
Low Risk & Persistence		1E-06	70	75	1,000	0.4	2.0	30	1	1.0	0.22		
Lowest Risk & Persistence		1E-06	70	75	1,000	0.07	2.0	30	1	1.0	1.25		
Aroclor 1016	12674-11-2					not available							
Arochlor 1248	12672-29-6					not available							
Arochlor 1254	11097-69-1					not available							
Arochlor 1260						not available							
Tetrachloroethylene (PCE)	127-18-4	1E-06	70	75	1,000	0.051	2.0	30	2	1.0	0.86	47.1	54.9
Toluene	108-88-3					not available							
1,1,1 Trichloroethane	71-55-6					not available							
Trichloroethylene	79-01-6	1E-06	70	75	1,000	0.011	2.0	30	2	1.0	4.0	75.6	19.0
Xylenes	1330-20-7					not available							
m-Xylene	108-38-3					not available							
o-xylene	95-47-6					not available							
p-xylene						not available							
Gasoline (5)											1.5	11.1 & 20.1	7.35 & 13.31

Footnotes:

(1) Source of Cancer Potency Factor is the oral slope factors from EPA's IRIS database, except for tetrachloroethylene, trichlorothylene and vinyl chloride which are from HEAST.

(2) Value calculated using equation 720-2 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. This value is expressed in terms of 10-6 risk, that is a value of 58.9 is a risk of 58.9 X 10-6 or 5.89 X 10-5.

(5) First value for BP composition #4, second value for ARCO composition #5. Both results obtained using 4 phase model to predict benzene conc. at a soil gasoline conc. of 100 PPM. All values based on benzene. Risk calculated by dividing predicted benzene concentration by Method B benzene value.

Table 4-22: Calculation of Ground Water Cancer Risk Resulting from Proposed Method A Soil Cleanup Levels for Industrial Land Use

Risk Calculations – Carcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Risk (unitless)	Avg. Body Weight (kg)	Lifetime (years)	Unit Conv. Factor (ug/mg)	Potency Factor (kg-day/mg)	Drinking H_2O Ing. Rate (liters/day)	Duration of Exposure (years)	Inhalation Corr. Factor (unitless)	Drinking H_2O Fraction (unitless)	Method B Carcinogen (ug/l)	Predicted Concentration (3) (ug/l)	Risk @ Predicted Concentration (4) (unitless)
Arsenic	7440-38-2	1E-06	70	75	1,000	1.5	2.0	30	1	1.0	0.058	34.3	588.00
Benzene	71-43-2	1E-06	70	75	1,000	0.029	2.0	30	2	1.0	1.51	5.4	3.58
Cadmium	7440-43-9					not available							
T Chromium	7440-47-3												
Chromium III	16065-83-1					not available							
Chromium VI	18540-29-9					not available							
DDT	50-29-3	1E-06	70	75	1,000	0.34	2.0	30	1	1.0	0.26	0.296	1.15
Ethylbenzene	100-41-4					not available							
Ethylene dibromide (EDB)	106-93-4	1E-06	70	75	1,000	85	2.0	30	2	1.0	0.00051		
Lead	7439-92-1					not available							
Lindane	58-89-9	1E-06	70	75	1,000	1.3	2.0	30	1	1.0	0.067	0.325	4.83
Methylene chloride	75-09-2	1E-06	70	75	1,000	0.0075	2.0	30	2	1.0	5.8	4.7	0.81
Mercury (inorganic)	7439-97-6					not available							
MTBE	1634-04-4					not available							
Naphthalene	91-20-3					not available						23.6	
cPAH Mixtures	na												
Benzo[a]anthracene	56-55-3					not available							
Benzo[b]fluoranthene	205-99-2					not available							
Benzo[k]fluoranthene	207-08-9					not available							
Benzo[a]pyrene	50-32-8	1E-06	70	75	1,000	7.3	2.0	30	1	1.0	0.012		
Chrysene	218-01-9					not available							
Dibenzo[a,h]anthracene	53-70-3					not available							
Ideno[1,2,3-cd]pyrene	207-08-9					not available							

Footnotes:

(1) Source of Cancer Potency Factor is the oral slope factors fromEPA's IRIS database, except for Lindane which is from HEAST.

(2) Value calculated using equation 720-2 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. This value is expressed in terms of 10-6 risk, that is a value of 58.9 is a risk of 58.9 X 10-6 or 5.89 X 10-5.

Table 4-22 Continued:

Risk Calculations – Carcinogenic Effects of Drinking Water Ingestion

Hazardous Substance	CAS No.	Risk (unitless)	Avg. Body Weight (kg)	Lifetime (years)	Unit Conv. Factor (ug/mg)	Potency Factor (kg-day/mg)	Drinking H_2O Ing. Rate (liters/day)	Duration of Exposure (years)	Inhalation Corr. Factor (unitless)	Drinking H_2O Fraction (unitless)	Method B Carcinogen (ug/l)	Predicted Concentration (3) (ug/l)	Risk @ Predicted Concentration (4) (unitless)
PCB mixtures	1336-36-3												
High Risk & Persistence		1E-06	70	75	1,000	2.0	2.0	30	1	1.0	0.044		
Low Risk & Persistence		1E-06	70	75	1,000	0.4	2.0	30	1	1.0	0.22		
Lowest Risk & Persistence		1E-06	70	75	1,000	0.07	2.0	30	1	1.0	1.25		
Aroclor 1016	12674-11-2					not available							
Arochlor 1248	12672-29-6					not available							
Arochlor 1254	11097-69-1					not available							
Arochlor 1260						not available							
Tetrachloroethylene (PCE)	127-18-4	1E-06	70	75	1,000	0.051	2.0	30	2	1.0	0.86	4.7	5.48
Toluene	108-88-3					not available							
1,1,1 Trichloroethane	71-55-6					not available							
Trichloroethylene	79-01-6	1E-06	70	75	1,000	0.011	2.0	30	2	1.0	4.0	4.5	1.13
Xylenes	1330-20-7					not available							
m-Xylene	108-38-3					not available							
o-xylene	95-47-6					not available							
p-xylene						not available							
Gasoline (5)											1.51	6.74 & 3.53	4.5 & 2.3

Footnotes:

(1) Source of Cancer Potency Factor is the oral slope factors from EPA's IRIS database, except for tetrachloroethylene, trichlorothylene and vinyl chloride which are from HEAST.

(2) Value calculated using equation 720-2 and default assumptions in that equation.

(3) Concentration in ground water predicted with 3 phase model if current Method A soil cleanup level is used. Values not calculated for soil cleanup levels equal to or greated than current Method A soil cleanup level.

(4) Predicted ground water concentration divided by Method B value. This value is expressed in terms of 10-6 risk, that is a value of 58.9 is a risk of 58.9 X 10-6 or 5.89 X 10-5.

(5) First value for BP composition #4, second value for ARCO composition #5. Both results obtained using 4 phase model to predict benzene conc. at a soil gasoline conc. of 30 PPM. All values based on benzene. Risk calculated by dividing predicted benzene concentration by Method B benzene value.

Table 4-23: Estimated Cost of Adverse Health Effects

Condition	Cost per Case ($)	Measure
Cancer Health Effects		
• All Cancers (non-fatal)	$21,733 (1)	Cost of illness
• Lung Cancer (non-fatal)	$41,184 (1)	Cost of illness
Non-Cancer Health Effects		
• Effects on nervous system	$6,467 (1)	Willingness to pay / contingent valuation
• Effects on respiratory system	$34,228 (1)	Willingness to pay / contingent valuation
• Effects on cardiovascular system	$5,668 (1)	Cost of illness
• Effects on the kidneys	$24,250 (2),(3)	Cost of illness
• Effects on the liver	$222,077 (2),(3)	Cost of illness

Footnotes:

(1) Source: Tolley, G., D. Kenkel, and R. Fabian, *Valuing Health for Policy: An Economic Approach*, The University of Chicago Press (1994).

(2) Source: Cooper, B.S., and D.P. Rice, *The Economic Cost of Illness Revisited*, Social Security Bulletin, pp. 21-36, Feb. 1976.

(3) The estimated costs of illness for effects on the kidneys and liver are based on aggregated values obtained from the source in footnote (2). These aggregated figures were adjusted for a single case based on national statistics obtained from a different source. Accordingly, these figures may not be as reliable.

Notes:

- Values have been adjusted for inflation and converted (when necessary) to an annual basis.
- Values are shown on a per-case basis since available information does not allow application of incidence rates to potentially affected populations.
- Annualization of values originally derived and reported on a daily, weekly, or monthly basis was done in order to provide a common time dimension. However, these rather broad categories of health effects include conditions (e.g., headaches, nausea) that may typically run their course in less than a year. In such cases, the values shown should be adjusted accordingly.
- The reported values are drawn from information generated using different measurement frameworks – the cost of illness approach versus willingness to pay contingent value studies. The further reduces the direct comparability of values for different health effects categories.

Table 4-24: Estimated Incremental Value of a Statistical Life

Hazardous Substance	Cancer Incidence (1)	Estimated Cancer Deaths (2)	Deaths per 100,000	Cumulative Deaths	Death Increment	Cumulative Death Rate per 100,000	Cumulative WTP/hh/yr (3)	Incremental WTP/hh/yr	Cumulative WTP/Death/ hh/yr	Incremental WTP/death/ hh/yr	Cumulative Value of Statistical Life ($/yr)	Incremental Value of Statistical Life ($/yr)
Gasoline range organics	21	9	0.291	9	9	0.290	46	46	5.07	5.07	11,813,865	11,813,865
Trichloroethylene	55	24	0.763	33	24	1.053	74	29	2.28	1.22	5,312,548	$2,838,474
Methylene chloride	58	25	0.805	58	25	1.858	92	18	1.60	0.72	3,736,336	$1,672,851
Tetrachloroethylene	153	66	2.122	123	66	3.980	123	31	1.00	0.47	2,329,288	$1,097,613
Benzene	171	74	2.372	197	74	6.352	147	24	0.75	0.33	1,743,044	$759,353
Lindane	1,469	632	20.376	829	632	26.728	254	107	0.31	0.17	714,928	$394,434
												$18,576,591

Footnotes:

(1) Table 4-4.

(2) Based on a mortality rate of 43%. Mortality rate derived from statistics obtained from the National Cancer Institute (NCI, 2000).

(3) Based on duVair, P. and Loomis, J., *Household's Valuation of Alternative Levels of Hazardous waste Risk Reduction: An Application of the Referendum Format Contingent Valuation Method*, Journal of Environmental Management, Vol. 39, pp. 143-55, 1999.

(4) Based on the size and number of households in Washington State. Washington State Office of Financial Management, Forecasting Division, *1999 Population Trends*, September 1999.

Chapter 5 Technical Analysis – Probable Cost Impact on Petroleum Contaminated Sites

5.1 Introduction

5.1.1 Conceptual Approach

To assess the impact of the proposed rule amendments on costs, an analysis of the impact of the proposed rule amendments on petroleum contaminated sites was conducted. This analysis includes an analysis of the impacts of the following proposed rule amendments:

- Changes to the Method A soil and ground water cleanup levels.
- Establishment of soil cleanup levels – evaluation of the soil-to-ground water pathway.
- Establishment of soil cleanup levels – evaluation of the dermal exposure pathway.
- Establishment of soil cleanup levels – evaluation of the vapor exposure pathway.
- Establishment of soil cleanup levels – conducting a terrestrial ecological evaluation.

Petroleum contaminated sites were selected for this analysis for the following reasons:

- Petroleum contaminated sites represent the largest percentage of cleanup sites.
- Petroleum contaminated sites represent the largest percentage of cleanup sites that use Method A cleanup levels.
- Petroleum hydrocarbons are the most commonly detected hazardous substances at all cleanup sites.

This analysis supplements the generic approach used for estimating the impact of the proposed rule amendments on costs discussed in **Chapter 3**.

5.1.2 Study Design

To assess the impact of the proposed rule amendments on costs, the impact of the current rule (the baseline) must first be evaluated. To assess that impact, Ecology conducted a statewide study of leaking fuel tank sites. A description of that study and the results of that study are presented in **Section 5.2**.

To assess the impact of the proposed rule amendments on petroleum contaminated sites, three "typical" petroleum contaminated sites were developed for analysis based on actual cleanup sites in Washington State. These three site scenarios are as follows:

- **Site "A"** – Commercial gas station with no ground water contamination. This scenario was used to assess the impact of excavating soil to Method A soil cleanup levels.
- **Site "B"** – Commercial gas station with soil and ground water contamination. This scenario was used to assess the impact of treating soil and ground water to Method B cleanup levels.

- **Site "C"** – Industrial facility with soil and ground water (non-potable) contamination.

Analysis of the impact of the proposed rule amendments on these three "typical" sites is presented in **Sections 5.3 through 5.5**.

5.2 Statewide Leaking Fuel Tank Study

5.2.1 Methodology

For the statewide leaking fuel tank site study, Ecology randomly selected twenty nine (29) sites from the January 5, 2000, version of Ecology's Leaking Underground Storage Tank (LUST) list that have received a "No Further Action" letter from Ecology. Specifically, ten (10) sites were selected from Ecology's Northwest and Central Regions, with nine (9) sites selected from Ecology's Southwest Region.

The following data was then collected and compiled for each site:

- The site name, address, city and county;
- BTEX[2], TPH-Gasoline and TPH-Diesel concentrations in both soil and ground water;
- The depth to ground water;
- The type of laboratory analysis used for petroleum constituents; and
- The number of cubic yards of soil removed during cleanup.

Once this information was compiled, the post-cleanup data for each region was sorted and tabulated according to the following six (6) categories:

- Sites where it was not clear what was done (i.e., unknown);
- Sites where petroleum hydrocarbon soil levels were non-detect (ND);
- Sites where petroleum hydrocarbon soil levels were greater than non-detect (ND) but less than the *current* Method A levels;
- Sites where petroleum hydrocarbon soil levels were greater than non-detect (ND) but less than the *proposed* Method A levels;
- Sites where petroleum hydrocarbon soil levels were greater than the *current* Method A levels; and
- Sites where petroleum hydrocarbon soil levels were greater than the *proposed* Method A levels.

In order for a site to qualify as a "non-detect," all the samples had to be non-detect for all petroleum constituents. For sites where soil levels were somewhere between non-detect and existing or proposed Method A, best professional judgement was used to determine a "representative" petroleum hydrocarbon concentration for the site. This type of assessment was necessary because in most situations multiple soil samples from different depths and locations were collected and reported. Best professional judgment was also used to determine

[2] BTEX = benzene, toluene, ethyl benzene and xylene.

representative concentrations for sites where the petroleum hydrocarbon soil concentrations exceeded either current or proposed Method A levels.

5.2.2 Study Results

Compilation and analysis of the data acquired as part of the statewide leaking fuel tank study revealed the following:

- 62% of the sites (18 of 29 sites) were cleaned up to either non-detect (ND) or to levels less than the *current* Method A soil cleanup levels, with 24% of the sites (7 sites) exceeding *current* Method A cleanup levels (**Figure 5-1**).

- Applying the *proposed* Method A cleanup levels the same data set, 49% of the sites were cleaned up to either non-detect (ND) or levels less than the *proposed* Method A cleanup levels, with 38% of the sites (11 sites) exceeding the *proposed* Method A cleanup levels **Figure 5-2**).

