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STATE OF WASHINGTON
KING COUNTY SUPERIOR COURT

STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, Plaintiff, v. BNSF RAILWAY COMPANY, Defendant.	NO. 07-2-33672-9 SEA FOURTH AMENDMENT TO CONSENT DECREE RE: BNSF FORMER MAINTENANCE AND FUELING FACILITY, SKYKOMISH, WASHINGTON

Pursuant to Section XV of the Consent Decree Re: BNSF Former Maintenance and Fueling Facility in Skykomish, Washington (Site), entered by this Court on October 19, 2007, Plaintiff, State of Washington, Department of Ecology (Ecology), and Defendant BNSF Railway Company, hereby stipulate to amend the Consent Decree as follows:

1. All of Exhibit B to the Consent Decree (Cleanup Action Plan) is replaced by the revised Exhibit B, which is provided in the attached Exhibit 1 (Amended Exhibit B, Cleanup Action Plan).

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Except as set forth above, all other provisions of the Consent Decree remain in full force and effect, unchanged by this Fourth Amendment.

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

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BNSF RAILWAY COMPANY

John Lovenburg
Vice President, Environment and Sustainability

Date: 03-30-2023

ENTERED this 29 day of Sept 2023.

JUDGE Tanya L. Thorp
King County Superior Court

Exhibit B

CLEANUP ACTION PLAN

for

BNSF Former Maintenance and Fueling Facility, Skykomish, Washington

by
Washington State Department of Ecology

As Amended August 2022

Table of Contents

Table of Contents iii
List of Tables iv
List of Figures iv
List of Acronyms and Abbreviations v
Chapter 1 - Introduction 1
Chapter 2 - Site Conditions 3
2.1 Site History 3
2.2 Human Health and Environmental Concerns 3
Chapter 3 - Cleanup Requirements 7
3.1 Ecology Expectations for Cleanup Actions 7
3.2 Minimum Requirements for Cleanup Actions 8
3.3 Requirements for a Groundwater Conditional Point of Compliance 9
3.4 Cleanup Levels, Remediation Levels, and Points of Compliance 10
3.5 Applicable Local, State, and Federal laws 14
3.5.1 Required Permits 15
3.5.2 Substantive Requirements 15
Chapter 4 - Site Remedy 17
4.1 Cleanup Action 17
4.1.1 Levee Zone 17
4.1.2 Northwest Developed Zone (NWDZ) 18
4.1.3 Northeast Developed Zone (NEDZ) 24
4.1.4 South Developed Zone (SDZ) 27
4.1.5 Former Maloney Creek (FMC) Zone 28
4.1.6 Railyard Zone 29
4.2 Types, Levels, and Amounts of Contamination Remaining On-Site 34
Chapter 5 - Alternatives Considered and Basis for Remedy Selection 35
5.1 Introduction 35
5.2 Proposed Cleanup Technologies 35
5.3 Initial Assessment of Feasibility Study Alternatives 41
5.4 Permanence Assessment of Alternatives ECY, PB5, and STD 52
5.5 Selected Remedy 59
Chapter 6 - Implementation of the Cleanup Action 61
6.1 Community-Based Cleanup: Integrating Community Concerns 61
6.2 Schedule 64
6.3 Financial Assurances 68
6.4 Overburden Management 68
Chapter 7 - References 69

List of Tables

Table 1: Summary of Cleanup Levels, Remediation Levels, and Points of Compliance
Table 2: Summary of Cleanup Actions
Table 3: Summary of Remedial Alternatives Considered in the Feasibility Study
Table 4: Initial Assessment of Alternatives

List of Figures

Figure 1: Site Location Map
Figure 2: Town Street Plan
Figure 3: Conceptual Site Diagram with Petroleum Cleanup Levels
Figure 4: Site Petroleum Distribution, 2005
Figure 4A: Site Petroleum Distribution, June 2020
Figure 5: Site Zones
Figure 6: Summary Map of Cleanup Actions
Figure 7: Conceptual Diagram of Petroleum Monitoring and Recovery Trench Downgradient from School Treatment Area
Figure 8: Former Maloney Creek Cleanup Requirements
Figure 9: Conceptual Hydraulic Control and Containment System – Groundwater Barrier Trench Design
Figure 10: Amount of Petroleum Remaining On-Site (All Zones) Over Time
Figure 11: Feasibility Study Alternative Restoration Time Frames
Figure 12: Evaluation of Protectiveness (10 Years) and Permanence (100 Years) for Alternatives ECY, PB5, and STD
Figure 13: Cleanup Schedule
Figure 14: Project Control Documents

List of Acronyms and Abbreviations

AKART	All known available and reasonable methods of treatment
APH	A laboratory method for measuring petroleum hydrocarbons in air
BNP	BNSF preferred alternative
BNSF	BNSF Railway Company
CSL	Cleanup Screening Level
Ecology	Washington State Department of Ecology
ECY	Ecology alternative
FMC	Former Maloney Creek
mg/kg	milligrams per kilogram (same as parts per million)
mg/L	milligrams per liter (same as parts per million)
MTCA	Model Toxics Control Act
NAPL	Nonaqueous phase liquid
NEDZ	Northeast Developed Zone
ng/kg	nanograms per kilogram (same as parts per trillion)
NWDZ	Northwest Developed Zone
NWTPH-Dx	A laboratory method for measuring the total petroleum concentration in soil, sediment, and water
OHWM	Ordinary high water mark
PB	Property Boundary, used to preface Feasibility Study Alternatives that used a property boundary point of compliance, as PB1
RCW	Revised Code of Washington
SDZ	South Developed Zone
SQS	Sediment Quality Standards
STD	Standard, refers to the Feasibility Study standard alternative
SW	Surface Water, used to preface Feasibility study Alternatives that use a surface water point of compliance, as SW1
TPH	Total petroleum hydrocarbons
V/E	VPH/EPH laboratory method, a laboratory method for measuring the concentrations of petroleum constituents in soil, sediment, and water
WAC	Washington Administrative Code
µg/L	micrograms per liter (same as parts per billion)

Chapter 1 - Introduction

This cleanup action plan presents the cleanup action to be taken at the BNSF Former Maintenance and Fueling Facility in Skykomish, Washington (BNSF Skykomish Site or Site). The plan was developed using information obtained during Site investigations that began in 1993 and that are ongoing. This information is presented in the Remedial Investigation reports (RETEC, 2002 and 1996), in the Final Feasibility Study report (RETEC, 2005), and the Engineering Design Report – Levee Zone Interim Action for Cleanup (RETEC, 2006).

In addition to meeting cleanup requirements, implementation of the actions called for under this plan will serve to largely restore the natural resources damaged by the release (e.g., restoration of groundwater in the Town of Skykomish, and restoration and enhancement of the river bed, bank and levee completed during the 2006 interim action), and therefore will reduce future damages to resources at the Site.

This cleanup action plan is being updated in 2022. Cleanup actions covered under this cleanup action plan were performed between 2008 and 2018 and are summarized below:

- Excavation of impacted soil from most of the Town north of the BNSF's railyard facility property and areas south and west of the railyard (including moving structures to excavate soil beneath them);
- Excavation of approximately 7,500 cubic yards of soil from the BNSF's railyard facility property;
- Installation and operation of an air sparging system north of the northeastern portion of the BNSF's railyard facility property;
- Excavation of impacted soil in the Former Malone Creek (FMC) East and West Wetland area. Backfilling and conversion of the FMC East Wetland to an upland habitat and restoration of the FMC West Wetland to a functioning wetland. Excavation of impacted soil adjacent to the 5th Street Bridge area Monitoring and maintenance were completed after a period of ten years;
- Installation and operation the Hydraulic Control and Containment System (HCC) groundwater treatment compound, and sheet pile barrier wall with carbon-filled treatment gates separating the BNSF railyard from the Town to the north;
- Operation of HCC recovery wells in the BNSF's railyard facility property and around the Skykomish School property;
- Successful operation of a Hot Water Flushing (HWF) system at the Skykomish School property;

Successful completion of HWF in 2017 and decommissioning in 2018 marked the end of active remediation on the Skykomish School property.The Site transitioned from quarterly to semiannual groundwater monitoring in September 2020 under the Long-Term Monitoring Plan. Site-wide groundwater monitoring is conducted in March and September.

A 24-month HCC system passive operation pilot study was completed in December 2020 to evaluate the ability of the carbon-filled HCC treatment gates to meet the cleanup objective. The results of the study confirmed that passive operation is effective in meeting the cleanup objective. Following completion of the passive pilot study, active operation of the HCC system resumed on January 4, 2021. This cleanup action plan is being updated to allow greater operational flexibility as remaining remedial actions near completion.

Chapter 2 - Site Conditions

2.1 Site History

In 1893, train service to Seattle started along the Great Northern Railway, and the Town of Skykomish, Washington, became a center for railroad operations. Skykomish is located on the west side of the Cascade Mountains, approximately 16 miles west of Stevens Pass. It is reached via U.S. Highway 2, which follows the south fork of the Skykomish River. Skykomish was incorporated in 1909. Mining, lumbering, milling, and railroad maintenance and fueling were its economic mainstays until these activities declined at end of the 20th Century. The rail line running through Skykomish was and remains one of the main transcontinental rail transportation corridors. The population of Skykomish is currently just over 200 people. Figure 1 shows the Site location. Figure 2 shows the town street plan.

A maintenance and fueling facility operated in Skykomish from the early 20th Century until 1974. The first known record of petroleum being discharged to the Skykomish River is in 1926, when the Game Commission of King County wrote the General Manager of the Great Northern Railroad, then operating the line, to indicate, "There is a quantity of oil being cast into the Skykomish river at the town of Skykomish, and heretofore it has been charged that it came from your road." (Game Commission for King County, 1926) Correspondence from 1930 indicates discharge was continuing. (Assistant Chief Engineer, 1930, and Burgunder, 1930) (See electronic file BNSF Skykomish 1926 and 1930 letters.pdf).

Over the decades discharge to the environment of Bunker-C and diesel fuel from railyard operations continued. The petroleum flowed downward to the water table, and thence horizontally along the water table under the Town of Skykomish to the south fork of the Skykomish River. Seasonal fluctuation of the water table resulted in petroleum being smeared across the zone of fluctuation. Sediments in the river and Former Maloney Creek (FMC) were contaminated with petroleum. Free product occurs at the groundwater table and in the smear zone, and groundwater contains dissolved petroleum constituents. Soil throughout the Site is contaminated with petroleum.

The railroad is now owned by the BNSF Railway Company (BNSF). BNSF and Ecology investigated the Site between 1993 and 2006. Remedial investigations and feasibility studies and interim actions have been completed. They provide sufficient data and information for Ecology to select a cleanup action.

2.2 Human Health and Environmental Concerns

Contamination at the Site poses several potential threats to human health. Soil contamination poses a potential direct contact threat through ingestion of soil. Petroleum constituents in groundwater pose a human health threat due to the potential for ingesting groundwater as a drinking water supply. Contaminated groundwater also impacts the

Skykomish River, which is used for recreation and can be used for drinking water supply. Petroleum vapors pose a potential human health threat by inhalation.

The primary environmental concern at the Site is the discharge of petroleum to the environment on the railyard and its migration both north to the Skykomish River and south to FMC and other off-railyard areas.

Data collected during Site investigations have roughly estimated the equivalent of approximately two million gallons of petroleum are currently in the subsurface, occurring as free product, nonaqueous phase liquid (NAPL) in soil pore space, sorbed to the soil, and dissolved in the groundwater.

Figure 3 presents a conceptual diagram of exposure pathways at the Site and presents risk-based petroleum cleanup levels associated with each pathway. These risk-based petroleum concentrations represent the concentrations below which the cumulative effects associated with the petroleum and its constituents do not pose unacceptable risk to human health and the environment. The individual petroleum-based hazardous chemicals that have been identified in soil and groundwater at this site include semi-volatiles, such as polynuclear aromatic hydrocarbons (PAHs) and specific carcinogenic PAHs (cPAHs). These individual hazardous chemicals will be removed as part of the total petroleum concentrations being removed during this cleanup and, thus, it is expected that there will no longer be a threat to human health and the environment from these individual petroleum-based hazardous chemicals after cleanup.

Figure 4A summarizes the distribution of petroleum on-site, as defined in the FS (RETEC, 2005). Figure 4A summarizes the distribution of petroleum on-site as of June 2020.

Human health and environmental concerns at the Site also include arsenic and lead contamination, PCB contamination, and dioxin/furan contamination. Lead and arsenic are present in elevated concentrations on the railyard in shallow surface soils to an approximate depth of 2-3 feet below ground surface. Lead and arsenic are present in isolated surface soils off BNSF's railyard facility property in residential soils at elevated concentrations to an approximate depth of two feet.

PCB was detected on the BNSF's railyard facility property in several locations and exceeded cleanup levels for soil in only one location within surface soils to an approximate depth of 1 foot. The areas of PCB contamination also have lead, arsenic, and petroleum impacts.

Dioxin/furan at concentrations exceeding the MTCA Method B soil level were detected in surface sediments in the portion of FMC on and adjacent to the railyard and to the south behind the Skykomish School Bus Barn and King County fire station. Dioxin/furan contamination in sediments extends to approximately 2 feet below ground surface, and is located within the area of petroleum release. Thus, it is expected that dioxin/furan contaminated sediments will be removed as part of the petroleum remedial actions and handled appropriately.

The Site has been divided into zones to facilitate discussion of cleanup actions. The zones, shown on Figure 5, are:

- Railyard Zone – The Railyard Zone has historically been used for railroad maintenance and fueling activities. Almost all of the Railyard Zone is currently used as a rail transportation corridor. The three tracks on the north side of the Railyard are known collectively as the BNSF mainline. The discharge of Bunker-C and diesel fuel to the environment occurred on BNSF's railyard facility property as a result of maintenance and fueling operations. PCBs were discharged to the environment from transformers associated with an electrical substation formerly on the railyard. Arsenic and lead were discharged to the environment as a result of maintenance activities that used sandblast grit. The Railyard Zone is almost entirely owned by BNSF Railway Company. The Railyard Zone includes five small areas immediately adjacent to the BNSF's railyard facility property: two with surface soil impacted by arsenic and lead, and three with surface and subsurface soil impacted by petroleum.

- Northwest Developed Zone – The Northwest Developed Zone is used for residential and commercial purposes. It has multiple property owners. It is affected by petroleum contamination that consists primarily of Bunker-C. The petroleum composition is extremely resistant to biodegradation at high concentrations. Near surface lead and arsenic contamination is present in isolated areas.

- South Developed Zone – The South Developed Zone is used for residential purposes. It has multiple property owners. It is affected by petroleum contamination that consists of primarily of Bunker-C. The petroleum composition is extremely resistant to biodegradation at high concentrations.

- Northeast Developed Zone –The Northeast Developed Zone is used for residential and commercial purposes. It has multiple property owners. It is affected primarily by diesel. The diesel is more soluble and more biodegradable than the Bunker-C in other zones. Near surface lead contamination is present in isolated areas.

- Levee Zone –The South Fork Skykomish River provides aquatic habitat for endangered and other species, and recreational opportunities. The Levee provides protection against high-velocity flows entering the Town of Skykomish during floods. Both are affected by petroleum contamination that consists primarily of Bunker-C. The petroleum composition is extremely resistant to biodegradation at high concentrations.

- Former Maloney Creek Zone – The Former Maloney Creek channel and associated wetlands provide aquatic habitat for endangered and other

species, storm water detention, and recreational opportunities. The creek and wetlands are affected primarily by Bunker-C contamination. The petroleum composition is extremely resistant to biodegradation at high concentrations. Dioxin/furan contamination is located within the area of petroleum release.

An interim action to clean up the Levee Zone and part of the Northwest Developed Zone was conducted in 2006; free product and soil with TPH exceeding 3,400 mg/kg was removed within the cleanup area.

Chapter 3 - Cleanup Requirements

The Model Toxics Control Act Cleanup Regulation, Chapter 173-340 WAC describes the manner in which cleanup actions are to be selected. The following sections discuss the regulatory considerations that are most pertinent[1] to the BNSF Skykomish Site and specify performance standards that the cleanup must meet. Most of the discussion relates to the petroleum contamination at the Site, since the concentration, volume, and distribution of this contamination drives the selection of cleanup actions at the Site. Metals contamination is shallow and much less in volume than the petroleum contamination. PCB contamination is also limited to shallow soils and is limited to the railyard in the area of the old transformer pads. Dioxin/furan contamination in the FMC Zone is located within the area of petroleum release.

3.1 Ecology Expectations for Cleanup Actions

Ecology has certain expectations for the types of cleanup actions selected for cleanup sites, as laid out in WAC 173-340-370. Those most pertinent to the BNSF Skykomish Site are discussed below.

Ecology expects that treatment technologies will be emphasized at sites containing liquid wastes, areas contaminated with high concentrations of hazardous substances, highly mobile materials, and/or discrete areas of hazardous substances that lend themselves to treatment. WAC 173-340-370(1). At the BNSF Skykomish Site, petroleum contamination is present as free product, as NAPL in soil pore spaces, in high concentrations sorbed to soil and sediment, and dissolved in groundwater. Excavation, active treatment, and product removal are expected to be used to address this high-level contamination.

Ecology expects that, for facilities adjacent to a surface water body, active measures will be taken to prevent/minimize releases to surface water via surface runoff and groundwater discharges in excess of cleanup levels. WAC 173-340-370(6). The BNSF Skykomish Site is adjacent to the Skykomish River and includes a wetland that is the former channel of Maloney Creek. Contaminated groundwater discharges to both of these surface water bodies, and free product discharges to the Skykomish River. At the BNSF Skykomish Site, Ecology expects active measures will be taken to prevent these releases. WAC 173-340-370(6).

Ecology expects that natural attenuation of hazardous substances may be appropriate at sites where: (a) Source control (including removal and/or treatment of hazardous substances) has been conducted to the maximum extent practicable; (b) Leaving contaminants on-site during the restoration time frame does not pose an unacceptable threat to human health or the environment; (c) There is evidence that natural biodegradation or chemical degradation is occurring and will continue to occur at a reasonable rate at the site; and (d) Appropriate monitoring requirements are conducted to

[1] Cleanup actions at the BNSF Skykomish Site must meet all regulatory requirements whether discussed herein or not.

ensure that the natural attenuation process is taking place and that human health and the environment are protected. WAC 173-340-370(7). At the BNSF Skykomish Site Ecology expects that free product and soil and sediment with high concentrations of Bunker-C will be removed by excavation or active treatment. Site investigations indicate that Bunker-C contamination at high concentrations will not degrade by natural attenuation at reasonable rates. Ecology expects that treatment by enhanced bioremediation techniques such as air sparging will be done for soil and groundwater with high concentrations of diesel contamination.

3.2 Minimum Requirements for Cleanup Actions

The MTCA Cleanup Regulation specifies minimum requirements for cleanup actions. WAC 173-340-360(2). All cleanup actions must meet these requirements. Those most pertinent to the BNSF Skykomish Site are discussed below. In considering how best to use agency discretion and best professional judgment in implementing minimum cleanup requirements at specific sites, Ecology gives careful consideration to the regulatory expectations summarized in the preceding section.

The minimum regulatory requirements that every cleanup action must meet are:

- Protect human health and the environment – Cleanup actions that achieve cleanup levels at the applicable point of compliance under Methods A, B, or C (as applicable) and comply with applicable laws are presumed to be protective of human health and the environment. WAC 173-340-702. Cleanup action alternatives that provide for the containment of soils must be demonstrated to be protective of human health and the environment through either qualitative or quantitative risk assessments.

- Comply with cleanup standards and applicable state and federal laws[2] – Cleanup standards are those standards adopted under RCW 70A.305.030(2)(e)[3] and Chapter 173-340 WAC. Establishing cleanup standards requires specification of hazardous substance concentrations that protect human health and the environment ("cleanup levels"), the location on the site where those cleanup levels must be attained ("points of compliance"), and additional regulatory requirements that apply to a cleanup action because of the type of action and/or the location of the site. WAC 173-340-200. These requirements are specified in applicable state and federal laws and are generally established in conjunction with the selection of a specific cleanup action. Cleanup standards for the BNSF Skykomish Site are discussed in §3.4. They include cleanup levels and their respective points of compliance, and applicable and relevant and appropriate requirements of state and federal laws. (Cleanup actions at the BNSF Skykomish Site must also meet remediation levels as applicable, plus applicable permit and substantive requirements, discussed in §3.4 and §3.5).

[2] "Applicable state and federal laws" means all legally applicable requirements and those requirements that Ecology determines, based on the criteria in WAC 173-340-710(4), are relevant and appropriate requirements. WAC 173-340-200.

[3] Note that WAC 173-340-200 incorrectly references RCW 70.105D.030(2)(d) on this point.

- Provide for compliance monitoring – Each cleanup action must include plans for compliance monitoring to ensure human health and the environment are protected during construction, operation, and maintenance activities; to confirm that the actions have attained cleanup standards, remediation levels, and other performance standards; and to confirm the long-term effectiveness of the action once cleanup standards, remediation levels, and other performance standards have been attained. WAC 173-340-410(1).

There are several other requirements that cleanup actions must meet. Those most pertinent to the BNSF Skykomish Site are:

- Treatment or removal of the source of the release shall be conducted for liquid wastes, areas contaminated with high concentrations of hazardous substances, highly mobile hazardous substances, or hazardous substances that cannot be reliably contained. This includes removal of free product consisting of petroleum and other light nonaqueous phase liquid (LNAPL) from the groundwater using normally accepted engineering practices. WAC 173-340-360(2)(c)(ii)(A).

- Groundwater containment, including barriers or hydraulic control through groundwater pumping, or both, shall be implemented to the maximum extent practicable to avoid lateral and vertical expansion of the groundwater volume affected by the hazardous substance. WAC 173-340-360(2)(c)(ii)(B).

- Provide for a reasonable restoration time frame. WAC 173-340-360(2)(b)(ii)

- Consider public concerns. WAC 173-340-360(2)(b)(iii).

- Use permanent solutions to the maximum extent practicable. WAC 173-340-360(2)(b)(i).

Ecology carefully considered these minimum requirements when selecting the cleanup action for the BNSF Skykomish Site from among the alternatives, technologies, and information presented in the Feasibility Study (RETEC, 2005). The manner in which these regulatory requirements were considered is discussed in Chapter 5.

3.3 Requirements for a Groundwater Conditional Point of Compliance

Ecology is approving use of a conditional point of compliance at the BNSF Skykomish Site pursuant to WAC 173-340-720(8)(c) and (d)(ii). A conditional point of compliance is being established within the Skykomish River and FMC and associated wetlands for protection of sediments at the points where groundwater flows into the River and the Creek via surface or subsurface seeps. This is called an "off-property point of compliance" for groundwater.

There are several requirements in WAC 173-340-720(d) that must be met in order for Ecology to approve an off-property conditional point of compliance for groundwater. The requirements most pertinent to selecting the cleanup action to be implemented at this

Site are as follows:

- It has been demonstrated that it is not practicable to meet the cleanup level at the standard point of compliance, or at a point within the ground water before it enters surface water, within a reasonable restoration time frame.

- Groundwater discharges shall be provided with all known available and reasonable methods of treatment (AKART) before being released into surface waters.

- Groundwater discharges shall not result in violations of site-specific sediment quality values.

- A notice of the proposed conditional point of compliance is to be mailed to the Washington State Department of Natural Resources, and the United States Army Corps of Engineers and the natural resource trustees. The natural resource trustees are the National Oceanic and Atmospheric Administration, the U.S. Fish and Wildlife Service, the Washington Department of Fish and Wildlife, and the Tulalip Tribe. This notice is in addition to any notice provided under WAC 173-340-600, and is to invite comments on the proposal.

- The affected property owners between the source of contamination and the surface water body must agree in writing to the use of the conditional point of compliance.

Ecology carefully reviewed whether these requirements were met before selecting the cleanup actions for the BNSF Skykomish Site from the alternatives and information presented in the Feasibility Study (RETEC, 2005). The manner in which Ecology determined whether the first three requirements were met is discussed further in Chapter 5. The fourth requirement was met based on the mailing of required notices and the receipt and review of comments received on the proposal. Finally, affected property owners have approved the use of the conditional point of compliance in writing, per WAC 173-340-720(8)(d)(ii), as discussed further below.

3.4 Cleanup Levels, Remediation Levels, and Points of Compliance

Cleanup levels have been established for petroleum for sediment, surface water, groundwater, soil, and air at the Site. The development of the cleanup levels is discussed in Chapter 5 of the Feasibility Study (RETEC, 2005, see particularly Table 5-1). Figure 2 of this report summarizes the manner in which petroleum cleanup levels were developed and provides other information that was used to develop remediation levels, where appropriate. Petroleum cleanup levels and remediation levels are expressed as total petroleum hydrocarbons (TPH). The cleanup levels, remediation levels[4], and their

[4] A remediation level defines a concentration of a hazardous substance in a particular medium above which a particular cleanup action component must be used. WAC 173-340-200. In practice, a remediation level is a contaminant concentration that is above a cleanup level. When contamination is above the remediation level,

respective points of compliance are summarized below and on Table 1:

Sediment – Skykomish River: The cleanup level for petroleum in surface sediment (top 10 centimeters) and subsurface sediment (below 10 centimeters) is 40.9 mg/kg as measured by the NWTPH-Dx method[5] (40.9 mg/kg NWTPH-Dx). This concentration was determined via site-specific biological assessment. The cleanup level for subsurface sediment was determined by considering the potential for subsurface sediments becoming surface sediment as a result of changing river dynamics. The cleanup level of 40.9 mg/kg NWTPH-Dx applies to sediment within the Skykomish River as defined by the location of the ordinary high water mark (OHWM), and will be used as the performance monitoring standard when excavating sediment. Bioassays will be used to evaluate whether the cleanup remains protective in the long-term. That is, bioassays will be used as the standard during confirmational monitoring to evaluate whether the cleanup remains protective of surface sediments. Bioassay tests to be performed for confirmational sampling are *Hyalella azteca*: 10-day mortality, *Chironomus tentans*: 20- day growth and mortality, and Microtox®: 15-minute reduction in bioluminescence (Ecology, 1995).

Sediment – Former Maloney Creek Zone: – The cleanup level for petroleum in surface sediment (top 10 centimeters) and subsurface sediment (below 10 centimeters) is 40.9 mg/kg as measured by the NWTPH-Dx method (40.9 mg/kg NWTPH-Dx). This concentration was determined via site-specific biological assessment. The cleanup levels and points of compliance for FMC areas restored as uplands will be in accordance with "Soil" cleanup levels and points of compliance discussed below. Dioxin/furan contamination is located within the area of petroleum release and will be fully removed with the petroleum contamination. The point of compliance for sediment in FMC areas to be restored as wetlands is within the creek channel as delineated by the wetland boundary as defined by wetland vegetation or by the OHWM. The cleanup level of 40.9 mg/kg NWTPH-Dx will be used as the performance monitoring standard when excavating sediment. Dioxin/furan removal will be confirmed based on existing sample data delineation.. Dioxin/furan-contaminated sediment will need to be evaluated to determine proper disposal requirements. Bioassays will be used to evaluate whether the cleanup remains protective in the long-term. That is, bioassays will be used as the standard during confirmational monitoring to evaluate whether the cleanup remains protective of surface sediments. Bioassay tests to be performed for confirmational sampling are *Hyalella azteca*: 10-day mortality, *Chironomus tentans*: 20-day growth and mortality, and Microtox®: 15-minute reduction in bioluminescence (Ecology, 1995).

Surface Water – The petroleum cleanup level for surface water is 208 µg/L NWTPH-Dx and absence of sheen or free product. This cleanup level is based upon protection of sediment from recontamination. The point of compliance is the point at which contaminated groundwater is released to the Skykomish River and to the FMC Zone.

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more aggressive cleanup actions are taken than for contamination between the remediation level and the cleanup level. For example, soil with contamination above a remediation level may be excavated whereas soil with contamination between the cleanup level and the remediation level may be managed on site.

[5] NWTPH-Dx is a laboratory method for measuring the concentration of petroleum in soil, sediment, and water. When used after a numerical petroleum concentration, it indicates the NWTPH-Dx method is to be used in laboratory measurements relevant to that concentration.

Groundwater – The petroleum cleanup level for groundwater is 208 µg/L NWTPH-Dx and absence of sheen or free product. This cleanup level is based upon protection of sediment from recontamination by groundwater flowing through it. The cleanup level point of compliance for groundwater is shown on Figure 6.

Ecology is also setting a petroleum remediation level for groundwater of 477 µg/L NWTPH-Dx and absence of sheen or free product. This remediation level is protective of drinking water. This remediation level applies at the BNSF's railyard facility property boundary, to ensure that groundwater flowing beyond the BNSF's railyard facility property boundary and to the cleanup level point of compliance meets potable levels and meets the cleanup level of 208 µg/L NWTPH-Dx and absence of sheen or free product at the cleanup level conditional point of compliance. Groundwater beneath both BNSF's railyard facility property and areas off of BNSF's railyard facility property are considered potable groundwater as defined in the MTCA Cleanup Regulation. WAC 173-340-720(2). Ecology is setting the 477 µg/L NWTPH-Dx and absence of sheen or free product remediation level to protect groundwater off BNSF's railyard facility property, in conjunction with the groundwater cleanup level to protect sediment at the surface water boundary[6]. Hydraulic control and containment must be implemented at the BNSF property boundary and operated to ensure groundwater exiting the property boundary meets the remediation level of 477 µg/L NWTPH-Dx and absence of sheen or free product.

Note particularly that the remediation level groundwater point of compliance is at the BNSF's railyard facility property, not the boundary of the Railyard Zone, which includes some property not owned by BNSF.

As discussed further in §4.2, Ecology recognizes that there may be isolated areas off of BNSF's railyard facility property where the 477 µg/L NWTPH-Dx remediation and absence of sheen or free product level may not be achieved in groundwater. Ecology will not require the remediation level be met under and downgradient of such isolated areas, but the cleanup level of 208 µg/L NWTPH-Dx and absence of sheen or free product must still be met at compliance wells at the cleanup level conditional point of compliance.

Even in the event some contamination in areas off of BNSF's railyard facility property acts as a source of contaminants to groundwater, these sources will be small in comparison to the large amounts of high concentration material left under the BNSF mainline and the rest of the railyard. And where met, this remediation level will avoid institutional controls on private property, will restore a large portion – if not all – of the groundwater resource off of BNSF's railyard facility property, and will increase the permanence of cleanup by better ensuring the groundwater cleanup standard can be met.

Property owners affected by the conditional point of compliance have approved

[6] The unique composition of the petroleum at this site has resulted in the concentration of petroleum in groundwater that is protective of sediment (208 µg/L NWTPH-Dx) being lower than the petroleum concentration in groundwater that is protective of drinking water (477 µg/L NWTPH-Dx). For this reason, Ecology is granting a conditional point of compliance for the cleanup level of 208 µg/L NWTPH-Dx at the surface water boundary for sediment protection and also setting a remediation level of 477 µg/L NWTPH- DX for drinking water protection at the BNSF property boundary.

the conditional point of compliance in writing. Two property owners did not approve the conditional point of compliance and one property owner could not be located. Ecology has enclosed these properties within a boundary exclusion interior to the larger conditional point of compliance area shown on Figure 6. Therefore, these properties will not be affected by use of the conditional point of compliance. Subject to each owner providing access for cleanup and monitoring, the groundwater cleanup level of 208 µg/L NWTPH-Dx and absence of sheen or free product will be required for these properties. As a contingency measure (if necessary to prevent recontamination), air-sparging, enhanced bioremediation, or similar in-place treatment measures will be taken upgradient of these properties to ensure the groundwater cleanup level will be met on these properties.

Soil – The cleanup levels for soil are as follows: For petroleum, 22 mg/kg NWTPH-Dx; for arsenic, 20 mg/kg, for lead, 250 mg/kg, for total PCBs 0.65 mg/kg, and for dioxin/furan, 6.67 ng/kg Total Toxicity Equivalent Concentration. The cleanup level point of compliance for petroleum is throughout the Site since the cleanup level is based upon protection of groundwater. However, as described in §4.2 , an empirical demonstration may be used to show the remediation level selected is protective of groundwater, sediment, and surface water, and therefore effective as the soil cleanup level at this Site. The remediation level selected for petroleum in soil is established at 3,400 mg/kg NWTPH-Dx based on direct contact, air quality, and groundwater protection. The point of compliance for the remediation level of 3,400 mg/kg NWTPH-Dx is throughout the portion of the Site which is off BNSF's railyard facility property except within 25 feet south of the OHWM of the Skykomish River and within 25 feet of any area to be restored as wetland of the FMC Zone as delineated by wetland vegetation or the OHWM, where the cleanup level of 22 mg/kg NWTPH-Dx must be met to a depth of 4 feet. Below 4 feet and within 25 feet of the FMC Zone the petroleum soil remediation level of 3,400 mg/kg NWTPH-Dx applies. For any portion of FMC Zone to be restored as upland the petroleum soil remediation level of 3,400 mg/kg NWTPH-Dx applies. In the NEDZ, soil with petroleum concentrations exceeding a remediation level of 30,000 mg/kg NWTPH-Dx will be used to define soil that must be excavated[7]. Soil in the NEDZ with petroleum concentrations above the remediation level of 3,400 mg/kg NWTPH-Dx will be addressed using air sparging.

Free product and soil with high concentrations of petroleum will remain on BNSF's railyard facility property. Groundwater contamination resulting from free product and high soil concentrations will be managed with a robust and reliable hydraulic control and containment system. The system may consist of one or more of the following: a barrier system, groundwater pumping, groundwater treatment, and/or a free product removal system. The system must be capable of detecting leaks of free product that may occur anywhere along the length of the barrier system. The system will be operated and

[7] When petroleum concentrations in soil at the excavation limits are greater than 30,000 mg/kg NWTPH- Dx or free product is observed to be flowing into or accumulating in an excavation four or more hours after all recoverable free product has been removed using best available technology, more excavation will be required. Hydraulic control and containment will ensure that any free product remaining beyond the excavation limits will be treated or stay on BNSF property.

maintained as needed, such that free product and groundwater exceeding the 477 µg/L NWTPH-Dx remediation level does not leave the BNSF railyard facility property boundary or exit any functional gates of the containment system. Alterations to the system or suspension and/or decommissioning of the groundwater pumping component of the system will require 1) approval from Ecology, and 2) a demonstration illustrating the proposed operation will meet the remediation level as described above. The demonstration must be supported by analytical laboratory data from samples collected at the Site. The HCC system will be decommissioned following Ecology approval, based on performance monitoring data.

Limited soil excavation will be performed on BNSF's railyard facility property as well. Soil will be excavated in selected areas of free product; these excavations will be based on excavating a specified soil volume. A remediation level for petroleum in soil is established at 1,870 mg/kg NWTPH-Dx to protect soil biota. The point of compliance for the remediation level of 1,870 mg/kg is to a depth of two feet.[8] Soil within two feet of the surface exceeding a petroleum concentration of 1,870 mg/kg occurs only in the Railyard Zone. The specified point of compliance of a depth of 2 feet is appropriate for the soil in the railyard pursuant to WAC 173-340-7490(4). Soil within BNSF's railyard facility property will also be excavated as necessary to meet the requirements for the Former Maloney Creek Zone.

The cleanup level for soil for arsenic is 20 mg/kg; for lead is 250 mg/kg; for total PCBs is 0.65 mg/kg; and for dioxin/furan is 6.67 ng/kg Total Toxicity Equivalent Concentration. The cleanup level point of compliance for arsenic, lead, total PCBs, and dioxin/furan is throughout the Site to a depth of 15 feet below the ground surface. On the Railyard, arsenic and lead will be excavated to a depth of 2 feet; arsenic and lead contamination below 2 feet, if any, will be contained with two feet of clean soil backfill.

Air – The air cleanup level for petroleum vapors is 1,346 µg/m[8] APH outside of the BNSF railyard facility property boundary and 2,944 µg/m^3 within the BNSF railyard facility property boundary[9]. These concentrations are the residential (Method B) and industrial (Method C) air cleanup levels, respectively. The point of compliance is indoor and ambient air throughout the Site[10].

3.5 Applicable Local, State, and Federal laws

Cleanup actions must comply with applicable local, state and federal laws. WAC 360(2)(a)(iii); WAC 173-340-710; RCW 70A.305.090. In certain cases, obtaining a permit is required. In other cases, the cleanup action must comply with the substantive

[8] The direct contact cleanup level of soil in the vadose zone is 2130 mg/kg V/E. Such soils occur only in the Railyard Zone. Excavation of soil exceeding 1,870 mg/kg NWTPH-Dx will also be protective of direct contact in the Railyard Zone.

[9] APH is a laboratory method for measuring the concentration of petroleum in air. When used after a numerical petroleum concentration, it indicates the APH method is to be used in laboratory measurements relevant to that concentration.

[10] The establishment of the Method C air cleanup level, 2,944 µg /m^3, is discussed in RETEC, 2007 and ARGUS PACIFIC, 2007.

requirements of the law, but are exempt from the procedural requirements of the law. RCW 70A.305.090; WAC 173-340-710(9).

Persons conducting remedial actions have a continuing obligation to determine whether additional permits or approvals are required, or whether substantive requirements for permits or approvals must be met. In the event that either BNSF or Ecology becomes aware of additional permits or approvals or substantive requirements that apply to the remedial action, they shall promptly notify the other party of this knowledge. WAC 173-340-710(9)(e).

3.5.1 Required Permits

Cleanup actions at the Site will require the following permits. These are listed in Exhibit D of the Consent Decree. They are:

- Permit for discharge of pollutants pursuant to Section 402 of the Clean Water Act, 33 U.S.C. § 1342. Ecology issued National Pollutant Discharge Elimination System Waste Discharge Permit No. WA-003212-3 on May 4, 2006 for the discharge of industrial storm water and de-watering water resulting from BNSF cleanup activities in Skykomish.
- Permit for the discharge of dredged, excavated or fill material to waters of United States pursuant to Section 404 of the Clean Water Act, 33 U.S.C. § 1344 (which may be incorporated in a U.S. Army Corps of Engineers (USCOE) Nationwide 38 permit).
- Water Quality Certification from the State of Washington pursuant to Section 401 of the Clean Water Act, 33 U.S.C. § 1341(which may be incorporated in a USCOE Nationwide 38 permit).
- Permit for the dredge and fill of FMC-E as upland pursuant to Section 404 of the Clean Water Act, 33 U.S.C. § 1344 (which may be incorporated in a USCOE Nationwide 38 permit).

3.5.2 Substantive Requirements

The applicable substantive requirements of the following exempt permits or approvals (as identified at the time of entry of this Decree) will be more particularly identified during each phase of the cleanup action.

- King County Special Use Permit for Septic Drainfield
- King County Special Use Permit for Levee Cleanup project
- Underground Injection Permit
- Hydraulic Project Application
- Water Discharge for Industrial Waste to Groundwater
- Water Quality Protection Requirements
- Town of Skykomish Requirements.

In addition, specific conditions that apply via Ecology's Section 401 certification authority under the Clean Water Act, 33 U.S.C. § 1341, for the dredge and fill of FMC-E as upland shall be identified in Exhibit E to the Consent Decree.

BNSF has a continuing obligation to determine whether additional permits or approvals addressed in RCW 70A.305.090(1) are required for remedial actions to be conducted under the Consent Decree. BNSF is responsible for a yearly evaluation and identification of any such additional substantive requirements as part of fulfilling its obligation to develop and submit phased Engineering Design Reports (EDR) for each year's work (see §6.2 and Exhibit C of the Consent Decree)

Chapter 4 - Site Remedy

4.1 Cleanup Action

The cleanup action for this Site incorporates different actions targeted to different zones of the Site. The actions to be taken for each zone are interdependent. Achieving cleanup in one zone depends not only upon the actions to be taken in that zone, but also upon the actions to be taken in other zones.

For example, some of the actions specified herein for the Levee Zone and part of the Northwest Developed Zone were completed as an interim action in 2006 under Agreed Order No. DE 3279. In the interim action, petroleum-contaminated sediment and soil within the Levee Zone and part of the Northwest Developed Zone were excavated. Limited areas in the Levee Zone (i.e., the area in the vicinity of the south abutment of the Fifth Street Skykomish Bridge[11]) remain to be addressed as part of final cleanup. The long-term success of the interim action depends upon the remainder of the zones being cleaned up as specified herein. Compliance monitoring will be performed as part of the final cleanup to confirm the success of the interim action in meeting cleanup standards. These monitoring activities will be part of the complete compliance monitoring plan to be implemented at the Site.

Table 2 summarizes the cleanup actions to be taken at the Site. Figure 6 shows a summary map of cleanup actions to be taken at the Site. The following sections discuss the actions for each zone. The extent of cleanup in each zone will be revised as necessary based upon findings of investigations that are described in §6.2.

The cleanup actions require extensive soil excavation which will require backfilling. All backfill soils must come from a source approved by Ecology and must have suitable geotechnical characteristics. The backfill must be washed prior to placement near surface water to minimize turbidity impacts on surface water.

4.1.1 Levee Zone

The Levee Zone includes both the levee west of 5th Avenue along the South Fork of the Skykomish River and the river itself. Contaminated surface sediment and soil have been excavated from the river as part of the earlier interim action referenced above, and described in the *Engineering Design Report – Levee Zone Interim Action for Cleanup* (RETEC, 2006).

The river and levee are being restored as appropriate habitat. Levee reconstruction is being done according to plans developed in consultation with the community. Habitat restoration, enhancement, and reconstruction plans for the levee are described in the engineering design report for the levee work. Habitat restoration, enhancement, and reconstruction will be finished as part of the final cleanup actions.

[11] The formal name of the Fifth Street Skykomish Bridge is the John Glick Henry Memorial Bridge.

Compliance monitoring is to be conducted as part of the cleanup action, to ensure that excavations remove the soil to the concentrations specified and to assess whether sediment becomes recontaminated over time by migration of contamination remaining on-site. As a contingency, should recontamination of sediments occur above the site-specific sediment cleanup screening level (CSL), as determined by bioassay, BNSF will excavate the contaminated sediments, monitor the sediments to ensure they meet the site-specific sediment quality standards (SQS) within ten years of completion of the initial cleanup action, and will also employ, as necessary, treatment methods at the levee to reduce the petroleum concentrations in groundwater flowing to the river so that sediments will continue to meet the SQS within this timeframe. If recontamination occurs at levels below the CSL but above the SQS, as determined by bioassay, then BNSF will employ, as necessary, treatment methods at the levee to reduce the petroleum concentrations in groundwater flowing to the river to levels that allow sediments to naturally recover, and will monitor the natural recovery of the contaminated sediments, which must meet the SQS within ten years of the completion of the initial cleanup action. Ecology anticipates that reducing petroleum concentrations in groundwater will be accomplished using enhanced bioremediation techniques such as air sparging, and that this will be used as the contingency measure to prevent recontamination of sediment.

Soil and sediment within the Levee Zone are expected to meet cleanup and remediation levels at the completion of the interim action with the exception of the soil and sediment in the vicinity of south abutment of the Fifth Street Bridge, to be addressed later in the cleanup (see §6.2) . Contaminated groundwater will still be entering the Levee Zone at the completion of the interim action. Additional cleanup of groundwater will occur as actions are taken in other zones. Compliance wells to monitor groundwater will be installed in the Levee Zone. See further discussion in §4.1.2 regarding the Northwest Developed Zone (NWDZ).

No institutional controls are expected to be needed within the Levee Zone. Excavation is expected to decrease contamination to concentrations that protect aquatic organisms in the river, that protect drinking water uses, and that are protective of direct contact with the soil.

4.1.2 Northwest Developed Zone (NWDZ)

Free product is to be excavated in the NWDZ, and petroleum-contaminated soil in the NWDZ is to be excavated to the remediation level of 3,400 mg/kg NWTPH-Dx throughout the zone, with the exception of properties where property owners will not allow access and under the Skykomish School only if thermal technologies are employed. If excavation of petroleum-contaminated soil is selected for the school, the soil beneath the school is to be excavated to the remediation level of 3,400 mg/kg NWTPH-Dx, as specified below in Section 4.1.2.3. Soil contaminated with lead exceeding the cleanup level of 250 mg/kg and/or arsenic exceeding the cleanup level of 20 mg/kg is to be excavated throughout the zone. No structures will be relocated to facilitate surface metal contamination removal unless the metals contamination is coincident with TPH contamination that requires a structure to be relocated.

4.1.2.1 Residential and Commercial Properties

Cleanup of residential and commercial properties will require temporary relocation of buildings and structures that are on the property and otherwise disturb the property so that excavation or other cleanup actions can occur. Property owners will be contacted by BNSF well in advance of the time during which cleanup actions will occur. Arrangements for access, cleanup, and property restoration will be made in the manner discussed in §6.1.

After cleanup, protection against vapor intrusion may be required for any building, structure, or enclosed space that remains or is built in the NWDZ over petroleum contamination exceeding 3,400 mg/kg NWTPH-Dx. After excavation is complete in the NWDZ, compliance monitoring of indoor and ambient air will use the air cleanup level of 1,346 $\mu g/m^3$ APH as the standard when evaluating monitoring data to assess whether vapor protection measures are required.

Compliance monitoring is to be conducted to ensure that excavations remove the soil to the concentrations specified. Removal of soil exceeding 3,400 mg/kg NWTPH-Dx and control, remediation, and/or isolation of contaminated soil under the school (see Section 4.1.2.3) is expected to result in significant decline of groundwater contamination resulting from removal of the soil source contamination.

Groundwater compliance monitoring is to be conducted to assess the decline of groundwater contamination after excavation and control/isolation of contamination under the school have been completed. This assessment may be used to empirically demonstrate that the soil remediation level is in fact protective of groundwater, sediment, and surface water, and therefore effective as the soil cleanup level at this Site. This assessment will thus be used to decide whether additional remedial actions near the levee are necessary to reduce groundwater contamination to below the cleanup level of 208 µg/L NWTPH-Dx. It is expected that excavation to the soil remediation level will reduce groundwater dissolved petroleum concentrations to 208 µg/L NWTPH-Dx at the conditional point of compliance and to 477 µg/L NWTPH-Dx throughout the zone, except for where isolated pockets of contamination may remain under the school or inaccessible properties, if any.

Air-sparging, enhanced bioremediation, or other similar in-place treatment measures may be required at the conditional point of compliance at or near the river or around individual properties shown on Figure 6 at any time following completion of the primary cleanup activities described above if the petroleum cleanup level of 208 µg/L NWTPH-Dx is not being met at its conditional point of compliance, or if sheen or free product is observed at the conditional point of compliance.[12] Compliance monitoring data reviews may be conducted at any time. Further contingency cleanup activities will not be required so long as the groundwater cleanup level of 208 µg/L NWTPH-Dx is being met at its conditional point of compliance and no sheen or free product is observed at the

[12] In this and subsequent references to meeting cleanup levels or other cleanup standards, the statistical data evaluation methods, or other methods as appropriate, for assessing whether a cleanup level or other cleanup standard is met will be specified in the compliance monitoring plan.

conditional point of compliance. If the foregoing conditions are met, soil petroleum contamination of less than 3,400 mg/kg NWTPH-Dx will be considered sufficiently contained for the purposes of groundwater, sediment and surface water protection.

Excavation is expected to decrease contamination to concentrations that protect aquatic organisms in the river, that protect drinking water uses, and that are protective of direct contact with the soil. A prohibition on the withdrawal of groundwater will be necessary if the groundwater contamination expectations are not met. This prohibition will be accomplished pursuant to WAC 173-340-440(8)(c) by Public Health – Seattle & King County through its well-permitting process. The prohibition may be removed when compliance monitoring indicates groundwater in compliance wells meets cleanup levels (208 µg/L NWTPH-Dx) and absence of sheen or free product at the point of compliance and remediation levels (477 µg/L) and absence of sheen or free product throughout the NWDZ.

Some property owners will be asked to relocate temporarily to allow for excavation under homes and other buildings. Such property owners will have the choice to relocate or not to relocate. For property owners who elect to move forward with the relocation, a fair and equitable access agreement will be negotiated. The agreement will outline and provide for necessary arrangements and relocation expense. If a property owner agrees in concept to relocate but is unable to reach agreement with BNSF on relocation terms, Ecology will make available mediation services to facilitate agreement being reached. Ecology also plans to make mediation services available in case relocation issues arise during cleanup implementation.

Excavation may consequently not occur under some buildings if current owners choose not to temporarily relocate as necessary.[13] Property owners who choose not to relocate will still be required to provide access to their properties to allow cleanup actions to occur around existing residences or buildings, and must agree to record a restrictive covenant on their property. Access will be subject to fair and equitable terms in an access agreement negotiated with BNSF. If a property owner agrees in concept to provide access but is unable to reach agreement on specific terms with BNSF, Ecology will make available mediation services to facilitate agreement being reached. Ecology also plans to make mediation services available in case access issues arise during cleanup implementation. However, because contamination will remain on such properties, such access will be regulatorily required to allow for cleanup actions that are necessary to contain and control the contamination that will remain, avoid recontamination of adjoining properties to the extent feasible, and ensure the effectiveness and protectiveness of the cleanup. Containment structures are anticipated to be impermeable walls installed in the subsurface inside the perimeter of the property that isolate the contamination under the property and limit its movement; ancillary facilities to capture contamination may also be associated with such installations. Design will be on a case-by-case basis.

Restrictive covenants will also be regulatorily required for those properties where the

[13] All properties owned by BNSF that are not part of BNSF's railyard facility property that require excavation will be excavated.

owner chooses not to relocate and free product and/or high level contamination (above 3,400 mg/kg NWTPH-Dx) will remain after cleanup. The restrictive covenant serves as a means to notify future owners of the presence of contamination, of the need to maintain containment structures, and of the restrictions placed on use of the property. Since these properties will not be fully-excavated, restoration will only be to the extent necessary after installation of the containment structures. Moreover, since cleanup of the property will not occur, and because the cleanup construction activities and waste water treatment system construction activities will be closely coordinated, there will be no provision for using any public funding for connecting to the community waste water treatment system for that property. Operation and maintenance of containment structures will be the responsibility of BNSF.

Ecology recognizes that the 477 µg/L NWTPH-Dx remediation level may not be achieved in groundwater under and downgradient of such properties. In such cases Ecology will not require that any additional measures be taken to control or remediate these properties. However, the cleanup level of 208 µg/L NWTPH-Dx and absence of sheen or free product must still be met at compliance wells at the cleanup level conditional point of compliance and as a contingency, air-sparging, enhanced bioremediation, or similar in-place treatment measures will be taken at the levee if necessary.

4.1.2.2 Skykomish Hotel

The Skykomish Hotel is the second largest building in the NWDZ. This DCAP assumes that the hotel will be temporarily moved or supported so that excavation of soil exceeding 3,400 mg/kg NWTPH-Dx beneath the Skykomish Hotel may occur. BNSF will document the feasibility of moving or supporting the hotel.

If moving or supporting the hotel is not feasible, BNSF shall develop alternative options such as in-place treatment with the goal of reaching the soil remediation level of 3,400 mg/kg NWTPH-Dx beneath the hotel to the greatest degree practicable.[14] The remaining accessible portions of the property on which the Skykomish Hotel is located will be excavated to 3,400 mg/kg NWTPH-Dx.

4.1.2.3 School Property

Because of the unique nature of the school's role in the Skykomish community, BNSF and Ecology will conduct early and open communication with the school board regarding development of cleanup plans for the school to minimize and mitigate impacts on the learning environment and the community as a whole.

Ecology has determined that excavation or aggressive treatment are acceptable methods for addressing the petroleum contamination under the school. BNSF will either excavate or aggressively treat petroleum contamination beneath the school. BNSF will make the

[14] If development of alternative options is necessary, a work plan shall be prepared for Ecology review and approval which describes the scope of work to be done, including reporting requirements.

decision for which method to implement, subject to approval by the school district. If treatment is implemented, the objectives of the treatment are to reduce the amount of petroleum beneath the school to the extent technically possible, with the goal of removing separate phase mobile or volatile liquid petroleum components or nonaqueous phase liquid (NAPL). If excavation is implemented, BNSF shall remove free product and petroleum-contaminated soil beneath the Skykomish School to the remediation level of 3,400 mg/kg NWTPH-Dx, to the extent technically possible while protecting the structural integrity of the School building. After excavation or treatment, protection against vapor intrusion may be required if petroleum contamination exceeding 3,400 mg/kg NWTPH-Dx remains under the building. After excavation or treatment, compliance monitoring of indoor and ambient air will use the air cleanup level of 1,346 $\mu g/m^3$ APH as the standard when evaluating monitoring data to assess whether vapor protection measures are required.

Compliance monitoring is to be conducted to ensure that excavations remove the soil to the concentrations specified. Removal of soil exceeding 3,400 mg/kg NWTPH-Dx and control, remediation, and/or isolation of contaminated soil under the school, is expected to result in significant decline of groundwater contamination resulting from removal of the soil source contamination, as described further below.

BNSF must include a work plan for treatment beneath the school in the EDR for the work year(s) in which activities associated with the remediation work are to be performed. The work plan must discuss how detailed design of the remediation activities will be performed and provide for Ecology review and approval of the design calculations, plans, and specifications. The work plan will discuss restoration time frame and impacts on school operations and learning environment.

One technology being considered for the school is thermal treatment. This treatment option is discussed below to illustrate the consideration which needs to be given to treatment beneath the school. Other options which may be considered include surfactant flushing and water flushing. If other options are used, they must remove and immobilize oil to at least as great a degree as would be achieved by thermal technology, although possibly taking longer. The decision of which technology will be used will be developed in discussions among BNSF, Ecology, and the School Board and documented in a School Cleanup Alternatives Evaluation Report. Preparation of this report is a requirement for developing cleanup plans for the school. See further discussion of this report under §6.2.

If it is the selected technology, thermal treatment would be done by drilling boreholes in the basement of the school to access the petroleum. The soil would be heated and mobilized petroleum extracted through the boreholes. A recovery trench would be installed on the north and west sides of the school to capture any petroleum that is not extracted through the boreholes. Figure 7 shows a conceptual diagram of the recovery

trench design associated with thermal treatment.[15,16]

It is anticipated the entire thermal treatment process would take about a year. During that time, the school's basement, at a minimum, would not be available for classes. If, in the school's estimation, temporary classrooms are needed, BNSF would make accommodations to ensure the school's needs are met in order to minimize any disruption.

If treatment is implemented, BNSF would conduct vapor monitoring in the school's basement during the heating phase of the cleanup and for two years afterward. Monitoring during the heating phase (including collection of baseline data prior to heating) would measure whether the basement meets the air cleanup level of 1,346 $\mu g/m^3$ APH as a result of the heating. Vapor monitoring for the following two years would ensure that vapors from petroleum remaining after the heating phase are not impacting the school. The monitoring frequency would be monthly for the first three months of the thermal treatment; thereafter, the monitoring frequency would be reduced to quarterly, if the vapor concentrations are below the air cleanup level of 1,346 $\mu g/m^3$ APH. If impacts are found, BNSF would install vapor control measures to reduce the vapor concentrations to safe levels.

If treatment is implemented, BNSF would monitor the wells installed in the downgradient trench as part of confirmational monitoring; this monitoring would be included in the compliance monitoring plan that BNSF would submit to Ecology for review and approval. Observations would be made quarterly for the first two years following thermal treatment. The observation frequency may be reduced after that, depending upon what is observed, with Ecology's approval. The observations would consist of visual observation of water removed from each well with a bailer for petroleum visible as nonaqueous phase liquid. Chemical analyses for these wells may be necessary, and would be included in the confirmational monitoring plan if Ecology determines it is necessary. If petroleum as nonaqueous phase liquid is observed in any well, BNSF would install equipment in the well to recover the nonaqueous phase liquid. Additional monitoring wells would be installed downgradient and observed for the presence of petroleum as nonaqueous phase liquid, and tested for dissolved chemical components. If petroleum as nonaqueous phase liquid is observed in these wells, BNSF would take actions to remove it and stop the migration of petroleum through the trench. BNSF would propose a plan for this contingency in the EDR.

If excavation is implemented, BNSF would install monitoring wells and conduct monitoring in accordance with the compliance monitoring plan. An interception and recovery trench as noted above for treatment technologies will be

[15] Monitoring/recovery wells will be located on centers no greater than 10 feet apart unless otherwise approved by Ecology. Such approval will only be given if sufficient information is presented to Ecology for Ecology to determine that a proposed wider spacing will ensure that any free product entering the trench will flow to the monitoring wells prior to penetrating to the downgradient side of the trench.

[16] Surfactant or water flushing will require a trench design incorporating an impermeable barrier and groundwater extraction and treatment similar to that shown on Figure 9.

constructed, only if free product remained under the School building and were present in downgradient monitoring wells.

Excavation, or treatment, and monitoring for and removal as necessary of free product in a downgradient interception and recovery trench and beyond the recovery trench if necessary, is likely to result in the groundwater remediation level of 477 µg/L NWTPH-Dx being met downgradient of the school, and the groundwater cleanup level of 208 µg/L NWTPH-Dx being met at the conditional point of compliance. However, in the event dissolved petroleum concentrations in groundwater still exceed 477 µg/L NWTPH-Dx downgradient from the school after the excavation or treatment and associated interception and recovery trench installation has been performed, no additional measures on or at the school property will be required to meet the 477 µg/L NWTPH-Dx dissolved petroleum remediation level on property or downgradient. Instead, as a contingency, treatment methods will be employed at the levee if necessary to ensure that the cleanup level of 208 µg/L NWTPH-Dx and absence of sheen or free product would still be met at and downgradient of compliance wells in the levee. BNSF may elect to perform measures between the school and the levee if BNSF believes they would be more effective.

Even after excavation or treatment, contamination would remain beneath the school at concentrations exceeding 3,400 mg/kg NWTPH-Dx in soil and 477 ug/l NWTPH-Dx in groundwater. Restrictive covenants as previously described in Section 4.1.2.1 would be required as an institutional control for the school property to ensure that future generations are aware of the remaining contamination and the need to manage it appropriately if it is exposed by future activities on the property.

4.1.3 Northeast Developed Zone (NEDZ)

Free product and soil with petroleum concentrations exceeding 30,000 mg/kg NWTPH-Dx in the NEDZ is to be excavated. For compliance monitoring purposes, excavation is to continue until petroleum concentrations in soil measured at the excavation limits are equal to or less than 30,000 mg/kg NWTPH-Dx and there is no evidence of free product flowing into or accumulating in an excavation four or more hours after all recoverable free product has been removed using best available technology. Soil with petroleum contamination above the remediation level of 3,400 mg/kg NWTPH-Dx is to be remediated by enhanced bioremediation techniques such as air sparging. Air sparging is to be conducted so as to reduce soil petroleum concentrations below 3,400 mg/kg NWTPH-Dx and to reduce groundwater petroleum concentrations below 477 µg/L NWTPH-Dx throughout the NEDZ. Soil contaminated with lead exceeding the cleanup level of 250 mg/kg and/or arsenic exceeding the cleanup level of 20 mg/kg is to be excavated throughout the zone. No structures will be relocated to facilitate surface metal contamination removal unless the metals contamination is coincident with TPH contamination that requires a structure to be relocated.

Excavation of free product will require excavation in Railroad Avenue. Air-sparging wells and associated piping and equipment must be installed in appropriate locations.

Protection against vapor intrusion may be required for any building, structure, or enclosed space that remains or is built in the NEDZ over petroleum contamination exceeding 3,400 mg/kg NWTPH-Dx. Compliance monitoring of indoor and ambient air and the air cleanup level of 1,346 $\mu g/m^3$ APH will be used as the standard when evaluating monitoring data to assess whether vapor protection measures are required. Vapor intrusion protection measures must be taken so long as air-sparging has not yet reduced soil concentrations below 3,400 mg/kg NWTPH-DX or indoor air exceeds the air cleanup level.

Cleanup of residential and commercial properties may require temporary relocation of buildings and structures that are on the property and otherwise disturb the property so that excavation or other cleanup actions can occur. Property owners will be contacted by BNSF well in advance of the time during which cleanup actions will occur. Arrangements for access, cleanup, and property restoration will be made in the manner discussed in §6.1.

Soil compliance monitoring during excavation is to be conducted to ensure that excavation removes all free product and soil exceeding 30,000 mg/kg NWTPH-Dx. If the work identifies free product extending beyond anticipated limits that cannot be removed during the work planned for a given season, BNSF will consult with Ecology and affected property owners to discuss how best to excavate it. At the end of these discussions, Ecology will provide direction to BNSF on how to excavate the unanticipated free product and extend the associated schedule for completion as appropriate to accommodate the work. Additional exploration to assess the extent of free product in the NEDZ is to be performed prior to or during the engineering design phase

to minimize the potential for this contingency. If it is determined that any property owners would need to relocate to allow for excavation of free product under buildings, BNSF will follow the same protocol as in the NWDZ and SDZ, and as outlined in §4.1.2.1 and §6.1, to address the situation where owners may choose not to relocate.

Groundwater compliance monitoring is to be conducted during air-sparging to confirm that the rate of decline of groundwater contamination will reduce soil and groundwater contamination below their respective remediation levels of 3,400 mg/kg and 477 µg/L NWTPH-Dx within a reasonable restoration time frame of 10 years. This assessment may also be used to empirically demonstrate that the soil remediation level of 3,400 mg/kg is in fact protective of groundwater, sediment and surface water, and therefore effective as the soil cleanup level at this Site. Once soil is remediated to 3,400 mg/kg, if the empirical demonstration fails to show this remediation level is protective of groundwater, sediment and surface water, contingent actions at the groundwater conditional point of compliance will be required to ensure the cleanup level of 208 µg/L and absence of sheen or free product is met and will continue to be met at the conditional point of compliance, as part of the final remedy.

Once excavation is complete in the NEDZ, the groundwater petroleum cleanup level of 208 µg/L and absence of sheen or free product is to be met at its conditional point of compliance immediately except where that conditional point of compliance is at the Skykomish River. Where the conditional point of compliance is at the Skykomish River, the cleanup level of 208 µg/L and absence of sheen or free product is to be met within two years of start-up of air-sparging operations. It is expected that six months will be required to optimize the air sparging system. A trend analysis will be completed after one year to evaluate system effectiveness. If this trend analysis determines the system is not performing as intended, additional actions may be required. If the cleanup level of 208 µg/L and absence of sheen or free product is not met, or showing a significant declining trend, within two years at these locations, additional air-sparging wells must be installed and operated as necessary to achieve the cleanup level and absence of sheen or free product in a time frame approved by Ecology.

Groundwater compliance monitoring will also be used to decide whether additional remedial actions are necessary to reduce groundwater contamination to below the cleanup level of 208 µg/L and absence of sheen or free product at the groundwater cleanup level conditional point of compliance. It is expected that air-sparging will reduce groundwater petroleum concentrations to 208 µg/L and absence of sheen or free product at the conditional point of compliance immediately (within 2 years where the conditional point of compliance is at the river) and to 477 µg/L NWTPH-Dx and absence of sheen or free product throughout the NEDZ within a restoration time frame of 10 years. Air-sparging, enhanced bioremediation, or other similar in-place treatment measures at the conditional point of compliance may be required at any time following completion of the primary cleanup activities described above if review of compliance monitoring data indicates the petroleum cleanup level of 208 µg/L and absence of sheen or free product is

not being met at its conditional point of compliance. Compliance monitoring data reviews may be conducted at any time.

BNSF and Ecology will review the performance of the air-sparging system annually. This review will be documented in draft and final air-sparging system reports prepared by BNSF that will be submitted to Ecology for review and approval.

Two institutional controls will be needed in the NEDZ during implementation of the cleanup. These are:

- Permit overlay – A permit overlay[17] will be necessary during implementation of the cleanup to ensure correct procedures are followed during property redevelopment if soil is excavated to depths that reach petroleum-contaminated soil. Under the permit overlay, the Town of Skykomish can review grading permit applications for properties within the NEDZ for the potential for grading to expose contaminated soil that may be a direct contact hazard. The review will ensure that, in such a case, the contaminated soil will be handled by the permit applicant in accordance with all applicable laws and regulations. The permit overlay may be removed when compliance monitoring indicates soil concentrations have declined below concentrations protective of direct contact and groundwater.

- Groundwater withdrawal prohibition – Public Health – Seattle & King County will prohibit withdrawal of groundwater during the restoration time frame for enhanced bioremediation to reduce soil and groundwater petroleum concentrations below concentrations that will cause exceedance of drinking water standards (477 µg/L) throughout the zone and the groundwater cleanup level (208 µg/L) at the point of compliance. This prohibition will be accomplished pursuant to WAC 173-340-440(8)(c) through Public Health's well-permitting process. The prohibition may be removed when compliance monitoring indicates groundwater in compliance wells meets cleanup levels (208 µg/L) and absence of sheen or free product at the point of compliance and remediation levels (477 µg/L) and absence of sheen or free product throughout the NEDZ.

In addition, restrictive covenants and a restriction of groundwater use will also be required after implementation of the cleanup action, as applicable. See §4.1.2.1 and §6.1 for more specific discussion on relocation and on institutional control requirements, which are applicable to this zone as well.

[17] A permit overlay is a set of special permit requirements applied to an area within a larger area subject to more general permit requirements. For example, in towns, all buildings require a building permit. In a contaminated area, special permit conditions may apply that do not apply to the entire town. The area where the special permit conditions apply are said to "overlie" and are in addition to the more general permit conditions that apply to the larger area.

4.1.4 South Developed Zone (SDZ)

Petroleum-contaminated soil in the SDZ is to be excavated to the remediation level of 3,400 mg/kg NWTPH-Dx throughout the zone. See also special requirements within 25 feet of the FMC Zone in §4.1.5, which require excavation of soil with petroleum concentrations exceeding 22 mg/kg NWTPH-Dx within 25 feet of the FMC Zone to a depth of 4 feet.

Cleanup of residential and commercial properties will require temporary relocation of buildings and structures that are on the property and otherwise disturb the property so that excavation or other cleanup actions can occur. Property owners will be contacted by BNSF well in advance of the time during which cleanup actions will occur. Arrangements for access, cleanup, and property restoration will be made in the manner discussed in §6.1.

After cleanup, protection against vapor intrusion may be required for any building, structure, or enclosed space that remains or is built in the SDZ over petroleum contamination exceeding 3,400 mg/kg NWTPH-Dx. Compliance monitoring of indoor or ambient air will use the air cleanup level of 1,346 $\mu g/m^3$ APH as the standard when evaluating monitoring data to assess whether vapor protection measures are required.

Groundwater compliance monitoring is to be conducted to assess the decline of groundwater contamination after excavation and control/isolation of contamination under properties where access for excavation cannot be obtained (see below). This assessment may be used to empirically demonstrate that the soil remediation level is in fact protective of groundwater, sediment, and surface water, and therefore effective as the soil cleanup level at this Site. This assessment will thus be used to decide whether additional remedial actions are necessary near the boundary of the FMC zone to reduce groundwater contamination to below the cleanup level of 208 µg/L and absence of sheen or free product at the conditional point of compliance. It is expected that excavation to the soil cleanup level within 25 feet of the FMC Zone and to the remediation level of 3,400 mg/kg NWTPH-Dx will reduce groundwater levels to 208 µg/L and absence of sheen or free product at the south boundary of the FMC Zone and to 477 µg/L NWTPH-Dx and absence of sheen or free product immediately except for where isolated pockets of contamination may remain under inaccessible properties, if any.

Air-sparging, enhanced bioremediation, or similar in place techniques at the conditional point of compliance near the FMC Zone may be required at any time following completion of the primary cleanup activities described above if review of compliance monitoring data indicates the petroleum cleanup level of 208 µg/L and absence of sheen or free product is not being met immediately at the south boundary of the FMC Zone. Compliance monitoring data reviews may be conducted at any time.

Further contingency cleanup activities will not be required. So long as the groundwater cleanup level of 208 µg/L and absence of sheen or free product is being met at its conditional point of compliance, soil petroleum contamination of less than 3,400 mg/kg

NWTPH-Dx will be considered sufficiently contained for the purposes of groundwater, sediment and surface water protection.

Excavation is expected to decrease contamination to concentrations that protect aquatic organisms in the FMC, that protect drinking water uses, and that are protective of direct contact with the soil.

In addition, restrictive covenants and a restriction of groundwater use will also be required after implementation of the cleanup action, as applicable. See §4.1.2.1 and §6.1 for more specific discussion on relocation and on institutional control requirements, which are applicable to this zone as well.

4.1.5 Former Maloney Creek (FMC) Zone

The FMC Zone includes the wetland along the former channel of Maloney Creek. The FMC Zone is comprised of east and west wetland areas bisected by the Old Cascade Highway. The FMC-East (FMC-E) wetland area is primarily on BNSF property along the southern boundary of the railyard. A culvert carries water downstream from FMC-E under the old Cascade Highway, behind the school bus barn and fire department, to FMC-West (FMC-W) wetland. FMC-W is not on BNSF property and is comprised of a number of privately-owned properties. The cleanup requirements for FMC-E and FMC-W are based on the restoration plans of the respective wetland areas. FMC-W will be restored as wetland. FMC-E may be restored as wetland or as upland. The decision to restore FMC-E as upland is a land use decision by BNSF and other private property owners and subject to access, plus permitting and substantive requirements that include wetland mitigation via a wetlands bank. FMC Zone cleanup is scheduled to occur during the "fish window" in 2010 but could be delayed to 2011 if permit applications or project documents filed by BNSF are not approved by local, state or federal agencies in time for the 2010 "fish window." Restoration of FMC-E as upland would provide additional, usable upland space and flood control that could benefit the community, consistent with the goals of the Community Based Cleanup (Section 6.1).

For FMC-E & W areas restored as wetland, the cleanup requirements, which include buffer zones for sediment protection, are as follows:

- Sediment between the OHWM or wetland boundary, less than 4 feet from the bottom of the stream channel, and having petroleum concentrations exceeding 40.9 mg/kg NWTPH-Dx is to be excavated. Ecology has determined that dioxin/furan contamination is located within the area of petroleum release and will be fully removed with the petroleum contamination removal and confirmation sampling requirements. Dioxin/furan-contaminated sediment removal will be confirmed via existing data, as excavation sample confirmation is not practical due to analytical time requirements. Dioxin/furan-contaminated sediment will need to be evaluated to determine proper disposal requirements.

- Sediment between the OHWM or wetland boundary, greater than 4 feet from the bottom of the stream channel, and having petroleum concentrations exceeding 3,400 mg/kg NWTPH-Dx is to be excavated.

- Soil within a 25-foot lateral buffer zone extending outward from the OHWM or wetland boundary, less than 4 feet from the bottom of the stream channel, and having petroleum concentrations exceeding 22 mg/kg NWTPH-Dx is to be excavated.

- Soil within a 25-foot lateral buffer zone extending outward from the OHWM or wetland boundary, greater than 4 feet from the bottom of the stream channel, and having petroleum concentrations exceeding 3,400 mg/kg NWTPH-Dx is to be excavated.

For upland restoration of FMC-E, the cleanup requirements are as follows:

- Petroleum-contaminated soil is to be excavated to the soil remediation level of 3,400 mg/kg NWTPH-Dx throughout the FMC-E zone. Ecology has determined that dioxin/furan contamination above the cleanup level from unspecified sources exists at depths up to 2-feet at the western end of the FMC-E stream channel approximately 20-feet from the culvert inlet to FMC-W. Dioxin/furan contamination does not exist above the cleanup level in samples approximately 100-feet from the culvert inlet. An FMC-E upland restoration remedy will include excavation of the upper 2-feet of soils within 100-feet of the culvert inlet and within the OHWM unless bio-assay analyses are completed and results within site specific sediment cleanup screening level (CSL).

- In the case of FMC-E restoration as upland, the requirements for future compliance monitoring of the FMC Zone would then apply only to the FMC-West Zone which would be restored as wetland. The FMC-E area restored as upland would have compliance requirements in accordance with other upland areas.

Once confirmation has been obtained that the excavated areas have reached the required standards, the excavated creek areas and adjacent wetlands are to be backfilled and restored as appropriate habitat. This will include replacing excavated creek sediment and upland soils with appropriate clean material and replanting with appropriate vegetation. The restoration is to be consistent with the substantive requirements of the Town's Shoreline Management Program and regulations, and with other applicable laws and regulations such as Section 404 of the Federal Clean Water Act.

Compliance monitoring is to be conducted to ensure that excavations remove the sediment and soil to the concentrations specified. A confirmational monitoring plan will be developed and implemented to assess whether sediment remediation performs according to predictions or is becoming recontaminated over time by migration of contamination remaining on-site. As a contingency, should recontamination of sediments occur above the site-specific sediment cleanup screening level (CSL), as determined by bioassay, BNSF will excavate the contaminated sediments, monitor the sediments to

ensure they meet the site-specific sediment quality standards (SQS) within ten years of completion of the initial cleanup action, and will also employ, as necessary, treatment methods at or adjacent to Former Maloney Creek to reduce the petroleum concentrations in groundwater flowing to the creek so that sediments will continue to meet the SQS within this timeframe. If recontamination occurs at levels below the CSL but above the SQS, as determined by bioassay, then BNSF will employ, as necessary, treatment methods at or adjacent to Former Maloney Creek to reduce the petroleum concentrations in groundwater flowing to the creek to levels that allow sediments to naturally recover, and will monitor the natural recovery of the contaminated sediments, which must meet the SQS within ten years of the completion of the initial cleanup. Ecology anticipates that reducing petroleum concentrations in groundwater will be accomplished using enhanced bioremediation techniques such as air sparging, and that this will be used as the contingency measure to prevent recontamination of sediment.

So long as the groundwater cleanup level of 208 µg/L and absence of sheen or free product is being met at its conditional point of compliance near the FMC Zone (for areas of FMC restored as wetland), petroleum-contaminated soil remaining after excavation will be considered sufficiently contained for the purposes of groundwater, sediment, and surface water protection. For areas of FMC restored as upland, the groundwater RL of 477 µg/L applies provided the property owners have agreed to a Conditional Point of Compliance.

No institutional controls will be needed within the FMC Zone.

4.1.6 Railyard Zone

All lead and arsenic soil within two feet of the surface with contamination exceeding 250 and 20 mg/kg respectively will be excavated, as well as all PCB contamination exceeding a total PCB concentration of 0.65 mg/kg. All petroleum contamination within two feet of the surface exceeding a concentration of 1,870 mg/kg NWTPH-Dx, the concentration protective of soil biota, will be excavated.

All soil with petroleum concentrations exceeding 3,400 mg/kg NWTPH-DX will be removed from property within the railyard zone which is not part of BNSF's railyard facility property.

Additional requirements for excavation within the Railyard Zone to provide a buffer of clean soil adjacent to Former Maloney Creek are given in §4.1.5.

Petroleum-contaminated soil and free product remaining within the Railyard Zone must be contained at the BNSF's railyard facility property boundary and as much as possible recovered over time. In addition, groundwater leaving BNSF's railyard facility property and flowing under the town and toward the Skykomish River must be remediated to a petroleum concentration equal to or less than 477 µg/L NWTPH-DX and absence of sheen or free product. This will be measured near the BNSF's railyard facility property line. Groundwater entering the FMC Zone from either the Railyard Zone or the SDZ and flowing toward the FMC Zone must be remediated to a petroleum concentration of 208 µg/L NWTPH-DX and absence of sheen or free product. This will be measured at least 25 feet from of the boundary of the FMC Zone. See discussion for FMC Zone, §4.1.5.

BNSF will implement groundwater containment and remediation measures along the north of BNSF's railyard facility property boundary where soil petroleum concentrations exceed 3,400 mg/kg NWTPH-DX and, if necessary, along a line 25 feet north of the FMC and Railyard Zone boundary, with the length to be determined by required hydrogeologic investigations. Free product containment and recovery will be required, and groundwater control/treatment will be employed to the degree necessary to ensure that groundwater flowing off the railyard meets the remediation level or cleanup level (as applicable). Design calculations, plans, and specifications for the hydraulic control and containment system must be included in the Engineering Design Report (EDR) that is submitted for Ecology's review and approval for the year in which the system is to be installed.

Petroleum-contaminated soil associated with the two southern free product areas near the Former Maloney Creek Zone and with the far east free product area are to be excavated in association with installation of the hydraulic control and containment system or to limit the extent of the installation of the hydraulic control and containment system (See Figures 4 and 4A for free product area locations as of 2005 and 2020, respectively).[18]

The hydraulic control and containment system is a critical component of the overall site remedy. A large mass of contamination, including a significant volume for free product, must be contained within BNSF's railyard facility property, contaminant movement must be controlled, free product must be captured, and contaminated groundwater treated to applicable cleanup and remediation levels before it can be re-injected for flushing or exit BNSF's railyard facility property. Free product, in particular, must be prevented from leaving BNSF's facility property boundary due to the combination of a needed short response time and the disruption of such a response if free product migrates off BNSF's facility property into the Town of Skykomish, and the high-consequence of re-contaminating the Town.

BNSF will implement hydraulic control and containment by installing a groundwater barrier in a groundwater interception trench. Figure 9 shows a conceptual sketch of the trench construction. The barrier system must be capable of detecting leaks of free product that may occur anywhere along the length of the barrier system.

BNSF will install an extraction system to pump water and associated nonaqueous phase liquid from the trench, treat it, and reintroduce it into the subsurface at appropriate locations to flush petroleum contamination to the trench. The alignment and extent of the physical barrier, trench, pumping system, and flushing system will be designed using standard analytical and numerical modeling techniques (e.g. Modflow). Hydraulic containment will be field verified using a groundwater level gauging program that will be developed during the design, in addition to the groundwater compliance monitoring described below. The system may consist of one or more of the following: a barrier system, groundwater pumping, groundwater treatment, and/or a free product removal system. The system must be capable of detecting leaks of free product that may occur anywhere along the length of the barrier system. The system will be operated and

[18] Estimated soil volumes are 5,000 cubic yards of petroleum contaminated soil within the two southern plumes and 600 cubic yards of petroleum contaminated soil within the far east plume.

maintained as needed, such that free product and groundwater exceeding the 477 µg/L NWTPH-Dx remediation level does not leave the BNSF railyard facility property boundary or exit any functional gates of the containment system. Alterations to the system or suspension and/or decommissioning of the groundwater pumping component of the system will require 1) approval from Ecology, and 2) a demonstration illustrating the proposed operation will meet the remediation level as described above. The demonstration must be supported by analytical laboratory data from samples collected at the Site. The HCC system will be decommissioned following Ecology approval, based on performance monitoring data.

BNSF will pump any extracted groundwater to a treatment system where free product is separated and recovered for recycling or disposal and/or passively treat groundwater via the carbon-filled HCC gates. If needed, BNSF will treat the extracted groundwater to a petroleum remediation level of 477 µg/L NWTPH-Dx and absence of sheen or free product (or to the cleanup level of 208 µg/L NWTPH-Dx and absence of sheen or free product for water flowing toward the FMC Zone). The treatment system will also provide a means to aerate the water so it has a high dissolved oxygen content. The extracted treated water will then be reintroduced into the railyard subsurface at appropriate locations and by appropriate means in order to flush petroleum contamination toward the hydraulic control and containment system trench or discharged via existing stormwater outfalls under an NPDES permit. The reintroduction area will be located just north of the extent of the FMC Zone excavation buffer and possibly at other locations as determined during design of the treatment system. Reintroduction of water north of the FMC Zone excavation buffer will create a hydraulic barrier between contamination remaining within the Railyard Zone and the FMC Zone. The reintroduction of treated water will serve as a means to oxygenate and promote biodegradation of soil and groundwater throughout the Railyard Zone. Reintroduction of treated water will comply with the substantive requirements of all applicable laws and regulations. Treated water may also be discharged to surface water consistent with applicable state and local substantive requirements and with applicable federal permits.

The hydraulic control and containment system will be designed to resist seismic forces that may impact the system and emergency procedures will be developed to bring the system back on line rapidly in case of shut-down due to earthquake or other outage.

Design of the hydraulic control and containment system will be documented in a Hydraulic Control and Containment System Special Design Report (see §6.2).

BNSF will install confirmational groundwater monitoring wells downgradient from the trench along the north boundary of BNSF's railyard facility property to verify that petroleum concentrations in groundwater underneath portions of the site immediately adjacent to BNSF's railyard facility property meet the required remediation or cleanup levels, as applicable. BNSF will install a groundwater monitoring well at each end of the trench along the north boundary of BNSF's railyard facility property to assess whether groundwater flowing past the ends of the trench meets the required petroleum remediation level. The groundwater confirmational monitoring program, contingency trigger levels and procedures, and contingent actions specified in this CAP will be included in a groundwater compliance monitoring plan. It is anticipated that contingent

actions will include additional monitoring and increased groundwater extraction rates.

BNSF and Ecology will review the performance of the hydraulic control and containment system annually to assess how best to optimize its performance to recover as much petroleum over time as possible. This review will be documented in draft and final annual reports prepared by BNSF that will be submitted to Ecology for review and approval. As part of this review, BNSF will identify additional areas where petroleum-contaminated soil can be excavated from the smear zone or the vadose zone without disrupting rail operations. Preference will be given to excavating the most highly contaminated soil. A minimum of 7,500 cubic yards of petroleum contaminated soil is to be excavated within 20 years of the effective date of the Consent Decree. This yardage does not include any soil excavated in association with the installation of the hydraulic control and containment system or limiting the extent of the installation of the hydraulic control and containment system. The timing of the smear zone or vadose zone soil removal will be at BNSF's option so as not to interfere with rail operations, but is to be done as soon as possible after Ecology and BNSF agree on the area and volume to be excavated. If the excavation is not to be done in the construction season after the area and volume to be excavated are identified, BNSF is to provide Ecology with a letter stating the operational reasons that excavation cannot proceed and BNSF is to propose a date when excavation can proceed. If all excavation has not been done by the 20th year, Ecology will direct BNSF as to when and where to excavate any volume of smear zone or vadose zone soil remaining in the 7,500 cubic yard total to be removed in the 20 years after the hydraulic control and containment system becomes operational.

The annual review of hydraulic control and containment system performance will also assess whether additional technologies can be employed to promote the timely removal of petroleum. Technologies to be considered include pulsing of the flushing water at various points to change flow directions and hence reduce channeling of infiltration water, use of surfactants to reduce surface tension and hence mobilize more free product, enhanced bioremediation, and new technologies. The goal of the technologies considered will be to enhance removal of free product and to decrease petroleum soil concentrations. The hydraulic control and containment system must be maintained and operable until groundwater standards are met. Enhanced removal of free product and decrease of petroleum soil concentrations may reduce the operating time for the system, currently considered to be indefinite.

Additional investigations are to be performed to define hydrogeologic conditions in the area of FMC prior to or during the engineering design phase. BNSF will propose monitoring requirements and a plan for implementing such hydraulic control and containment as part of the EDR.

Protection against vapor intrusion will be required for any building, structure, or enclosed space that remains or is built in the Railyard Zone over petroleum contamination exceeding 3,400 mg/kg NWTPH-Dx. Compliance monitoring of indoor or ambient air will use the air cleanup level of 1,346 $\mu g/m^3$ APH outside the BNSF facility property boundary and 2,944 $\mu g/m^3$ within the BNSF facility property boundary as the standard when evaluating monitoring data to assess whether vapor protection measures are required.

Compliance monitoring will be conducted to ensure that excavations remove the required amount of contaminated soil, that all required metals and PCB contamination is removed, and that contaminated soil exceeding 1,870 mg/kg NWTPH-Dx that is within two feet of the surface is removed.

Compliance monitoring will be conducted at BNSF's railyard facility property boundary to ensure that no free product is leaving BNSF's railyard facility property and that groundwater leaving BNSF's railyard facility property does not have petroleum concentrations exceeding 208 µg/L and absence of sheen or free product for groundwater flowing into the FMC Zone and 477 µg/L NWTPH-Dx and absence of sheen or free product elsewhere. Groundwater leaving BNSF's railyard facility property must meet the appropriate cleanup levels and remediation levels immediately after installation of hydraulic control and containment systems. If free product is detected outside of BNSF's railyard facility property at any time, measures to stop its migration and control any future migration are to be taken immediately. Compliance monitoring will be done to evaluate whether the migration has been stopped and controlled. The size and distribution of the free product outside BNSF's railyard facility property boundary will be assessed to evaluate whether additional remedial actions should be taken.

Air-sparging, enhanced bioremediation, or other in-place treatment techniques may be required as additional contingency measures at any time following completion of the primary cleanup activities described above if review of compliance monitoring data indicates the petroleum cleanup and remediation levels are not being met at the conditional points of compliance specified in this CAP. Compliance monitoring data reviews may be conducted by Ecology at any time. Contingency cleanup actions other than or in addition to air-sparging, enhanced bioremediation, or other in-place treatment techniques will require amending this CAP.

So long as the groundwater petroleum cleanup and remediation levels are being met at their conditional points of compliance petroleum, contamination on the railyard will be considered sufficiently contained for the purposes of groundwater, sediment, and surface water protection. Further contingency cleanup activities will not be required.

Cleanup of properties not owned by BNSF will achieve petroleum concentrations protective of direct contact and drinking water uses. Cleanup of residential and commercial properties may require temporary relocation of buildings and structures that are on the property and otherwise disturb the property so that excavation or other cleanup actions can occur. Property owners will be contacted by BNSF well in advance of the time during which cleanup actions will occur. Arrangements for access, cleanup, and property restoration will be made in the manner discussed in §6.1.

No institutional controls will be necessary for properties within the Railyard Zone not owned by BNSF. A restrictive covenant will be required for BNSF's railyard facility property. The covenant must be placed on the property deed that provides notice that contaminated soil remains on BNSF's railyard facility property above concentrations that are protective of direct contact and protective of groundwater. The covenant must provide for maintaining the integrity of all cleanup actions. The covenant must

include a prohibition against withdrawal of groundwater from the railyard, except for withdrawal for treatment purposes, because contaminated groundwater will remain beneath the railyard. The groundwater withdrawal prohibition may be removed if compliance monitoring indicates groundwater flowing to Former Maloney Creek meets the cleanup level of 208 µg/L and absence of sheen or free product and groundwater underlying all of BNSF's railyard facility property meets the remediation level of 477 µg/L and absence of sheen or free product.

4.2 Types, Levels, and Amounts of Contamination Remaining On-Site

Figure 10 shows the estimated decline of petroleum on-site with time using the comparative rates developed in the Feasibility Study. This may be compared to similar graphs in the Feasibility Study (RETEC, 2005, Figures 8-1 through 8-10 and 10-11).

High concentrations of petroleum are expected to remain in soil under the Railyard for decades and act as a source of contamination to groundwater under the Railyard that must be contained and treated at BNSF's railyard facility property boundary.

Arsenic, lead, and PCB contaminated soil will be completely removed from the residential/commercial zones and from the upper 2 feet on the Railyard. Arsenic, lead and PCB contaminated soil below a depth of 2 feet on the Railyard (if any), will be contained with two feet of clean soil backfill. Dioxin/furan contaminated sediment will be entirely removed from the Site.

Chapter 5 - Alternatives Considered and Basis for Remedy Selection

5.1 Introduction

The Feasibility Study (RETEC, 2005) divided the Site into six zones and considered several cleanup actions for each zone. These were assembled into eleven different Site-wide alternatives for assessment. The proposed cleanup actions for each alternative considered in the Feasibility Study (RETEC, 2005) are summarized in Table 3.

The alternatives were named according to the proposed groundwater point of compliance. Those proposing a groundwater point of compliance at the point where groundwater enters surface water were given a prefix of SW; those proposing a groundwater point of compliance at BNSF's railyard facility property boundary were given a prefix of PB. A preferred alternative was also developed, which proposed a surface water point of compliance for groundwater. This is BNSF's preferred alternative, and is labeled BNP in this document. A "standard" alternative was developed as well, labeled STD. The STD alternative was the only permanent alternative developed in the Feasibility Study, and is the baseline alternative used when comparing alternatives in the disproportionate cost analysis to assess whether other alternatives are permanent to the maximum extent practicable pursuant to WAC 173-340-360(3)(e).

Although each Site-wide alternative differed from the others in material ways, many elements were common among the several alternatives. Only the proposed cleanup actions in the NWDZ differed across all eleven alternatives. Cleanup actions in other Site zones were the same in two or more of the alternatives.

In addition to the alternatives considered in the Feasibility Study, Ecology developed another alternative, labeled ECY, which used elements from the alternatives considered in the Feasibility Study combined with some additional technologies. The reasons for developing ECY are explained below.

5.2 Proposed Cleanup Technologies

The alternatives presented in the Feasibility Study proposed use of several cleanup technologies to degrees that varied among the alternatives. The MTCA Cleanup regulation has a guide for assessing the relative degree of long-term effectiveness of proposed technologies, stating that,

> "The following types of cleanup action components may be used as a guide, in descending order, when assessing the relative degree of long-term effectiveness: Reuse or recycling; destruction or detoxification; immobilization or solidification; on-site or off-site disposal in an engineered, lined and monitored facility; on-site isolation or containment

> with attendant engineering controls; and institutional controls and monitoring." WAC 173-340-360(3)(f)(iv)

The order is a qualitative sequencing to be considered on a site-specific basis. Ecology's assessment of long-term effectiveness by this general guide must also therefore be tempered by site-specific considerations. At this Site, the technologies proposed in the Feasibility Study vary greatly in the time they take to achieve cleanup, which significantly lessens the usefulness of this guide. Some of the technologies work incompletely and/or over a very long time. In addition, the effectiveness at the BNSF Skykomish Site of some of the proposed technologies is uncertain.

The technologies proposed are discussed below.

Petroleum recovery booms – Petroleum recovery booms are sausage-shaped bundles of absorbent material that float. Their primary use is for emergency response for petroleum spills. They are placed around a petroleum slick on water to contain the petroleum to a limited area while it is being recovered by boats. When water is calm they can be effective, but their effectiveness is lessened or eliminated as winds, waves, and currents increase. At the BNSF Skykomish Site petroleum recovery booms were used for years as interim actions designed to reduce petroleum migration in surface water. They were placed in the Skykomish River adjacent to free product seeps along the bank. Their performance has ranged from only moderately effective to poor. The booms required constant maintenance to change when saturated, and to redeploy in response to changing river conditions. They also had to be removed during high water conditions. Petroleum booms became detached from their anchors during high water and floated down river, and these booms have not been recovered. In addition, petroleum-absorbent pads used to reduce fouling of the booms have floated downriver. Achieving even marginal performance required constant Ecology oversight. The booms were disposed of off-site at a facility permitted to accept such waste. The booms have now been removed pursuant to the 2006 interim action.

Skimmer Wells –A skimmer well is a well with a continuous belt, like a conveyor belt, that runs up and down through a layer of petroleum. The belt picks up the petroleum and is routed through rollers that squeeze the petroleum from the belt into a receptacle. The receptacle is emptied periodically. Skimmers wells rely upon the product to flow directly into the wells. Even when additional hydraulic controls are in place to direct slow moving heavy oils, the equipment has to be optimized to operate when needed and to prevent failure. At the BNSF Skykomish Site, former skimmer well operations required high maintenance and only achieved low rates of product recovery. Since installed in 1996, skimmer wells recovered only a small amount of product. The skimmer wells have had numerous maintenance problems, including flooded vaults and electro-mechanical failures. Ecology does not believe that skimmer wells can remove the remaining quantity of product in a reasonable time frame and does not believe, based on past performance that the wells would be maintained in a satisfactory manner. Petroleum recovered by skimmer wells would be sent off-site to a permitted waste facility. See further discussion under petroleum recovery trenches.

Petroleum recovery trenches – Petroleum recovery trenches are trenches filled with gravel and cobbles. Their purpose is to intercept free product floating on the water table and remove it using skimmer wells installed at intervals along the trench. The Feasibility Study indicates petroleum recovery trenches will recover 20% of the free product in 100 years; 80% of the free product will remain behind indefinitely. This estimate is based on gross assumptions used in the Feasibility Study to compare alternatives. The Feasibility Study did not develop sufficient information to provide useful estimates of actual removal rates, stating:

> "It should be noted that the [rates of contaminant decline] were based on gross assumptions that allow for comparison between alternatives but are not intended to indicate actual degradation rates or timeframes." (RETEC, 2005, p. 10-29, §10.4.5.7)

The successful operation of the trench design proposed in the feasibility study depends upon two factors. The first is the contrast between the hydraulic conductivity of the recovery trench and the surrounding soil. If the hydraulic conductivity of the gravel and cobbles used to backfill the recovery trench is much higher than the surrounding soil, water and free product flowing into the trench will tend to be able to flow laterally to the skimmer wells for removal much faster than out of the trench. This is key to removal of the free product. At the BNSF Skykomish Site, however, this key factor is missing. The surrounding soils in which the recovery trenches are to be installed are mountain river gravels. These gravels have a high hydraulic conductivity, which may approach the hydraulic conductivity of the trench backfill material. Consequently, skimmer wells along the recovery trenches are likely to be ineffective, since the ratio of lateral flow of free product along the trench to flow out of the trench of free product is likely to be too low.

The second factor upon which the success of recovery trenches depends, is the specific gravity of the free product with the specific gravity of water. The specific gravity of the free product found at this Site is about 98% that of water (RETEC, 2005, p. 3.8). That is, the free product floats, but only barely. This means the buoyant forces acting to bring free product to the surface of the water in the trench are relatively small. This is important because the free product is likely not "floating" on the water, but is moving through the gravel with the water as a petroleum-water mix. The low buoyant force, combined with the similar hydraulic conductivities of the trench backfill and the surrounding river gravel, means much of the petroleum is likely to simply flow through and exit the trench, rather than moving to the surface and flowing laterally toward skimmer wells. The viscosity of the free product, which is similar to molasses, will exacerbate this potential. Rather than being effective at removing free product from the entire length of the trench, the skimmer wells are likely to remove free product in the trench in a very limited area only – likely an area not much larger than the diameter of the well itself.

No pilot tests of recovery trenches have been performed at the Site.

The free product recovered from the recovery trenches would be sent off-site, either for recycling or to a permitted waste facility.

Natural attenuation – Natural attenuation is defined in the MTCA cleanup regulation as the variety of physical, chemical or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of hazardous substances in the environment. These processes include: natural biodegradation; dispersion; dilution; sorption; volatilization; and, chemical or biological stabilization, transformation, or destruction of hazardous substances. WAC 173-340-200. Among Ecology's expectations in WAC 173-340-370(7) are that source control (including removal and/or treatment of hazardous substances) has been conducted to the maximum extent practicable before relying on natural attenuation, that contaminants remaining on-site during the restoration time frame do not pose an unacceptable threat to human health or the environment, and that there is evidence that natural biodegradation or chemical degradation is occurring [at a reasonable rate] and will continue to occur at a reasonable rate at the site.

Natural attenuation has been proposed in many of the alternatives. The Feasibility Study assumes that natural attenuation will remove 50% of the mass of Bunker-C and 75% of the mass of diesel in contaminated soil over a period of 100 years. This estimate is based on gross assumptions for comparative purposes; the Feasibility Study did not develop sufficient information to provide useful estimates of actual removal rates (See RETEC, 2005, p. 10-29, §10.4.5.7, quoted above). Natural attenuation is assumed not to act on free product. (RETEC, 2005, Appendix P, p. 4 and associated Excel workbook, Remedial_Alt_Ranking_135_ft_june 20 2005 w stats.xls, worksheet Amt Left[19]).

Natural attenuation is normally used to reduce lower concentration contamination, after more active treatment methods or excavation has been used to remove higher concentration contamination. At the BNSF Skykomish Site, monitored natural attenuation may be appropriate for soil and groundwater after more active treatment methods have been applied. Natural attenuation is not expected to be effective on Bunker-C and diesel until their concentrations have been significantly reduced by more active treatment methods.

Natural attenuation destroys and detoxifies the contamination.

Enhanced bioremediation – Enhanced bioremediation operates in a similar manner to natural attenuation, except that a number of techniques may be used to increase, or enhance the rate at which the attenuation occurs. Air sparging is the enhanced bioremediation technique considered in the Feasibility Study. This technique injects air into the ground through a network of wells connected by manifold piping to a blower. The aeration of the soil and groundwater acts to increase the rate at which natural soil bacteria use the petroleum for energy and excrete waste products that are not hazardous such as carbon dioxide, water, and methane at low concentrations.

[19] The assumed natural attenuation decline rates are embedded in RETEC's spreadsheet calculations.

Enhanced bioremediation has been proposed in many of the alternatives. The Feasibility Study assumes that enhanced bioremediation will remove 50% of the mass of Bunker-C and 75% of the mass of diesel in contaminated soil over a period of 10 years. This estimate is based on gross assumptions for comparative purposes; the Feasibility Study did not develop sufficient information to provide useful estimates of actual removal rates (See RETEC, 2005, p. 10-29, §10.4.5.7, quoted above). Enhanced bioremediation is assumed not to act on free product (RETEC, 2005, Appendix P, p. 4 and associated Excel workbook, Remedial_Alt_Ranking_135_ft_june 20 2005 w stats.xls, worksheet Amt Left[20]).

Enhanced bioremediation destroys and detoxifies the contamination. It is more effective on diesel contamination such as is in the NEDZ and has limited or no effectiveness on Bunker-C contamination, depending upon the concentration.

Excavation – Excavation is proposed in several alternatives for remediating petroleum-contaminated soil. All alternatives use excavation to recover metals-contaminated soil. Alternatives that propose to recover PCB contamination use excavation.

The Feasibility Study states that:

> "Excavation has been determined to be the most effective and practicable remedial technology for addressing the petroleum impacts associated with the Site. Less intrusive *in situ* technologies would be preferable to excavation with respect to having significantly less disruption to the Town. However, such technologies have not been found to be practicable at Skykomish at their current state of development and understanding. As a result, [many alternatives presented in the Feasibility Study include] areas of the Town and railyard that will be excavated, and others that will not be disrupted by excavation, but will contain these contaminants for a long-term future (likely to approach 100 years)." (RETEC, 2005, §10.6, p. 10-37)

The statement that the need for containment of the remaining petroleum (TPH) is likely to approach 100 years conflicts with the Feasibility Study's assumptions that 50% will be remaining after 100 years, and 80% for the free product. Containment and management will likely have to continue for an indefinite period beyond 100 years.

Where contaminated soil is accessible, excavation can recover 100% of the contamination that is to be cleaned up by excavation within the construction season in which excavation occurs. The construction schedule requires excavation in all zones be completed by 2011.

Excavation reuses and recycles a portion of the free product and contaminated soil. Excavations to recover free product result in free product accumulating on the water in the excavation. This free product is skimmed from the surface of the water, along with some of the water. The product is separated from the water in a treatment plant and sent

[20] The assumed enhanced bioremediation decline rates are embedded in RETEC's spreadsheet calculations.

to a recycler. The water is treated to remove dissolved constituents and discharged. Excavation of free product is expected to result in much greater volumes of free product being recycled than the recovery trench technology because the recovery trench technology only recovers 20% of the free product over a 100 year period whereas excavation will recover 100% of the free product during the construction season in which excavation occurs. Interim actions performed in the Levee Zone and adjacent parts of the NWDZ in 2006 indicate that some free product can be recovered during excavation and eventually recycled, and that some contaminated soil excavated for cleanup can be reused as daily cover at landfills.

Petroleum-contaminated soil is anticipated to be sent to a landfill for disposal.[21] While this could initially be characterized as off-site disposal, the soil allows for additional benefits beyond mere disposal. Landfill operations must cover all waste received each day with soil – known as daily cover – to secure the waste against wind and disease vectors (birds and rodents). Petroleum-contaminated soil received at landfills is often used as part of the daily cover – a reuse. This reduces the amount of clean soil the landfill operator must excavate and transport for daily cover operations. Soil with petroleum contamination too great for disposal in landfills is sent to an incinerator, where the petroleum is burned. This is a destruction/detoxification process.

On-Site Containment – Many of the alternatives contain petroleum-contaminated soil on-site at concentrations up to and including those for soil containing free product. These high levels of petroleum contamination would be isolated beneath clean soil. Free product is proposed to be contained by the petroleum recovery trenches discussed earlier, but such trenches do not contain or treat petroleum constituents dissolved in groundwater. As noted, the trenches would recover only 20% of the free product petroleum over 100 years; the rest would remain behind as a significant source of ongoing groundwater contamination. Site studies have indicated flow of free product petroleum to a well would be slow. The petroleum is currently being transported in groundwater and would likely continue to be transported by groundwater as small globules making their way slowly through the soil pores. As noted above, some petroleum is likely to exit the recovery trenches, making containment ineffective.

On-site isolation and containment would be required for an indefinite time, likely well over 100 years.

Institutional Controls – Institutional controls are measures undertaken to limit or prohibit activities that may interfere with the integrity of an interim action or a cleanup action or result in exposure to hazardous substances at a site. They are not active cleanup measures, but rather administrative measures. One example is a deed restriction on property that limits the owner's activities on the property. The Feasibility Study, when discussing BNSF's preferred alternative, notes that,

[21] Petroleum-contaminated soil with dioxin and PCB may require different disposal actions. Such soil is only a small portion of the total amount of petroleum-contaminated soil to be excavated.

> "Institutional controls are used primarily on the railyard where they are more effective and reliable at reducing risk but they will also reduce risk in both the NE and NW Developed Zone by preventing direct contact with soil and ingestion of groundwater." (RETEC, 2005, §10.4.5.3, p. 10-28)

Ecology agrees that institutional controls would be more effective and reliable when applied to BNSF's railyard facility property as opposed to off-railyard properties. Where institutional controls are implemented on properties with a single, large institutional owner, they can be moderately effective and reliable at reducing risk although the reliability declines with time and change of personnel. Institutional controls are markedly less effective and reliable at reducing risk where there are multiple property owners impacted – here, off the railyard and spanning an entire town. Such property owners are not experienced in managing environmental contamination, and consequently the effectiveness of institutional controls rapidly declines – especially in the long run. Many of the alternatives propose managing the highest levels of petroleum contamination with institutional controls placed on individual residential or small-business use properties. Such institutional controls would have to be maintained indefinitely.

In summary, the Feasibility Study proposes several technologies for cleaning up the BNSF Skykomish Site. These technologies vary in reliability and effectiveness. The Feasibility Study combines these technologies into eleven Site-wide alternatives. All of these alternatives except STD use conditional points of compliance.

5.3 Initial Assessment of Feasibility Study Alternatives

As stated in the Feasibility Study, excavation is the most effective and practicable remedial technology for addressing the petroleum contamination at the Site. (RETEC, 2005, Feasibility Study §10.6, p. 10-37). Many of the other technologies rely upon gross assumptions regarding their effectiveness and rates of operation. The Feasibility Study did not develop sufficient information to meet the required burden of proof to demonstrate the effectiveness of many of the proposed technologies (recovery trenches, enhanced bioremediation, natural attenuation containment, off-railyard institutional controls) at addressing petroleum contamination. Ecology therefore carefully evaluated whether each alternative was likely to be effective on the different types and levels of petroleum contamination throughout the Site. This evaluation was completed by first conducting an initial assessment of whether each proposed cleanup alternative met all minimum requirements for cleanup actions required by the MTCA Cleanup Regulation except for the minimum requirement to use permanent solutions to the maximum extent practicable. Those that passed through this initial screening were then included in the determination of which cleanup action uses permanent solutions to the maximum extent practicable as required by WAC 173-340-360(3). Ecology also developed a twelfth alternative, called ECY and described in Chapter 4, from the cleanup components considered in the Feasibility Study and from additional work performed by Ecology. The reasoning for developing ECY is discussed in §5.4.

ECY relies on many of the technologies used in the alternatives developed in the Feasibility Study as well as technologies developed by Ecology, primarily excavation and air-sparging. ECY uses enhanced bioremediation and natural attenuation only at lower petroleum concentrations, where these technologies have a greater chance of being effective.

Ecology assessed the cleanup components proposed for each Site cleanup zone in each Site-wide alternative. Table 4 summarizes Ecology's initial assessment of the alternatives presented in the Feasibility Study. An "**X**" was placed in the box for any cleanup component in any zone that failed to meet one or more of the minimum requirements for cleanup actions. Any Site-wide alternative column that contains one or more "**X**'s" means that Site-wide alternative does not meet one or more of the minimum requirements for cleanup actions. The alternative having the fewest number of "**X**"s, PB4, was carried forward to the analysis for determining which alternative is permanent to the maximum extent practicable for comparison purposes. The rest of the alternatives with "**X**'s" were not carried forward into the analysis for determining which alternative is permanent to the maximum extent practicable.

One of the key minimum requirements for cleanup actions is that the action provides for a reasonable restoration time frame. WAC 173-340-360(2)(b)(ii) Figure 11 summarizes the restoration time frames for free product, groundwater, and soil presented in the Feasibility Study. This figure summarizes information presented in Figures 10-8, 10-9, and 10-10 in the Feasibility Study (RETEC, 2005). The times on the figure represent the mid-point of ranges of restoration time frames estimated in the Feasibility Study as follows (RETEC, 2005, p. 10-25):

- 4 years represents a 3 to 5 year range
- 8 years represents a 5 to 10 year range
- 15 years represents a 10 to 20 year range
- 25 years represents a 20 to 30 year range
- Greater than 30 years represents an indefinite time frame.

Levee Zone – An interim action to clean up the levee has already been completed, except for compliance monitoring. The interim action for the levee cleanup excavated sediment, free product, and upland soil at higher concentrations, consistent with PB4 and PB5.

Alternatives SW1, SW2, and PB1 did not propose to excavate free product or high level contamination, but instead relied on enhanced biodegradation with boom maintenance — in effect allowing petroleum to continue to seep into the Skykomish River, and to recover the petroleum with booms. These alternatives fail to meet the minimum requirement of removing free product using normally acceptable engineering practices (here, excavation). These alternatives fail to meet Ecology's expectation that high concentrations of hazardous and highly mobile substances will be treated, and that active measures be taken to prevent/minimize releases to surface water via surface runoff (i.e., the petroleum seeps) and groundwater discharge. These

alternatives rely upon an off-property conditional point of compliance, but do not apply AKART because known and reasonable treatment methods that are practicable can be implemented as proposed in other alternatives. The Feasibility Study indicates the restoration time frame is 8 years for free product, groundwater, and soil, but does not support this assertion. The proposed method of recovering the petroleum with booms has been shown during the Site investigation period to have limited effectiveness. The proposed method of treating groundwater is also likely to be ineffective on the high concentrations of contamination that will be left in place. Consequently, these alternatives are likely to be ineffective in achieving cleanup standards within a reasonable restoration timeframe. Considering the foregoing, alternatives SW1, SW2, and PB1 fail to meet the threshold requirement to protect human health and the environment, and otherwise fail to meet minimum requirements for cleanup based on the actions proposed for the levee.

Alternatives SW3 and PB2 propose to remove free product from the levee but leave all other contamination in the Levee, including the highest concentrations of petroleum-contaminated soil short of soil with free product. These alternatives fail to meet Ecology's expectation that high concentrations of hazardous and highly mobile substances will be treated. These alternatives rely upon an off-property conditional point of compliance, but do not use AKART because they fail to remove soil with high petroleum concentrations: Known and reasonable treatment methods that are practicable can be implemented as proposed in other alternatives. The Feasibility Study indicates the restoration time frame is 2 years for free product and 4 years for groundwater and soil, but does not support this assertion. The proposed method of treating groundwater is likely to be ineffective on the high concentrations of contamination that will be left in place. Consequently, these alternatives are likely to be ineffective in achieving cleanup standards within a reasonable restoration timeframe. Considering the foregoing, alternatives SW3 and PB2 fail to meet the threshold requirement to protect human health and the environment, and otherwise fail to meet minimum requirements for cleanup based on the actions proposed for the levee.

Former Maloney Creek Zone (FMC) – Alternatives SW1, SW2, SW3, PB1, and PB2 propose to use only natural attenuation in the FMC. These alternatives fail to meet the minimum requirement of removing free product using normally accepted engineering practices. These alternatives fail to meet Ecology's expectation that high concentrations of hazardous and highly mobile substances will be treated, and that source control will be conducted to the maximum extent practicable prior to using natural attenuation. Failure to conduct such source control precludes natural attenuation from being considered an appropriate active cleanup measure. These alternatives fail to meet Ecology's expectation that active measures will be taken to prevent/minimize releases to surface water via groundwater discharge. These alternatives do not use AKART prior to releasing contamination into surface water (the wetland), because known and reasonable treatment methods that are practicable can be implemented as proposed in other alternatives. The Feasibility Study indicates the restoration time frame is 0 years for free product (omitting the free product in the

area of well 2-A-B-8 to be excavated by BNP alternative but to remain behind in these alternatives) and 8 years for groundwater and soil, but does not support this assertion. It has not been demonstrated that a reasonable rate of natural attenuation is occurring or is likely to occur for the high concentrations of Bunker-C contaminated soil in the FMC Zone, and natural attenuation alone is likely to be ineffective to reduce such high petroleum contamination — a consideration factor when assessing the restoration time frame. Consequently, these alternatives are likely to be ineffective in achieving cleanup standards within a reasonable restoration timeframe. Considering the foregoing, alternatives SW1, SW2, SW3, PB1, and PB2 fail to meet the threshold requirement to protect human health and the environment, and otherwise fail to meet minimum requirements for cleanup based on the actions proposed for FMC.

Alternatives SW4, PB3, and PB4 propose to use enhanced bioremediation in FMC to treat soil and groundwater sufficiently to achieve a groundwater cleanup level of 208 µg/L NWTPH-Dx. SW4 and PB3 propose to excavate surface sediments to a remediation level of 2000 mg/kg. However, this level is not protective of aquatic life (2000 mg/kg is above concentrations that caused bioassay failures). In addition, these alternatives do not remove free product in the subsurface sediments, and therefore do not meet the minimum requirement to remove free product using normally accepted engineering practices. These alternatives also leave behind high level contamination in soil (in addition to free product) that has not been shown to be amenable to enhanced bioremediation. The Feasibility Study indicates the restoration time frame is 0 years for free product (omitting the free product in the area of well 2-A-B-8 to be excavated by the BNP alternative, but to remain behind in these alternatives) and 4 years for groundwater and soil, but does not support this assertion. Site studies have not demonstrated that the high concentrations of contamination remaining behind in soil and groundwater can be biodegraded at a reasonable rate. The proposed method of treating soil and groundwater is likely to be ineffective on the high concentrations of contamination that will be left in place. Consequently, these alternatives are likely to be ineffective in achieving cleanup standards within a reasonable restoration timeframe. Considering the foregoing, alternatives SW4, PB3, and PB4 fail to meet the threshold requirement to protect human health and the environment, and otherwise fail to meet minimum requirements for cleanup based on the actions proposed for FMC.

Alternative BNP proposes to remove free product in FMC in the area of Well 2-A-B-8 and in the former channel, but leave in place higher concentrations of soil (in addition to free product) that has not been shown to be amenable to enhanced bioremediation. Enhanced bioremediation is then proposed to remediate high concentrations of contamination in soil and groundwater remaining behind. A groundwater restoration time frame is given as 2 years, and a soil restoration time frame is given as 4 years, but the proposed method of treating soil and groundwater is likely to be ineffective on the high concentrations of contamination that will be left in place. Consequently, these alternatives are likely to be ineffective in achieving cleanup standards within a reasonable restoration timeframe. Considering the

foregoing, alternative BNP fails to meet the threshold requirement to protect human health and the environment, and otherwise fails to meet minimum requirements for cleanup based on the actions proposed in FMC.

Northeast Developed Zone (NEDZ) – Alternatives SW1, SW2, and PB1 propose to use natural attenuation in the NEDZ to reduce petroleum contamination in soil to concentrations that will achieve the groundwater cleanup level of 208 µg/L NWTPH-Dx at the river. These alternatives do not meet the minimum requirement to remove free product using normally accepted engineering practices. These alternatives do not meet the minimum requirement to treat or remove areas that are highly contaminated. These alternatives fail to meet Ecology's expectation that source control will be conducted to the maximum extent practicable prior to using natural attenuation. Failure to conduct such source control precludes natural attenuation from being considered an appropriate active cleanup measure. These alternatives fail to meet Ecology's expectation that active measures will be taken to prevent/minimize releases to surface water via groundwater discharge. These alternatives propose to meet the groundwater cleanup level of 208 µg/L NWTPH-Dx at the river, but contamination has not been shown to reach the river throughout the NEDZ (see e.g. RETEC, 2005, Figures 8-1, 8-2, and 8-5). The Feasibility Study indicates the restoration time frame is 0 years for groundwater, relying upon the conditional point of compliance to leave contaminated groundwater under the NEDZ because the groundwater is to achieve cleanup levels by natural attenuation by the time it reaches the conditional point of compliance. The Feasibility Study indicates the restoration time frame is 15 years for free product and 25 years for soil, but does not support this assertion. It has not been demonstrated that a reasonable rate of natural attenuation is occurring or is likely to occur for the high concentrations of petroleum-contaminated soil in the NEDZ zone, and natural attenuation alone is likely to be ineffective to reduce such high petroleum contamination — a consideration factor when assessing the restoration time frame. Consequently, these alternatives are likely to be ineffective in achieving cleanup standards within a reasonable restoration timeframe. Considering the foregoing, alternatives SW1, SW2, and PB1 fail to meet the threshold requirement to protect human health and the environment, and otherwise fail to meet minimum requirements for cleanup based on the actions proposed in the NEDZ.

Alternatives SW3, SW4, PB2 and PB3 propose to use enhanced bioremediation in the NEDZ to reduce petroleum contamination in soil to concentrations that will achieve the groundwater cleanup level of 208 µg/L NWTPH-Dx at the river. These alternatives indicate enhanced bioremediation will be used to reduce free product impacts, but free product will not be excavated. These alternatives therefore do not meet the minimum requirement to remove free product using normally accepted engineering practices. In addition, the enhanced bioremediation wells are to be located only along the hydraulically upgradient side of the NEDZ, at its boundary with the Railyard Zone (See RETEC 2005, Figures 8-3, 8-4, 8-6, and 8-7). Hence, these alternatives propose to use enhanced bioremediation to treat contaminated groundwater exiting the Railyard Zone, but do not propose enhanced bioremediation for contaminated soil and groundwater in the rest of the zone. Soil contamination remaining behind would continue to be a source of contamination to groundwater. Natural attenuation would be relied upon to treat the

soil and groundwater downgradient from the row of enhanced bioremediation wells along the upgradient boundary of the NEDZ.

While the petroleum composition in the NEDZ (diesel rather than Bunker-C) is more amenable to enhanced bioremediation, the Feasibility Study did not support that enhanced bioremediation would be effective on free product. These alternatives also fail to meet Ecology's expectation that source control will be conducted to the maximum extent practicable prior to using natural attenuation. Failure to conduct such source control precludes natural attenuation from being considered an appropriate active cleanup measure. These alternatives rely upon an off-property conditional point of compliance, but do not use AKART because known and reasonable treatment methods that are practicable can be implemented as proposed in other alternatives. Excavation of free product prior to installing enhanced bioremediation wells is considered a known and reasonable treatment method, and is proposed in other alternatives. These alternatives propose to meet the groundwater cleanup level of 208 µg/L NWTPH-Dx at the river, but contaminated groundwater reaches the Skykomish River only in some areas (see Figures 4 and 4A). The Feasibility Study indicates the restoration time frame is 0 years for groundwater, relying upon the conditional point of compliance to leave contaminated groundwater under the NEDZ, because the groundwater is to achieve cleanup levels by natural attenuation by the time it reaches the conditional point of compliance. The Feasibility Study indicates the restoration time frame is 4 years for free product and 15 years for soil, but does not support this assertion. It has not been demonstrated that enhanced bioremediation at BNSF's railyard facility property boundary combined with natural processes off of BNSF's railyard facility property will reduce the contaminant concentrations present in the NEDZ zone, a consideration factor when assessing the restoration time frame. Consequently, these alternatives are likely to be ineffective in achieving cleanup standards within a reasonable restoration timeframe. Considering the foregoing, alternatives SW3, SW4, PB2, and PB3 fail to meet the threshold requirement to protect human health and the environment, and otherwise fail to meet minimum requirements for cleanup based on the actions proposed in the NEDZ.

Alternatives PB4 and BNP propose to use excavation of free product and limited enhanced bioremediation in the NEDZ to reduce petroleum contamination in soil to concentrations that will achieve the groundwater cleanup level of 208 µg/L NWTPH-Dx at the river. These alternatives propose to meet the groundwater cleanup level of 208 µg/L NWTPH-Dx at the river, but contaminated groundwater reaches the Skykomish River only in some areas (see Figure 4). The enhanced bioremediation wells are to be located along the hydraulically upgradient side of the NEDZ, at its boundary with the Railyard Zone (See RETEC 2005, Figures 8-8 and 10-1). Hence, these alternatives propose to use enhanced bioremediation to treat contaminated water exiting the Railyard Zone, but do not propose enhanced bioremediation for contaminated soil and groundwater in the rest of the zone. Soil contamination remaining behind would contaminate groundwater. Natural attenuation would be relied upon to treat the soil and groundwater downgradient from the row of enhanced bioremediation wells along the upgradient boundary of the NEDZ, with the attendant failure to meet minimum cleanup requirements discussed in the preceding paragraph. The Feasibility Study indicates the

free product restoration time frame is 1 year for PB4 and BNP, and 8 years for soil, but does not support the assertion regarding biodegradation rates of soil after free product is excavated. It has not been demonstrated that natural processes will reduce the soil contaminant concentrations remaining in the NEDZ zone at a reasonable rate, a consideration factor when assessing the restoration time frame. The Feasibility Study indicates the groundwater restoration time frame is 8 years for PB4, assuming natural attenuation will reduce the groundwater contamination throughout the NEDZ to below the cleanup level within 8 years even given that petroleum-contaminated soil will remain throughout the site with concentrations up to free product levels. The Feasibility Study indicates the restoration time frame is 0 years for groundwater for BNP, relying upon the conditional point of compliance to leave contaminated groundwater under the NEDZ because the groundwater is to achieve cleanup levels by natural attenuation by the time it reaches the conditional point of compliance. Consequently, these alternatives are likely to be ineffective in achieving cleanup standards within a reasonable restoration timeframe. Considering the foregoing, Alternatives BNP and PB4 fail to meet the threshold requirement to protect human health and the environment, and otherwise fail to meet minimum requirements for cleanup based on the actions proposed in the NEDZ.

South Developed Zone (SDZ) – Alternatives SW1, SW2, and SW3 propose to remove free product and use natural attenuation in the SDZ to reduce petroleum contamination in soil to concentrations that will achieve the groundwater concentration protective of water in FMC, 208 µg/L NWTPH-Dx. These alternatives do not meet Ecology's requirement to treat or remove areas that are highly contaminated, because highly contaminated soil is to be left behind. These alternatives fail to meet Ecology's expectation that source control will be conducted to the maximum extent practicable prior to using natural attenuation. Failure to conduct such source control precludes natural attenuation from being considered an appropriate active cleanup measure. These alternatives rely upon an off-property conditional point of compliance, but do not use AKART because known and reasonable treatment methods that are practicable can be implemented as proposed in other alternatives. Restoration time frames are given as 1 year for free product, based on excavation; 0 years for groundwater, based upon a groundwater point of compliance at the river; and 15 years for soil. Natural attenuation has not been shown to be effective on soil contaminated with Bunker-C at this Site and is unlikely to be effective at the high concentrations proposed to remain after free product excavation. Consequently, these alternatives are likely to be ineffective in achieving cleanup standards within a reasonable restoration timeframe. Considering the foregoing, alternatives SW1, SW2, and SW3 fail to meet the threshold requirement to protect human health and the environment, and otherwise fail to meet minimum requirements for cleanup based on actions proposed in the SEDZ.

Northwest Developed Zone (NWDZ) – Alternatives SW1, SW2, SW3, and BNP propose to leave significant amounts of free product in the NWDZ. This does not meet the minimum requirement to remove free product using normally accepted engineering practices. All but SW1 propose to use natural attenuation without meeting Ecology's expectation that source control will be conducted to the maximum

extent practicable prior to using natural attenuation (and SW1 does not even propose to use natural attenuation). Failure to conduct such source control precludes natural attenuation from being considered an appropriate active cleanup measure. All fail to remove or treat soil with high Bunker-C concentrations, hence failing to meet Ecology's expectations on this point as well. In essence, these alternatives propose to leave free product, and highly contaminated soil and groundwater in the NWDZ to be managed in perpetuity. The restoration time frame for free product and soil contamination is indefinite, likely to exceed 100 years. Ecology does not consider this a reasonable restoration time frame for this Site. The groundwater restoration time frame is given as 0 years, but this depends upon a point of compliance at the river. The proposed alternatives do not meet AKART because known and reasonable treatment methods that are practicable can be implemented as proposed in other alternatives. Hence, these alternatives fail to meet the minimum requirement that AKART be used prior to establishing an off-property point of compliance. The existing barrier wall and skimming system relied upon by SW1 has been proven ineffective at the Site. For alternatives SW2 and BNP, the recovery trenches fail to remove or treat dissolved phase groundwater contamination, and are likely to be ineffective at recovering free product. The remaining high level contamination in the NWDZ will act as a continuing source of contamination to the river under all these alternatives, and natural attenuation is unlikely to be effective on this high level Bunker-C contamination. Consequently, these alternatives are likely to be ineffective in achieving cleanup standards within a reasonable restoration timeframe. Considering the foregoing, alternatives SW1, SW2, SW3 and BNP fail to meet the threshold requirement to protect human health and the environment, and otherwise fail to meet minimum requirements for cleanup based on actions proposed in the NWDZ.

Alternative SW4 proposes to excavate all free product, but leave significant amounts of soil with high Bunker-C concentrations in the NWDZ. Natural attenuation is then proposed to reduce petroleum concentrations. This does not meet Ecology's expectation that source control will be conducted to the maximum extent practicable prior to using natural attenuation. Failure to conduct such source control precludes natural attenuation from being considered an appropriate active cleanup measure. Alternative SW4 proposes to leave highly contaminated soil and groundwater in the NWDZ to be managed in perpetuity. The restoration time frame for soil contamination is indefinite, likely to exceed 100 years. The groundwater restoration time frame is given as 0 years, but this depends upon a conditional point of compliance at the river. However, the proposed alternatives do not meet AKART, as required for a conditional point of compliance, because known and reasonable treatment methods that are practicable can be implemented as proposed in other alternatives. The remaining high level contamination in the NWDZ will act as a continuing source of contamination to the river, and natural attenuation is unlikely to be effective on this high level contamination. Consequently, this alternative is likely to be ineffective in achieving cleanup standards within a reasonable restoration timeframe. Considering the foregoing, alternative SW4 fails to meet the threshold

requirement to protect human health and the environment and otherwise fails to meet minimum requirements for cleanup based on actions proposed in the NWDZ.

NWDZ cleanup actions for alternatives PB1, PB2, PB3, and PB4 have similar concerns to those for alternatives SW1, SW2, SW3, and SW4. All either leave free product behind, failing to meet the minimum requirement to remove free product using normally accepted engineering practices, or leave significant amounts of soil with high Bunker-C concentrations behind without sufficiently proven methods for addressing such ongoing sources of contamination. The alternatives propose to use enhanced bioremediation, but this has not been shown to be an effective technique for reducing the high level petroleum concentrations in soil and groundwater at this Site, particularly for the Bunker-C present in the NWDZ. Consequently, these alternatives are likely to be ineffective in achieving cleanup standards within a reasonable restoration timeframe. Restoration time frames for free product, groundwater, and soil are all indefinite for PB1. For PB2 and PB3, the restoration time frame is given as 1 year for free product, as it is to be excavated; for groundwater and soil, the restoration time frames are indefinite. PB4 has a 1 year restoration time frame for free product, as it is to be excavated; for groundwater and soil, the restoration time frames are given as 25 years. The 25-year restoration time frames are not supported by Feasibility Study investigations. Considering the foregoing, alternatives PB1, PB2, PB3, and PB4 fail to meet the threshold requirement to protect human health and the environment, and otherwise fail to meet minimum requirements for cleanup based on actions proposed in the NWDZ.

Railyard Zone – Railyard cleanup actions for alternatives SW1, SW2, SW3, SW4, PB1, PB2, PB3, PB4, and BNP all leave free product and highly contaminated soil on the Railyard indefinitely. They all propose to use various configurations of skimmer wells and recovery trenches and natural attenuation. However, none of these methods have been proven effective. As discussed previously neither the skimmer wells, recovery trenches or enhanced bioremediation have been proven effective as proposed, particularly with respect to the high concentrations of soil contamination proposed to remain in place and act as a source to groundwater. Because the free product containment measures, and groundwater treatment measures, are likely to be ineffective to prevent free product and high level groundwater contamination from migrating into the NWDZ, these actions on the railyard are likely to be ineffective for achieving site cleanup standards within a reasonable restoration timeframe. In addition, alternatives SW1, SW2, SW3, PB1, and PB2 fail to excavate surface petroleum impacts within two feet of the surface, failing to meet the regulatory requirement that contaminated soils must be contained. Considering the foregoing, alternatives SW1, SW2, SW3, SW4, PB1, PB2, PB3, PB4, and BNP fail to meet the threshold requirement to protect human health and the environment, and otherwise fail to meet minimum requirements for cleanup based on the actions proposed for the Railyard.

Summary of Initial Assessment – As summarized on Table 4, all alternatives presented in the Feasibility Study (RETEC, 2005) except PB5 and STD fail to meet

one or more cleanup requirements in several of the cleanup zones. Alternatives failed to meet cleanup requirements because they relied on technologies that are unproven and likely to be ineffective for reducing or eliminating the petroleum contamination at this Site within a reasonable restoration time frame.

The purported reason for this emphasis was to avoid short-term disruption to the town which would be caused by using the most effective and practicable remedial technology for the contamination at this Site — excavation. However, the Feasibility Study did not consider the long-term disruption caused by leaving contamination behind, particularly in off-property areas, which would have to be managed for generations.

In addition, these alternatives over-rely on institutional controls to protect human health and the environment. As discussed above under §5.2, institutional controls are particularly difficult to sustain in areas owned by multiple parties, particularly individual residential properties, small business properties, and properties owned by small local governments, and are likely to become less effective over the long-term. Many of the alternatives leave behind a great deal of high-level contamination that would have to be managed for generations – over a century or in perpetuity. Although Ecology has discretion to select a cleanup action that does rely in part on institutional controls in residential areas, Ecology does not believe the heavy reliance on institutional controls in these alternatives is appropriate at this Site.

Some of the Feasibility Alternatives failed to meet minimum requirements by a wide margin and some less so. Of the failing alternatives, alternative PB4 came the closest to meeting all regulatory requirements. Alternative PB4 failed to meet minimum requirements in the least number of cleanup action components, and the failing components themselves were closer to passing than the components addressing the same environmental issue for other alternatives. Ecology's review of the alternatives also indicated a large "gap" between Alternative PB4 and Alternative PB5. That is, actions in addition to PB4 are available that could be taken, which meet minimum requirements without costing as much as the PB5 alternative. Ecology consequently developed the Ecology alternative (ECY), which is summarized below and presented in Chapter 4, as the selected Site remedy on this basis.

ECY uses the following cleanup components to augment those in PB4 and provides an alternative that meets minimum regulatory requirements:

- In the FMC Zone, ECY excavates contaminated soil and sediment exceeding their respective cleanup levels. This reduces soil and sediment contamination to concentrations that are protective of groundwater. A buffer of soil with petroleum concentrations less than 3,400 mg/kg NWTPH-Dx in adjacent zones provides high likelihood that soil and groundwater petroleum concentrations remaining in these zones are low enough that, if necessary, they can be successfully treated by air-sparging, enhanced bioremediation, or

similar in place techniques at the conditional point of compliance within a reasonable restoration time frame.

- In the NEDZ, ECY excavates free product, as does PB4, but provides for a network of enhanced bioremediation wells in the portion of the zone where soil petroleum concentrations exceed 3,400 mg/kg NWTPH-Dx, instead of just at the hydraulically upgradient side of the zone at the Railyard boundary. It is anticipated that enhanced bioremediation will be able to reduce soil and groundwater petroleum concentrations to target remediation level and cleanup level concentrations, respectively, within a reasonable restoration time frame (10 years). This expectation, and hence the use of enhanced bioremediation for this zone rather than excavation, is based upon the greater biodegradability of the diesel composition of the petroleum in the NEDZ as compared to the Bunker-C composition of the petroleum in the other zones.

- In the NWDZ, ECY excavates soil to 3,400 mg/kg NWTPH-Dx (except under the school and potentially other properties), rather than only to 20,000 mg/kg NWTPH-Dx. This removes free product and high concentration soil that could act as a source to groundwater. It reduces soil contamination to concentrations that are likely to be protective of groundwater and, as a contingency, provides a high likelihood that remaining soil and groundwater petroleum concentrations can be successfully treated by air-sparging, enhanced bioremediation, or similar in place techniques at the conditional point of compliance within a reasonable restoration time frame, if necessary. This has the added advantage that restrictive covenants on individual properties will not be necessary. The additional excavation adds little to the volume that has to be excavated because the soil contamination concentration contours are very close in the NWDZ. (See Figure 4; the 2,000 mg/kg and the 20,000 mg/kg contours are close together in the NWDZ).

- In the Railyard Zone, ECY contains, controls, and treats free product and groundwater contamination with a robust hydraulic control and containment system at the BNSF railyard facility property boundary. Free product and contaminated groundwater will be contained with a barrier system. The barrier system must be capable of detecting leaks of free product that may occur anywhere along the length of the barrier system. The system is capable of re-circulating treated water through BNSF's railyard facility property to flush free product and contaminated groundwater to pumping stations where they can be routed to a treatment system. Groundwater flow can be controlled by pumping and re-injection wells. Limited excavation of smear- zone soil is performed in some free-product areas, and soil is excavated to provide a buffer zone of soil with petroleum concentrations less than the remediation level of 3,400 mg/kg NWTPH-Dx to protect FMC. Soil within two feet of the surface which is contaminated with metals, PCBs, or petroleum is excavated and replaced with clean soil.

Regulatory factors to consider when assessing whether the restoration time frame is reasonable include current and potential future use of the Site, surrounding areas, and associated resources. Alternative ECY recognizes the different uses of BNSF's railyard facility property versus the off-property area. BNSF's railyard facility property is dedicated to rail corridor uses and is owned by a single large corporate owner with an in-house environmental program to oversee its significant nationwide environmental liabilities. In contrast, the off-property area is a small town with multiple small property owners and a small-town local government, which impacts reliability that certain measures like institutional controls will be effective long-term. ECY adopts a cleanup action that will result in minimal long-term disruption to the town and its citizens. ECY avoids generations of Skykomish citizens having to deal with the significant and ongoing involvement that would come with living on highly-contaminated land. Conversely, ECY recognizes that BNSF Railway is much more capable of managing the high levels of contamination underlying BNSF's railyard facility property over a much longer time period.

In the next section, Alternatives ECY, PB5, and STD are assessed to determine which alternative uses cleanup actions that are permanent solutions to the maximum extent practicable using the disproportionate cost analysis test in the MTCA Cleanup Regulation. WAC 173-340-360(3).

PB4 was included in a portion of the analysis for comparison purposes, even though it does not meet all minimum requirements for cleanup actions. This was done because ECY was developed by enhancing cleanup actions in PB4 in order to develop an alternative that met all other minimum requirements.

5.4 Permanence Assessment of Alternatives ECY, PB5, and STD

Alternatives that meet all other minimum requirements for cleanup actions are assessed to determine which of them uses permanent solutions to the maximum extent practicable. WAC 173-340-360(3). This assessment is conducted by performing a disproportionate cost analysis. WAC 173-340-360(3)(e).

To conduct the disproportionate cost analysis the alternatives are ranked from most to least permanent. The most practicable permanent solution is the baseline cleanup action against which the other alternatives are compared. For the BNSF Skykomish Site, this is Alternative STD. Alternatives are compared by evaluating seven cost/benefit criteria: protectiveness, permanence, cost, effectiveness over the long-term, management of short-term risks, technical and administrative implementability, and consideration of public concerns. The regulation gives a general discussion of the types of factors to consider when evaluating each criterion. The relevance of the factors considered varies on a site-by-site basis.

When assessing criteria, the test used to evaluate which should be chosen is as follows:

> "**Test.** Costs are disproportionate to benefits if the incremental costs of the alternative over that of a lower cost alternative exceed the incremental degree of benefits achieved by the alternative over that of the other lower cost alternative." WAC 173-340-360(3)(e)(i).

The term disproportionate means that the degree of exceedance of incremental costs to incremental benefits must be substantial.

The MTCA Cleanup Regulation states,

> "The comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment. In particular, the department has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action. Where two or more alternatives are equal in benefits, the department shall select the less costly alternative provided the requirements of subsection (2) of this section are met." WAC 173-340-360(3)(3)(ii)(C).

Quantitative measures of costs and benefits, when made, must be made in units that are common among all alternatives so that the comparison can be meaningful. It is best if the units of costs and the units of benefits can be the same, such as dollars. This is rarely possible at environmental cleanup sites. Costs are estimated in dollars, but quantitative measures of benefits are usually only available in terms of mass or volume of contaminant removed or some other physical, non-monetary measure. This is the case at BNSF Skykomish. One quantitative measure of benefits that can be assessed is the measure of amount of contamination on the Site and the rate at which it would decline with time.

Where benefits cannot be quantified in common units they should be assessed qualitatively. The MTCA Regulation allows the agency to use best professional judgment to assess benefits qualitatively, and to use its discretion to favor or disfavor qualitative benefits.

At the BNSF Skykomish Site, quantitative data were developed to assess the amount of contamination on the Site and the rate at which it would decline with time for each of the SW and PB alternatives as well as BNP and STD. (RETEC, 2005, Figures 8-1 through 8-10 and 10-11 and supporting Excel workbook Remedial_Alt_Ranking_135_ft_june 20 2005 w stats.xls, worksheet Amt Left. Quantitative data were developed for cost for these alternatives (RETEC, 2005, Appendix N). The costs are given in Table 3. Similar data were developed by Ecology for Alternative ECY. (See Excel workbook Amount_Removed_10 and 100 years_4 Alts.xls)

The quantitative data were used in addition to qualitative considerations to assess protectiveness, permanence and cost at this Site, as discussed below. At the BNSF Skykomish Site, assessing the amount of contamination removed over time is, in the

agency's qualitative judgment, an appropriate comparison for this site in particular for protectiveness, permanence and cost. As discussed earlier, many of the containment measures proposed have not been proven to be effective to contain the high level contamination proposed to remain on the Site under other alternatives, and institutional controls also present problems in particular at this Site for ensuring the remedy is effective and protective in the long-term.

The other disproportionate cost analysis factors were assessed purely in a qualitative manner.

Ecology considers long-term effectiveness of the cleanup technologies as a significant factor at this Site, and has carefully considered it qualitatively in selecting the alternative to be implemented. Short-term risks and technical and administrative implementability are less important in selecting an alternative for this Site, because each alternative can be more easily modified to reduce short-term risk and improve implementability, but the same is not true for long-term effectiveness. Public concerns are also carefully considered in how the selected remedy will be implemented.

The assessment of the disproportionate cost criteria is as follows.

Cost – Costs to implement each alternative are taken from the cost estimates discussed above. Costs for the alternatives presented in the feasibility study (RETEC, 2005) are summarized in Table 3 (see bottom row, *Total Cost*). The estimated cost of alternative ECY is $44 million.

Amounts removed – The amounts removed for Alternatives PB4, PB5, and STD were taken from the feasibility study (RETEC, 2005, Remedial_Alt_Ranking_135_ft_june 20 2005 w stats.xls, worksheet Amt Left).

The amount of petroleum removed by ECY was estimated: (1) by increasing the amount of petroleum removed from soil by alternative PB4 by the amount removed from the NWDZ by excavating the additional soil with petroleum concentrations between 3,400 and 20,000 mg/kg petroleum concentrations; (2) by increasing the amount of petroleum removed from soil from the NEDZ by air-sparging in 10 years and natural attenuation over the next 90 years; and (3) by increasing the petroleum amount removed by ECY by excavating additional smear zone soil on the Railyard in addition to that excavated in PB4. The air-sparging and natural attenuation effectiveness presented in the feasibility study (RETEC, 2005) were used for the diesel in the NEDZ (75% reduction in 10 years and 75% reduction in 100 years for air-sparging and natural attenuation, respectively). (See Excel workbook Amount_Removed_10 and 100 years_4 Alts.xls, worksheet Adds)

Protectiveness – Protectiveness is evaluated by considering the overall protectiveness of human health and the environment, including the degree to which risk is reduced at a facility and the time to achieve that reduction. For the BNSF Skykomish Site, protectiveness was assessed by plotting the amount of contamination removed from the Site by the most active cleanup activities. The most active cleanup activities will occur

in the first ten years of the cleanup (and most excavation within the first three or four years). Data regarding the amount of petroleum removed from the Site during the first 10 years were plotted against cost. Both the amount removed and the cost were first normalized so that a unitless relative benefit – protectiveness – was compared against a unitless relative cost. The normalization process was done as follows:

> **Consider** that the four alternatives each have an associated cost, C_{PB4}, C_{ECY}, C_{PB5}, C_{STD}. Let COST represent the entire set of the four costs, C_{PB4} … C_{STD}. Then the normalized cost of, say C_{ECY} is:
>
> Normalized C_{ECY} = [C_{ECY} – Min(COST)] / [Max(COST) – Min(COST)]
>
> Where Min is the minimum value of COST and Max is the Maximum value of COST.
>
> **Consider** that the four alternatives each have an associated amount removed, AR_{PB4}, AR_{ECY} , AR_{PB5}, AR_{STD}. Let AMT represent the entire set of the four amounts removed, AR_{PB4} … AR_{STD}. Then the normalized amount removed of, say AR_{ECY} is:
>
> Normalized AR_{ECY} = [AR_{ECY} – Min(AMT] / [Max(AMT) – Min(AMT)]

The cost normalization calculates the fraction cost increase for each alternative compared to the total cost difference between PB4 and STD. Hence, PB4 costs 0.00 times the cost difference between PB4 and STD. STD costs 1.00 times the cost difference between PB4 and STD. The normalization of the amount removed is the same. By doing this, the slope of the line connecting the alternatives can be compared to a 1:1 slope to assess whether the incremental change in cost as a percentage of total cost difference is greater than or less than the incremental change in amount removed as a percentage of total amount removed difference. (See Excel workbook Amount_Removed_10 and 100 years_4 Alts.xls, worksheet Data)

Figure 12 shows the results of this calculation. The "10 Years" line represents Protectiveness of each alternative. A series of lines with a 1:1 slope is included on the graph. Where the slope of the "10 years" curve is shallower than the 1:1 slope, the relative amount removed (benefit) decreases more rapidly than relative cost decreases when moving from more permanent to less permanent alternatives.

The baseline for comparison to assess permanence to the maximum extent practicable is STD, which is the only permanent remedy evaluated in the Feasibility Study. Comparing the next most permanent remedy, PB5, it is apparent that when moving from STD to PB5 the incremental cost decreases much more rapidly than the benefit decreases. That is, the incremental cost of STD over PB5 is much greater than – i.e., is disproportionate to – the incremental benefit gained by choosing STD over PB5. Hence, PB5 is preferred to STD.

Comparing PB5 to ECY, the incremental benefit lost in going from PB5 to ECY is greater than the incremental cost savings. That is the incremental cost of PB5 is less than

the incremental benefit of PB5 when compared to ECY. Hence, PB5 is the remedy that is permanent to the maximum extent practicable with regard to Protectiveness.

It should also be noted, for comparative purposes, that the incremental cost of ECY compared to PB4 is about the same as the incremental benefit gained by removing more contamination. Hence, the incremental cost increase is not disproportionate to the incremental benefit increase. This finding is consistent with the distribution of petroleum on-site. Referring to Figure 4, the petroleum distribution in the NWDZ is such that the 3,400 mg/kg concentration contour, which is the limit of excavation for ECY, is close to the 20,000 mg/kg concentration contour, which is the limit of excavation for PB4. Hence, it takes little extra excavation to remove the soil with petroleum concentrations between 3,400 and 20,000 mg/kg. This is more significant than the graph indicates. Removing this concentration range removes all soil with petroleum exceeding the concentration protective of direct contact (3,400 mg/kg NWTPH-Dx) from the NWDZ. This both better protects human health and avoids deed covenants to restrict activities that might result in a direct contact exposure. Avoiding deed covenants that restrict property use is a significant public concern. The additional excavation on the Railyard excavates free product, which removes the greatest amount of petroleum per cubic yard of excavation. Excavation of free product has the benefit of removing the highest concentration and most mobile petroleum on the site.

Moreover, part of the cost increase from PB4 to ECY is due to the installation of a robust hydraulic containment and control system along BNSF's railyard facility property boundary to treat groundwater. The quantitative analysis does not capture this groundwater cleanup (nor the groundwater cleanup to be conducted in the NEDZ), as it considers only the amount of petroleum removed by soil cleanup. Because groundwater becomes contaminated by much smaller masses of petroleum than soil, the mass removed by cleaning up groundwater is not significant when compared to the mass removed by cleaning up soil, especially by excavation. However, the environmental benefit gained is great. The regulation supports protection of off-property potable groundwater resources. The amount of free product which will be recovered by the hydraulic control and containment system is difficult to estimate and also is not included in this quantitative analysis. Its recovery offers significant environmental benefits as it is the source of ongoing soil contamination and contamination dissolved in groundwater. In Ecology's professional qualitative judgment, the benefit gained under ECY from groundwater protection of ECY outweighs the incremental cost when comparing ECY to PB4. This is not surprising; one of the reasons PB4 does not meet minimum requirements (and cannot be selected in any case) is because it fails to adequately treat contaminated groundwater exiting the railyard and hence fails to use all practicable methods of treatment when proposing a conditional point of compliance.

ECY would be selected over PB4 even if PB4 met all other minimum regulatory requirements.

Permanence – