DEPARTMENT OF
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State of Washington

Preliminary Cost-Benefit and Least Burdensome Alternative Analyses

Chapter 173-204 WAC
Sediment Management Standards

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Preliminary Cost Benefit and Least Burdensome Alternative Analysis

Chapter 173-204 WAC
Sediment Management Standards

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Executive Summary

This report reviews the economic analyses performed by the Washington State Department of Ecology (Ecology) to estimate the incremental expected benefits and costs of the proposed amendments to the Sediment Management Standards (SMS rule; Chapter 173-204 WAC). This analysis is generally intended for use with an associated Least Burdensome Alternative (LBA) analysis also in this publication, and Small Business Economic Impact Statement (SBEIS, Ecology publication 12-09-052[1]) to develop an understanding of the full impact of the proposed rule amendments.

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

The proposed rule amendments:

- Allow for establishment of cleanup standards for sediment sites that are protective of human health and the environment. This includes:
  - Establish a two tier framework incorporating human health and benthic criteria, a cleanup screening level and sediment cleanup objective.
  - Establishing the sediment cleanup level as the sediment cleanup objective, which may be adjusted upward based on certain criteria but may not exceed the cleanup screening level;
  - Determining the sediment cleanup objective based on the highest of: risk-based levels; natural background; or practical quantitation limit.
  - Determining the cleanup screening level based on the highest of risk-based levels; regional background; or practical quantitation limit.
- Incorporate background concentrations of contaminants – both "regional" and MTCA natural background. Allows for Ecology to establish regional background level(s) for contaminants.
- Clarifies how Ecology can establish a sediment cleanup unit – a subdivision of a sediment site for the purpose of expediting cleanup.
- Clarify information to be included in the remedial investigation/feasibility study for a sediment site.
- Use the cleanup screening level and the sediment cleanup objective to identify and assess the hazard of sites.
- Establish how risk-based levels will be set: based on protection of human health; based on protection of benthic toxicity; based on protection of higher tropic level species; or based on other applicable state or federal laws.
  - Describe how setting a risk-based level based on protection of human health will include an exposure parameter using a site specific fish consumption rate.
  - Detail how to set a risk-based level based on protection of benthic community in freshwater sediments. .
  - Detail how to set a risk-based level based on protection of higher tropic level species.

[1] Available at *http://www.ecy.wa.gov/biblio/1209052.html*

- Clarify requirements for selection of cleanup actions for sediment sites.
- Clarify requirements governing establishment and monitoring of sediment recovery zones.

Ecology determined that the likely benefits of the proposed rule amendments exceed the costs, when including both qualitative and quantifiable costs and benefits. Moreover, while for many sites the proposed rule amendments will require compliance similar (or identical) to the baseline of current SMS and MTCA requirements, other sites will potentially save in characterization and cleanup costs, while still moving toward remediating to sufficient and achievable cleanup levels sooner.

HOW IS THE RULE BENEFICIAL OVERALL?

Cleanup Timing

Ecology determined the most likely result of the proposed rule amendments in the short term (within the 20-year scope of Ecology rule analyses) would be to either:

- Not change cleanup standards that are set at the Sediment Cleanup Objective, in most cases this would be natural background concentrations (because regional background concentrations are equivalent and risk based concentrations fall below background).
- Or, to raise cleanup standards above the Sediment Cleanup Objective but no higher than the Cleanup Screening Level, in most cases this would be regional background concentrations (that are less stringent).

In addition, the proposed rule amendments, by clarifying the cleanup standard methodology, setting clear compliance requirements, allowing cleanup of individual units within larger sites, addressing liability for recontamination from upland sources, and adopting freshwater benthic criteria would likely expedite site characterization and compliance with necessary and viable remediation. In the short term, the proposed rule amendments would in this way immediately address those sites that are contaminated above regional background levels, and allow for long-term reductions in background levels in a bay-wide or watershed-wide area through a combination of active cleanup, natural recovery, and source control efforts.

Prospectively, by increasing the cleanup standard for some sites from natural background concentrations up to, but not exceeding, regional background concentrations, the proposed rule amendments potentially increase risk associated with human and environmental health to that associated with regional background concentrations in some areas. Ecology could not confidently quantify this risk, but acknowledges that it may exist (with mitigation as described in section 3.9), and over time is likely to fall in the long-term, as background concentrations fall without contribution from contaminated sites. However, under the proposed rule, by conducting active cleanup of highly contaminated site units in the nearshore environment, risk reduction and natural resource restoration will occur sooner in this area.

Faster remediation and settling of disputed site cleanup would likely also allow property owners (at affected sites, and those nearby) to make property transactions more freely. The demand for cleaned up properties would also increase sooner, and property values are likely

to rise. Ecology could not quantify this increase in the present value of property at or near sediment sites, and so included it as a qualitative (but no less significant) benefit. Further discussion of these benefits is in section 3.2.

Property Value and Exchange Benefits

Remediated properties (as well as those suffering from contagion of nearby low contaminated property values) are likely to sell for higher prices, and allow for redevelopment, or replacement with other industry compliant with modern environmental and health regulations. In the interim, they are also likely to burden current owners and operators for a shorter time. Further discussion of these benefits is in section 3.3.

WHAT HAPPENS AT THE SITE OR EMBAYMENT LEVEL?

Site Characterization

Ecology estimated that the proposed rule amendments may result in reduced site-characterization costs for a representative site contaminated with bioaccumulative chemicals of concern, of approximately $148 thousand per site. This cost savings results from reduced necessary sampling, and reduced core-sample depth. This is the cost reduction for a typical site, and some sites will experience no cost savings, while others will experience a larger cost savings The analyses supporting these conclusions can be found in section 3.4.

Sediment Cleanup at a Representative Embayment Site

The proposed rule amendments may results in higher cleanup standards for some sites, as compared to the baseline. Ecology estimated the change in cleanup standards at a sediment site could save a maximum of $2.4 million in cleanup and monitoring costs, based on an analysis of a representative embayment requiring sediment cleanup, and posing human health risk.

The cost savings for another real embayment could potentially be zero, but could also be larger than this. It would be zero in the case that site-specific attributes of a site drive the cleanup level down to the same level as under the baseline (e.g., in cases with limited regional concentrations). The analyses supporting these conclusions can be found in section 3.5.

Sediment Cleanup at a Freshwater Sediment Site for Benthic Community Protection

Ecology estimated that the proposed rule amendments may result in reduced site characterization costs for freshwater sites where the benthic community is impacted within a range of $2,312 - $60,387 thousand per site. This is the cost reduction for a typical site, and some sites will experience no cost savings, while others will experience a larger cost savings. The analyses supporting these conclusions can be found in section 3.6.

Soil and Ground Water Cleanup on Upland Sites

Ecology does not anticipate that the proposed SMS rule revisions will significantly impact requirements for soil and ground water cleanup standards at MTCA sites that are adjacent to a river, lake, stream or bay.

Under the proposed rule revisions, the CSL requirements are similar to the Method C provisions in the current MTCA rule. However, the CSL may be higher than allowed under the baseline rule because regional background levels may exceed risk-based concentrations and analytical limits. In these situations, the site-specific sediment cleanup standard might be higher than allowed under the baseline rule.

Soil and ground water cleanup standards must be established at concentration that prevent exceedances of sediment cleanup standards based on protecting human health, surface water, and sediment benthic communities. At a significant number of upland sites, surface water standards under MTCA will be protective of sediment.

Analytical Costs for Evaluating Compliance

Ecology estimated a possible cost increase for additional analysis for evaluating compliance at sediment sites, within a range of $1.2 – $4.6 million, over 20 years. The analyses supporting these conclusions can be found in section 3.8.

Dredged Material for Marine Sediment

Ecology also estimated additional dredging costs for analysis at an average of $373,296 thousand for all proposed dredging projects over 20 years. The analyses supporting these conclusions can be found in section 3.9.1.

Source Control

Ecology estimated a possible cost increase for additional analysis at permitted effluent discharge sites in Puget Sound over the next 20 years, within a range of $481,600 - $2,889,600, only for those permittees that are also PLPs. The analyses supporting these conclusions can be found in section 3.10.

For dischargers that are not identified PLPs for a sediment cleanup site, Ecology does not anticipate significant new permitting requirements near term for the majority of these facilities outside of the current permitting and TMDL efforts Ecology is undertaking.

WHAT HAPPENS ON A BROADER SCALE?

Puget Sound-wide Analysis for Site Identification

The acreage and number of sites identified for sediment cleanup under the proposed rule may prospectively fall, or they may stay the same as under the baseline. Ecology estimated number of sites, cleanup acreage, and likely remediation plans including amounts of dredging, capping, and monitoring. Smaller quantities of each would likely be required for cleanup in example analyses for dioxin and mercury. The analyses supporting these conclusions can be found in section 3.11. The falling number of sites and acreage would scale the overall site-level or embayment-level benefits and costs discussed above.

Statewide Impacts

While Ecology did not have adequate data to perform a similar analysis statewide, Ecology believes a similar result would hold in other areas of the state. The benefits and costs resulting from the proposed rule at a representative embayment would be further scaled to

include other locations in the state. Since Ecology believes the benefits of the proposed rule exceed the costs at the embayment-level (see above and sections 3.4 – 3.10), scaled up for the state, this conclusion should hold.

CHAPTER 1: Background and Introduction

1.1 Introduction

This report reviews the economic analyses performed by the Washington State Department of Ecology (Ecology) to estimate the incremental expected benefits and costs of the proposed amendments to the Sediment Management Standards (SMS rule; Chapter 173-204 WAC). This analysis is generally intended for use with an associated Least Burdensome Alternative (LBA) analysis also in this publication, and Small Business Economic Impact Statement (SBEIS, Ecology publication 12-09-052[1]) to develop an understanding of the full impact of the proposed rule amendments.

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

Ecology's analysis is based on the best available information at the time of this analysis. Ecology encourages the public to submit relevant comments on the economic analyses, during the public comment period, which might improve the accuracy or precision of the analyses.

1.2 Summary of the proposed rule amendments

The proposed rule amendments:

- Allow for establishment of cleanup standards for sediment sites that are protective of human health and the environment. This includes:
  - Establish a two tier framework incorporating human health and benthic criteria, a cleanup screening level and sediment cleanup objective.
  - Establishing the sediment cleanup level as the sediment cleanup objective, which may be adjusted upward based on certain criteria but may not exceed the cleanup screening level;
  - Determining the sediment cleanup objective based on the highest of: risk-based levels; natural background; or practical quantitation limit.
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- Incorporate background concentrations of contaminants – both "regional" and MTCA natural background. Allows for Ecology to establish regional background level(s) for contaminants.
- Clarifies how Ecology can establish a sediment cleanup unit – a subdivision of a sediment site for the purpose of expediting cleanup.

[1] Available at *http://www.ecy.wa.gov/biblio/1209052.html*

- Clarify information to be included in the remedial investigation/feasibility study for a sediment site.
- Use the cleanup screening level and the sediment cleanup objective to identify and assess the hazard of sites.
- Establish how risk-based levels will be set: based on protection of human health; based on protection of benthic toxicity; based on protection of higher tropic level species; or based on other applicable state or federal laws.
    - Describe how setting a risk-based level based on protection of human health will include an exposure parameter using a site specific fish consumption rate.
    - Detail how to set a risk-based level based on protection of benthic community in freshwater sediments. .
    - Detail how to set a risk-based level based on protection of higher tropic level species.
- Clarify requirements for selection of cleanup actions for sediment sites.
- Clarify requirements governing establishment and monitoring of sediment recovery zones.

1.3 Reasons for the proposed rule amendments

The proposed rule amendments are necessary to:

- Allow for greater coordination of the sediment and upland portion of sites by harmonizing the SMS rule and the MTCA rule.
- Reduce the risk to human health and the environment by incentivizing cleaning up of high risk contaminated areas (site units).
- Establish cleanup level(s) for sites which will be achievable and protective of human health and the environment. This includes taking into account anthropogenic background contaminant concentrations (both natural and regional).
- Establish a clear path for making cleanup decisions using risk-based levels based on protection of human health, protection of benthic toxicity, and protection of higher tropic level species.
- Deal with inconsistent decision making and costly site characterization and investigation at freshwater sediment sites by providing for use of chemical and biological standards in setting a risk-based level based on protection of benthic community.

By establishing a clear path for management of sediment cleanup sites, from identification to the cleanup action decision, the proposed rule amendments will encourage quicker and more effective cleanup actions thus reducing human and environmental exposure to contaminants.

1.4 Document organization

Ecology organized this document into the following chapters:

- **Baseline and proposed rule amendments** (Chapter 2): In-depth description and comparison of the baseline requirements in state rules to the proposed rule amendments.
- **Likely costs and benefits of proposed rule amendments** (Chapter 3): Analysis of the types and size of costs and benefits Ecology expects impacted entities to incur. Costs include site-characterization costs and background contaminant exposure. Benefits include reduced cleanup costs and monitoring, and expedited cleanup leading to long-term reductions in regional and natural background contaminant levels.
- **Cost-benefit comparison and conclusions** (Chapter 4): Discussion of the complete implications of the Cost-Benefit Analysis. Comments on the results.
- **Least burdensome alternative analysis** (Chapter 5): Analysis of considered alternatives to the final rule.

CHAPTER 2: Baseline and Proposed Rule Amendments

2.1 Introduction

In this chapter, Ecology describes the baseline to which the proposed rule amendments are compared. The baseline is the regulatory context in the absence of the proposed amendments being adopted.

In this chapter, Ecology also describes the proposed rule amendments, addresses complexities in the scope of analysis, and indicates which cost and benefit analyses are discussed in Chapter 3 of this document.

2.2 Baseline

In most cases, the regulatory baseline is the existing rule. If there is no existing rule, the federal or local rule is the baseline. Sometimes there is no baseline because there is no regulation at any level of government, and yet other times, the baseline is for changes to other regulations (e.g., federal regulation is expected to be enacted before or just after the adopted rule; or a regulatory program would otherwise change or expire in the absence of the adopted rule).

The baseline is complex for the proposed SMS rule because there are multiple factors involved. Those factors are:

- Existing SMS rule (Chapter 173-204 WAC).
- The state law authorizing the SMS rule (Chapter 70.105D RCW, the Model Toxics Control Act). The state law requires the minimum cleanup standards for remedial actions to be at least as stringent as the cleanup standards under section 121 of the federal cleanup law, 42 U.S.C. Sec. 9621, and at least as stringent as all applicable state and federal laws.
- Existing Model Toxics Control Act (MTCA) rule (Chapter 173-340 WAC).

2.3 Analytic scope

Ecology typically analyzes the impact of proposed rules over a 20-year timeframe, using a 1.58 discount rate where appropriate and possible.[1] This means, where possible, Ecology typically presents quantifiable costs and benefits in current-dollar present values. For this proposed rule, Ecology could not confidently determine the number of future sediment cleanup sites (most identified sites are due to historic contamination and are likely already identified), and so chose instead to compare costs and benefits on a per-site and regional basis. If benefits likely exceed costs at each of the representative sites or regions, then the same holds regardless of how many sites there are in future.

[1] 1.58 is the current historical average of real (inflation-adjusted), risk-free rates of return on US Treasury I Bonds.

2.4 Analyzed changes

Ecology is proposing to establish a cleanup decision framework to address bioaccumulative chemicals which present risks to human health and the environment. The proposed framework includes methods and policies for establishing risk-based cleanup standards, procedures for incorporating background concentrations, and requirements for sediment cleanup actions. Depending on site-specific characteristics, these proposed rule amendments may result in changes to site characterization, cleanup level, cleanup actions, and monitoring activities. Those impacts at a site, in turn, may result in the costs and benefits presented in Chapter 3. As part of the cost benefit analysis, Ecology qualitatively or quantitatively analyzed the impacts of the following proposed changes to the SMS rule:

2.4.1 Site characterization

The proposed rule revisions include updated requirements for site characterization, investigations, and evaluations. Under both the baseline and proposed rule amendments, the site is defined by the area where a hazardous substance came to be located. The sediment cleanup level, in combination with the point of compliance, typically defines the area or volume of sediment at a site or sediment cleanup unit that must be addressed by the cleanup action. The area of the site, or sediment cleanup unit, which requires remedial action because it is above the cleanup level, may be impacted by the proposed rule amendments.

Section 3.4. describes the costs and benefits associated with the proposed rule amendments impact on how the cleanup level is determined for a sediment site and how that may impact: (1) the size of a site; and (2) the number of samples required to adequately characterize a site.

2.4.2 Background concentrations

Under the proposed rule amendments, Ecology will establish a natural background and regional background for a site. These values are used in setting the site cleanup level.

Section 3.5.1.1 describes the impact of use of a regional background level in determining a site cleanup level. This analysis calculates natural background and regional background for Puget Sound.

2.4.3 Site identification

The proposed rule revisions include revised criteria for identifying cleanup sites where three sample stations that are spatially and chemically similar exceed the upper tier value, the cleanup screening level (CSL).[2]

[2] WAC 173-204-560(4) and WAC 173-204-510(2)(c)

Section 3.11.3 describes the impact of the proposed rule amendments on the number of sites likely to be identified, using the Puget Sound as an example.

2.4.4 Cleanup level and cleanup actions

Under both the baseline and proposed rule amendments, sediment cleanup actions conducted must comply with sediment cleanup standards based on human health protection. Under the proposed rule amendments, a sediment cleanup level is the concentration or level of biological effects for a contaminant in sediment that is determined by the department to be protective of human health and the environment. The sediment cleanup level is established in accordance with the requirements in WAC 173-204-560(2). The sediment cleanup level is be the sediment cleanup objective (SCO) and is only adjusted upward (less conservative) as required based on what is technically possible and whether meeting the cleanup level will have an adverse impact on the aquatic environment. A sediment cleanup level may not be adjusted upward above the cleanup screening level (CSL).

Section 3.5 describes the impact of the proposed rule amendments' change in setting cleanup levels, using a marine urban embayment as an example.

Section 3.11 describes the impact of the proposed rule amendments' change in setting cleanup levels and how that may impact the size of the site, the remedies selected for the site, and therefore the cost of implementing those remedial actions.

Section 3.2 describes the impact of the proposed rule amendment's change in setting cleanup levels and how that might affect the time required for a site to come into compliance and the potential affect of having cleanup levels set above the SCO.

2.4.5 Risk-based levels protective of human health

The proposed rule amendments clarify that risk-based cleanup standards must be based on a reasonable maximum exposure (RME) scenario, specifically taking into account tribal exposure. In addition, both the baseline and proposed rule amendments require that calculation of risk-based levels protective of human health take into account a site-specific fish consumption rate.

Section 3.5.1 describes the impact of the site-specific fish consumption rate in setting a risk-based level protective of human health, using three examples (urban marine embayment, rural marine embayment and an urban estuarine shoreline). The risk-based level protective of human health was then used in setting cleanup standards for contaminants.

2.4.6 Monitoring for cleanup sites

It may be assumed that under the proposed rule amendments, the added clarity and requirements for assessing risk to human health and the environment will require liable parties to use more sensitive analytical techniques to more accurately detect contaminants at very low levels, or detect specific types of chemicals.

Section 3.8 describes the impacts of Chapter 3.11.3 describes the impact of a requirement to use more sensitive analytical techniques to more accurately detect contaminants at very low levels, or detect specific types of chemicals.

2.4.7 Dredged material management

Chapter 3.9 describes the impact the additional requirements of the proposed rule amendments may have on dredged material management, using dioxin as a case study.

2.4.8 Freshwater benthic standards

Ecology is proposing to establish numeric criteria to support cleanup decisions at freshwater sediment sites. Under the proposed rule amendments, the narrative standard for freshwater sediments is replaced with numeric chemical and biological criteria for freshwater sediment cleanup to protect the benthic community. Ecology analyzed the impacts of the following proposed sediment cleanup requirements:

- Sediment cleanup sites are identified if three or more contiguous stations have chemical concentrations or biological effects that exceed the CSL.
- Remedial investigations must characterize the nature and extent of releases including areas that exceed the chemical concentrations and biological effect levels corresponding to the SCO and CSL.
- Sediment cleanup standards to protect the benthic community must be established as close as possible to the SCO but no higher than CSL levels which both include chemical criteria and biological effect levels.
- Sediment cleanup actions conducted at freshwater sediment sites must comply with sediment cleanup standards for benthic community protection.

Section 3.6 describes the impact of the proposed rule amendments on freshwater sediment sites and the sampling requirements for those sites, as well as the impact of the revision to freshwater standards and its impact on dredge material management.

2.4.9 Source control

Part IV of the current SMS rule establishes sediment source control requirements. WAC 173-204-410(1)(c) states that "…[t]he department shall implement the standards of WAC 173-204-420 so as to prevent the creation of new contaminated sediment cleanup sites identified under WAC 173-204-530(4)." The proposed rule amendments, aside from making a policy statement regarding source control, make no changes to Part IV of the SMS.

However, Ecology expects that as site cleanups progress under the proposed rule amendments, source control will become a priority and focus for the agency. Because the proposed rule amendments are likely to lead to the agency placing an emphasis on source control activities, a review of potential impacts was completed.

Chapter 3.10 reviews potential impacts from the proposed rule amendments on parties who may be involved in source control activities as liable persons for a cleanup site (e.g., NPDES permitted dischargers).

2.4.10 Upland cleanup sites.

Under the Model Toxics Control Act (MTCA) Cleanup Regulation, cleanup levels for soil and ground water at upland sites must be established at concentrations that prevent violations of cleanup levels for other media, such as surface water and sediments. For example:

- WAC 173-340-720(c) states that "…[g]round water cleanup levels shall be established at concentrations that do not directly or indirectly cause violations of surface water, sediments, soil or air cleanup standards established under this chapter or applicable state and federal laws…"
- WAC 173-340-740(d) states that "…[s]oil cleanup levels shall be established at concentrations that do not directly or indirectly cause violations of ground water, surface water, sediment, or air cleanup standards established under this chapter or applicable state and federal laws…"

Ecology analyzed the impacts of sediment cleanup requirements on soil and ground water cleanup standards that are established to prevent exceedances of sediment cleanup standards based on human health protection.

2.4.11 Summary figures

Figure 1, below, illustrates the structure of the proposed rule amendments for establishing sediment cleanup standards. The proposed rule amendments include elements of both parts of the baseline – the existing SMS rule and MTCA rule.

Figure 2, below, illustrates the likely impacts of the proposed rule amendments. Under the baseline, sediment chemical concentrations are likely to decrease slowly over a long timeframe. Under the proposed rule, sediment concentrations are likely to decrease more quickly, under clearer and more achievable broad cleanup objectives, and then further fall gradually over the long run. The site-specific cleanup standard may be located anywhere in between (and inclusive of) the sediment cleanup objective and maximum allowable level.

Figure 1: Proposed two tiered rule framework for establishing sediment cleanup standards that incorporates human health risks and background concentrations of contaminants

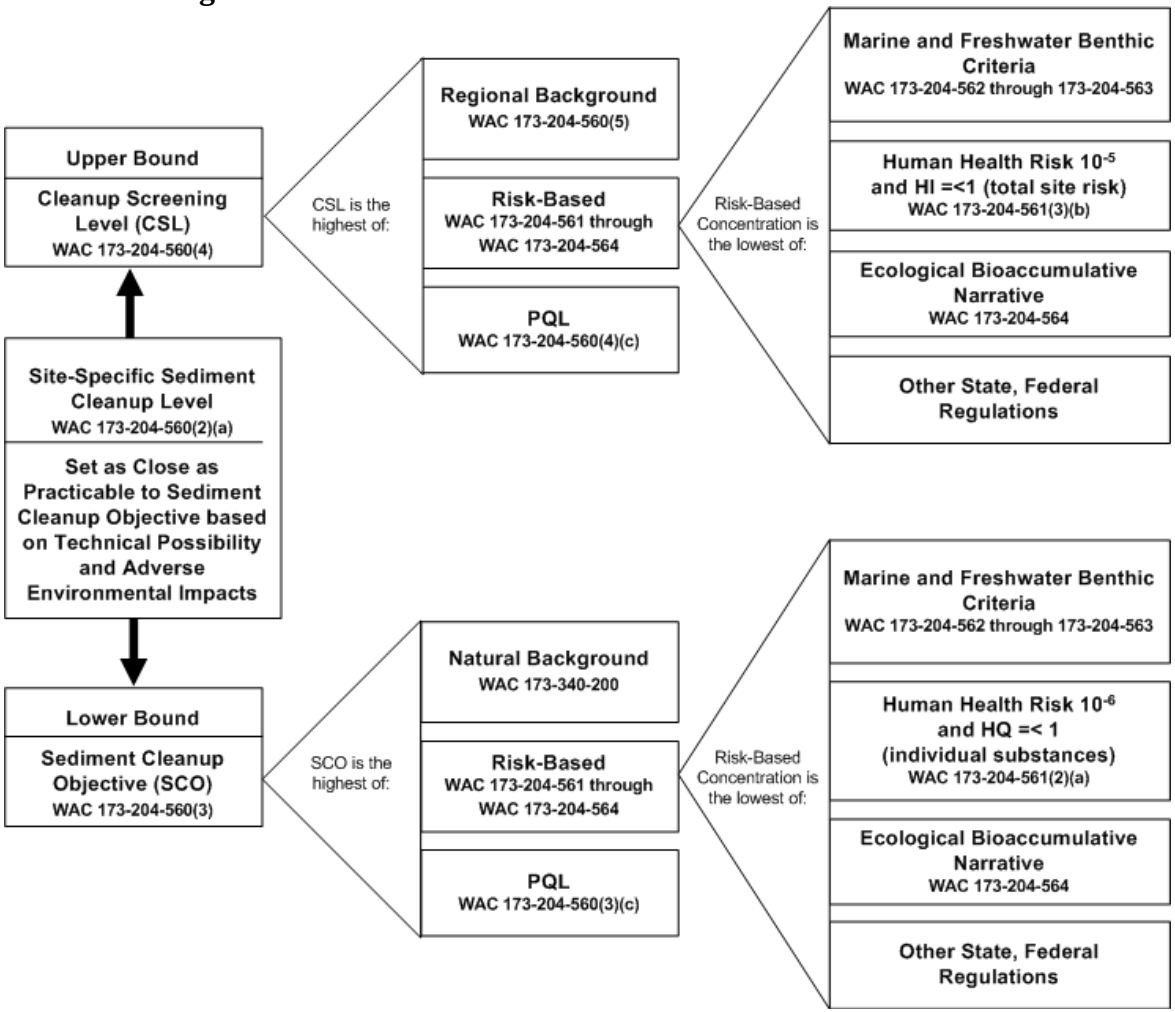
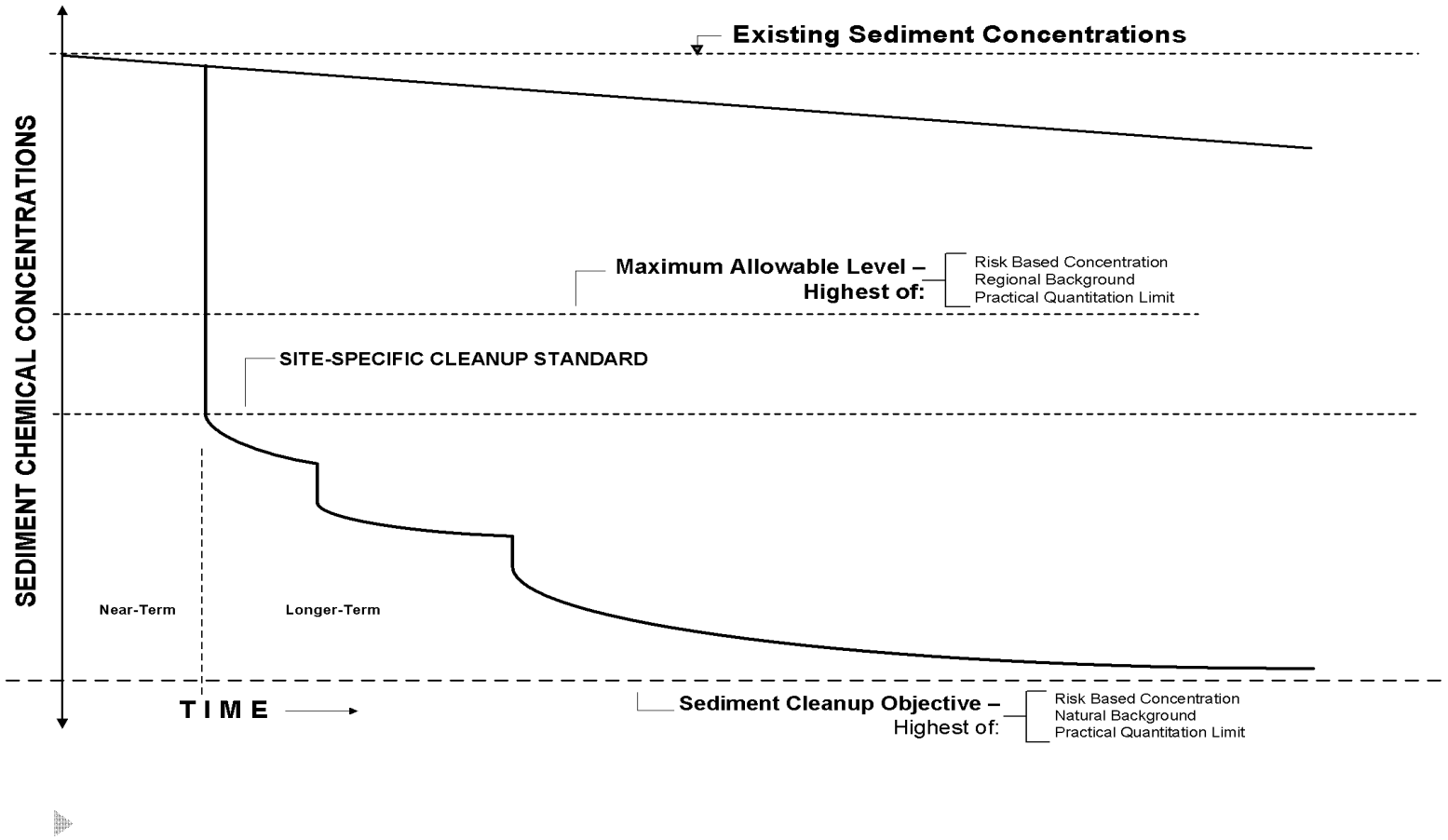


Figure 2: Sediment Contaminant Concentrations over Time under the Baseline and Proposed Rule
Baseline: Sediment chemical concentrations likely to decrease very gradually over time, but not to the sediment cleanup objective of the low risk-based concentration. Proposed rule amendments: Sediment chemical concentrations are reduced much sooner in the near term, to below achievable regional backgrounds by active cleanup. This will result in reduction of risk and natural resource restoration occurring sooner. Then sediment chemical concentrations gradually decrease closer to low risk-based concentrations over the long term by continued cleanup and large scale source reduction and source control strategies.



CHAPTER 3: Likely Costs and Benefits of Proposed Rule Amendments

3.1 Introduction

Ecology estimated the expected costs associated with the proposed amendments to the SMS rule, as described in section 2.2 of this document. The baseline is the regulatory circumstances and most likely application in the absence of the proposed rule amendments. The costs and benefits analyzed here are associated with the broad impacts of the proposed amendments, as they impact cleanup standards, site characterization, cleanup actions, and monitoring requirements.

Due to the levels of sediment contamination statewide, and the uncertainty in estimating discovery of new sediment cleanup sites (most identified sites are due to historic contamination and are likely already identified), Ecology could not confidently quantify the number of future sites to be regulated by either the existing or proposed SMS rule. Instead of estimating costs and benefits state wide, Ecology estimated the costs and benefits of the proposed rule amendments to different representative sites and geographies, including:

How is the rule beneficial overall?

- Cleanup timing and background concentrations (3.2)
- Property value and exchange benefits (3.3)

What happens at the site or embayment level?

- Site characterization (3.4)
- Sediment cleanup at a representative embayment site (3.5)
- Sediment cleanup at a freshwater sediment site for benthic community protection (3.6)
- Soil and ground water cleanup on upland sites (3.7)
- Analytical costs for compliance (3.8)
- Dredged material for marine sediment (3.9)
- Source control (3.10)

What happens on a broader scale?

- Puget Sound-wide analysis for site identification (3.11)

For these representative calculations, Ecology chose appropriate chemicals of concern that commonly drive human-health based sediment cleanups: mercury, dioxin, and polycyclic aromatic hydrocarbons (cPAHs).

To the extent possible, Ecology quantified these impacts, and has otherwise described them qualitatively to include in overall assessment of the costs and benefit of the proposed rule

amendments.

3.2 Cleanup timing and background concentrations

Ecology expects the proposed rule to result in more efficient determination of cleanup standards, though in the short term the cleanup level is likely to be based on background concentrations (CSL = regional background and SCO = natural background) because risk based levels are typically more conservative than background. Under the baseline, site identification and cleanup processes are likely insufficient to reduce the broad level of contamination in all sediments in Washington State. This is due to the high potential of recontamination from ubiquitous bioaccumulative contaminants (dioxin and mercury for example) and continuing inputs from upland sources such as stormwater (controllable and uncontrollable) and atmospheric deposition, potential infeasibility of meeting a lower cleanup standard, greater cost of actively remediating large areas contaminated above the lower cleanup standard, and the increased negotiation time before conducting the cleanup.

However, Ecology under the proposed rule amendments, expects that we can achieve more protective levels by first expediting the process to clean up sediments contaminated above background cleanup levels, and then allowing source control and natural recovery (under long-term monitoring) to reduce background levels to more protective risk-based concentrations (under a very long term time frame).

The medium-term and long-term expectations for the effects of the proposed rule amendments extend beyond the 20-year timeframe Ecology uses to analyze proposed rules, and so Ecology only considered, for this analysis, the short-term impacts of reducing sediment contamination to background levels.

Under the proposed rule amendments, some cleanup actions for sediment sites may not require active remedial actions to reduce contaminants to the level that would be required under the baseline (because the baseline results in a cleanup standard of natural background, while the proposed rule amendments result in a cleanup standard potentially as high as regional background). This could result in higher risks for human health and the environment under the proposed rule amendments as compared to the baseline. However, there are a number of mitigating factors to any potential additional risk posed:

- Cleanup actions: As illustrated in the Puget Sound-wide and embayment-specific analysis, a change in the cleanup standard does not necessarily result in a change to all active remedial actions as the remedy is also based on cost and technical feasibility.
- Sediment movement: Contaminated sediments are continuously covered by new sediments due to natural sediment deposition, resulting in reduced risk of humans or animals being exposed to them.
- Contamination distribution: Higher levels of contamination tend to be near shore, where the risk is greater to both human health and the environment, while regional and natural background levels are in subtidal areas. A change in cleanup standards may affect the remedy away from the near shore in terms of longer term monitoring, but will not adversely affect how human health and the environment are protected in high

exposure areas because those areas will still require an active remedial action. Under the proposed rule, this active remediation in the form of site units, may occur sooner.

- The sooner active remediation of the nearshore environment is conducted the sooner natural resource restoration can occur. This included reducing contaminant loading to the productive nearshore environment and restoration of shellfish and eelgrass beds, and other critical aquatic life habitat.

Ecology could not confidently quantify any health or environmental risk resulting from the shift between the baseline and proposed rule amendments. For human health, this is because of uncertainty and site-specificity in all of the inputs to risk calculations. Ecology used highly conservative assumptions in the embayment-specific analyses to calculate risk-based concentrations (to prospectively estimate an upper bound to costs if human-health drove the cleanups under either baseline or the proposed rule amendments). Used in reverse, however, the human health risk calculations would not accurately estimate health risk, and would not have a systematic bias allowing predictability in over- or under-estimation.

3.3 Property value benefits

By reducing the time to remediation of sediment sites – reducing concentrations in sediments sooner – the proposed rule amendments will likely make remediated properties (and adjacent or nearby real estate) able to be bought and sold both sooner and at better rates. This likely impact of the proposed rule amendments potentially benefits PLPs, nearby property owners, neighborhood development or redevelopment, and ultimately jobs and the tax base.

Remediated properties (as well as those suffering from contagion of nearby low contaminated property values) are likely to sell for higher prices, and allow for redevelopment, or replacement with other industry compliant with modern environmental and health regulations. In the interim, they are also likely to burden current owners and operators for a shorter time. For just those acreages identified in Puget Sound as complying with cleanup under the proposed rule amendments (nearly 2,000 acres along valuable coastlines), this could mean selling for millions of dollars sooner.

3.4 What happens at site level? – Site characterization

Ecology estimated the costs associated with characterizing a sediment cleanup site, using the typical example site from the embayment-specific analyses. This analysis was conducted based on real data from a Puget Sound embayment.

3.4.1 Baseline

Under the baseline, the level of effort and costs for an initial investigation would be similar to the proposed rule because the initial identification of the "site" is defined by the SCO. Under the baseline, the SCO is also the cleanup standard which is used to identify the site as requiring further investigation and cleanup. Hence, the SCO would

influence the level of effort and cost for further site characterization. To estimate further site characterization costs, Ecology estimated that an approximately 4,200 acre site (bounded by the SCO) would have similar site characterization costs to a one or two time monitoring event required during long-term monitoring of a remediated site.

Costs were determined based on sampling costs, and did not necessarily include the additional costs of report writing and negotiations with liable persons. Ecology conservatively assumed 125 total samples would be necessary for the first sampling event to characterize a site. Of those 125 samples, approximately 115 would be shallow "surface grabs", and the remaining ten would be deeper cores. The deeper cores would be necessary because of a lower baseline cleanup standard. Next, approximately 30 samples would need to be taken to fill gaps in the initial sampling data. Ecology estimated the total cost of baseline characterization based on $1,600 for surface samples, and $4,200 for deeper core samples.

The total baseline cost would be approximately $274 thousand to characterize a representative site.

3.4.2 Proposed rule amendments

Under the proposed rule, the initial identification of the "site" is defined by the SCO, similar to the baseline rule. However, under the proposed rule, the CSL is used to identify the site as requiring further investigation and cleanup. For this analysis, the cleanup standard was assumed to be at the CSL and cleanup standards would be used to bound the size of a site that requires remediation, rather than the SCO as required in the baseline rule. Therefore sites boundaries may be smaller under the proposed rule (For example, from 4,200 acres to 1,200 if the cleanup standard was established at the CSL under the proposed rule.

After the initial investigation, which is assumed to have similar level of effort and costs as the baseline, further site characterization would be conducted. To achieve this, Ecology estimated an approximately 1,200 acre site would have similar site characterization costs to a one or two time monitoring event required for long term compliance monitoring. Ecology conservatively assumed 55 total samples would be necessary for the first sampling event. Of those 55 samples, approximately 45 would be shallow "surface grabs", and the remaining ten would be deeper core samples. Because the cleanup standard under the proposed rule amendments would not be as stringent as under the baseline, however, these cores would not need to be as deep as those under the baseline. Next, approximately 14 samples would need to be taken to fill gaps in the initial sampling data.

Ecology estimated the total cost of this site characterization under the proposed rule amendments, based on $1,600 for surface samples, and $3,200 for deeper (but more shallow than under the baseline) core samples. The total proposed rule amendment cost would be approximately $126 thousand, on average.

3.4.3 Difference in cost

Based on total costs for site characterization of a representative site with contaminated sediments and posing a risk to human health, Ecology calculated reduced site characterization costs of approximately $148 thousand under the proposed rule, for a typical site. Specific sites will likely have higher or lower cost savings than the typical site. This is the cost reduction for a typical site, and some sites will experience no cost savings, while others will experience a larger cost savings.

3.5 What happens at site level? – Representative site (embayment-specific) analysis

Ecology analyzed the impact of the proposed rule amendments on costs associated with cleanup in an example embayment, using data from a real embayment containing multiple points of contamination. This analysis illustrates likely cost impacts on a collection of PLPs cleaning up an embayment.

Ecology also analyzed the impacts on cleanup levels at other types of representative embayment. These examples, while without associated dollar-value impacts, further illustrate possible variations on the scenario underlying the initial embayment cost example.

3.5.1 Embayment cost analysis

As a case study to determine impacts of different cleanup standards under the baseline and proposed rules, Ecology chose a real area for site-specific analysis, a marine urban embayment. Under the proposed rule amendments, the cleanup level is the SCO, but may be raised upward depending on whether certain factors are met. The cleanup level may not be set higher than the CSL. For purposes of this analysis, the CSL is the regional background and the cleanup standard was established at regional background to determine the maximum potential difference between the baseline and proposed rule amendments.

3.5.1.1 Background and PQL concentrations

Ecology calculated background and PQL concentrations under the baseline and proposed rule for the representative sites.

Baseline: Under the baseline, Ecology used the existing SMS screening level for mercury (0.59 ppm) and a literature value of dioxin toxic to fish (200 ppt TEQ). To include human-health considerations, Ecology used:

- Natural background: Ecology used data from the EIM database, for Ecology-approved reference areas, BOLD sampling stations, and other stations that were determined to be similarly influenced by anthropogenic sources as the reference areas. Ecology calculated the 95th upper confidence limit on the mean of the data for each chemical, as the MTCA natural background value:
    - 0.10 ppm for mercury.
    - 2.0 ppt TEQ for dioxin.

Ecology used the PQL for mercury and dioxin based on a review of recently surveyed laboratory reported values. Ecology removed outliers and calculated median values:

- 2.0×10^{-2} ppm for mercury.
- 5 ppt TEQ for dioxin.

Proposed rule amendments: Ecology determined that it would be inappropriate to calculate a regional background for mercury using sampling data from the embayment because, at this specific embayment, mercury comes from specific, identified sources. Ecology determined that it was feasible to calculate a regional background for dioxin due to the influence of numerous nonpoint sources to the bay that were distinguishable from specific releases using best professional judgment. Ecology calculated regional background for dioxin based on a statistical analysis of existing data in the EIM database, and spatial contouring to determine dioxin regional background:

- Ecology delineated the area believed to be regional background, and then excluded samples from areas near known point sources and areas suspected to be of a different population (e.g., cleanup sites). After removing trends from the data, Ecology then determined the extent of auto-correlation in samples from the background area.
- Ecology then generated upper-bound estimates (i.e., 90/90 UTL) from the regional background area determined earlier. Ecology achieved this by rendering the existing data set independent by selecting a subset of samples that are further than the auto-correlated distance apart from one another. The data set did not show evidence of significant auto-correlation among samples, so the complete data set was used to calculate the 90/90 UTL.

Ecology determined the following values for regional background to conduct the following embayment specific analysis:

- 0.10 ppm for mercury.
- 14.6 ppt TEQ for dioxin.

Ecology determined the PQLs for mercury and dioxin by reviewing a recent survey of laboratory-reported values. Ecology removed the highest and lowest values, and calculated the medians:

- 2.0 x 10-2 ppm for mercury.
- 5 ppt TEQ for dioxin.

3.5.1.2 Human health risk based concentrations

For both the baseline and proposed rule amendments, Ecology determined the human health risk based concentrations according to the specific equations and parameters listed in section 3.5.2 and Table 3, Marine Urban Embayment.

Table 1: Dioxin and mercury cleanup standards for a representative urban marine embayment site

	Dioxin (ppt TEQ)	Dioxin Cleanup Standard Baseline Rule	Dioxin Cleanup Standard Proposed Rule	Mercury (ppm)[1]	Mercury Cleanup Standard Baseline Rule	Mercury Cleanup Standard Proposed Rule
Baseline Rule 10-6 / HQ 1 Risk Based Concentration **173 g/day FCR**	9.21 E-03			0.016		
Proposed Rule Amendments 10-6 / HQ 1 Risk Based Concentration **173 g/day FCR**	9.21 E-03			0.016		
Proposed Rule Amendments 10-5 / HQ 1 Risk Based Concentration **173 g/day FCR**	9.21 E-02			0.016		
Baseline Rule Natural Background / PQL	2.0 / 5.0	2.0 / 5.0		0.104 / 2.0 E -02	0.104	
Proposed Rule Amendments SCO Natural Background / PQL	2.0 / 5.0			0.104 / 2.0 E -02		
Proposed Rule Amendments CSL Regional Background / PQL	14.6		14.6	0.104 / 2.0 E -02		0.104

The cleanup standard for mercury would be the same under the baseline rule and under the proposed rule amendments, while the cleanup standard for dioxin increases (becomes less stringent) under the proposed rule amendments.[2] If dioxin was the chemical driving cleanup at this site, remediation activity would stay the same or decrease, while if mercury was the driving chemical, remedial action would not change.

[1] The sediment risk based concentration and background value was for total mercury, which includes both the inorganic and organic form. The BSAFs incorporate the relative contribution of inorganic and organic mercury to the tissue burden. This may be an under or over estimate if the sediment-tissue pairings used to develop the BSAF are not representative of the methylmercury content of the sediment.

[2] Under the proposed rule amendments, the cleanup level is the SCO, but may be raised upward depending on whether certain factors are met. The cleanup level may not be set higher than the CSL. For purposes of this analysis, the CSL is the regional background and the cleanup standard was established at regional background to determine the maximum potential difference between the baseline and proposed rule amendments.

3.5.1.3 Remedy determination

Ecology used baseline and proposed rule amendments cleanup acreages from the embayment specific analyses to determine remedial actions required for cleanup, estimate the total costs of these remedies, and calculate the difference due to the proposed rule amendments. Remedies selected include a mix of technologies

- Dredging.
- Capping.
- Long-term monitoring.

The baseline allows an analysis to be conducted to select a remedy based on cost, technical feasibility, and environmental protection. The proposed rule amendments differ on some specifics in determining the remedial action, however, the basic approach is similar. Ecology determined that the area for active cleanup (involving dredging) would not significantly change between the baseline and proposed rule amendments cleanup acreages. However, monitoring behavior and capping were likely to change due to the size of the sites. Table 2 summarizes the likely remediation behavior under the baseline and proposed rule amendments, and the associated costs.

Costs for dredging included nearshore and offshore excavation, dewatering, re-handling, upland staging for disposal transport, environmental controls, transport, and disposal at an upland landfill. Costs for thin-layer capping included cap material purchase, transport, material placement, and environmental controls. Costs for monitoring included operation and mobilization of monitoring vessels, sampling, analysis, quality assurance and control, and report writing.

Table 2: Embayment-specific remediation costs under baseline and proposed rule amendments

	Baseline (Based on PQL)	**Proposed Rule (Based on Regional Background)**
Acreage of site	4,200	1,200
Volume dredged ($yard^3$)	48,399	48,399
Dredge cost ($/$yard^3$)	120.2	120.2
Area Capped (acres)	25	20
Cap cost /($yard^3$)	41	41
Monitoring Years	50	30
# Samples per Monitoring Event	90	40
Monitoring Events	15	7
Total Cost (millions of $)	**$11.3**	**$8.9 (to $11.3*)**

*Ecology estimated a potential savings of 2.4 million for a representative embayment. The cost savings for another real embayment could potentially be zero, but could also be larger than this. It would be zero in the case that site-specific attributes of a site drive the cleanup level down to the same level as under the baseline (e.g., in cases with limited regional concentrations).

3.5.1.4 Conclusions and key assumptions

Site identification and investigation.

- The proposed revisions to the sediment cleanup objective are similar to the MTCA human health policies that are currently applicable to sediment cleanup actions. Consequently, the Ecology does not anticipate that the proposed rule amendments will significantly increase or decrease the average size of sites initially identified. However, the size of the site required to be further investigated and remediated may decrease under the proposed rule amendments.
- The size of individual sites may increase or decrease depending on site location and the contaminants of concern.
- Unit costs (costs/acre) will not be significantly different than the baseline costs.
- PLPs may elect to investigate and remediate cleanup units located within larger cleanup sites. Cleanup units may be defined by regional background levels. This may occur more frequently under the proposed rule revisions (see discussion below).
- The proposed rule amendments provide the flexibility to establish cleanup standards that exceed the sediment cleanup objective. Site-specific cleanup standards can be establish at levels equal to the SCO, CSL (regional background), or a value in between these levels. The cleanup standards define areas for further investigation and remediation, but do not change the size of the site (as defined by the SCO).
- Resolving liability for unit cleanups within larger sites. Ecology anticipates that the proposed rule revisions will increase the number of situations where PLPs will seek to resolve cleanup liability for cleanup units.
- The baseline rule provides the flexibility for liable persons to implement this type of approach.
- Clarifying human health protection methods and policies will increase the potential utility of this approach.
- Regulatory uncertainty will limit use of this provision until a few agreements are successfully completed.

- Further site characterization and active remediation costs will be lower than baseline costs.
- Long term monitoring costs may decrease.
- Cleanup costs will be incurred sooner.
- Due to the high variability in the sediment environment, this site specific example may not be representative of areas across the state.
- For many contaminants of concern, sediment cleanup standards are currently based on natural background concentrations.
- Use of regional background concentrations to establish sediment cleanup standards will be limited by the proposed revisions that eliminate cost as a consideration when setting cleanup standards. Liable persons may incur costs to perform additional sampling to define regional background.

Sediment Recovery Zones.

- Ecology has not established any sediment recovery zones since 1991.
- Clarification of human health protection may increase need for sediment recovery zones. However, rule revisions will decrease the number of situations where sediment recovery zones must be established than required under the baseline.
- Current rules (MTCA and SMS) require periodic reviews and monitoring to be performed when levels remain above the cleanup standards defined by current MTCA health risk policies.

3.5.2 Fish consumption rates

The fish consumption rate is a key exposure parameter used to calculate risk-based concentrations protective of human health. The MTCA rule has a default of 54 grams per day based on a recreational use scenario, but the MTCA rule allows for upwards adjustments of the default fish consumption rate based on the reasonable maximum exposure (RME) scenario (for example, a tribal use scenario).

The proposed rule amendments are consistent with the current MTCA RME requirements which include developing a site specific fish consumption rate based on a tribal consumption patterns. In addition, the MTCA rule, and proposed rule amendments, allow for site specific adjustments of other exposure parameters such as fish diet fraction (portion of fish consumed coming from a site). To illustrate the effect of differing exposures parameters such as the fish consumption rate and fish diet fraction, Ecology used the following analysis to identify the different risk-based concentrations calculated using these exposure parameter values actually used, or proposed to be used, at three real sites:

1. An urban marine embayment.
2. A rural marine embayment
3. An urban estuarine shoreline[3]

These case studies are representative of the different types of environments found in Washington State. Each site has sufficient data of a quality suitable for assessing human health risk, and they are actual sediment cleanup sites where human health risk has been (or is currently being) addressed.

For the purpose of this analysis, Ecology made considerable effort to employ the same values used to calculate risk-based concentrations at the sites – including some actual exposure parameters (fish consumption rate, body weight, and fish diet fraction) used, or proposed to be used, at the sites – and using site data to calculate the baseline and proposed rule amendment impacts.

Although Ecology used site-specific input parameters, the same equations were used to calculate baseline risk-based concentrations for all case studies, and for the proposed rule amendments, to provide an accurate comparison. That means Ecology used actual data from existing sediment cleanup sites, but used a standardized approach to calculate risk-based concentrations. As a result, the risk-based concentrations calculated for this analysis will differ from those used at specific sites. This is because to date no standardized approach has existed, and cleanups have occurred with risk assessment methodologies that vary significantly across sites, and specific exposure parameters such as the biota sediment accumulation factors can vary greatly.

For each chemical at each site, Ecology calculated a risk-based concentration that is protective of human health, using the following equations. (Variables are defined in Table 3.)

- Risk Based Concentration (cPAH/dioxin) =

  $(CR \times BW \times AT \times UCF \times S_{foc}) / (SF_o \times FCR \times FDF \times EF \times ED \times SL \times BSAF)$
- Risk Based Concentration (arsenic) =

  $(CR \times BW \times AT \times UCF) / (SF_o \times FCR \times FDF \times EF \times ED \times BAF)$
- Risk Based Concentration (mercury) =

  $(HQ \times BW \times AT \times UCF \times RfDo) / (FCR \times FDF \times EF \times ED \times BAF)$

Table 3: Exposure parameter inputs for risk-based cleanup levels, by location and chemical

Exposure Parameter	Abbreviation	Urban Shoreline	Urban Embayment	Rural Embayment
Fish consumption rate (g/day)	FCR	97.5	173	499
Fish diet fraction	FDF	1	1	1

[3] Ecology also attempted to include a freshwater representative site, but data at the few freshwater sites with human-health impacts were insufficient to perform this analysis.

Body Weight (kg)	BW	81.8	81.8	79
Exposure Duration (years)	ED	70	70	70
Exposure Frequency (days/year)	EF	365	365	365
Unit Conversion Factor (ug/kg)	UCF	1000	1000	1000
Averaging Time (days)	AT	25,550	25,550	25,550
Shellfish lipid fraction	S_L	1.3	1.3	1.3
Fraction of organic carbon in sediment	SF_{oc}	3.0	3.0	3.0
Cancer Risk / Hazard Quotient	CR / HQ	10 -6 / 10 -5	10 -6 / 10 -5 / HQ 1	10 -6 / 10 -5

		Arsenic	**Dioxin**	**cPAH**	**Mercury**
Reference Dose (mg/kg-day)	RfDo	N/A	N/A	N/A	0.0003
Oral Slope Factor (kg-day/mg)	SFo	1.5	150000	7.3	N/A
		Arsenic Fish	**Dioxin Clams/Crab**	**cPAH Clams/ Fish**	**Mercury[4] Crab Muscle[5]**
Biota Sediment Accumulation Factor/ Bioaccumulation Factor	BSAF/BAF	0.53	0.13 / 0.79	0.11 / 0.07	9.03

3.5.6 Conclusions and key assumptions.

- Under a range of fish consumption rates, risk based concentrations protective of human health at a 10^{-5} risk level fall below natural and regional background levels for many bioaccumulative chemicals.
- Ecology anticipates that the proposed rule revisions may impact cleanup standards based on non-cancer health risks.
- Ecology does not anticipate this will significantly change the type and scope of sediment cleanup actions relative to the current rule requirements.
- The vast majority of sediment cleanup sites are located in Usual and Accustomed areas for one or more tribes.
- Ecology would continue to establish sediment cleanup standards based on a tribal exposure scenario at most sites under the baseline and proposed rules since this represents the reasonable maximum exposure scenario under the current MTCA rule and law.

[4] The sediment risk based concentration and background value was for total mercury, which includes both the inorganic and organic form. The BSAFs incorporate the relative contribution of inorganic and organic mercury to the tissue burden. This may be an under or over estimate if the sediment-tissue pairings used to develop the BSAF are not representative of the methylmercury content of the sediment.

[5] The BSAF mercury value was for 100% consumption of muscle and viscera. This did not include the hepatopancreas which would lower the BSAF value.

- For many bioaccumulative chemicals, sediment cleanup standards are currently based on natural background concentrations.
- Risk assessments are based on very conservative assumptions, and risk assessments for bioaccumulative chemicals in the sediment environment is surrounded by high uncertainty and variability. This is because the transfer of bioaccumulative contaminants from sediment to tissue and subsequently to humans is highly variable and dependent on a high number of site specific factors. Extrapolating results from a risk calculation across the state may not be feasible.

3.6 What happens at site level? – Freshwater sediment standards for benthic community protection

The existing SMS rule lacks adopted freshwater chemical or biological standards for protection of the benthic community. Instead, the rule has a narrative standard for freshwater sediments.

3.6.1 Freshwater sediment cleanup sites

There are many contaminated freshwater sediment sites in Washington State under Ecology or Environmental Protection Agency (EPA) oversight. Due to the lack of adopted freshwater sediment standards in the existing SMS rule, the narrative standard requires a site-specific evaluation to establish cleanup standards. This creates inconsistency in how sediment sites are identified and cleaned up. In addition, the lack of adopted freshwater sediment standards limits how the EPA uses the existing SMS rule at federal sediment cleanup sites in the state.

Ecology is proposing to adopt numeric chemical and biological criteria for freshwater sediment cleanup to protect the benthic community in the proposed rule amendments. In order to understand the differences between the baseline and proposed SMS rule, Ecology conducted an analysis that focuses on the cost difference to identify and characterize a freshwater cleanup site based on benthic community protection. This was based on the following assumptions.

- Baseline: Since the current SMS rule does not have adopted numeric criteria for benthic community protection, the process to characterize or identify a cleanup site is more comprehensive. It must include analyzing both chemistry and bioassays at all sampling stations.
- Proposed rule amendments: Numeric chemical and biological criteria for benthic community protection will likely allow a site to be initially characterized by analyzing chemistry, and then analyzing for bioassays for only samples that exceed the chemical criteria.

Ecology used the chemical and biological data that were included in the development of the freshwater sediment chemical and biological criteria. This included 34 surveys, with as few as two samples, and as many as 233 samples each. Ecology divided these data into

three groups, based on the number of samples in a survey, since there are different bioassay laboratory costs for different batch sizes. (Typically labs have different pricing for batches of less than ten, 10 – 20, and over 20 samples.)

Table 4: Pricing and sample size for bioassay and chemistry samples at freshwater sites

# of Samples (Grouping)	Chemistry cost per sample	Bioassay cost per sample	Average number of samples	Average percent of samples with chemistry exceedances
< 10	$1,600	$2,350	4.1	76
≥ 10 < 20	$1,600	$2,120	15.8	65
≥ 20	$1,600	$1,990	59.5	49

For each sample size necessary for freshwater site characterization, Ecology used the values in Table 4 to calculate total costs associated with characterization. Ecology calculated all costs at the average sample size. Under the baseline, all samples would need analysis for chemistry and bioassays. Under the proposed rule amendments, only those samples with chemistry exceedances would require bioassay analysis.

Table 5: Total freshwater sediment cleanup site characterization costs by sample size

# of Samples (Grouping)	Cost to analyze chemistry for all samples	Cost to analyze bioassays for all samples	Cost to analyze bioassays for samples with chemistry exceedances	Baseline Rule Total Costs	Proposed Rule Total Costs
< 10	$6,560	$9,635	$7,323	$16,195	**$13,883**
≥ 10 < 20	$25,280	$33,496	$21,772	$58,776	**$47,052**
≥ 20	$95,200	$118,405	$58,018	$213,605	**$153,218**

For the different sample sizes, cost differences range between $2 thousand and $60 thousand less per site under the proposed rule amendments.

3.6.2 Conclusions and key assumptions

- Under the baseline, all sites would be required to analyze for both chemistry and bioassays to comply with the SMS narrative standard.
- Monitoring costs may decrease under the proposed rule amendments due to the need to conduct fewer bioassays.

3.6.3 Dredged material management for freshwater

For the baseline, the 2007 Sediment Evaluation Framework approved by DMMP/RSET (an update from the 2003 Interim SQVs) was used. Samples are screened using chemistry and exceedances are followed up with bioassays. For compounds with marine standards that did not have freshwater standards, the dredge programs used the marine standards. For the proposed rule amendments we used the numeric chemical and biological criteria.

3.6.3.1 Analytical Requirements

The proposed rule amendments include criteria for more chemicals than under the baseline. Specifically, total petroleum hydrocarbons and the butyltin group of chemicals would be added to the list of chemicals that must be analyzed. Because analyzing the butyltin group is a new requirement, the analytical costs are anticipated to increase. The cost for analyzing PAHs is anticipated to decrease because TPH will be analyzed versus individual PAHs.

3.6.3.2 Exceedances

Table 6 includes an analysis of how the baseline and proposed rule amendments compare in terms of exceedances of the criteria, at the sediment quality standard. For this analysis, the baseline is defined as the 2006 interim values in the Sediment Evaluation Framework (RSET, 2006). Three common contaminants found in dredge material were evaluated which includes mercury, DDT, and PCBs. This analysis does not conclude which dredge projects would have failed or passed, but provides a general understanding of the relative criteria exceedances for a select number of commonly found contaminants. Analysis of dredge material includes using the chemical criteria as a screen. If the dredge material fails the chemical criteria, then bioassays are required to verify toxicity. For purposes of this narrative, it is assumed that a higher percent of failed chemical exceedances would result in higher monitoring costs because of the additional expense of analyzing bioassays.

Table 6: Comparison of exceedances of the sediment quality standard

	Baseline Rule	Proposed Rule Amendments
Mercury SQS Criteria (mg/kg)	0.28	0.66
PCBs SQS Criteria (ug/kg)	60	110
DDT SQS Criteria (ug/kg)	N/A – no criteria	100
Mercury: Percent of SQS Exceedances	19%	10%
PCBs: Percent of SQS Exceedances	53%	40%
DDT: Percent of SQS Exceedances	N/A – no criteria	5%

3.6.3.3 Key assumptions

- The chemicals used in this analysis are representative of all chemicals required to be analyzed.

3.6.3.4 Conclusions

- Monitoring costs for freshwater dredge material are not expected to significantly change under the proposed rule.
- The percent of sediment standard exceedances is not expected to significantly change under the proposed rule.

- Promulgating freshwater benthic criteria will facilitate more consistent and effective decision making for dredged material management under the proposed rule.

3.7 What happens at site level? – Soil and ground water cleanup requirements for upland sites.

- Ecology does not anticipate that the proposed SMS rule revisions will significantly impact requirements for soil and ground water cleanup standards at MTCA sites that are adjacent to a river, lake, stream or bay.
- The proposed rule revisions provide the flexibility to establish site-specific cleanup standards for some chemicals that are higher than the maximum allowable level under current regulation.
- Sediment cleanup standards are established on a site-specific basis. The site-specific standards are based on a RME scenario, EPA toxicity values, MTCA risk policies and consideration of natural background concentrations/analytical limits.
- Under the proposed rule, the sediment cleanup objective requirements are virtually identical to current MTCA requirements (baseline).
- Under the proposed rule revisions, the CSL requirements are similar to the Method C provisions in the current MTCA rule. However, the CSL may be higher than allowed under the baseline rule because regional background levels may exceed risk-based concentrations and analytical limits. In these situations, the site-specific sediment cleanup standard might be higher than allowed under the baseline rule.
- Soil and ground water cleanup standards must be established at concentration that prevent exceedances of sediment cleanup standards based on protecting human health, surface water, and sediment benthic communities. At a significant number of upland sites, surface water standards under MTCA will be protective of sediment.

3.8 What happens at site level? – Analytical costs for compliance

Table 7 shows general analytical costs for a cleanup site to conduct compliance monitoring that may be associated with the proposed rule amendments. Due to the added clarity and requirements for assessing risk to human health and the environment under the proposed rule amendments, it is assumed that liable persons will be required to use more sensitive analytical techniques to more accurately detect contaminants at very low levels, or detect specific types of chemicals. For purposes of this cost benefit analysis, the cost of analyzing PCB congener versus Total Aroclors was compared. The following assumptions were made to conduct this analysis:

- According to the 2008, Sediment Cleanup Status Report (Ecology 2008), there are 115 sediment cleanup sites in Puget Sound. Due to the ubiquitous nature of both dioxin and PCBs found in Puget Sound sediment, and for purposes of this cost benefit analysis, it is assumed that 75% of these cleanup sites, for a total of 86, have both dioxin and PCB contamination. Freshwater sites were not included for this analysis due to the variety of contaminants found at these sites that may not include both dioxin and PCBs.
- The new analytical costs will apply to existing sites for compliance evaluation and long term monitoring.
- In order to have a consistent number of sites for comparison between the proposed rule amendments and baseline rule, the existing number of cleanup sites in Puget Sound was used.
- An analytical cost of $900 per sample per contaminant for dioxin and PCB congeners.
- Sites under the baseline rule were not required to test for PCB congeners.
- An average of 5 -10 samples per cleanup to evaluate compliance at a remediated site, every 5 years, for a 20 year monitoring period.
- If dioxin is a chemical of concern, PCBs are a chemical of concern, and vice versa.
- Liable persons are responsible for the chemicals of concern identified for the sediment cleanup.

Table 7: Analytical costs associated with sampling sediment to evaluate compliance.

*PCB congener analysis @$900/sample; # PCB Total Aroclor analysis @$200/sample

	Baseline Rule	**Proposed Rule Amendments**
Number of cleanup sites required to test for dioxin and PCBs	86	86
Dioxin analytical costs per cleanup site per compliance sampling event	$4,500 – $9,000	$4,500 – $9,000
PCB analytical costs per cleanup site per compliance sampling event	$1,000# - $2,000#	$4,500* - $9,000*
Total dioxin and PCB congener analytical costs for all cleanup sites per each monitoring event	$473,000 – $946,000	$774,000 – $1,584,000
Total cost for all cleanup sites in Puget Sound over a 20 year compliance monitoring time period	**$1,892,000 – 3,784,000**	**$3,096,000 – 6,192,000**

Ecology conservatively assumed all costs are incurred immediately.

3.8.1 Conclusions and uncertainties:

- The cost for compliance monitoring under the proposed will increase.
- Compliance monitoring methods are still evolving. Approaches such as area-weighted averaging and/or fish tissue monitoring may limit remediation costs relative to the point-by-point compliance strategy used for cleanup standards based on ecological protection.

- Liable parties have the option of performing tissue testing and/or bioaccumulation testing to screen chemicals of concern which may decrease analytical costs for sediment chemistry.
- Site characterization and compliance monitoring costs for the proposed rule do not include emerging bioaccumulative contaminants that may be added to the list of chemicals of concern at sediment cleanup sites.

3.9 What happens at site level? – Dredged material management for marine sediment

Across the state, harbor areas, ports, and marinas naturally deposit silt from upstream sediment and upland soil draining to both marine and freshwater bodies. Because of this sediment deposition process, routine maintenance dredging is needed on a regular basis to remove the mud and sand that builds up and causes safety problems for navigation. This dredging helps keep navigation and commerce viable. This material is managed by the Dredged Material Management Program (DMMP) and consist of the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency (EPA), Ecology, and WA Department of Natural Resources. The DMMP provides the structure and system to manage publicly approved, environmentally protective open-water disposal sites in Puget Sound, Grays Harbor, and Willapa Bay.

The DMMP considers many factors to determine when evaluating dredging projects:

- Historical uses and existing sediment chemistry data in the area.
- Nearness to existing federal and state cleanup sites.
- Make up of materials at the site.
- How much and where material is proposed to be disposed.

The disposal alternatives approved by DMMP based on the above criteria include:

- Open-water at an approved site.
- Transferred to land for fill projects.
- Used for beneficial shoreline uses.

- An approved landfill.

Additionally, the DMMP evaluates antidegradation when there is potential for elevated chemical concentrations in the surface exposed by dredging.

The DMMP is a subgroup of the larger Regional Sediment Evaluation Team. In 2006 the RSET adopted interim guidance for freshwater sediments based on the 2003 freshwater guidance (Ecology 2003). In 2010, the DMMP revised the framework for assessing dioxins in dredged material in the Puget Sound region.

3.9.1 Dredged material management dioxin and PCB case study

Ecology analyzed the potential cost impacts of the rule revisions on dredged material disposal from cleanup sites and navigational dredge projects. For comparison purposes of this cost benefit analysis the baseline and proposed rules are as follows:

For the baseline rule, the requirements for dredged material disposal sites includes the SMS requirements in WAC 173-204-400, 173-204-410, and 173-204–420. The requirements for disposal are established using best available dredged material guidance and applicable federal and state rules. This guidance includes the Puget Sound dredged disposal analysis (PSDDA) requirements and the Users' Manual for Dredged Material Management (DMMP guidance), as amended. In addition, the sediment quality goal for the disposal site is the Sediment Cleanup Objective and the disposal site must not exceed the Cleanup Screening Level.

The DMMP guidance was developed to be consistent with the SMS and MTCA requirements and established the sediment quality goal for the disposal site at the Sediment Cleanup Objective but does not have an established Cleanup Screening Level. While the SMS rule allows establishment of a Sediment Impact Zone (SIZ) for dredge disposal sites for the benthic criteria chemicals, it does not specifically allow one for bioaccumulative chemicals. Therefore, anSIZ for dioxins is not allowed under the baseline rule. Specifically, the DMMP guidance defined the Sediment Cleanup Objective as follows:

- For dispersive sites: Dioxin concentrations could not exceed a maximum concentration of 4 ppt TEQ in any single dredge material management unit from the dredged area.
- For non-dispersive sites: The volume weighted average concentration of dioxin in material from each dredging project could not exceed 4 ppt TEQ, and could not exceed a maximum of 10 ppt TEQ for any dredged material management unit.

For the proposed rule amendments, the Sediment Cleanup Objective would be the same as the baseline rule above and the sediment quality goal for the disposal site. However, the disposal site would have a defined Cleanup Screening Level, which is a maximum chemical or biological effect concentration allowed at the disposal site under an authorized SIZ. Because the proposed rule amendments have an established Cleanup Screening Level, the rule would allow an authorized SIZ. For the purposes of this cost

benefit analysis, the Cleanup Screening Level for dioxin has been established consistent with section 3.5.1.2 of this document which is a Puget Sound wide Regional Background concentration of 11 ppt TEQ.

Because the agency has not made a decision to authorize SIZs for disposal sites, the Cleanup Screening Level is used as a maximum allowed chemical concentration for the sampled dredged sediment at non dispersive sites, rather than the maximum allowed chemical concentration for the disposal site as follows:

- For dispersive sites: Dioxin concentrations could not exceed a maximum concentration of 4 ppt TEQ in any single dredge material management unit from the dredged area.
- For non-dispersive sites: The volume weighted average concentration of dioxin in material from each dredging project could not exceed 4 ppt TEQ, and could not exceed a maximum of 11 ppt TEQ for any dredged material management unit.

Table 8 shows results from an analysis of dredge projects in the dredging years 2010 and 2011 that were used to compare the baseline and proposed rules. The DMMP reviewed a total of 17 maintenance or navigational and cleanup site dredge projects in Puget Sound which were analyzed for dioxin. For purposes of this cost benefit analysis, material was determined to be unsuitable for open-water disposal if the requirements under the baseline and proposed rule amendments stated above were not met. The cost differential was determined based on the increased costs of upland landfill disposal at a maximum cost of \$120.20 yd^3.

It was assumed that the volume of material determined unsuitable for open-water disposal would still be dredged but disposed of in an upland landfill. Under the proposed rule, the sediment quality goal would remain the Sediment Cleanup Objective of 4 ppt TEQ, but the maximum allowed concentration for a dredged material management unit would be 11 ppt TEQ for non dispersive sites.

Table 8: Sediment, in terms of cubic yards and number of projects, deemed suitable and unsuitable for open-water disposal based on concentrations of dioxin.

	Baseline Rule SCO: 4/10 ppt TEQ dioxin	**Proposed Rule SCO: 4/10 ppt TEQ dioxin**	**Proposed Rule SCO/CSL: 4/11 ppt TEQ dioxin**
Unsuitable Volume (yd^3)	153,570	153,570	153,570
Suitable Volume (yd^3)	1,378,796	1,378,796	1,378,796

Unsuitable (# of projects)	5	5	5
Suitable (# of projects)	12	12	12
Cost	**$18,459,114**	**$18,459,114**	**$18,459,114**

Ecology conservatively assumed all costs are incurred immediately.

Table 9 shows results from an analysis related to potential costs to characterize dredge material for dioxin as well as PCB congeners. For a three year period from 2007 – 2009, the amount of dredge projects required to be tested for dioxin increased from 10% to 38%, which predominantly included projects from urban areas. At this time, all urban projects are required to test for dioxins, and all projects going to dispersive sites must obtain dioxin data as well. It is predicted that dioxin testing will not increase. However, it is expected that more analysis for PCB congeners may be required, rather than Total Aroclors, to accurately assess human health risks. The following assumptions were made to conduct this analysis presented in Table 9:

- An average number of projects of 20 per year.
- An average analytical cost of $200 per sample for Aroclor analysis.
- An average analytical cost of $900 per sample for PCB congener analysis.
- An average cost of $900 per sample for Dioxin analysis.
- An average of 1 sample per DMMU.
- An average of 4 DMMUs per project.
- Assumption that all projects are required to test for PCB Total Aroclors, therefore the proposed rule may require testing for PCB congeners instead of PCB Total Aroclors.

Table 9: Analytical costs associated with dredge material sampled for potential open-water disposal.

*PCB congener analysis @$900 per sample; # PCB Total Aroclor analysis @ $200 per sample.

	Baseline Rule	**Proposed Rule**
Percent of projects required to test for dioxin	38%	38%
Number of projects required to test for dioxin	$\geq$ 8	$\geq$ 8
Dioxin analytical costs per project	$3,600	$3,600
Total dioxin analytical costs for all projects	**$28,800**	**$28,800**
Percent of projects required to test for PCB Aroclors	100%	0%
Percent of projects required to test for PCB congeners	0%	100%
Number of projects required to test for PCB Aroclors	20	0

Number of projects required to test for PCB congeners	0	20
PCB analytical costs per project	$800[#]	$3,600*
Total PCB analytical costs for all projects	$16,000	$72,000
Average total dioxin and PCB congener analytical costs for all projects for a three year period 2007 - 2009	$44,800	$100,800
Average total dioxin and PCB congener analytical costs for all projects for a twenty year period	**$298,636**	**$671,932**

Ecology conservatively assumed all costs are incurred immediately.

3.9.2 Key assumptions

- This analysis was conducted with a limited number of bioaccumulative chemicals due to lack of data. It is uncertain if this analysis is predictive of future monitoring requirements for other bioaccumulative chemicals and/or emerging contaminants.
- The pas number of dredge projects submitted to the DMMP is representative of the future number of dredge projects.

3.9.3 Conclusions

- Disposal options for dredged material and monitoring costs would not significantly change under the proposed rule amendments.
- Analytical costs may increase under the proposed rule amendments.

3.10 What happens at site level? – Source control to protect sediment cleanups

3.10.1 NPDES permitted dischargers for potentially liable parties (PLPs)

Ecology anticipates that, for dischargers that are identified PLPs for a sediment cleanup site, monitoring requirements will change in order to protect the cleanup and comply with cleanup standards. In addition, Ecology anticipates these facilities will need to implement new and updated best management practices and conduct potential treatment of the discharge to prevent recontamination of the cleanup site above the cleanup standard. However, the requirement for PLPs to conduct source control of a discharge exists under both the baseline and proposed rule amendments.

The features of a discharger can be highly variable based on the sediment cleanup standard, contaminants in the discharge, type of treatment and best management practices employed, volume of water and contaminant load to receiving water, physical aspects of the facility, and receiving water and sediment characteristics. Therefore, anticipating the costs of any additional treatment or best management practices would be facility specific and highly variable. It is assumed that, the differential between the baseline and proposed rule amendments is based on the cleanup standard and the required analytical methods and the cost would be roughly proportional to the concentration of the cleanup standard.

Ecology acknowledges that, under the proposed rule amendments, the analytical methods required to verify compliance with a cleanup standard for bioaccumulative chemicals will change. Table 10 includes an analysis of a representative contaminant that may require more sensitive analytical methods. Assumptions made to conduct this analysis include:

- According to the 2008, Sediment Cleanup Status Report (Ecology 2008), there are 115 sediment cleanup sites in Puget Sound. Due to the ubiquitous nature of both dioxin and PCBs found in Puget Sound sediment, and for purposes of this cost benefit analysis, it is assumed that 75% of these cleanup sites, for a total of 86, have both dioxin and PCB contamination. Freshwater sites were not included for this analysis due to the variety of contaminants found at these sites that may not include both dioxin and PCBs.
- One to three NPDES permitted discharges (outfalls) per cleanup site would be sampled for chemicals of concern.
- A total of two to four effluent and collection basin samples per discharge would be required per permit cycle (every 5 years) to verify compliance with the sediment cleanup standard over a 20 year monitoring time period.
- Liable persons are responsible for the chemicals of concern identified for the sediment cleanup.
- An average cost of $900 per sample for both dioxin and PCB congeners, and $200 per sample for Total Aroclors.

Table 10: Analytical costs associated with effluent and catch basin sampling to verify compliance with the sediment cleanup standard.

*PCB congener analysis @$900 per sample; # PCB Total Aroclor analysis @$200 per sample

	Baseline Rule	**Proposed Rule Amendments**
Percent of PLPs required to test discharge for dioxin	100%	100%
Percent of PLPs required to test discharge for PCBs	100%	100%
Dioxin analytical costs per PLP/cleanup site	$7,200 - 43,200	$7,200 – 43,200
PCB analytical costs per PLP/cleanup site	$1,600 – 9,600#	$7,200 – 43,200*
Total analytical costs per PLP/cleanup site	$8,800 – 52,800	$14,400 – 86,400
Total analytical cost for all cleanup sites in Puget Sound over a 20 year monitoring time period	**$756,800 – 4,540,800**	**$1,238,400 – 7,430,400**

3.10.2 NPDES permitted dischargers (non PLPs)

According to an Ecology report (Ecology, 2011) the majority of ubiquitous contaminants, such as PCBs, are entering Puget Sound through storm water runoff. It follows that a significant source of potential recontamination of sediment cleanup sites is from stormwater runoff, the majority of which includes unpermitted dischargers and nonpoint sources but also includes permitted dischargers. These permitted stormwater dischargers include facilities under both Phase I and II municipal permits, individual industrial permits, and general industrial permits. In addition, both municipal and industrial wastewater discharges may be a source of sediment contamination.

Part IV of the SMS rule requires that NPDES discharges monitor effluent to protect sediment quality and that permits are conditioned to prevent the creation of new sediment cleanup sites. The impact the proposed rule may have on these dischargers is highly uncertain due to many facility and sediment site specific variables. These include, but are not limited to:

- Current and future number of permitted and unpermitted dischargers that may be subject to new requirements
- The type of NPDES permit (individual or general industrial or municipal stormwater, industrial or municipal wastewater)
- Specific nature of the discharge including:
  - Volume of water discharged
  - Chemicals discharged
  - Treatment and best management practices employed
  - Acreage draining to and from the facility
- Analytical limitations of effluent sampling
- The load of contaminants discharged that actually result in sediment contamination from these varied sources including receiving water and sediment physical and chemical characteristics

3.10.3 Key Assumptions

- A limited number of bioaccumulative chemicals were used in this analysis with the assumption they are representative of other chemicals that may require different analytical methods. However, uncertainties remain regarding any future additions of new chemicals to the cleanup or monitoring process. Site specific costs to protect sediment cleanups from discharges may potentially increase which could include implementation of new treatment and/or best management practices. This is highly site specific so the potential for new requirements is uncertain.

3.10.4 Conclusions

For NPDES permitted dischargers that are PLPs:

- Discharge monitoring and analytical costs may increase under the proposed rule and costs will be incurred sooner.
- Cleanup standards are not expected to be more conservative under the proposed rule. They may remain the same as the baseline rule or be established at a higher level. Therefore costs to attain and maintain a cleanup standard at the sediment cleanup site are not expected to increase.

For dischargers that are not identified PLPs for a sediment cleanup site, Ecology does not anticipate significant new permitting requirements near term for the majority of these facilities outside of the current permitting and TMDL efforts Ecology is undertaking.

3.11 What happens at a broader scale? – Puget Sound-wide analysis

Ecology estimated the impacts of the proposed rule amendments on sediment cleanup across the Puget Sound, as one illustration of the likely costs and benefits.

3.11.1 Background concentrations

Ecology calculated one value each for both natural and regional background for all of Puget Sound in order to consistently identify sites for comparison. Ecology acknowledges that the intent of Regional Background is to be location-specific, but for purposes of this cost benefit analysis, it was necessary to have comparable results across Puget Sound regardless of sub-location.

Ecology analyzed two bioaccumulative chemicals (dioxin and mercury) based on:

1. Availability of sufficient high quality data.
2. Ubiquitous nature of the chemicals in Puget Sound sediment.

3.11.1.1 Baseline

Under the baseline of combined SMS benthic and MTCA human health criteria, Ecology calculated a baseline cleanup standard for dioxin and mercury across Puget Sound. The SMS chemical criteria for dioxin, at the CSL benthic criteria (200 ppt TEQ[6]), corresponds to toxicity in fish. The SMS chemical criteria for mercury, at the CSL (0.59 ppm[7]), corresponds to toxicity to benthic organisms.

[6] Parts per trillion, total equivalent toxicity. There are multiple forms of dioxin. TEQ combines and converts their concentrations to a single toxicity-equivalent concentration for human health.
[7] Parts per million.

Under the baseline rule, the cleanup standard is the highest of a risk based cleanup level (which is the lowest value for either human health or benthic risk), practical quantitation limit, or natural background. The human health cleanup standard is more stringent than benthic criteria, practical quantitation limit and natural background for both mercury and dioxin so natural background was determined to be the cleanup standard. Ecology used data from the Environmental Information Management (EIM) database, including samples from Ecology-approved reference areas, OSV *BOLD* (DMMP 2009) sampling stations, and other stations that were determined to be similarly influenced by anthropogenic sources as the reference areas.

Ecology calculated the 95th upper confidence limit on the mean of the data for each chemical, and used MTCA natural background values:

- 0.01 ppm for mercury.
- 2.0 ppt TEQ for dioxin

3.11.1.2 Proposed rule amendments

The proposed rule amendments in establishing the cleanup standard consider both natural background and regional background. The natural background was determined using the same data as described above for the baseline. For determining regional background, Ecology used the EIM database to download sediment data for all of Puget Sound. Ecology then removed data within 500 meters of shore, as this data could be directly influenced by sources such as cleanup sites, stormwater discharges, and other discharges, and would not appropriately represent the proposed definition of regional background. Ecology also performed standard data cleaning procedures to remove outlier data. For purposes of this cost benefit analysis, Ecology calculated the 90th upper tolerance limit on the 90th percentile as regional background:

- 0.23 ppm for mercury.
- 11.0 ppt TEQ for dioxin.

Under the proposed rule amendments, the cleanup level is the SCO, but may be raised upward depending on whether certain factors are met. The cleanup level may not be set higher than the CSL. For purposes of this analysis, the CSL is the regional background and the cleanup standard was established at regional background to determine the maximum potential difference between the baseline and proposed rule amendments.

3.11.2 Number of sites in Puget Sound

Ecology identified cleanup sites in Puget Sound by using the current provisions in the existing SMS rule for identifying sites and the corresponding provisions under the proposed rule.

3.11.2.1 Baseline

Under the baseline rule, cleanup sites are identified if the average of three sample stations that were spatially and chemically similar exceeded the CSL benthic criteria. Additionally, if each of three sample stations that were spatially and chemically similar exceed the narrative standard of "no significant risk to human health", the location was identified as a cleanup site. Ecology interpreted the SMS narrative standard of "no significant risk to human health" as the MTCA human health criteria. These are the highest of:

- Natural background.
- PQL.
- 10^{-6} human-health risk level for individual carcinogens, or a hazard quotient of 1 for noncarcinogens.

In some cases, the PQL could be higher than the MTCA natural background. However, since this PQL determination is site-specific and variable, for purposes of this cost benefit analysis, Ecology defaulted to the MTCA natural background because it provided a consistent value for all of Puget Sound.

- For mercury, Ecology identified clusters if stations no more than 500 feet apart were above this level.
- For dioxin, Ecology identified clusters if stations no more than 1000 feet apart were above this level. Ecology made this change due to the lack of data for dioxin.

3.11.2.2 Proposed rule amendments

The proposed rule amendments combine existing SMS benthic criteria with MTCA-based human health criteria, a new regional background, and freshwater sediment standards for protection of the benthic community. If each of three sample stations that are spatially and chemically similar exceed the Cleanup Screening Level (CSL), Ecology identified a cleanup site (cluster of potential concern).[8] The CSL is the highest of:

- Regional background.
- PQL.
- Risk-based concentration, which is the lowest of:
    - 10^{-5} human health total site risk level for carcinogens, or a hazard quotient of 1 for noncarcinogens.
    - Current SMS cleanup screening level for benthic criteria.

In some cases, the PQL could be higher than the proposed rule amendments' regional background. However, since this determination is site specific and variable, for

[8] See proposed WAC 173-204-560(4) and WAC 173-204-510(2)(c).

purposes of this cost benefit analysis, Ecology defaulted to SMS regional background because it provided a consistent value for all of Puget Sound.

- For mercury, Ecology identified clusters if stations no more than 500 feet apart were above this level.
- For dioxin, Ecology identified clusters if stations no more than 2,000 feet apart were above this level. Ecology made this change due to the lack of data for dioxin.

3.11.3 Acreage and site boundaries

Ecology used the cluster analysis detailed above to identify sites requiring further investigation and cleanup. Ecology defined site boundaries requiring remediation by:

- Baseline: Ecology identified SMS benthic criteria sites by chemical concentrations at or above the existing SMS CSL, and the boundaries of the site by chemical concentrations above the SMS benthic SQS. Ecology identified and bounded baseline sites based on human health/background using chemical concentrations at or above MTCA natural background cleanup standard.[9]
- Proposed rule amendments: Ecology identified sites requiring further investigation and cleanup by clusters at or above the proposed regional background level. Ecology identified boundaries of clusters using chemical concentrations above proposed SMS regional background, or concentrations above MTCA natural background. The proposed rule allows a site specific cleanup standard to be established between the CSL and SCO tiers, and the CSL could be bounded by regional background. For purposes of this cost benefit analysis, Ecology defaulted to regional background as the cleanup standard. Conclusions on cost differences for the proposed rule would be based on a maximum rather than a minimum cost difference.

3.11.4 Puget Sound-wide results

Table 11 summarizes the resulting site-acreage for dioxin and for mercury, across Puget Sound, under the baseline and the proposed rule amendments.

Table 11: Puget Sound sites and total acreage requiring further investigation and cleanup under baseline and proposed rule amendments

Rule	Dioxin			Mercury		
	Number of sites	Site acreage bounded by Natural Background	Site acreage bounded by Regional Background	Number of sites	Site acreage bounded by Natural Background	Site acreage bounded by Regional Background
Baseline MTCA Natural Background	23	16,167		60	20,592	

[9] For this analysis, the practical quantitation limit was not used as this determination is site specific.

Proposed Rule Amendments SMS Regional Background	16		1,749	41		2,874

3.11.5 Remedy determination and cost differential

Ecology used baseline and proposed cleanup acreages from Table 11 to determine remedial actions required for cleanup, estimate the total costs of these remedies, and calculate the difference due to the proposed rule amendments. Remedies selected typically include a mix of technologies

- Dredging.
- Capping.
- Long-term monitoring.

The baseline allows an analysis to be conducted to select a remedy based on cost, technical feasibility, and environmental protection. The baseline and proposed rules differ on the specifics of calculating the remedial action this way, however, the basic approach is similar. Ecology determined that the area for active cleanup (involving dredging) would not significantly change between the baseline and proposed rule amendments cleanup acreages. However, monitoring behavior and capping were likely to change. Tables 12 and 13 summarize the likely remediation behavior under the baseline and proposed rule amendments, and the associated costs, for dioxin and mercury, respectively.

Costs for dredging included nearshore and offshore excavation, dewatering, re-handling, upland staging for disposal transport, environmental controls, transport, and disposal at an upland landfill. Costs for thin-layer capping included cap material purchase, transport, material placement, and environmental controls. Costs for monitoring included operation and mobilization of monitoring vessels, sampling, analysis, quality assurance and control, and report writing.

Table 12: Puget Sound-wide remediation under baseline and proposed rule amendments, for Dioxin

	Baseline (Based on MTCA Natural Background)	**Proposed Rule Amendments (Based on Regional Background)**
Acreage of site	16,167	1,749
Volume dredged ($yard^3$)	186,336	70,663
Area Capped (acres)	96.3	29.2
Monitoring Years	192.5	43.8
# Samples per Monitoring Event	90	40

Monitoring Events	57.75	10.22

Table 13: Puget Sound-wide remediation under baseline and proposed rule amendments, for Mercury

	Baseline (Based on MTCA Natural Background)	**Proposed Rule Amendments (Based on Regional Background)**
Acreage of site	20,592	2,874
Volume dredged ($yard^3$)	237,300	115,916
Area Capped (acres)	122.6	47.9
Monitoring Years	245.15	71.95
# Samples per Monitoring Event	90	40
Monitoring Events	73.55	16.77

3.11.6 Key assumptions

- When conducting this analysis, both regional and natural background were used as the defaults for the SCO and CSL values. This was done due to the site specific nature of establishing human health risk based concentrations, for example bioavailability of total mercury versus methyl mercury. It was assumed the risk based concentrations were below background which may not be the case site specifically.
- The cleanup standard, and the standard that defined an area for remediation, was established at the CSL. The proposed rule allows a cleanup standard to be established within a range of the SCO and CSL. Site specific decisions may establish the cleanup standard closer to the SCO.
- This analysis was conducted with a limited number of bioaccumulative chemicals with the assumption that they may be representative of other bioaccumulative chemicals. Considering the potential number and widespread nature of other contaminants that have yet to be fully investigated due to lack of data, there are uncertainties with this assumption.

3.11.7 Conclusions

- Ecology does not anticipate that the proposed SMS rule revisions will significantly increase or decrease the number of sediment cleanup sites initially identified. Ecology anticipates that the number and area of sites requiring further investigation and cleanup may be reduced under the proposed rule. However, the number of cleanup

sites may increase under the proposed rule relative to the number of sites identified using the SMS benthic criteria.

- Ecology anticipates that clarifying the current listing policies will result in earlier site decisions relative to the current rule.
- The proposed rule revisions will provide the flexibility to use higher listing thresholds for sites requiring further investigation and cleanup for widely distributed bioaccumulative chemicals than allowed under current regulations. However, most sediment contains a wide range of contaminants and this will limit the impact of this revision.
- The proposed listing criteria are similar to the MTCA human health policies that are currently used to implement the narrative provisions in the SMS rule for identifying cleanup sites based on human health protection.

Statewide Impacts

While Ecology did not have adequate data to perform a similar analysis statewide, Ecology believes a similar result would hold in other areas of the state. The benefits and costs resulting from the proposed rule at a representative embayment would be further scaled to include other locations in the state. Since Ecology believes the benefits of the proposed rule exceed the costs at the embayment-level (see above and sections 3.4 – 3.10), scaled up for the state, this conclusion should hold.

3.12 Summary

- The number of cleanup sites may increase relative to the number of sites identified using the SMS benthic criteria. However, the number of cleanup sites under the proposed rule amendments will be less than the number identified using the MTCA risk policies to implement the current SMS narrative standard. This is due to the change in site listing criteria and cleanup standards. See sections 3.5 and 3.11 for further information.
- The average size of cleanup sites and initial characterization costs for investigations will not significantly change under the proposed rule amendments. However, the size of the site area required to be remediated, remedial investigation, and the long term monitoring costs may decrease. This is due to the potential change in cleanup standards which clarifies how to identify site and site unit boundaries for active remediation. See section 3.4 for further information.
- Ecology expects that liable persons will choose to conduct unit cleanups more frequently under the proposed rule amendments. Near-term investigation and negotiation costs may decrease but these costs will be incurred sooner. This is because the cleanup decision making framework is more effective and predictable, the ability to resolve liability for recontamination more incentives for conducting active cleanup sooner have been incorporated into the proposed rule .See sections 3.4 through 3.11 for further information.

- Active remediation costs under the proposed rule amendments will be lower than baseline costs but these costs will be incurred sooner. The proposed rule amendments include potentially higher cleanup standards that will be used to identify the boundaries of the area for active cleanup. Therefore, there may be less volume and acreage for active cleanup. See section 3.5. and 3.11 for further information.
- The proposed rule amendments will not significantly impact current dredge material disposal practices but analytical costs may increase. This is due to the need to use more sensitive analytical methods, and the potential addition of new chemicals to the sampling suite, to assess risk from bioaccumulative chemicals. See section 3.9, tables 8 and 9 for further information
- The proposed rule amendments will not significantly impact soil and ground water cleanup standards because the surface water standards under MTCA are not changing and sediment cleanup standards have potential to be higher than the baseline rule. Evaluation costs may increase, but cleanup costs may actually decrease because site-specific sediment cleanup standards may be established at levels above the sediment cleanup objective. See section 3.10 for further information.
- The proposed rule amendments will not significantly change requirements for most NPDES permitted dischargers. However, monitoring costs for dischargers that are PLPs will increase and costs to comply with requirements will be incurred sooner. This is due to the requirement to conduct source control to prevent recontamination. This will entail potentially analyzing effluent for other chemicals of concern and employing more costly analytical methods. See section 3.10, table 16 for further information

CHAPTER 4: Cost-Benefit Comparison and Conclusions

4.1 Introduction

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

4.2 Costs and benefits of the proposed rule amendments

Overall, Ecology estimated that the proposed rule amendments potentially result in a cost savings, from site characterization and cleanup, mitigated to some extent by possible cost increases for site compliance assessment and permit compliance. Also, the circumstances of many sites may not change at all under the proposed rule amendments.

4.2.1 How is the rule beneficial overall?

4.2.1.1 Cleanup timing

Ecology determined the most likely result of the proposed rule amendments in the short term (within the 20-year scope of Ecology rule analyses) would be to either:

- Not change cleanup standards that are set at the Sediment Cleanup Objective, in most cases this would be natural background concentrations (because regional background concentrations are equivalent and risk based concentrations fall below background).
- Or, to raise cleanup standards above the Sediment Cleanup Objective but no higher than the Cleanup Screening Level, in most cases this would be regional background concentrations (that are less stringent).

In addition, the proposed rule amendments, by clarifying the cleanup standard methodology, setting clear compliance requirements, allowing cleanup of individual units within larger sites, addressing liability for recontamination from upland sources, and adopting freshwater benthic criteria would likely expedite site characterization and compliance with necessary and viable remediation. In the short term, the proposed rule amendments would in this way immediately address those sites that are contaminated above regional background levels, and allow for long-term reductions in background levels in a bay-wide or watershed-wide area through a combination of active cleanup, natural recovery, and source control efforts.

Prospectively, by increasing the cleanup standard for some sites from natural background concentrations up to, but not exceeding, regional background

concentrations, the proposed rule amendments potentially increase risk associated with human and environmental health to that associated with regional background concentrations in some areas. Ecology could not confidently quantify this risk, but acknowledges that it may exist (with mitigation as described in section 3.9), and over time is likely to fall in the long-term, as background concentrations fall without contribution from contaminated sites. However, under the proposed rule, by conducting active cleanup of highly contaminated site units in the nearshore environment, risk reduction and natural resource restoration will occur sooner in this area.

Faster remediation and settling of disputed site cleanup would likely also allow property owners (at affected sites, and those nearby) to make property transactions more freely,. The demand for cleaned up properties would also increase sooner, and property values are likely to rise. Ecology could not quantify this increase in the present value of property at or near sediment sites, and so included it as a qualitative (but no less significant) benefit. Further discussion of these benefits is in section 3.2.

4.2.1.2 Property value and exchange benefits

Remediated properties (as well as those suffering from contagion of nearby low contaminated property values) are likely to sell for higher prices, and allow for redevelopment, or replacement with other industry compliant with modern environmental and health regulations. In the interim, they are also likely to burden current owners and operators for a shorter time. Further discussion of these benefits is in section 3.3.

4.2.2 What happens at the site or embayment level?

4.2.2.1 Site characterization

Ecology estimated that the proposed rule amendments may result in reduced site-characterization costs for a representative site contaminated with bioaccumulative chemicals of concern, of approximately $148 thousand per site. This cost savings results from reduced necessary sampling, and reduced core-sample depth. This is the cost reduction for a typical site, and some sites will experience no cost savings, while others will experience a larger cost savings The analyses supporting these conclusions can be found in section 3.4.

4.2.2.2 Sediment cleanup at a representative embayment site

The proposed rule amendments may results in higher cleanup standards for some sites, as compared to the baseline. Ecology estimated the change in cleanup standards at a sediment site could save a maximum of $2.4 million in cleanup and monitoring costs, based on an analysis of a representative embayment requiring sediment cleanup, and posing human health risk.

The cost savings for another real embayment could potentially be zero, but could also be larger than this. It would be zero in the case that site-specific attributes of a site drive the cleanup level down to the same level as under the baseline (e.g., in cases with limited regional concentrations). The analyses supporting these conclusions can be found in section 3.5.

4.2.2.3 Sediment cleanup at a freshwater sediment site for benthic community protection

Ecology estimated that the proposed rule amendments may result in reduced site characterization costs for freshwater sites where the benthic community is impacted within a range of $2,312 - $60,387 thousand per site. This is the cost reduction for a typical site, and some sites will experience no cost savings, while others will experience a larger cost savings. The analyses supporting these conclusions can be found in section 3.6.

4.2.2.4 Soil and ground water cleanup on upland sites

Ecology does not anticipate that the proposed SMS rule revisions will significantly impact requirements for soil and ground water cleanup standards at MTCA sites that are adjacent to a river, lake, stream or bay.

Under the proposed rule revisions, the CSL requirements are similar to the Method C provisions in the current MTCA rule. However, the CSL may be higher than allowed under the baseline rule because regional background levels may exceed risk-based concentrations and analytical limits. In these situations, the site-specific sediment cleanup standard might be higher than allowed under the baseline rule.

Soil and ground water cleanup standards must be established at concentration that prevent exceedances of sediment cleanup standards based on protecting human health, surface water, and sediment benthic communities. At a significant number of upland sites, surface water standards under MTCA will be protective of sediment.

4.2.2.5 Analytical costs for evaluating compliance

Ecology estimated a possible cost increase for additional analysis for evaluating compliance at sediment sites, within a range of $1.2 – $4.6 million, over 20 years. The analyses supporting these conclusions can be found in section 3.8.

4.2.2.6 Dredged material for marine sediment

Ecology also estimated additional dredging costs for analysis at an average of $373,296 thousand for all proposed dredging projects over 20 years. The analyses supporting these conclusions can be found in section 3.9.1.

4.2.2.7 Source control

Ecology estimated a possible cost increase for additional analysis at permitted effluent discharge sites in Puget Sound over the next 20 years, within a range of $481,600 - $2,889,600, only for those permittees that are also PLPs. The analyses supporting these conclusions can be found in section 3.10.

For dischargers that are not identified PLPs for a sediment cleanup site, Ecology does not anticipate significant new permitting requirements near term for the majority of these facilities outside of the current permitting and TMDL efforts Ecology is undertaking.

4.2.3 What happens on a broader scale?

Puget Sound-wide Analysis for Site Identification

The acreage and number of sites identified for sediment cleanup under the proposed rule may prospectively fall, or they may stay the same as under the baseline. Ecology estimated number of sites, cleanup acreage, and likely remediation plans including amounts of dredging, capping, and monitoring. Smaller quantities of each would likely be required for cleanup in example analyses for dioxin and mercury. The analyses supporting these conclusions can be found in section 3.11. The falling number of sites and acreage would scale the overall site-level or embayment-level benefits and costs discussed above.

Statewide Impacts

While Ecology did not have adequate data to perform a similar analysis statewide, Ecology believes a similar result would hold in other areas of the state. The benefits and costs resulting from the proposed rule at a representative embayment would be further scaled to include other locations in the state. Since Ecology believes the benefits of the proposed rule exceed the costs at the embayment-level (see above and sections 3.4 – 3.10), scaled up for the state, this conclusion should hold.

4.3 Conclusion

Based on qualitative and quantitative assessment of the likely costs and benefits, Ecology concludes that there is reasonable likelihood that estimated benefits of the proposed rule amendments exceed their costs.

Cost and benefit comparison summary

Overall, costs for initial site characterization and cleanup are potentially at least $36 million in Washington State over the next 20 years (based on a subset of sites, and case studies), while various analytic costs could potentially increase by $2.3 million for the same context. Additionally, sites would likely be cleaned up sooner, reducing the duration of exposure to contaminants (for people and the environment), and allowing for earlier, more lucrative real estate trade in contaminated sites (and those near them).

Potentially, even if quantified cost savings was smaller due to limited default to regional background as the cleanup standard, the limited real costs of the proposed rule would still be outweighed by benefits to health from reduced duration of exposure to contaminated soils, and improved property values and real estate transactions.

CHAPTER 5: Least Burdensome Alternative Analysis

RCW 34.05.328(1)(d) requires Ecology to "…[d]etermine, after considering alternative versions of the rule and the analysis required under (b) and (c) of this subsection, that the rule being adopted is the least burdensome alternative for those required to comply with it that will achieve the general goals and specific objectives stated under (a) of this subsection." This chapter is intended to establish that the proposed rule does not impose requirements in excess of what is necessary to achieve Ecology's rule-making goals. The goals and objectives include 1) Protection of human health and the environment, 2) Consistency with current scientific information, 3) The least burdensome rule requirements, including the most efficient and effective requirements which reduces transaction costs.

The intended result of the rulemaking is to 1) Clarify the requirements for sediment cleanup that integrate, to the extent possible, the requirements in both the SMS and MTCA rules, 2) Clarify how to address risks from bioaccumulative chemicals to calculate cleanup standards, 3) Adopt freshwater benthic standards to calculate cleanup standards 4) Increase the effectiveness, predictability, and consistency of the decision making process for establishing cleanup standards and selecting remedial actions.

Ecology assessed alternatives to the proposed rule amendments, and determined whether they met the general goals and specific objectives of the authorizing statute. Of those that would meet these objectives, Ecology considered alternative rule language and policies that would have imposed a larger burden on those require to comply with the rule and determined whether the adopted rule amendments were the least burdensome. These alternatives include:

5.1 No action

Human health standards: Ecology considered the alternative of taking no action in the proposed rulemaking, and continued to administer sediment cleanup as under the baseline for addressing human health risks. Ecology experienced, however, that given the ubiquitous nature of some bioaccumulative contaminants at sediment cleanup sites in Washington State (and approximately five years of experience with existing human-health related state led sediment cleanup sites) that continuing to function under the baseline would result in inconsistent cleanup decisions and more costly negotiations. This is due to the lack of clarity and predictability in both rules to address human health risks at sediment cleanup sites. Continuing to operate under the baseline also was not likely to reduce sediment concentrations in the long term. Therefore, taking no action did not meet the goals and objectives of the rulemaking.

Freshwater sediment standards. Ecology considered the alternative of taking no action (not adopting benthic numeric chemical and biological criteria) in the proposed rulemaking, and continue to administer sediment cleanup as under the baseline. However, Ecology determined that continuing to interpret the narrative standard for freshwater

sediment cleanup results in inconsistent cleanup decisions, more costly site characterization, and less predictability for the liable parties conducting the cleanup, Ecology, and the dredged material management agencies. Therefore, taking no action did not meet the goals and objectives of the rulemaking.

5.2 SMS benthic criteria only

Ecology considered the alternative of limiting sediment cleanup decisions for bioaccumulative contaminants, including establishing cleanup standards and identifying cleanup sites, by using the current SMS benthic numeric chemical and biological criteria. This alternative would include assuming that the MTCA criteria for addressing human health risks and background concentrations of bioaccumulative contaminants did not legally apply to sediment cleanup and the SMS benthic criteria were protective of bioaccumulative risks to human health and the environment. This alternative is consistent with past practice during the early days of sediment cleanup, as the numeric criteria were developed under the assumption that they were protective of higher trophic levels. However, as the science of the toxic effects of bioaccumulative contaminants has evolved, and Ecology's awareness of the legal and practical need to integrate the SMS and MTCA rules has increased, it has become clear that this alternative is not fully protective of human health and the environment. Therefore, limiting cleanup decisions by use of the SMS benthic criteria did not meet the goals and objectives of the rulemaking.

5.3 CERCLA approach

Ecology considered the alternative of adopting similar provisions in the U.S. EPA Superfund law. Specifically, the option of using a human health risk level range of 10^{-4} to $10^{-6.}$ This risk range is not consistent with the MTCA rule, which has a risk range of 10^{-6} for single carcinogens and 10^{-5} for multiple carcinogens and exposure pathways, with the option of a $10^{-5\ risk}$ level for industrial based areas (MTCA Method C). While the SMS rule revisions do not necessitate exact duplication of the MTCA rule, the goals of this rulemaking were to integrate both rules for a more effective and efficient rule. To accomplish this, Ecology attempted to be as consistent with the MTCA rule as feasible and deviate when necessary due to the unique nature of sediment cleanup. Therefore, this alternative did not meet the goals and objectives of the rulemaking.

5.4 Human health risk-based criteria – No option of background

Ecology considered the alternative of limiting sediment cleanup decisions for bioaccumulative contaminants, including establishing cleanup standards and identifying cleanup sites, by using only risk based criteria. This alternative would include assuming that the MTCA criteria for addressing human health risks and background concentrations of bioaccumulative contaminants did not legally apply to sediment cleanup.

Analysis has shown that risk based concentrations protective of human health and the environment are frequently below MTCA natural background by an order of magnitude or more. Under this alternative, the technical feasibility of attaining and maintaining cleanup standards at these low levels is highly unlikely, the cost of actively remediating sites significantly larger than if bounded by MTCA natural background levels would be inordinate, and the uncertainty of the environmental and human health benefit is high due to the inherent uncertainties in risk calculations. Therefore, limiting cleanup decisions by use of the risk based criteria did not meet the goals and objectives of the rulemaking.

5.5 Setting a numerical fish consumption rate

Ecology considered setting a numerical fish consumption rate in the proposed rule amendments. This would have potentially had impacts related to implementation of Water Quality Standards, and so Ecology chose not to include a numeric fish consumption rate in this rulemaking. Ecology believes this choice still meets the goals and objectives of the authorizing statute, while reducing compliance burden.

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Appendix A: Embayment-Specific Examples of Cleanup Level Impacts

Ecology analyzed the impacts of the proposed rule on cleanup levels in three alternative embayment scenarios (each based on real embayment data). The examples illustrate that it is likely most cleanup levels will not change or will prospectively become less stringent for the contaminants driving cleanup.

A.1 Urban shoreline example

This site contains arsenic, cPAHs, PCBs, and dioxins. It is a highly urbanized environment and includes multiple sources and responsible parties. Primary contributors to contamination are historic industrial operations. This is an estuarine river environment that supports industrial and residential use, recreation, and tribal fishing. It is in a heavily urbanized area.

Ecology chose the chemicals for this calculation – arsenic and cPAHs – based on the quality of data available. That is, although PCBs are also a chemical of concern at this site, the data available was not of sufficient quality to perform accurate risk-based calculations or determine background concentrations, because most data available in the EIM database was based on total Aroclors, and background data was primarily based on PCB congeners.

Table 14 summarizes the risk-based concentrations Ecology calculated using the fish consumption rate at the real site, the background concentration being considered for the actual site, a risk-based concentrations calculated using the site specific fish consumption rate at two risk levels, and regional background concentrations that would be considered under the proposed rule amendments decision framework. Baseline and proposed rule amendments risk based concentrations were calculated using a 97 g/ day fish consumption rate.

Table 14: Arsenic and cPAH cleanup standards for a representative urban shoreline site

	Arsenic[14] (ppm)	Arsenic Cleanup Standard Baseline Rule	Arsenic Cleanup Standard Proposed Rule	cPAH (ppb TEQ)	cPAH Cleanup Standard Baseline Rule	cPAH Cleanup Standard Proposed Rule
Baseline Rule 10-6 Risk Based Concentration **97 g/day FCR**	2.43 E-03			3.79		
Proposed Rule Amendments 10-6 Risk Based Concentration **97 g/day FCR**	2.43 E-03			3.79		

[14] Arsenic speciation was not taken into account to calculate the risk based concentration. It was assumed 100% was bioavailable.

Proposed Rule Amendments 10-5 Risk Based Concentration **97 g/day FCR**	2.43 E-02			37.9		
Baseline Rule Natural Background	7.3	7.3		8.48	8.48	
Proposed Rule Amendments SCO Natural Background	7.3			8.48		
Proposed Rule Amendments CSL Regional Background	7.3		7.3	42.59		42.59

Because all risk-based concentrations fall below their respective background concentrations, backgrounds are used to set cleanup standards for both arsenic and cPAHs.[15] The cleanup standard for arsenic does not change, while the cleanup standard for cPAHs goes up (becomes less stringent) under the proposed rule amendments because the cleanup level is based on regional background.

If arsenic was the chemical driving this cleanup, cleanup behavior would not likely change, while if cPAH was driving this cleanup, remediation activities would likely stay the same or fall under the proposed rule amendments. In addition, the risk based concentration could be significantly below background concentrations depending on what site specific exposure parameters are used in the risk equations. For example, BSAFs used on a site specific basis can significantly alter the risk based concentrations even further below background.

A.2 Urban marine embayment example

This site contains mercury and dioxins. It is an urban embayment with a long history of industrial marine operations. It is currently undergoing extensive cleanup operations. This embayment supports recreational, commercial fishing, subsistence fishing, residential and industrial activities, and major municipal port activities.

Table 15 summarizes the risk-based concentrations calculated with the fish consumption rate used at the actual site, the background concentration being considered at the actual site, risk-based concentrations calculated using the site specific fish consumption rate for two risk levels, and regional background concentrations that would be considered under the proposed rule amendments' SMS framework. Note that, for dioxin, risk-based concentrations and natural background concentrations are below PQL. Baseline and proposed rule amendments risk based concentrations were calculated using a 173 g/ day fish consumption rate.

Table 15: Dioxin and mercury cleanup standards for a representative urban marine embayment site

[15] Under the proposed rule amendments, the cleanup level is the SCO, but may be raised upward depending on whether certain factors are met. The cleanup level may not be set higher than the CSL. For purposes of this analysis, the CSL is the regional background and the cleanup standard was established at regional background to determine the maximum potential difference between the baseline and proposed rule amendments.

	Dioxin (ppt TEQ)	Dioxin Cleanup Standard Baseline Rule	Dioxin Cleanup Standard Proposed Rule	Mercury (ppm)[16]	Mercury Cleanup Standard Baseline Rule	Mercury Cleanup Standard Proposed Rule
Baseline Rule 10-6 / HQ 1 Risk Based Concentration **173 g/day FCR**	9.21 E-03			0.016		
Proposed Rule Amendments 10-6 / HQ 1 Risk Based Concentration **173 g/day FCR**	9.21 E-03			0.016		
Proposed Rule Amendments 10-5 / HQ 1 Risk Based Concentration **173 g/day FCR**	9.21 E-02			0.016		
Baseline Rule Natural Background / PQL	2.0 / 5.0	2.0/5.0		0.104 / 2.0 E -02	0.104	
Proposed Rule Amendments SCO Natural Background / PQL	2.0 / 5.0			0.104 / 2.0 E -02		
Proposed Rule Amendments CSL Regional Background / PQL	14.6		14.6	0.104 / 2.0 E -02		0.104

The cleanup standard for mercury would not change under the proposed rule amendments, while the cleanup standard for dioxin increases (becomes less stringent).[17] If dioxin was the chemical driving cleanup at this site, remediation activity would stay the same or decrease under the proposed rule amendments, while if mercury was the driving chemical, remedial action would not change.

A.3 Rural marine embayment example

This site is a rural Puget Sound embayment with contamination from a single long-term industrial operation. The embayment supports thriving shellfish and forage fish populations, with a primarily rural, residential, and tribal population.

[16] The sediment risk based concentration and background value was for total mercury, which includes both the inorganic and organic form. The BSAFs incorporate the relative contribution of inorganic and organic mercury to the tissue burden. This may be an under or over estimate if the sediment-tissue pairings used to develop the BSAF are not representative of the methylmercury content of the sediment

[17] Under the proposed rule amendments, the cleanup level is the SCO, but may be raised upward depending on whether certain factors are met. The cleanup level may not be set higher than the CSL. For purposes of this analysis, the CSL is the regional background and the cleanup standard was established at regional background to determine the maximum potential difference between the baseline and proposed rule amendments.

Table 16 summarizes the human health risk-based concentrations calculated with the fish consumption rate used at the actual site and two risk levels, the background concentration at the actual site, and background concentrations that would be considered under the proposed rule amendments' SMS decision framework. Note that, for dioxins, risk-based concentrations and natural background are below PQL. Baseline and proposed rule risk based concentrations were calculated using a 499 g/ day fish consumption rate in accordance with decisions at the actual site.

Table 16: Dioxin and cPAH cleanup standards for a representative rural marine embayment site

	Dioxin (ppt TEQ)	**Dioxin Cleanup Standard Baseline Rule**	**Dioxin Cleanup Standard Proposed Rule**	**cPAH (ppb TEQ)**	**cPAH Cleanup Standard Baseline Rule**	**cPAH Cleanup Standard Proposed Rule**
Baseline Rule 10-6 Risk Based Concentration **499 g/day FCR**	0.0187			0.455		
Proposed Rule Amendments 10-6 Risk Based Concentration **499 g/day FCR**	0.0187			0.455		
Proposed Rule Amendments 10-5 Risk Based Concentration **499 g/day FCR**	0.187			4.55		
Baseline Rule Natural Background / PQL	1.17 / 5.0	5.0		5.32	5.32	
Proposed Rule Amendments SCO Natural Background / PQL	1.17 / 5.0		5.0	5.32		5.32
Proposed Rule CSL Regional Background	1.17 / 5.0		5.0	5.32		5.32

For this representative site, cleanup standards do not change for dioxin or cPAHs under the proposed rule amendments.[18] In addition, the risk based concentration could be even further below background concentrations depending on what site specific exposure parameters are used in the risk equations. For example, BSAFs used on a site specific basis can significantly alter the risk based concentrations further below background.

Ecology does not expect a change in cleanup behavior under the proposed rule amendments at sites like this where there is not a clear distinction between regional and natural background and site specific fish consumption rates are used to calculate human health risks.

[18] Under the proposed rule amendments, the cleanup level is the SCO, but may be raised upward depending on whether certain factors are met. The cleanup level may not be set higher than the CSL. For purposes of this analysis, the CSL is the regional background and the cleanup standard was established at regional background to determine the maximum potential difference between the baseline and proposed rule amendments.