- Thus, applying the *proposed* instead of the *current* Method A cleanup levels to the data set resulted in a 14% increase in the number of sites exceeding the applicable cleanup level (i.e., at *current* Method A, seven (7) sites exceeded; at *proposed* Method A, eleven (11) sites exceeded).

A more detailed analysis of the data set also found the following:

- TPH-gasoline was the most frequently detected contaminant (12 of 29 sites or 41%; **Table 5-1**).

- The impact of the *proposed* Method A standards for TPH-gasoline and benzene was more significant than other hazardous substances (toluene, ethylbenzene, and xylene). Specifically, 9 of 12 (75%) sites exceeded the *proposed* TPH-G standard of 30 ppm, while 4 of 4 sites (100%) exceed the *proposed* benzene standard of 0.03 ppm. Conversely, the proposed standards for TPH-diesel, T, E an X had less impact, i.e. 2 of 5 sites (40%) exceeded the proposed standard (7 ppm) for toluene; 3 of 8 sites (37.5%) exceeded the proposed standard (6 ppm) for ethyl benzene and 4 of 9 (44%) sites exceeded the proposed standard (9 ppm) for xylene.

- Benzene and toluene (B & T) were detected in soil less frequently than ethyl benzene and xylene (E & X). This is probably an artifact of water solubility (i.e., B and T are more soluble in water, while E and X are less soluble and are therefore less mobile).

- Even though gasoline was the most frequently detected hazardous substance in soil, 69% of the sites (20 of 29) did not test the ground water for benzene.

- The median amount of petroleum contaminated soil removed (16 sites) was 125 cubic yards; the mean was 713 cubic yards.

- The average ground water depth for 13 sites was 13 feet below ground surface (bgs).

5.2.3 Conclusions

Based on the statewide leaking fuel tank study, Ecology determined that the proposed changes to the Method A cleanup levels under the proposed rule amendments would likely impact only 51% of the sites evaluated. This is based on the fact that 49% of the sites surveyed cleaned up soil to either non-detect or to levels that are below both the current and proposed Method A cleanup levels.

5.3 Site "A" – Commercial Gas Station with Contaminated Soil and No Ground Water Contamination

5.3.1 Site "A" Description

A description of the site is as follows:

- The property is ¼ acre in size (100 x 100 feet) and either paved or covered with buildings.
- The property is zoned for commercial land use.
- The site contains nine fuel tanks (7 gasoline, 1 heating oil and 1 waste oil).
- The soil is contaminated with a gasoline mixture.
- A TPH-gasoline soil concentration of 1,700 ppm was measured at the site.
- The remedy selected for the site consisted of tank removal and excavation and disposal of contaminated soil. Approximately 500 cubic yards of soil was removed during the excavation, stockpiled on site and eventually transported to an in-state facility for disposal. The size of the tank pit area was 30 feet wide, 50 feet long and 12 feet deep (5,400 cubic feet).
- After the soil was excavated, seven (7) samples were collected from the bottom of the tank pit (12 feet deep) and analyzed for TPH-gasoline. The range of gasoline concentrations detected was non-detect (ND) to 12 ppm.
- Ground water was not encountered during the excavation and the site soil was comprised of brown silty-sandy clay.

5.3.2 Site "A" Analysis

The impact of the proposed rule amendments on this "typical" site depends on several factors, including the gasoline composition, the method for establishing soil cleanup levels, the remedy selected for the site, and the volume of contaminated soil.

5.3.2.1 Gasoline Composition

Ecology also derived a representative gasoline composition for this site. This composition was derived using actual data and the four-phase equilibrium partitioning model. First, Ecology derived the composition of fresh gasoline by having one sample of British Petroleum (BP) brand

gasoline sent to a laboratory and analyzed for Volatile Petroleum Hydrocarbons (VPH)[3] and volatile organics (VOA's).[4]

The composition of fresh gasoline was then used as the initial composition in the four-phase model which was encoded in an Excel™ spreadsheet. A soil TPH-gasoline concentration of 100 mg/kg[5] was then selected as the initial soil concentration for each fuel composition. Specifically, once the fresh composition has been entered into the spreadsheet, a simulation was done at 100 mg/kg TPH-gasoline. Each subsequent composition was then determined by summing the amount of gasoline adsorbed to soil plus the amount of gasoline present as a non-aqueous phase liquid (NAPL). That is, the amount of fuel in the air (vapor) and water (soil pore water) was subtracted from the system to simulate weathering of the fresh fuel This represents the parts of the fuel removed by volatization and leaching/biodegradation.

This iterative modeling process resulted in the fuel compositions provided in **Table 5-2**. The median BTEX composition of this data set was then compared to the modeled compositions. This analysis found that composition No. 4 most closely resembled actual field data **(Table 5-3 and Figures 5-3 and 5-4)**.

5.3.2.2 Cleanup Levels

For Site "A," Ecology assumed that soil cleanup levels were established under Method A. Method A soil cleanup levels for TPH-G (TPH-gasoline) and BTEX (benzene, toluene, ethyl benzene and xylene) established under the proposed rule were compared against those established under the current rule. **See Table 5-5**.

Note that soil cleanup levels may only be established using Method A if those levels are protective of terrestrial ecological receptors. For Site "A," Ecology determined that both the current and proposed cleanup levels are protective.

As discussed in Chapter 2, the terrestrial ecological rule amendments will only impact cleanup costs if a terrestrial ecological evaluation were required under the proposed rule, but not the current rule, and that evaluation resulted in additional remedial actions being required. Considering the factors discussed in Chapter 2, Ecology does not consider this likely for most sites.

---

[3] Volatile Petroleum Hydrocarbons (VPH) are defined as all hydrocarbon compounds eluting just prior to n-pentane through 1-methylnaphthalene. VPH is comprised of C5 through C6, >C6 through C8, >C8 through C10 and >C10 through C12 Aliphatic Hydrocarbons, as well as >C8 through C10, >C10 through C12 and >C12 through C13 Aromatic Hydrocarbons as well as benzene and toluene.

[4] Volatile Organics (VOA's). Includes BTEX and MTBE, per Ecology's Manchester Laboratory Method (EPA Method 8020, GC/PID).

[5] 100 ppm was selected because it is a convenient number to work with when dealing with percentages. As it turns out, Ecology found that it really does not matter what number you start with. That is, if you select a higher starting concentration, all it means is that it will take that much longer to redistribute or partition the various gasoline components.

For Site "A," the terrestrial ecological evaluation could end by comparing the ecological indicator soil concentrations in Table 749-3 under WAC 173-340-900 against soil concentrations protective of human health. Specifically, the 30 ppm human health cleanup level is less than the 100 ppm ecological indicator soil concentration for TPH-G. The 100 ppm concentration is expected to be protective at any MTCA site. The selected remedy will not result in residual contamination in excess of that ecological indicator concentration.

Alternatively, Ecology expects that the site could qualify for an exclusion from conducting a terrestrial ecological evaluation. Specifically, the site should qualify for an exclusion under WAC 173-340-7491(1)(b) because the site is, or will be, covered by buildings, paved roads, pavement, or other physical barriers that will prevent plants or wildlife from being exposed to soil contamination. Institutional controls would not be required to obtain this exclusion because the remedy selected will not result in residual contamination in excess of that ecological indicator soil concentrations.

5.3.2.3 Remedy Selection

For Site "A," Ecology assumed that a more permanent remedy would be selected. Assumption of a more permanent remedy is a conservative assumption that highlights the potential cost differential. Assumption of a less permanent remedy that includes engineered and/or institutional controls (such as containment) and results in residual contamination at the site may not result in any cost differential. For this site, Ecology assumed that soil excavation and removal was the selected remedy. This assumption is based on the common use of soil excavation and removal at leaking fuel tank sites in Washington State.

5.3.2.4 Cleanup Costs

For Site "A," the impact of the proposed rule on cleanup costs is based on the amount of soil requiring removal under the proposed rule as compared with current rule. The cleanup cost is based on the volume of soil excavated (cubic yards) multiplied by the unit cost of excavating one cubic yard of soil.

- **Volume of Remediated Soil:** To estimate the amount of soil that would have to be remediated under proposed rule compared to the current rule. Ecology first plotted measured TPH-gasoline soil concentrations[6] against depth **(Figure 5-5)**. The data in this plot were then fitted to a linear regression and a slope of the line through these points was derived. The slope of the straight line (m = 0.0035) through the measured data points was then used to construct hypothetical X,Y data pairs by using the straight line equation y = mx + b. This process resulted in the values specified in **Table 5-4**.

  Hypothetical concentration versus depth profiles for TPH-G and BTEX were then constructed using an assumed composition (No. 4) and the information from the linear regression through the measured data points **(Figure 5-6; Figure 5-7)**.

[6] According to the site report, the highest measured soil TPH-gasoline concentration (1,700 ppm) was detected at 6 feet; with 6.3 – 12 ppm TPH-gasoline detected at 12 feet depth (based of tank excavation).

Once the concentration versus depth profiles were constructed, it was then possible to precisely estimate how much soil would need to be excavated to meet both the current and proposed Method A table soil values (column labeled "y" depth in **Table 5-4**). This analysis assumed that the length (50 feet) and width (30 feet) of the excavation pit remained constant and the only variable was depth.

If TPH-G determined the volume of soil that required remediation, then the proposed rule would require excavation and removal of 14 additional cubic yards of soil. If benzene, and not TPH-G, determined the volume of soil that required remediation, then the proposed rule would require excavation and removal of 73 additional cubic yards of soil. **See Table 5-5.**

- **Unit Cost:** The unit cost was estimated to be **$75 per cubic yard**. This estimation is based on the best professional judgment of site managers and a review of site cleanups.

- **Total Cost:** If TPH-G determined the volume of soil that required remediation, the proposed rule would increase the cleanup cost from $48,667 to $49,668, resulting in a cost differential of **$1,021 or 2.1%. See Table 5-5.**

  If benzene, not TPH-G, determined the volume of soil that required remediation, the proposed rule would increase the cleanup cost from $44,292 to $49,883, resulting in a cost differential of **$5,542 or 11.1%. See Table 5-5.**

5.3.2.5 Evaluation Costs

Under this scenario, Ecology does not expect additional evaluation costs to be incurred under the proposed rule at most sites since additional or more complicated analyses would not be required. To the extent that additional analyses would be required, such as for MTBE, the costs are expected to be minor.

5.3.3 Site "A" Summary

For this site, the impact of the proposed rule amendments on costs is relatively minor. The proposed rule would not result in additional evaluation costs. The proposed rule could result in an increase in cleanup costs of anywhere from **$1,021 to $5,542 (2.1% to 11.1%).**

5.4 Site "B" – Commercial Gas Station with Soil and Ground Water Contamination

5.4.1 Site "B" Description

The description of Site "B" is the same site as Site "A," described in **Section 5.3**, except that the release at the site is assumed to have caused contamination of potable ground water. Specifically, because of the duration of the release and because the base of leaking fuel tanks were in close proximity to the ground water table, the release is assumed to have resulted in the mass of gasoline in the ground water being larger than in the soil. In addition, the release was

assumed to have resulted in a ground water plume larger in area than the area of soil contamination. The following specific assumptions were also made:

- The ground water is classified as potable under WAC 173-340-720.
- A 30 ft. wide x 50 ft. long x 12 ft. deep (18,000 cubic feet) area of soil is uniformly contaminated with 1,700 ppm TPH-gasoline.
- A 15 ft. wide x 50 ft. long x 1.5 ft. deep (1,125 cubic feet) light non-aqueous phase liquid (gasoline) layer is present on the ground water table. It was assumed that the gasoline LNAPL has concentration of 764,000 mg/kg, which is based on a laboratory measurement of fresh gasoline **(Table 5-6)**.
- A dissolved-phase (gasoline components) ground water plume with a uniform concentration of 2.3 mg/l **(see Table 5-12)** is also present beneath the site. The plume has the following dimensions: 30 ft. wide x 100 x long x 12 feet deep.

5.4.2 Site "B" Analysis

The impact of the proposed rule amendments on this "typical" site depends on several factors, including the gasoline composition, the method for establishing soil and ground water cleanup levels, the remedy selected for the site, and the volume or mass of contaminated soil and ground water.

5.4.2.1 Gasoline Composition

The gasoline composition assumed for Site "B" is the same as for Site "A". **See Section 5.3.**

5.4.2.2 Method B Ground Water Cleanup Levels

For Site "B," standard Method B ground water cleanup levels were established under both the current and proposed rules. The current and proposed Method B ground water cleanup levels are presented in Table 5-7.

- Under the current rule, the standard Method B ground water cleanup levels are 1,000 ppb for TPH-G and 1.3 ppb for benzene.
- Under the proposed rule, the standard Method B ground water cleanup levels are 490 ppb for TPH-G and 5 ppb for benzene.

5.4.2.3 Method B Soil Cleanup Levels

For Site "B," standard Method B soil cleanup levels were established under both the current and proposed rules. Derivation of the standard Method B soil cleanup levels included consideration of the direct contact, leaching and vapor pathways for protection of human health. Derivation of soil cleanup levels also included consideration of terrestrial ecological receptors. Under both rules, the cleanup levels are determined by the leaching pathway. The current and proposed Method B soil cleanup levels are presented in **Table 5-7**.

- Under the current rule, the standard Method B soil cleanup levels are 100 ppm for TPH-G and 0.13 ppm for benzene.

- Under the proposed rule, the standard Method B soil cleanup levels are 22 ppm for TPH-G and 0.03 ppm for benzene.

Consideration of each of the exposure pathways is discussed below.

- **Direct Contact Pathway:** Under the current rule, evaluation of the direct contact pathway requires consideration of only the ingestion pathway. Protective soil concentrations were derived using the Interim TPH Policy and the gasoline composition. None of the existing soil concentrations at the site (TPH-G and BTEX) exceeded the protective soil concentrations derived under the current rule. **See Table 5-8.** Under the proposed rule, evaluation of the direct contact pathway for petroleum mixtures requires consideration of both the dermal and ingestion pathways. Protective soil concentrations were derived using Equation 740-3 and the gasoline composition. The protective soil concentrations derived under the proposed rule were greater than those derived under the current rule. However, none of the existing soil concentrations at the site (TPH-G and BTEX) exceeded the protective soil concentrations derived under the proposed rule. **See Table 5-8.** Since the existing soil concentrations are protective under both rules, evaluation of this pathway under the proposed rule would not result in additional cleanup costs. To the extent that the contaminants evaluated are the same, the evaluation costs are expected to be the same.

- **Leaching Pathway:** Under the current rule, the Interim TPH Policy was used to determine whether the existing soil concentrations were protective of ground water. Ecology determined that the existing soil concentrations were not protective, finding that the existing 1,700 ppm TPH-G soil concentration would result in a TPH-G ground water concentration of 2.46 mg/l, which exceeds the criteria of 1 mg/l. **See Table 5-11.** Protective soil concentrations were then derived using the "100 x ground water cleanup level" methodology. **See Table 5-9.** Application of this approach resulted in a protective soil concentration of 100 ppm for TPH-G and 0.13 for benzene. **See Table 5-8.**

  Under the proposed rule, the 4-phase equilibrium partitioning model was used to determine whether the existing soil concentrations were protective of ground water. Ecology determined that the existing soil concentrations were not protective, finding that the existing 1,700 ppm TPH-G soil concentration would result in a TPH-G ground water concentration of 2.3 mg/l, which exceeds the criteria of 0.49 mg/l. **See Table 5-12.** Protective soil concentrations were then derived using the 4-phase model. **See Table 5-13.** Application of this model resulted in a protective soil concentration of 22 ppm for TPH-G and 0.03 for benzene. **See Table 5-8.**

- **Vapor Pathway:** As discussed in Chapter 2, the proposed rule amendment will only impact cleanup costs if an evaluation of the vapor pathway were required under the proposed rule, but not the current rule, and that evaluation resulted in a more stringent soil cleanup level than would have been established without that evaluation. Considering the factors discussed in Chapter 2, Ecology does not consider this likely at most sites. At this site, Ecology assumed that an evaluation of this pathway would not be required under either the current or proposed rule because the concentration derived under the leaching pathway would not likely

cause a concern regarding soil vapors. Thus, additional evaluation or cleanup costs would not be incurred as a consequence of this pathway.

- **Terrestrial Ecological Evaluation:** As discussed in Chapter 2, the proposed rule amendment will only impact cleanup costs if a terrestrial ecological evaluation were required under the proposed rule, but not the current rule, and that evaluation resulted in additional remedial actions being required. Considering the factors discussed in Chapter 2, Ecology does not consider this likely for most sites.

  For Site "B," the terrestrial ecological evaluation could end by comparing the ecological indicator soil concentrations in Table 749-3 under WAC 173-340-900 against soil concentrations protective of human health. Specifically, the 22 ppm human health cleanup level is less than the 100 ppm ecological indicator soil concentration for TPH-G. The 100 ppm concentration is expected to be protective at any MTCA site. The selected remedy will not result in residual contamination in excess of that ecological indicator concentration.

  Alternatively, Ecology expects that the site could qualify for an exclusion from conducting a terrestrial ecological evaluation. Specifically, the site should qualify for an exclusion under WAC 173-340-7491(1)(b) because the site is, or will be, covered by buildings, paved roads, pavement, or other physical barriers that will prevent plants or wildlife from being exposed to soil contamination. Institutional controls would not be required to obtain this exclusion because the remedy selected will not result in residual contamination in excess of the ecological indicator soil concentration.

5.4.2.4 Remedy Selection

For Site "B," Ecology assumed that a more permanent remedy would be selected. Again, assumption of a permanent remedy is a conservative assumption that highlights the potential cost differential. Assumption of a less permanent remedy that included engineered and/or institutional controls (such as containment) and resulted in residual contamination at the site may not result in any cost differential. For this site, Ecology assumed that "dual-phase extraction" would be used to cleanup the soil and ground water simultaneously to meet applicable cleanup standards. Dual-phase extraction consists of soil vapor extraction (SVE) and air sparging of ground water.

5.4.2.5 Cleanup Costs

For Site "B," the cleanup cost is based on the cost of using "dual-phase extraction" to cleanup the soil and ground water to meet the applicable cleanup standards. The mass of soil or ground water contamination that must be removed under either rule is based on the difference between the existing mass of contamination and the mass of contamination at the applicable cleanup level. The cost differential is based on the mass of contamination in the soil and ground water that must be removed under the proposed rule as compared with the current rule.

- **Mass of Contamination:** The existing mass of soil contamination is 1,300 kilograms. This estimate is based on the assumption that the site (50 x 30 x 12 feet) was uniformly contaminated with TPH-G at a concentration of 1,700 ppm. The change in the mass of soil contamination requiring removal is 69.7 kilograms. **See Table 5-14.**

The existing mass of ground water contamination is 17,761 kilograms. This estimate is based on the assumption that the depth to ground water is 12 feet, the soil is uniformly contaminated with TPH-G at a concentration of 1,700 ppm, and the affected aquifer is 100 x 30 x 15 feet. The estimate is also based on assumption that a layer of non-aqueous phase liquid (LNAPL) is present on the ground water table and is 15 x 50 x 1.5 feet. The change in mass of ground water contamination requiring removal is less than 1 kilogram. **See Table 5-14.**

Thus, the total increase in the mass of TPH-G contamination requiring removal from the soil and ground water is **70 kilograms. See Table 5-14.**

Note that the change in the mass of benzene requiring removal from the soil was calculated to be less than 1 kilogram. Note also that there would be no change in the differential mass of benzene requiring removal from the ground water. **See Table 5-14.**

- **Unit Cost of Soil and Ground Water Cleanup (Dual-Phase Extraction):** The unit cost of conducting dual-phase extraction was estimated to be **$65.20 per kilogram.** This estimate is based on the median cost of the costs at four commercial gas stations (**Table 5-15**).

- **Total Cost:** The impact of the proposed rule on cleanup costs was calculated by multiplying the unit cost of dual-phase extraction by the differential mass of soil and ground water contamination that must be removed. That amount was calculated to be **$4,564**, representing an increase of **0.37%. See Table 5-14.**

5.4.2.6 Evaluation Costs

Under this scenario, Ecology does not expect additional evaluation costs to be incurred under the proposed rule since additional or more complicated analyses would not generally be required. In a few circumstances, relatively small increases in the cost of evaluating the leaching or ecological pathways might be incurred.

5.4.3 Site "B" Summary

For Site "B," the impact of the proposed rule amendments on costs is expected to be small. The proposed rule could result in an increase in cleanup costs at Site "B" of **$4,560**, representing an increase of **less than 1%** in cleanup costs. The proposed rule is not expected to result in any significant increase in the costs of conducting any evaluations.

5.5 Site "C" – Industrial Facility with Soil and Non-Potable Ground Water Contamination

5.5.1 Site "C" Description

A description of the site is as follows:

- The property is 5 acres in size and zoned for industrial land use.
- Both the soil and ground water are contaminated with a gasoline mixture.
- The maximum TPH-G soil concentration measured at the site is 10,000 ppm.
- The ground water is demonstrated to be non-potable under WAC 173-340-720.

5.5.2 Site "C" Analysis

The impact of the proposed rule amendments on this "typical" site depends on several factors, including the gasoline composition, the method for establishing soil and ground water cleanup levels, the remedy selected for the site, and the volume or mass of contaminated soil and ground water.

5.5.2.1 Gasoline Composition

The gasoline composition assumed for Site "C" is the same as for site A. **See Section 5.3.**

5.5.2.2 Method C Ground Water Cleanup Levels

For Site "C," Ecology assumed that the ground water was not classified as potable under WAC 173-340-720 under both the current and proposed rules. Under both the current and proposed rule, ground water cleanup levels for ground water that is not classified as potable may be established on a site-specific basis. Consequently, the proposed rule is not expected to result in either additional evaluation costs or lower cleanup levels.

5.5.2.3 Method C Soil Cleanup Levels

For Site "C," Ecology assumed that soil cleanup levels for industrial land use (standard Method C) could be established under both the current and proposed rules. Derivation of standard Method C soil cleanup levels included consideration of the direct contact, leaching and vapor pathways for protection of human health. Derivation of soil cleanup levels also includes consideration of terrestrial ecological receptors.

- **Direct Contact Pathway:** Under the current rule, evaluation of the direct contact pathway requires consideration of only the ingestion pathway. Protective soil concentrations would be derived using the Interim TPH Policy and the Method C equations. The measured TPH-G and benzene concentrations would not exceed the protective soil concentrations derived under the current rule. Under the proposed rule, evaluation of the direct contact pathway for petroleum mixtures requires consideration of both the dermal and ingestion pathways. Protective soil concentrations would be derived using Equations 745-3, 745-4 and 745-5. While the protective soil concentrations derived under the proposed rule would be lower than under the current rule, the measured TPH-G and benzene concentrations would not exceed the protective soil concentrations derived under the proposed rule. Since the existing soil concentrations are protective, evaluation of this pathway under the proposed rule would not result in additional cleanup costs. To the extent that the contaminants evaluated are the same, the evaluation costs are expected to be the same.

- **Leaching Pathway:** Derivation of a soil concentration that is protective of ground water depends on the applicable ground water cleanup level. In this case, the ground water cleanup levels were based on a site-specific analysis and are unknown. Hence, the protective soil

concentrations are unknown. The protective soil concentrations derived under the proposed rule are expected to be relatively similar to those under the current rule. Because similar analyses would be conducted, the proposed rule is not expected to result in additional evaluation costs.

- **Vapor Pathway:** As discussed in Chapter 2, the proposed rule amendment will only impact cleanup costs if an evaluation of the vapor pathway were required under the proposed rule, but not the current rule, and that evaluation resulted in a more stringent soil cleanup level than would have been established without that evaluation. Considering the factors discussed in Chapter 2, Ecology does not consider this likely for most sites. Depending on the evaluation of the leaching pathway, an analysis of the vapor pathway may be required. Evaluation of the pathway may not even require a lower cleanup level. Even if a lower cleanup level were required, Ecology expects that if an evaluation were required under the proposed rule, such an evaluation would also be required under the current rule and would result in the same conclusion. Thus, additional evaluation or cleanup costs would not be incurred as a consequence of this pathway.

- **Terrestrial Ecological Evaluation:** As discussed in Chapter 2, the proposed rule amendment will only impact cleanup costs if a terrestrial ecological evaluation were required under the proposed rule, but not the current rule, and that evaluation resulted in additional remedial actions being required. Considering the factors discussed in Chapter 2, Ecology does not consider this likely for most sites.

  For Site "C," the site might qualify for an exclusion from conducting a terrestrial ecological evaluation. Specifically, the site could qualify for an exclusion under WAC 173-340-7491(1)(b) if the site is, or will be, covered by buildings, paved roads, pavement, or other physical barriers that will prevent plants or wildlife from being exposed to soil contamination. Such containment measures are typical at industrial sites. Institutional controls would be required to obtain this exclusion. However, implementation of these institutional controls would not increase cleanup costs because institutional controls would already be required because Method C was used to establish cleanup levels at the site.

  Alternatively, if the site qualifies for a simplified evaluation, the analysis could end by comparing the priority contaminant soil concentration for industrial sites in Table 749-2 under WAC 173-340-900 against the measured soil concentration. For gasoline, the maximum soil concentration of 10,000 ppm measured at the site is less than the priority contaminant concentration of 12,000 ppm. To end the analysis, an institutional control is required. Again, implementation of these institutional controls would not increase cleanup costs because institutional controls would already be required because Method C was used to establish cleanup levels at the site.

5.5.2.4 Remedy Selection

For Site "C," Ecology assumed that a less permanent remedy would be selected under both the current and proposed rules. More specifically, Ecology assumed that remedy selected would consist of soil treatment and containment and remediation levels to define when those two components are used. Residual contamination above the soil cleanup levels would remain at the

site. Institutional and engineered controls would also be required. Because the ground water cleanup levels are expected to be the same, the cost of cleaning up ground water is expected to be same, irrespective of the remedy selected.

5.5.2.5 Cleanup Costs

For Site "C," the proposed rule is not expected to result in additional cleanup costs. The cost of remediating ground water is not expected to change. Because the ground water cleanup levels are expected to be the same, the cost of cleaning up ground water is expected to be same, irrespective of the remedy selected. The cost of remediating soil is also not expected to change. If a more permanent remedy consisting of soil excavation or treatment were selected for the site, Ecology would expect cleanup costs to increase. However, because a less permanent remedy was selected for this site, the costs are not expected to increase. This is based on the fact that the same engineered and institutional controls would be implemented and the cleanup would result in the same amount of residual contamination.

5.5.3 Site "C" Summary

For Site "C," neither cleanup nor evaluation costs are expected to increase. This conclusion is based in part on the assumption that a less permanent remedy would most likely be selected at such a site. Though unlikely, any increase in costs would be relatively minor, particularly in comparison with the total cost.

5.6 Conclusion

Based on the statewide leaking fuel tank study, Ecology determined that the proposed changes to the Method A cleanup levels under the proposed rule amendments would likely impact only 51% of the sites evaluated. This is based on the fact that 49% of the sites surveyed cleaned up soil to either non-detect or to levels that are below both the current and proposed Method A cleanup levels.

For Site "A," the impact of the proposed rule amendments on costs is expected to be small. The proposed rule would not result in additional evaluation costs. The proposed rule could result in an increase in cleanup costs of anywhere from about **$1,000 to $5,600**, representing an increase in cleanup costs of about **2% to 11%**.

For Site "B," the impact of the proposed rule amendments on costs is also expected to be small. The proposed rule could result in an increase in cleanup costs at Site "B" of **$4,560**, representing an increase of **less than 1%** in cleanup costs. The proposed rule is not expected to result in any significant increase in the costs of conducting any evaluations.

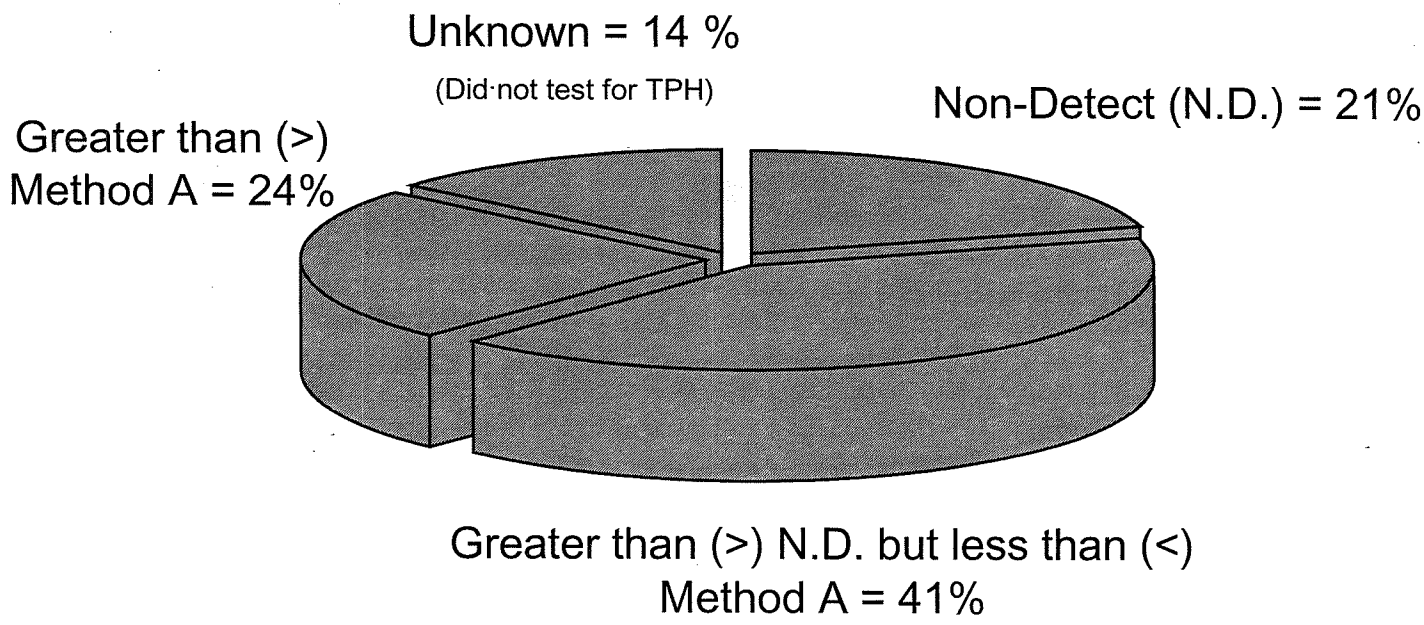
For Site "C," neither cleanup nor evaluation costs are expected to increase. This conclusion is based in part on the assumption that a less permanent remedy would most likely be selected at such a site. Though unlikely, any increase in costs would be relatively minor, particularly in comparison with the total cost.

5.7 Calculations

Figure 5-1: Leaking Fuel Tank Study – Impact of Current Method A Soil Cleanup Levels

Impact of Current Method A Soil Cleanup Levels

62% of All Sites Cleaned-Up to Less than Current Method A Soil Values



N.D. = Non-Detect in Soil

Figure 5-2: Leaking Fuel Tank Study – Impact of Proposed Method A Soil Cleanup Levels

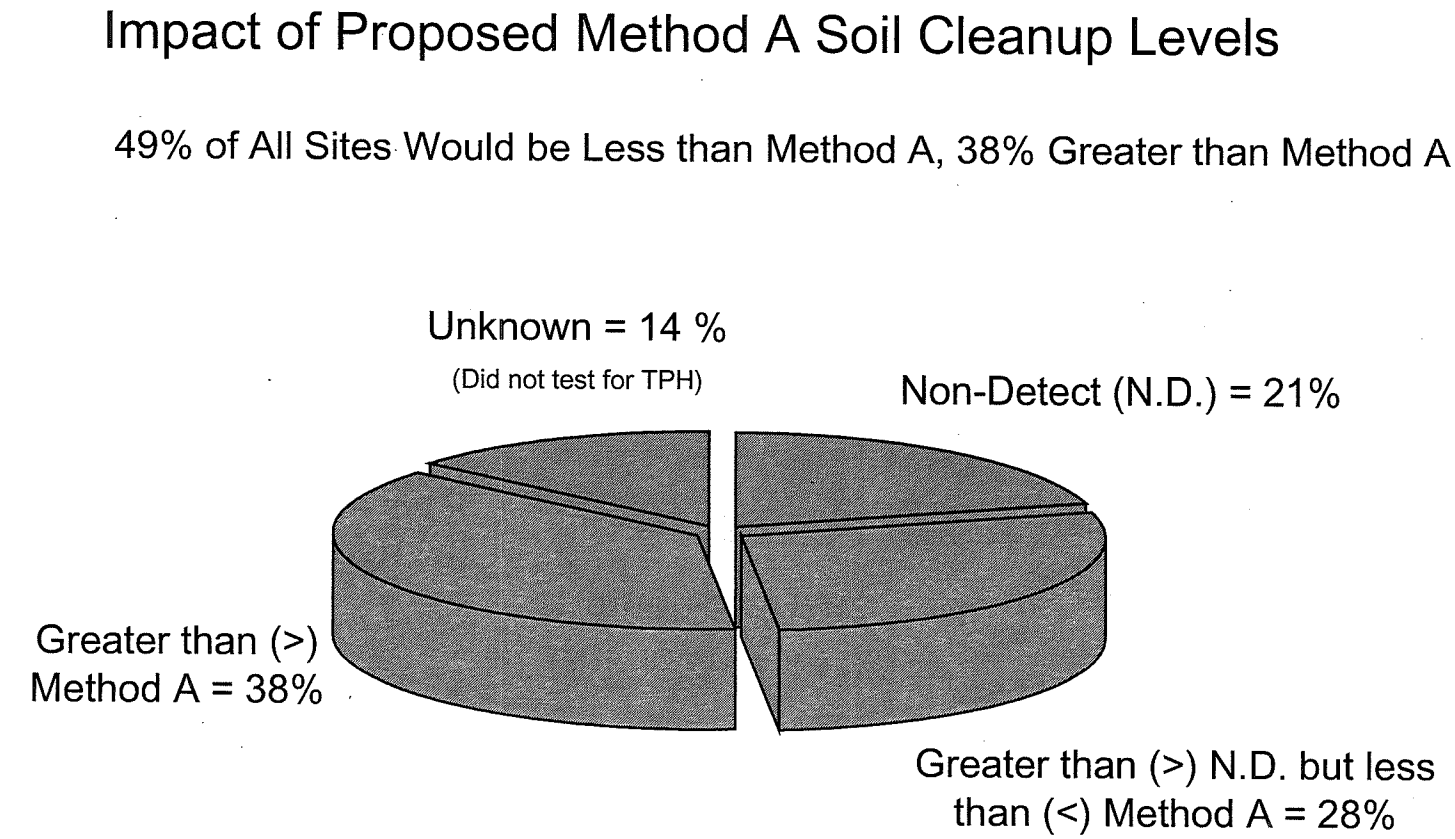


Table 5-1: Leaking Fuel Tank Site Study – Residual Soil Concentrations (12 of 29 Sites)

Site	TPH-G ppm	TPH-D ppm	B ppm	T Ppm	E ppm	X ppm
1	14	655	0.366	0.19	0.009	0.06
2	43	11,000	0.15	4.7	0.3	0.1
3	306	82	7.1	0.23	0.15	0.832
4	110	45	5.3	160	5.35	0.11
5	1,210	39	-	41	0.055	247
6	100	-	-	-	8.3	4.5
7	41	-	-	-	100	78.0
8	730	-	-	-	82	610
9	26	-	-	-	-	250
10	5,900	-	-	-	-	-
11	2,800	-	-	-	-	-
12	9	-	-	-	-	-
Number of Detects (n)	12	5	4	5	8	9
Current Method A	**100**	**200**	**0.5**	**40**	**20**	**20**
Proposed Method A	**30**	**2,000**	**0.1**	**7**	**6**	**9**
Mean Value Detected	869	1,971	3.4	35.2	22.7	120
Median Value Detected	105	82	2.8	4.7	2.8	4.5

Table 5-2: Gasoline Composition Derivation – Fuel Compositions

Equivalent Carbon (EC) Group	Gasoline Fuel Compositions						
	1	2	3	**4**	5	6	7
AL >5-6	28.48%	14.18%	6.4%	**2.640%**	1.09%	0.44%	0.18%
AL >6-8	17.2%	18.1%	16.7%	**14.131%**	11.58%	9.3%	7.29%
AL >8-10	4.6%	6.9%	8.6%	**9.935%**	10.79%	11.4%	11.8%
AL >10-12	5.5%	8.7%	11.5%	**13.808%**	15.59%	17.1%	18.4%
B	2.9%	1.2%	0.4%	**0.127%**	0.04%	0.011%	0.003%
T	7.7%	5.6%	3.5%	**2.003%**	1.11%	0.6%	0.32%
E	1.7%	1.7%	1.4%	**1.135%**	0.87%	0.6%	0.5%
X	8.9%	9.1%	8.0%	**6.427%**	5.00%	3.8%	2.8%
AR >8-10	5.5%	7.9%	9.4%	**10.248%**	10.55%	10.5%	10.4%
AR >10-12	9.2%	13.9%	17.6%	**20.242%**	21.97%	23.2%	24.0%
AR >12-16	6.6%	10.4%	13.5%	**16.106%**	18.04%	19.6%	20.9%
EC >16-21	0.0%	0.0%	0.0%	**0.000%**	0.00%	0.0%	0.0%
EC >21-35	0.0%	0.0%	0.0%	**0.000%**	0.00%	0.0%	0.0%
Naphthalene	1.6%	2.4%	2.9%	**3.198%**	3.37%	3.4%	3.5%
	100%	100%	100%	**100%**	100%	100%	100%

Note: Composition #4 is the most representative of weathered gasoline and was selected based on a comparison with field data. See Table 5-3. Composition #4 was selected as the composition for all three sites – Site "A," Site "B," and Site "C."

Table 5-3: Gasoline Composition Derivation – Soil BTEX Composition Ratios

	Median (16 Sites)	Ecology Comp. No. 4	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
B	0.14%	0.13%	0.06%	0.12%	0.01%	0.80%	0.02%	0.09%
T	1.85%	2.00%	2.82%	2.29%	1.45%	9.81%	0.16%	1.42%
E	1.15%	1.14%	1.64%	0.69%	0.65%	0.00%	0.43%	1.20%
X	7.22%	6.43%	12.14%	4.83%	10.05%	0.00%	3.66%	7.68%

	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
B	0.08%	0.03%	0.16%	0.03%	0.27%	0.18%	0.37%	0.33%
T	1.53%	0.44%	2.17%	0.32%	2.91%	2.50%	3.14%	3.08%
E	1.02%	0.48%	1.25%	0.49%	1.55%	1.37%	1.20%	1.42%
X	8.47%	4.80%	7.33%	3.66%	7.64%	7.12%	8.00%	7.92%

	Site 15	Site 16
B	0.25%	0.20%
T	0.30%	0.98%
E	1.46%	1.09%
X	6.63%	5.29%

Figure 5-3: Gasoline Composition Derivation – Gasoline Weathering Profile

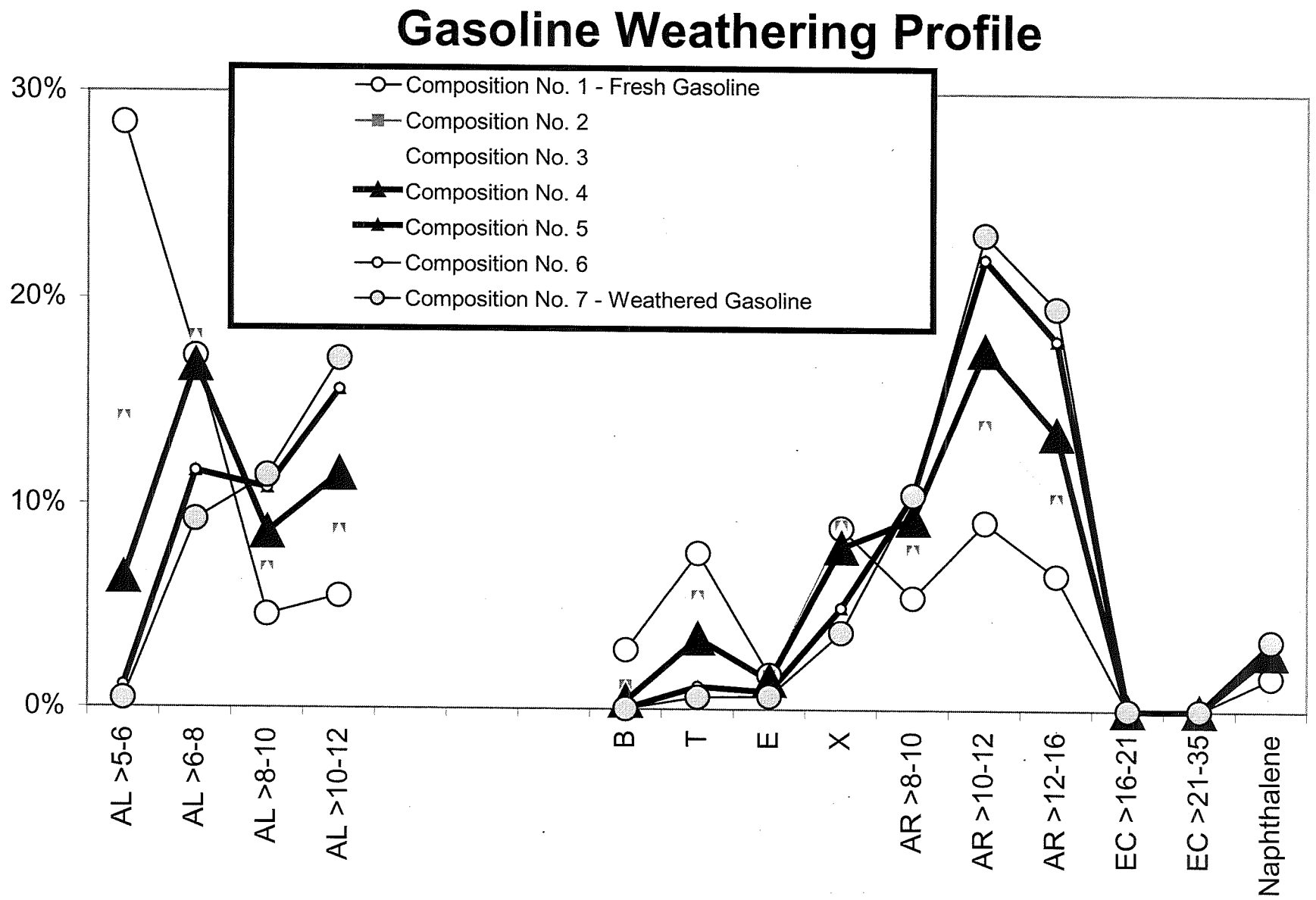


Figure 5-4: Gasoline Composition Derivation – Measured vs. Predicted Soil BTEX Composition Ratios

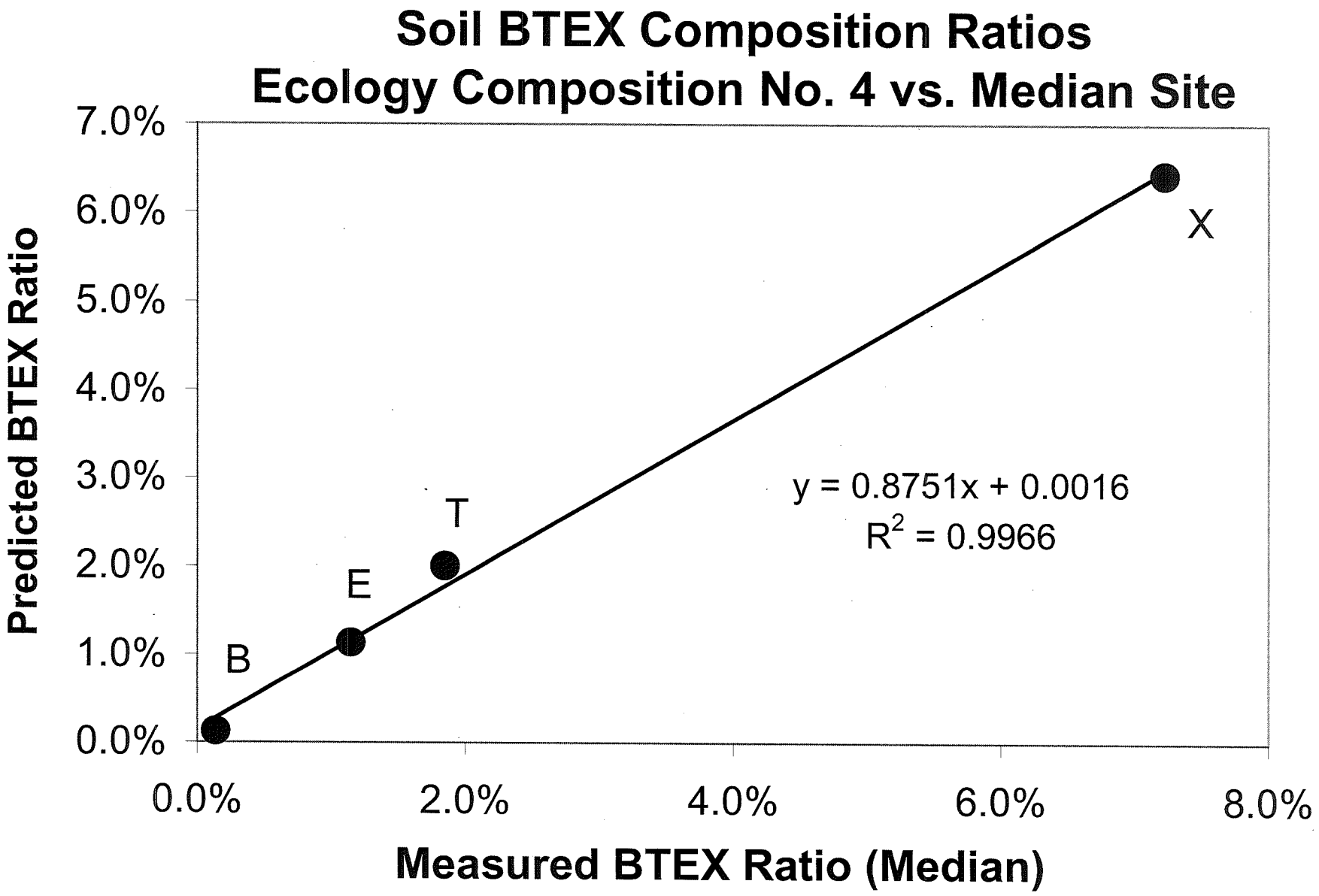


Figure 5-5: Site "A" – Measured Gasoline Soil Concentrations vs. Depth

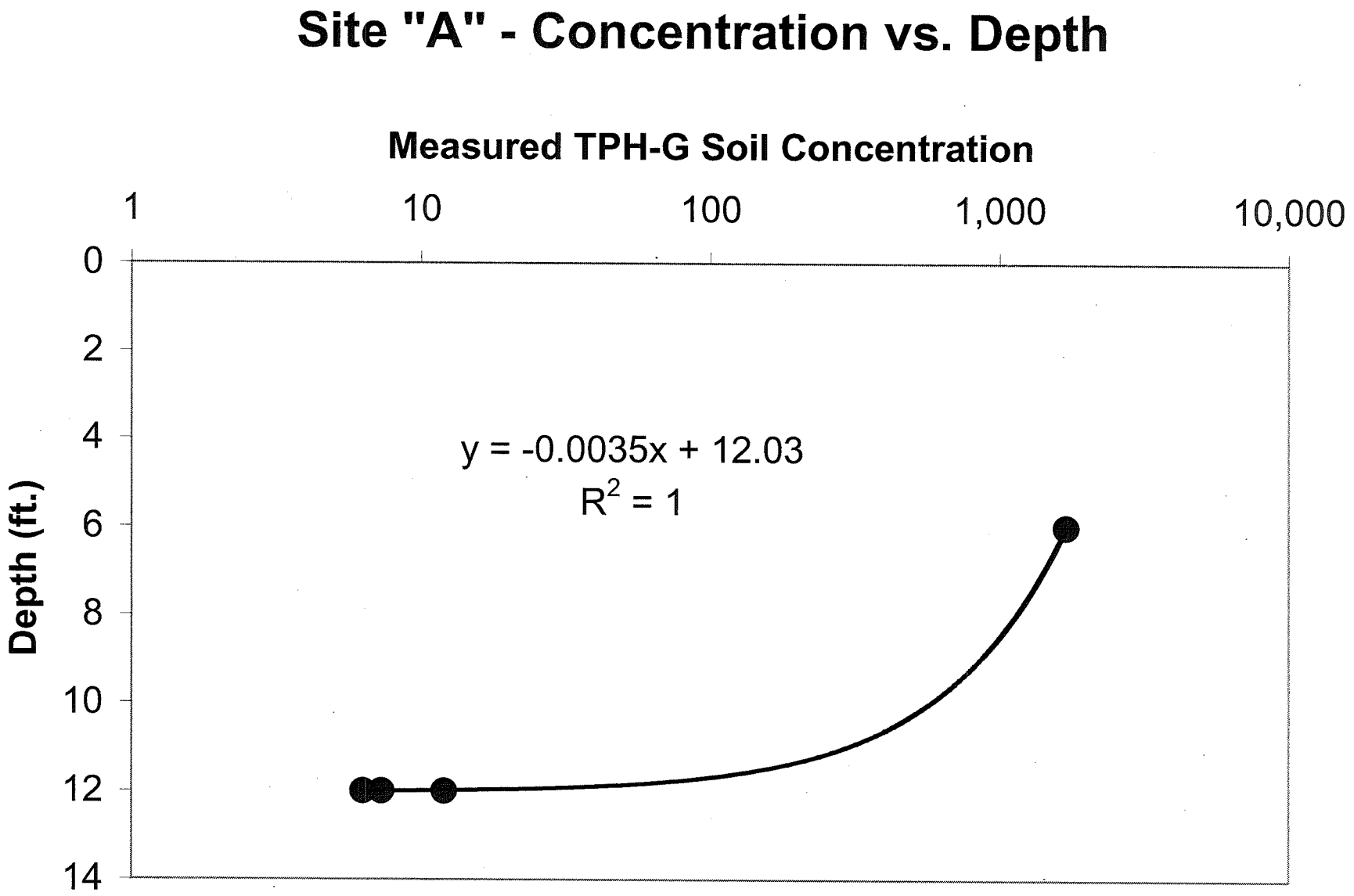


Table 5-4: Site "A" – Hypothetical Soil Data

TPH-G (ppm)	B (ppm)	T (ppm)	E (ppm)	X (ppm)	y (Depth ft)	m (Slope)	b (y-intercept)
10	0.0127	0.200	0.113512	0.6427	**11.995**	-0.0035	12.03
20	0.0254	0.401	0.227025	1.2854	**11.96**	-0.0035	12.03
30	0.0381	0.601	0.340537	1.9282	**11.925**	-0.0035	12.03
40	0.0469	0.801	0.45405	2.5709	**11.89**	-0.0035	12.03
50	0.0507	1.001	0.567562	3.2136	**11.855**	-0.0035	12.03
60	0.0634	1.202	0.681075	3.8563	**11.82**	-0.0035	12.03
70	0.0761	1.402	0.794587	4.4991	**11.785**	-0.0035	12.03
80	0.0888	1.602	0.908099	5.1418	**11.75**	-0.0035	12.03
90	0.1015	1.803	1.021612	5.7845	**11.715**	-0.0035	12.03
100	0.1142	2.003	1.135124	6.4272	**11.68**	-0.0035	12.03
140	0.1268	2.804	1.589174	9.00	**11.54**	-0.0035	12.03
200	0.2537	4.006	2.270249	12.854	**11.33**	-0.0035	12.03
300	0.3805	6.009	3.405373	19.282	**10.98**	-0.0035	12.03
350	0.5074	7.010	3.972935	22.495	**10.805**	-0.0035	12.03
400	0.6342	8.012	4.540497	25.709	**10.63**	-0.0035	12.03
500	0.7611	10.015	5.675621	32.136	**10.28**	-0.0035	12.03
600	0.8879	12.018	6.810746	38.563	**9.93**	-0.0035	12.03
700	1.0148	14.021	7.94587	44.991	**9.58**	-0.0035	12.03
800	1.1416	16.024	9.080994	51.418	**9.23**	-0.0035	12.03
900	1.2685	18.027	10.21612	57.845	**8.88**	-0.0035	12.03
1,000	1.3953	20.030	11.35124	64.272	**8.53**	-0.0035	12.03
1,100	1.5222	22.033	12.48637	70.7	**8.18**	-0.0035	12.03
1,200	1.649	24.036	13.62149	77.127	**7.83**	-0.0035	12.03
1,300	1.7759	26.039	14.75662	83.554	**7.48**	-0.0035	12.03
1,400	1.9027	28.042	15.89174	89.981	**7.13**	-0.0035	12.03
1,500	2.0296	30.045	17.02686	96.409	**6.78**	-0.0035	12.03
1,600	2.1564	32.048	18.16199	102.84	**6.43**	-0.0035	12.03
1,700	2.2833	34.051	19.29711	109.26	**6.08**	-0.0035	12.03
1,800	2.4101	36.054	20.43224	115.69	**5.73**	-0.0035	12.03
1,900	2.537	38.057	21.56736	122.12	**5.38**	-0.0035	12.03
2,000	2.6638	40.060	22.70249	128.54	**5.03**	-0.0035	12.03
2,100	2.7907	42.063	23.83761	134.97	**4.68**	-0.0035	12.03
2,200	2.9175	44.066	24.97273	141.4	**4.33**	-0.0035	12.03
2,300	3.0444	46.069	26.10786	147.83	**3.98**	-0.0035	12.03
2,400	3.1712	48.072	27.24298	154.25	**3.63**	-0.0035	12.03
2,500	3.2981	50.075	28.37811	160.68	**3.28**	-0.0035	12.03
2,600	3.4249	52.078	29.51323	167.11	**2.93**	-0.0035	12.03
2,700	3.5518	54.081	30.64836	173.54	**2.58**	-0.0035	12.03
2,800	3.6786	56.084	31.78348	179.96	**2.23**	-0.0035	12.03
2,900	3.8055	58.087	32.9186	186.39	**1.88**	-0.0035	12.03
3,000	3.9323	60.090	34.05373	192.82	**1.53**	-0.0035	12.03
3,100	4.0592	62.093	35.18885	199.24	**1.18**	-0.0035	12.03
3,200	4.186	64.096	36.32398	205.67	**0.83**	-0.0035	12.03
3,300	4.3129	66.099	37.4591	212.1	**0.48**	-0.0035	12.03
3400	4.313	68.102	38.59423	218.53	**0.13**	-0.0035	12.03

Figure 5-6: Site "A" – Gasoline and Benzene Soil Concentrations vs. Depth

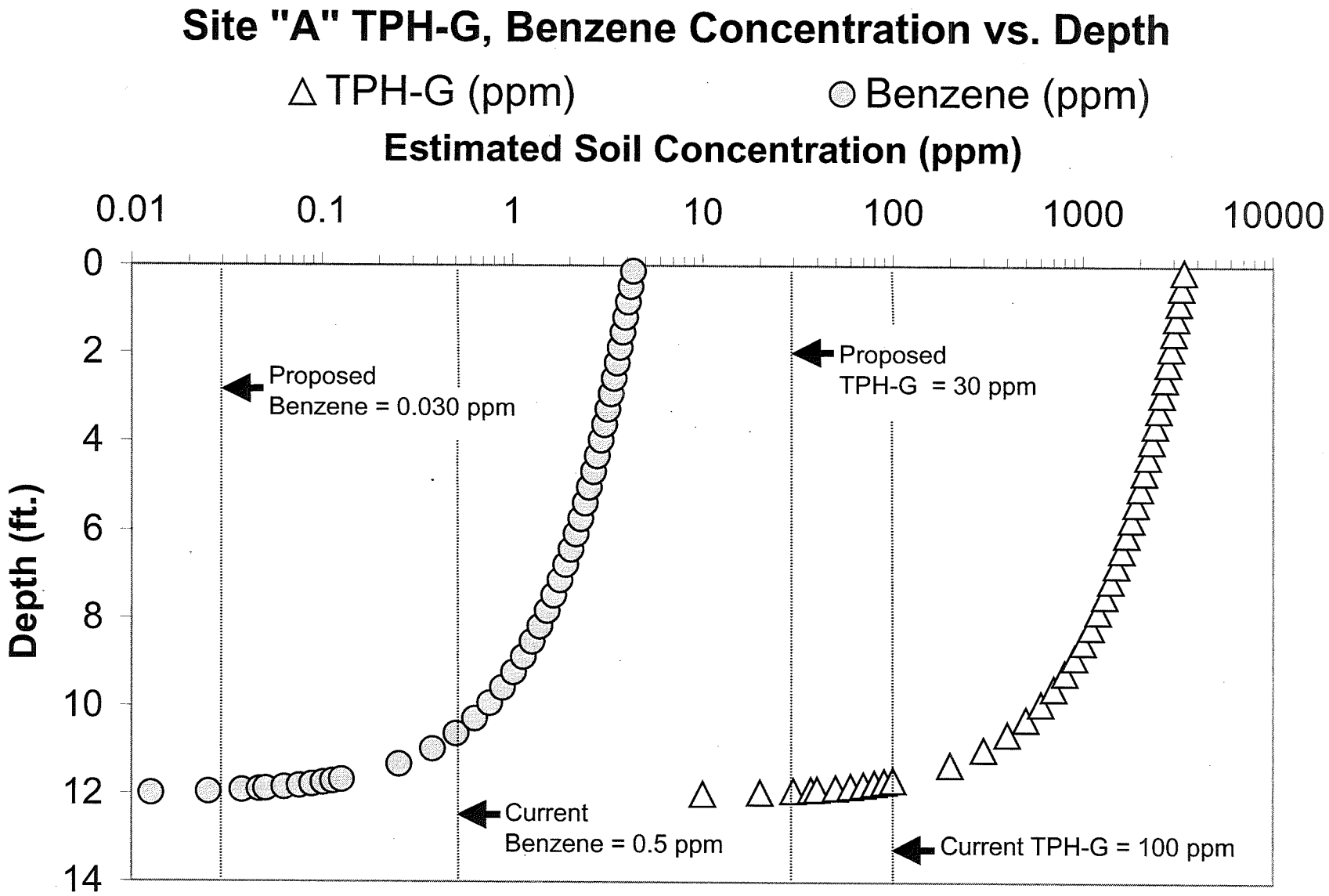


Figure 5-7: Site "A" – Toluene, Ethylbenzene & Xylene Soil Concentrations vs. Depth

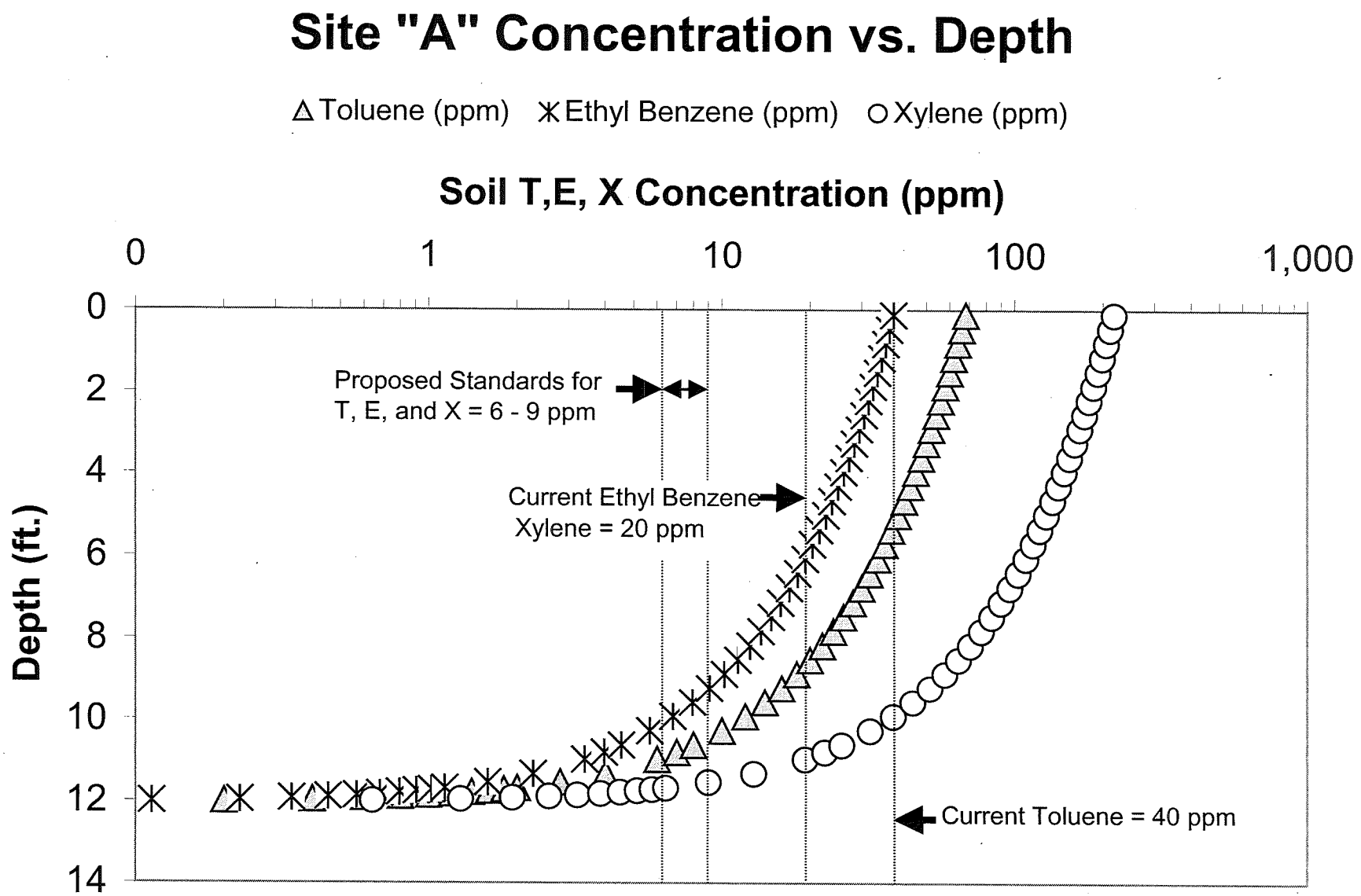


Table 5-5: Site "A" – Cost Estimates for Excavation of Soil to Method A Cleanup Levels

Hazardous Substance	Current Rule			Proposed Rule			Change	
	Cleanup Level (ppm)	Cubic Yards	Cleanup Cost	Cleanup Level (ppm)	Cubic Yards	Cleanup Cost	Δ Cost	% Δ
TPH-G	100	649	$ 48,667	30	663	$ 49,688	$1,021	2.1%
B	0.5	591	$ 44,292	0.03	664	$ 49,833	$5,542	11.1%
T	40	279	$ 20,958	7	600	$ 45,021	$24,063	53.4%
E	20	318	$ 23,875	6	571	$ 42,833	$18,958	44.3%
X	20	610	$ 45,750	9	641	$ 48,083	$2,333	4.9%

Table 5-6: Existing Ground Water Concentrations based on NEAT (Pure) Gasoline Composition

BP Gasoline (NEAT)	Analytical Method	Concentration (mg/kg)	Weight (%)
Aliphatics			
AL 5-6	VPH	194,000	25.4%
AL > 6 – 8	VPH	117,000	15.3%
AL > 8 – 10	VPH	31,300	4.1%
AL > 10 – 12	VPH	37,600	4.9%
Aromatics			
Benzene	GC/PID	19,800	2.6%
Toluene	GC/PID	52,400	6.9%
Ethyl Benzene	GC/PID	11,600	1.5%
Xylene	GC/PID	60,800	7.9%
AR > 8 – 10	VPH	110,000	14.4%
AR > 10 – 12	VPH	74,000	9.7%
Naphthalene	GC/PID	11,200	1.5%
AR > 12 – 13	VPH	45,100	5.9%
TPH-G (sum)		764,800	100%

Source: Ecology Fuel / Water Mixing Experiment.

Table 5-7: Site "B" – Soil and Ground Water Cleanup Levels

Hazardous Substance	Ground Water Cleanup Levels (ppb)		Soil Cleanup Levels (ppm)	
	Current Rule (1)	Proposed Rule (2)	Current Rule (3)	Proposed Rule (4)
TPH-G	1,000	490	100	22
B	1.3	5	0.13	0.03
T	20	61	2	0.4
E	11	29	1.1	0.3
X	64	155	6.4	1.4

Footnotes:
(1) TPH-G based on interim TPH policy; other values based on % composition in fuel.
(2) Based on 4-phase model results.
(3) TPH-G based on 100 X ground water; other values based on % composition in fuel.
(4) Based on 4-phase model results.

Table 5-8: Site "B" – Protective Soil Concentrations: Direct Contact Pathway

Hazardous Substance	Existing Concentrations (ppm)	Protective Soil Concentrations (ppm)	
		Current Rule (1)	Proposed Rule (2)
TPH-G	1,700	3,380	3,870
B	2.2	4.3	4.9
T	34.0	68	77
E	19.3	38	44
X	109.3	217	249

Footnotes:
(1) First value based on interim TPH policy; other values based on % composition in fuel.
(2) First value based on Equation 740-3, others based on % composition in fuel.

Table 5-9: Site "B" – Protective Soil Concentrations: Leaching Pathway

Hazardous Substance	Existing Concentrations (ppm)	Protective Soil Concentrations (ppm)	
		Current Rule (1)	Proposed Rule (2)
TPH-G	1,700	100	22
B	2.2	0.13	0.03
T	34.0	2	0.4
E	19.3	1.1	0.3
X	109.3	6.4	1.4

Footnotes:
(1) First value based on 100 X ground water; other values based on % composition in fuel.
(2) Based on 4-phase model results.

Table 5-10: Site "B" – Calculation of Ground Water Cleanup Levels (Proposed Rule)

Hazardous Substance	Predicted Ground Water Concentration based on the 4-Phase Model (ug/l)	Composition of Predicted Ground Water (%)	Reference Dose (RfD) (mg/kg-day)	Hazard Quotient (HQ) (unitless)	Composition of HQ (%)
Aliphatics					
AL_EC >5-6	8	1.54%	5.7	1.65E-04	0.02%
AL_EC >6-8	18	3.73%	5.7	4.00E-04	0.04%
AL_EC >8-10	3	0.58%	0.03	1.18E-02	1.28%
AL_EC >10-12	1	0.12%	0.03	2.42E-03	0.26%
AL_EC >12-16	0	0.00%	0.03	0.00E+00	0.00%
AL_EC >16-21	0	0.00%	2	0.00E+00	0.00%
AL_EC> 21-34	0	0.00%	2	0.00E+00	0.00%
Aromatics					
Benzene (EC5-7)	5	1.01%	0.003	2.06E-01	22.50%
Toluene (EC>7-8)	61	12.38%	0.2	3.79E-02	4.13%
Ethylbenzene	29	5.90%	0.1	3.61E-02	3.94%
Xylenes	155	31.58%	2	9.67E-03	1.05%
AR_EC >8-10	62	12.64%	0.05	1.55E-01	16.88%
AR_EC >10-12	82	16.71%	0.05	2.04E-01	22.31%
AR_EC >12-16	34	6.94%	0.05	4.25E-02	4.63%
AR_EC >16-21	0	0.00%	0.03	0.00E+00	0.00%
AR_EC >21-35	0	0.00%	0.03	0.00E+00	0.00%
Naphthalene	34	6.87%	0.02	2.10E-01	22.94%
TPH-G (sum)	490	100%		* 0.92	100%

* The reason why the Hazard Index (HI) is less than 1 is because at a soil concentration of 22 mg/kg TPH-G, the predicted ground water benzene concentration is 5 ppb, which is the drinking water Maximum Contaminant Level (MCL). Thus, in this case, the limiting factor is the predicted concentration for benzene and not the HI of 1.

Table 5-11: Site "B" – Protective Soil Concentrations: Leaching Pathway Calculations #1

Under the current rule, the measured TPH-G soil concentration of 1,700 ppm is not protective of ground water because the predicted ground water concentration of 2,464 ppb exceeds the ground water cleanup level of 1,000 ppb and a hazard index of 1.

Hazardous Substance	Gasoline Comp. (%)	Existing Soil Concentration (mg/kg)	Predicted Ground Water Concentration based on I-TPH policy (ug/l)	MW (g/mol)	Moles (mmol/kg)	Mole Fraction	Solubility (mg/l)	Effective Solubility (mg/l)	DF
Aliphatics									
AL > 5-6	2.64%	44.88	59	81.0	5.5E-01	4.2E-02	2.80E+01	1.2E+00	20
AL > 6-8	14.13%	240.22	38	100.0	2.4E+00	1.8E-01	4.20E+00	7.6E-01	20
AL > 8-10	9.94%	168.90	2	130.0	1.3E+00	9.80E-02	3.30E-01	3.2E-02	20
AL > 10-12	13.81%	234.73	0.1	160.0	1.5E+00	1.11E-01	2.60E-02	2.9E-03	20
Aromatics									
B	0.13%	2.16	187.7	78.0	2.8E-02	2.1E-03	1.80E+03	3.8E+00	20
T	2.00%	34.05	726	92.0	3.7E-01	2.8E-02	5.20E+02	1.5E+01	20
E	1.14%	19.30	116	106.2	1.8E-01	1.4E-02	1.69E+02	2.3E+00	20
X	6.43%	109.26	664	106.2	1.0E+00	7.8E-02	1.71E+02	1.3E+01	20
AR > 8-10	10.25%	174.22	356	120.0	1.5E+00	1.1E-01	6.50E+01	7.1E+00	20
AR > 10-12	20.24%	344.11	250	130.0	2.6E+00	2.0E-01	2.50E+01	5.0E+00	20
AR > 12-16	16.11%	273.80	40	150.0	1.8E+00	1.4E-01	5.80E+00	8.0E-01	20
N	3.20%	54.36	27	240.0	2.3E-01	1.7E-02	3.20E+01	5.5E-01	20
TPH-G (sum)	100%	1,700	2,464		13.25516	1.0			

Table 5-12: Site "B" – Protective Soil Concentrations: Leaching Pathway Calculations #2

Under the proposed rule, the measured TPH-G soil concentration of 1,700 ppm is not protective of ground water because the predicted ground water concentration of 2,302 ppb exceeds the ground water cleanup level of 490 and a hazard index of 1.

Hazardous Substance	Predicted Ground Water Concentration (ug/l)	Composition of Predicted Ground Water	Reference Dose (Rfd) (mg/kg-day)	Hazard Quotient (HQ) (Unitless)	Composition of HQ
Aliphatics					
AL_EC >5-6	67	5.22%	5.7	1.47E-03	0.02%
AL_EC >6-8	48	5.91%	5.7	1.05E-03	0.01%
AL_EC >8-10	2	0.43%	0.03	8.77E-03	0.12%
AL_EC >10-12	0	0.06%	0.03	7.87E-04	0.01%
AL_EC >12-16	0	0.00%	0.03	0.00E+00	0.00%
AL_EC >16-21	0	0.00%	2	0.00E+00	0.00%
AL_EC> 21-34	0	0.00%	2	0.00E+00	0.00%
Aromatics					
Benzene (EC 5-7)	124	1.08%	0.003	5.18E+00	68.45%
Toluene (EC >7-8)	639	12.89%	0.2	4.00E-01	5.28%
Ethylbenzene	111	5.76%	0.1	1.39E-01	1.83%
Xylenes	646	30.72%	2	4.04E-02	0.53%
AR_EC >8-10	334	12.19%	0.05	8.34E-01	11.03%
AR_EC >10-12	242	14.99%	0.05	6.05E-01	8.00%
AR_EC >12-16	40	5.26%	0.05	4.96E-02	0.66%
AR_EC >16-21	0	0.00%	0.03	0.00E+00	0.00%
AR_EC >21-35	0	0.00%	0.03	0.00E+00	0.00%
Naphthalene	49	5.48%	0.02	3.06E-01	4.05%
TPH-G (Sum)	2,302	100%		7.56	100%

Table 5-13: Site "B" – Protective Soil Concentrations: Leaching Pathway Calculations #3

Under the proposed rule, the 4-phase equilibrium partitioning model was used to derive soil concentrations that are protective of ground water (i.e., will not cause an exceedance of the ground water cleanup level). The model results indicate that a TPH-G soil concentration of 22 mg/kg will not cause an exceedance of the TPH-G ground water cleanup level of 490 ug/l or a HQ of 1.

Hazardous Substance	Protective Soil Concentration (mg/kg)	Ground Water Composition @ HI = 1 (ug/l)	Reference Dose (RfD) (mg/kg-day)	Hazard Quotient (HQ) (unitless)	Composition of HQ (%)
Aliphatics					
AL_EC >5-6	0.58	8	5.7	1.65E-04	0.02%
AL_EC >6-8	3.11	18	5.7	4.00E-04	0.04%
AL_EC >8-10	2.19	3	0.03	1.18E-02	1.28%
AL_EC >10-12	3.04	1	0.03	2.42E-03	0.26%
AL_EC >12-16	0.00	0	0.03	0.00E+00	0.00%
AL_EC >16-21	0.00	0	2	0.00E+00	0.00%
AL_EC> 21-34	0.00	0	2	0.00E+00	0.00%
Aromatics					
Benzene (EC5-7)	0.03	5	0.003	2.06E-01	22.50%
Toluene (EC>7-8)	0.44	61	0.2	3.79E-02	4.13%
Ethylbenzene	0.25	29	0.1	3.61E-02	3.94%
Xylenes	1.41	155	2	9.67E-03	1.05%
AR_EC >8-10	2.25	62	0.05	1.55E-01	16.88%
AR_EC >10-12	4.45	82	0.05	2.04E-01	22.31%
AR_EC >12-16	3.54	34	0.05	4.25E-02	4.63%
AR_EC >16-21	0.00	0	0.03	0.00E+00	0.00%
AR_EC >21-35	0.00	0	0.03	0.00E+00	0.00%
Naphthalene	0.70	34	0.02	2.10E-01	22.94%
TPH-G (sum)	22.0	490		0.92	100%

Table 5-14: Site "B" – Mass and Cleanup Cost Calculations: TPH-G

	Existing Concentration (mg/kg)	Mass @ Existing Level (kg)	Mass @ Cleanup Level (kg)		Δ Mass (kg)		Δ Total Mass (kg)
			Current Rule	Proposed Rule	Current Rule	Proposed Rule	
TPH-G							
• **Soil**	1,700	1,300	76.5	6.7	1,223	1,293	69.7
• **Ground Water**	*764,800	17,761	0.5	0.3	17,761	17,761	0.3
Total		19,061	77.0	7	18,984	19,054	**70**
Benzene							
• **Soil**	2.2	1.6	0.11	0.030	1.53	1.62	0.08
• **Ground Water**	*19,800	460	0.00082	0.00082	460	460	0
Total		461	0.12	0.031	461	461	0.08

* A 15 ft. wide x 50 ft. long x 1.5 ft deep (1,125 cubic feet) LNAPL (gasoline) layer is present on the ground water table. "LNAPL" means light non-aqueous phase liquid. It was assumed that the gasoline LNAPL has a concentration of 764,000 mg/kg, which is based on a laboratory measurement of fresh gasoline **(Table 5-6)**. Note also that the dissolved-phase ground water plume with a concentration of 2.3 mg/l results in an existing mass of 1.26 kg and does not affect the calculation of the differential mass.

The increased cost of soil and ground water cleanup is then equal to the change in mass of contaminants requiring removal from the soil and ground water x unit cost of removal = 70 kg x $65.20/kg = **$4,564** (an increase of **0.37%**)

Table 5-15: Site "B" – Unit Cost of Dual-Phase Extraction

Site	Soil	Soil TPH (mg/kg)	Ground Water TPH-G + BTEX (mg/l)	LNAPL?	Contamination Removed		Removal Time (Days)	Total Cost ($)	Unit Cost ($/kg)	Year
					Pounds	Kg				
Houston, TX Gasoline Station	Silty-Clay	-	> 30	Yes	36,000	16,329	7,000	$380,000	$23.27	1994
UST Release, Car Rental Lot, Los Angeles, CA	Silty-Clay	1,400 avg 100	-	Yes – 3 ft.	17,000	7,711	196	$600,000	$77.81	1991
Gasoline Station, Indiana	Clay	1,000 – 10,000	1 - 16	Thin layer 1 well	2,500	1,134	142	$331,000	$292.42	1995
Amcor Precast, Ogden UT Gas and diesel	Silty Sand	555 avg.	51 avg	unk	9643	4,374	425	$230,015	$52.59	1992-93
								Average	**$111.52**	
								Median	**$65.20**	

Sources:

(1) U.S. Environmental Protection Agency, Analysis of Selected Enhancements for Soil Vapor Extraction, EPA-542-R-97-007, 1997.
(2) Federal Remediation Technologies Roundtable: Cost and Performance Reports. Web Site: http://clu-in.org/remed1.htm

Chapter 6 Technical Analysis – Probable Costs of Conducting a Terrestrial Ecological Evaluation

6.1 Introduction

To clarify how potential impacts were considered, this analysis describes the terrestrial ecological evaluation process. Following the description of each step in the process, a brief analysis is provided of the potential impacts. To further estimate the impact of the proposed rule amendment on evaluation costs, as well as cleanup costs, three typical site scenarios or case studies were developed and evaluated.

6.2 Case Studies

6.2.1 Commercial Gas Station

The impact of the proposed rule amendment on the cleanup of a commercial gas station is also discussed in **Chapter 5**.

6.2.1.1 Site Description

Soil has been contaminated by a release from an underground storage tank at a gas station location in a town's commercial area. All of the property is paved and all of the soil contamination is beneath this paved area.

6.2.1.2 Analysis

Part 1 – Simple Exclusions (WAC 173-340-7491(1)):

Evaluation of the site to establish whether it qualifies for an exclusion is optional. Instead of attempting to qualify for an exclusion, a site-specific evaluation may be conducted or the criteria in WAC 173-340-7491(2) may be used to decide whether the site qualifies for a simplified evaluation.

The exclusion criteria can be evaluated in any order. If the site meets any one of the criteria it is not necessary to evaluate the other criteria.

(a) WAC 173-340-7491(1)(a): This site does not qualify under this exclusion because surface soil is contaminated.

Making this determination does not require special information needs.

(b) WAC 173-340-7491(1)(b): This site qualifies for an exclusion under this provision because the contaminated soil is covered by paving.

Making this determination does not require special information needs. To obtain an exclusion under this provision, an institutional control is required to ensure that the paving is maintained in the future. If residual contamination above health-based cleanup levels remains after cleanup, an institutional control would also be required to protect human health. Thus, no additional cleanup costs would be incurred.

(c) WAC 173-340-7491(1)(c): This site qualifies for an exclusion under this provision because there is less than 1.5 acres of contiguous undeveloped land within 500 feet of the site.

A city or county planning department map and ground-truthing may be used to decide whether the site qualifies for this exclusion. Alternatively, an aerial photograph could be used. Aerial photographs are available from sources such as the Washington Department of Natural Resources Division of Photo and Map Sales, which also provides information on other aerial photograph resources. Estimated cost is $30. Information is available at http://www.wa.gov/dnr/htdocs/ger/specmate.htm

6.2.2 Industrial Site

6.2.2.1 Site Description

The site consists of soil contaminated at a former metal plating facility located in an industrial area of a large city. The site covers about 3 acres (450 ft by 300 ft) and borders on a multiple lane highway. Contaminants found throughout the site include cadmium, chromium, lead, nickel and zinc.

6.2.2.2 Analysis

Part 1 – Determining whether the site qualifies for a simple exclusion under WAC 173-340-7491(1):

Evaluation of the site to establish whether it qualifies for an exclusion is optional. Instead of attempting to qualify for an exclusion, a site-specific evaluation may be conducted or the criteria in WAC 173-340-7491(2) may be used to decide whether the site qualifies for a simplified evaluation.

The exclusion criteria can be evaluated in any order. If the site meets any one of the criteria it is not necessary to evaluate the other criteria.

(a) WAC 173-340-7491(1)(a): This site does not qualify under this exclusion because surface soil is contaminated.

Making this determination does not require special information needs.

(b) WAC 173-340-7491(1)(b): This site does not qualify for an exclusion under this provision because the contaminated soil is not covered.

Making this determination does not require special information needs.

(c) WAC 173-340-7491(1)(c): This site could qualify for an exclusion under this provision if there is less than 1.5 acres of contiguous undeveloped land within 500 feet of the site.

A city or county planning department map and ground-truthing may be used to decide whether the site qualifies for this exclusion. Alternatively, an aerial photograph could be used. Aerial photographs are available from sources such as the Washington Department of Natural Resources Division of Photo and Map Sales, which also provides information on other aerial photograph resources. Estimated cost is $30. Information is available at http://www.wa.gov/dnr/htdocs/ger/specmate.htm

Part 2 – Determining whether a site-specific terrestrial ecological evaluation is required or whether a simplified evaluation may be conducted under WAC 173-340-7491(2)(a):

For sites that do not qualify for a simple exclusion, the criteria under WAC 173-340-7491(2) are used to identify sites where ecological values require a site-specific evaluation. For all other sites, the less conservative and easier to use simplified evaluation procedure may be used.

(a) WAC 173-340-7491(2)(a)(i): Areas where management or land use plans will maintain or restore native or semi-native vegetation.

These may include, for example, areas set aside as open space, green belts, or environmentally sensitive areas. There is a high potential for future ecological exposure in these areas, which may increase over time where surrounding areas become developed.

This criteria does not apply to this site because the adjoining land is intensively used for industrial activities.

At some sites evaluation of this condition may require consultation with adjacent property owners and local city or county planning departments. (Note that the condition applies to the site, not the boundary of the property where the site is located. A property adjoining a greenbelt, for example, would not necessarily trigger a requirement for a site-specific terrestrial ecological evaluation unless the site was located adjacent to the greenbelt.)

(b) WAC 173-340-7491(2)(a)(ii): Sites used by listed species.

Listed species include threatened or endanged species designated by the Washington State Department of Fish and Wildlife as "priority species" or "species of special concern;" or a plant species listed in the Washington State Department of Natural Resources Natural Heritage Program's "Endangered, Threatened, and Sensitive Vascular Plants of Washington" publication.

This criteria does not apply to this site.

In this case, the location in an industrial area and the nature of the site provides sufficient information for a decision. For a site where there was some uncertainty, the evaluator could contact the Washington Department of Fish and Wildlife and the Washington Department of Natural Resources to consult their GIS databases. Cost would be about $70. Information to assist in making an enquiry is available at http://www.wa.gov/wdfw/hab/phspage.htm and http://www.wa.gov/dnr/htdocs/fr/nhp/order/fsorder.htm

(c) WAC 173-340-7491(2)(a)(iii): Areas of 10 or more acres of native vegetation within 500 feet of the site.

Area and plant community characteristics are used as operational predictors of ecological exposure (frequency, duration, number of individuals and taxa potentially exposed). In general, a larger block of vegetation is expected to attract more use than a smaller block, and native plant communities are similarly expected to support higher biotic diversity than plant communities composed of exotic, weedy plant species.

This criteria does not apply to this site.

There are no special information needs for this analysis. The property is less than 10 acres and there is one tree on the property.

Based on this analysis, this site is eligible for a simplified terrestrial ecological evaluation under WAC 173-340-7492.

Part 3 – Simplified Terrestrial Ecological Evaluation under WAC 173-340-7492:

The Simplified Evaluation for this site ends under WAC 173-340-7492(2)(a)(ii), with a determination that substantial wildlife exposure is unlikely.

Table 749-1 must be used to make this determination. The table requires an estimation of the area of contiguous land on the site or within 500 feet of any area on the site to the nearest half acre. A city or county planning department map and ground-truthing may be used to make this determination. Alternatively, an aerial photograph could be used. Aerial photographs are available from sources such as the Washington Department of Natural Resources Division of Photo and Map Sales, which also provides information on other aerial photograph resources. Estimated cost is $30. Information may be obtained at the following web site: http://www.wa.gov/dnr/htdocs/ger/specmate.htm. The table also requires a determination of the habitat quality of the site. While this evaluation should be undertaken by an experienced field biologist, a conservative estimate may be used as indicated in the table. Only a few hours of a biologist's time would be expected. The table also requires knowledge of the contaminants on the site. This information should already be available as part of the remedial investigation of the site.

6.2.3 City Park Site

6.2.3.1 Site Description

The site consists of soil contaminated by a former wood treating facility and is now part of a 24 acre city park. The site covers about 0.7 acres and is located within the park. The park is maintained as mown lawn for sports activities such as baseball and soccer. Contaminants of concern at the site include benzo(a)pyrene and pentachlorophenol.

6.2.3.2 Analysis

Part 1 – Determining whether the site qualifies for a simple exclusion under WAC 173-340-7491(1):

Evaluation of the site to establish whether it qualifies for an exclusion is optional. Instead of attempting to qualify for an exclusion, a site-specific evaluation may be conducted or the criteria in WAC 173-340-7491(2) may be used to decide whether the site qualifies for a simplified evaluation.

The exclusion criteria can be evaluated in any order. If the site meets any one of the criteria it is not necessary to evaluate the other criteria.

(a) WAC 173-340-7491(1)(a): This site does not qualify under this exclusion because surface soil is contaminated.

Making this determination does not require special information needs.

(b) WAC 173-340-7491(1)(b): This site does not qualify for an exclusion under this provision because the contaminated soil is not covered.

Making this determination does not require special information needs.

(c) WAC 173-340-7491(1)(c): This site does not qualify for an exclusion under this provision because there is more than 1.5 acres of contiguous undeveloped land within 500 feet of the site.

A city or county planning department map and ground-truthing may be used to decide whether the site qualifies for this exclusion. Alternatively, an aerial photograph could be used. Aerial photographs are available from sources such as the Washington Department of Natural Resources Division of Photo and Map Sales, which also provides information on other aerial photograph resources. Estimated cost is $30. Information is available at http://www.wa.gov/dnr/htdocs/ger/specmate.htm

Part 2 – Determining whether a site-specific terrestrial ecological evaluation is required or whether a simplified evaluation may be conducted under WAC 173-340-7491(2)(a):

For sites that do not qualify for a simple exclusion, the criteria under WAC 173-340-7491(2) are used to identify sites where ecological values require a site-specific evaluation. For all other sites, the less conservative and easier to use simplified evaluation procedure may be used.

(a) WAC 173-340-7491(2)(a)(i): Areas where management or land use plans will maintain or restore native or semi-native vegetation.

These may include, for example, areas set aside as open space, green belts, or environmentally sensitive areas. There is a high potential for future ecological exposure in these areas, which may increase over time where surrounding areas become developed.

This criteria does not apply to this site because the site is part of a park maintained for intensive sport activities such as baseball and soccer. Although there are greenbelts bordering the park, the site is not directly adjacent to these areas.

At some sites evaluation of this condition may require consultation with adjacent property owners and local city or county planning departments. (Note that the condition applies to the site, not the boundary of the property where the site is located. A property adjoining a greenbelt, for example, would not necessarily trigger a requirement for a site-specific terrestrial ecological evaluation unless the site was located adjacent to the greenbelt.)

(b) WAC 173-340-7491(2)(a)(ii): Sites used by listed species.

Listed species include threatened or endanged species designated by the Washington State Department of Fish and Wildlife as "priority species" or "species of special concern;" or a plant species listed in the Washington State Department of Natural Resources Natural Heritage Program's "Endangered, Threatened, and Sensitive Vascular Plants of Washington" publication.

This criteria does not apply to this site.

In this case, the nature of the site (an area of mown lawn within a sports park) provides sufficient information for a decision. For a site where there was some uncertainty, the evaluator could contact the Washington Department of Fish and Wildlife and the Washington Department of Natural Resources to consult their databases for this property. Cost would be about $70. Information to assist in making an enquiry is available at http://www.wa.gov/wdfw/hab/phspage.htm and http://www.wa.gov/dnr/htdocs/fr/nhp/order/fsorder.htm

(c) WAC 173-340-7491(2)(a)(iii): Areas of 10 or more acres of native vegetation within 500 feet of the site.

Area and plant community characteristics are used as operational predictors of ecological exposure (frequency, duration, number of individuals and taxa potentially exposed). In general, a larger block of vegetation is expected to attract more use than a smaller block,

and native plant communities are similarly expected to support higher biotic diversity than plant communities composed of exotic, weedy plant species.

This criteria does not apply to this site.

A city or county planning department map, and ground-truthing, may be used to decide whether the site meets this criterion. Alternatively, an aerial photograph could be used. Aerial photographs are available from sources such as the Washington Department of Natural Resources Division of Photo and Map Sales, which also provides information on other aerial photograph resources. Estimated cost is $30. Information is available at http://www.wa.gov/dnr/htdocs/ger/specmate.htm

Based on this analysis, this site is eligible for a simplified terrestrial ecological evaluation under WAC 173-340-7492.

Part 3 – Simplified Terrestrial Ecological Evaluation under WAC 173-340-7492:

The Simplified Evaluation also provides options for terminating the evaluation without any additional cleanup requirements. The options can be evaluated in any order and the evaluation can be terminated if any one of the criteria apply to the site. For this site, the evaluation ends under WAC 173-340-7492(2)(a)(ii), with a determination that substantial wildlife exposure is unlikely.

Table 749-1 must be used to make this determination. The table requires an estimation of the area of contiguous undeveloped land on the site or within 500 feet of any area on the site to the nearest half acre. A city or county planning department map and ground-truthing may be used to make this determination. Alternatively, an aerial photograph could be used. Aerial photographs are available from sources such as the Washington Department of Natural Resources Division of Photo and Map Sales, which also provides information on other aerial photograph resources. Estimated cost is $30. Information may be obtained at the following web site: http://www.wa.gov/dnr/htdocs/ger/specmate.htm. The table also requires a determination of the habitat quality of the site. While this evaluation should be undertaken by an experienced field biologist to derive a score, the conservative estimate (score) provided in the table may be used instead. If a field evaluation is conducted, only a few hours of a biologist's time would be expected. The table also requires knowledge of the contaminants on the site. This information should already be available as part of the remedial investigation of the site.

If the site had been one acre in size, then it would not have met this criterion. However, this would not result in more stringent soil cleanup levels or additional remedial actions since the Method A and Method B cleanup levels for benzo(a)pyrene and pentachlorophenol are more stringent than Table 749-2 ecologically-based values.

6.3 Conclusion

In summary, based on the impact analysis in Chapter 2 (see Section 2.6) and the evaluation of case studies in this chapter, Ecology has made the following determinations. First, only if a

simplified or site-specific terrestrial ecological evaluation were required under the proposed rule, but not under the current rule, and only if that evaluation resulted in additional remedial actions would the proposed rule result in additional cleanup costs. Considering the factors discussed in Chapter 2 and the results of the three case studies, Ecology does not expect that the proposed rule amendments will result in lower soil cleanup levels or additional cleanup actions being required at most sites. Consequently, Ecology does not expect that the proposed rule will result in additional cleanup costs at most sites.

Second, the cost of conducting a terrestrial ecological evaluation under the proposed rule is expected to be small at most sites, irrespective of whether such an evaluation were conducted under the current rule. This conclusion is based on two factors. One, as demonstrated by these case studies and the Terrestrial Environmental Evaluation Pilot Study (Ecology, 1999), most sites are expected to either obtain an exclusion or conduct a simplified evaluation. Two, as demonstrated by both these case studies and the Pilot Study, the cost of either obtaining an exclusion or conducting a simplified evaluation is small.

Third, even if the proposed rule amendment does not require additional cleanup actions, Ecology expects that the proposed rule amendment will expedite and facilitate cleanups at most sites by providing a clear and consistent process for ensuring the potential ecological threats from soil contamination are adequately considered in site cleanups. Furthermore, by establishing criteria for ecological protectiveness and defining a tiered process for evaluating potential threats from soil contamination to terrestrial ecological receptors, the proposed rule amendment provides the most cost-effective approach to meeting the statutory requirement that cleanup actions not only protect human health, but also the environment.

Chapter 7 Technical Analysis – Probable Cost Impact of Financial Assurances

7.1 Introduction

The purpose of this chapter is to estimate the cost of requiring financial assurances at a site. This analysis assumes that financial assurances would be required under the proposed rule, but not the current rule. Whether financial assurances would actually be required under the proposed rule, but not the current rule, is discussed in Chapter 2.

The analysis first identifies the types of remedial actions that may require coverage. Second, the analysis estimates the potential cost of obtaining that type of coverage under various mechanisms. Third, the analysis examines the potential cost of financial assurances for a single, more complex site to determine a high-end estimate of probable costs.

7.2 Coverage

The purpose of this section is to identify the categories of remedial action activities where the site could be required to "assure" resources are available and in place to provide for the long-term effectiveness of engineering and institutional controls. Financial assurances may be required to cover one or more of the following three categories: operation and maintenance, compliance monitoring, and corrective measures.

- **Operation and Maintenance**

First, financial assurances may be required to cover the cost of operation and maintenance activities. These activities may include routine facility inspections; maintenance of the function and integrity of the containment system; continuation of processes necessary for waste degradation on-site; maintenance of a monitoring system for run-on and run-off control; maintaining a ground water and soil monitoring system; operating and maintaining a leak detection system, if a double liner system is present; providing for an unsaturated zone soil monitoring system; operating a leachate collection, detection and removal system; and operating and maintaining a security system such as fencing or warning signs. The frequency of these activities should rely on past experience and sound engineering practices.

- **Compliance Monitoring**

Second, financial assurances may be required to cover the cost of compliance monitoring. Monitoring activities could include ground water monitoring, soil monitoring, leak detection monitoring, gas monitoring, and long-term monitoring for on-site disposal, isolation, or containment. Where the cleanup action includes engineered controls or institutional controls, the monitoring will be required until residual hazardous substance concentrations no longer exceed site cleanup levels.

- **Corrective Measures**

Third, financial assurances may be required to cover the cost of corrective measures. While it may be difficult to predict, the extent to which the final cover will require replacement should be a contingency cost estimate based on damages caused by severe storms or other periodic natural events that could be predicted to occur during the time that contamination will remain on site. Capital replacement costs, such as the cost of replacing a geomembrane or liner for capped contamination, are included in this category.

7.3 Cost of Coverage

The purpose of this section is to estimate the potential cost of financial assurances. The cost is dependent on the type and amount of coverage required, which is dependent on many site-specific factors. The cost is also dependent on the mechanism selected.

7.3.1 Methodology for Estimating Costs

The estimated cost of financial assurances is based on the following:

- The cost of selecting a financial assurance mechanism (administrative cost);
- The cost of establishing a financial assurance mechanism (administrative cost); and
- The cost of the financial assurance mechanism.

The cost of establishing a financial assurance mechanism and the cost of that mechanism are dependent on the mechanism selected.

The first step in estimating the costs of compliance was to identify the specific activities necessary for compliance. Those activities may depend on the site and the financial assurance mechanism selected. The second step is to determine the amount and type of labor needed (e.g., facility engineer and consultant) to accomplish each task. The third step is to develop unit cost estimates for each unit of labor. The costs or prices presented in this document are based on cost information obtained through vendor contacts; a review of background documentation used to support specific MTCA activities; professional journals; technical reports; and best professional judgment. The final step is to estimate the total costs by multiplying the unit cost by the number of units. Throughout this section, all dollar values have been presented in 1997 dollars.

Labor rates and hourly estimates were developed based on "Estimating Costs for the Economic Benefits of RCRA Noncompliance," dated September 1997 and a December 1997 update, prepared for EPA's RCRA Enforcement Division by Science Applications International Corporation with initial drafting by DPRA, Incorporated under EPA contracts. DPRA is an environmental engineering consulting. Depending on the circumstances, the "typical" hour amount may consist of the median, the mean, or an estimated derived from best professional judgment. The "typical" cost estimate is derived from information obtained from professional sources. Labor rates are "burdened;" that is, the hourly rate includes wages, fringe benefits, overhead and profit.

The cost estimates are also based on the following assumptions:

- The same financial assurance mechanism(s) throughout the period.
- The cost estimates for the amount of assured costs will not significantly change.
- A consulting firm will be used to estimate the assured costs.
- The trustee fees represent the average trustee fee over the pay-in period. During that time, the trust fund will increase steadily from zero to full value of the assured costs. A trust funds average size will be 50% of the assured costs and the annual trustee fees are 1% of the value of the trust fund. Therefore, over the pay-in period, the average annual trustee fee will equal 0.5% of assured costs (50% x 1.0% x assured costs). If a person has been noncompliant for a period of time greater than the pay-in period, this estimate will tend to underestimate the value of the annual trustee fees. If the period of noncompliance is less than the pay-in period, this estimate will tend to overestimate the value of the annual fees. In such instances, more detailed estimates of the annual trustee fees may be beneficial.
- The annual taxes on interest earned represent the average amount a firm will pay in taxes over the pay-in period.
- A stand-by trust will have no costs until it is utilized.
- A local government guarantee will have no additional costs since this analysis is done annually for a bond rating.

7.3.2 Cost Estimates

7.3.2.1 Administrative Costs of Selecting and Establishing Financial Assurance Mechanisms

The administrative costs are based on the costs of selecting and establishing a financial assurance mechanism. Selecting a financial assurance mechanism is estimated to cost **$499. See Table 7-1.** The cost of establishing a financial assurance mechanism is dependent on the mechanism. The estimated cost ranges from **$182 to $2,602. See Table 7-2.**

Table 7-1: Estimated Cost of Selecting a Financial Assurance Mechanism

Activity	Type of Personnel	Labor (hours)	Unit Labor Cost ($/hour)	Total Cost ($)
Select Financial Assurance Mechanism	Manager	1	$118	$118
	Accountant	2	81	162
	Attorney	2	99	198
	Clerical	1	21	21
TOTAL				**$499**

Table 7-2: Estimated Cost of Establishing a Financial Assurance Mechanism

Activity	Type of Personnel	Labor (hours)	Unit Labor Cost ($/hour)	Total Cost ($)
Establish	Manager	0.25	$118	$30

Financial Test	Attorney	1.0	99	99
	Accountant	10.0	81	810
	Clerical	1.75	21	37
TOTAL				$976
Establish Corporate Guarantee from Parent Company	Manager	0.5	$118	$59
	Attorney	0.5	99	50
	Accountant	0.5	81	41
	Clerical	1.5	21	32
TOTAL				$182
Establish Letter of Credit	Manager	1.75	$118	$207
	Attorney	5.25	99	520
	Accountant	2.0	81	162
	Clerical	1.5	21	32
TOTAL				$921
Establish Surety Bond	Manager	1.5	$118	$177
	Attorney	4.0	99	396
	Accountant	2.0	81	162
	Clerical	1.0	21	21
TOTAL				$756
Establish Trust Fund	Manager	1.5	$118	$177
	Attorney	4.0	99	396
	Accountant	2.0	81	162
	Clerical	5.5	21	116
TOTAL				$851
Establish Insurance Policy	Manager	1.5	$118	$177
	Attorney	4.0	99	396
	Accountant	2.0	81	162
	Clerical	1.0	21	21
	Admin. Fee			$1,846
TOTAL				$2,602

7.3.2.2 Cost of a Financial Assurance Mechanisms

The cost of a financial assurance mechanism is dependent on the mechanism, the coverage, and site-specific factors. Because the cost is dependent on site-specific factors, generic cost estimates could not be derived for most mechanisms. In the absence of site-specific estimates, the method for deriving a cost is presented. **See Table 7-3.**

Table 7-3: Estimated Cost of Financial Assurance Mechanisms

Activity	Type of Personnel	Labor (hours)	Unit Labor Cost ($/hour)	Total Cost ($)
Maintain Financial Test	Accountant	8 hour	$81	$648
	Clerical	4 hour	21	84
TOTAL				$732
Maintain Corporate Guarantee	Clerical	4 hour	$21	$84
TOTAL				$84

Activity	Cost Type	Method of Calculation
Maintain Letter of Credit	Credit Fee	Approximately 1.5% of assured costs (0.5 to 2.0% depending on firm's credit).
Maintain Surety Bond	Surety Fee	Approximately 1.5% of assured costs (0.5 to 3.0% depending on firm's credit).
Maintain Trust Fund	Payment into a Trust Fund	Total assured costs divided by number of years for pay-in period.
	Trustee Fee	Approximately 0.5% of assured costs.
	Taxes on Interest Earned on Trust Fund	50% of assured costs multiplied by trust fund rate of return and marginal tax rate (federal and state).
Maintain Insurance	Insurance Premium	Total assured costs divided by estimated facility life.

7.4 High-End Cost Estimate

The cost of a financial assurance mechanism is dependent on the mechanism, the coverage, and many site-specific factors. The coverage required may include one or more of the following: operation and maintenance, compliance monitoring, and corrective measures. Site-specific factors determine the coverage required. These factors include the remedy selected for the site. The remedy selected determines the type of engineering and/or institutional controls that is required at the site. For example, if containment is included as part of the remedy at a hazardous waste management facility, the cost of financial assurances are expected to be relatively high because they would have to cover significant operation and maintenance, compliance monitoring, and corrective measures. Remedies at other sites would not be expected to require as much coverage and, hence, financial assurances.

To estimate the probable high-end cost of financial assurances, Ecology reviewed a random sampling of six (6) sites where hazardous wastes were managed under the state dangerous waste rules and where financial assurances were required for post-closure care (operation and maintenance, compliance monitoring, and corrective measures). Hazardous waste management facilities are considered representative of more complex sites and cleanups that result in the containment of large volumes of highly contaminated substances. Typically, containment rather than complete off-site disposal is a component of the cleanup action at these sites. Ecology believes that these sites (where hazardous wastes are managed) require the greatest coverage (and hence cost) and are not representative of most sites that might require financial assurances under the MTCA Cleanup Regulation.

Based on its review, Ecology found that the coverage requiring financial assurances at the six facilities averaged $1.2 million, after discounting the low and high values as anomalies. Again, the cost of a financial assurance mechanism depends not only on the coverage required, but also the mechanism selected. Based on the method of calculation for the different mechanisms shown in **Table 7-3**, Ecology determined that the probable cost of financial assurance mechanisms for these sites could range from **$6,000 to $40,000**. Again, this estimate of probable costs is based on a complex site where hazardous wastes are managed and is not representative of most sites where financial assurances may be required. Accordingly, this estimate is a high-end estimate of probable costs.

7.5 Conclusion

In summary, the cost of financial assurance is dependent on the type and amount of coverage required, which is dependent on many site-specific factors, and the mechanism selected. The estimated cost of financial assurances is based on the administrative cost of selecting and establishing a financial assurance mechanism and the cost of the mechanism. The estimated **administrative costs** ranged from **$681 to $3,101**, depending on the mechanism selected. The cost of a financial assurance mechanism is dependent on the mechanism, the coverage, and site-specific factors. Because the cost is dependent on site-specific factors, generic cost estimates could not be derived for all sites. To estimate the probable high-end cost of financial assurances, Ecology reviewed a random sampling of six sites where hazardous wastes were managed under the state dangerous waste rules and where financial assurances were required for post-closure care. Based on that review, Ecology determined that the **probable high-end cost of financial assurance mechanisms** could range from **$6,000 to $40,000**. Again, this high-end estimate of probable costs is based on a complex site where hazardous wastes are managed and is not representative of all or most sites where financial assurances may be required.

Chapter 8 References

Cooper, B.S., and D.P. Rice, *The Economic Cost of Illness Revisited*, Social Security Bulletin, pp. 21-36, Feb. 1976.

duVair, P. and J. Loomis, *Household's Valuation of Alternative Levels of Hazardous Waste Risk Reduction: an Application of the Referendum Format Contingent Valuation Method*, Journal of Environmental Management, Vol. 39, pp. 143-155 (1993).

Ecology, 1999. *Terrestrial Environmental Evaluation Pilot Study Report*, Washington State Department of Ecology, Publication #99-604, Nov. 1999.

Federal Remediation Technologies Roundtable: Cost and Performance Reports. Web Site: http://clu-in.org/remed1.htm.

NCI, 2000. National Cancer Institute, The Surveillance, Epidemiology, and End Results (SEER) Program, SEER web site: http://SEER.cancer.gov (accessed October 2000), Supplemental Materials #2: Incidence Rates and Trends by Site and Sex for 1990-1997 and Mortality Rates and Trends by Site and Sex for 1990-1997, May 2000.

OFM, 1999a. *State of Washington Environmental Chartbook: A Collection of Indicators on Washington's Environment*, Washington State Office of Financial Management, June 1999.

OFM, 1999b. *1999 Population Trends*, Washington State Office of Financial Management, Forecasting Division, September 1999.

Tolley, G., D. Kenkel, and R. Fabian, *Valuing Health for Policy: An Economic Approach*, The University of Chicago Press (1994).

Tumwater, 2000a. Personal communication with Kathy Callison, City of Tumwater Public Works Department, Sept. 2000.

Tumwater, 2000b. City of Tumwater Year 2000 budget report.

U.S. EPA, 1995. *Soil Screening Guidance: Technical Background Document*, U.S. Environmental Protection Agency, EPA/540/R-9512B, May 1995.

U.S. EPA, 1997. *Analysis of Selected Enhancements for Soil Vapor Extraction*, U.S. Environmental Protection Agency, EPA-542-R-97-007, 1997.

U.S. EPA, 1999. Groundwater Cleanup: Overview of Operating Experiences at 28 Sites, U.S. Environmental Protection Agency, EPA-542-R-99-006, September 1999.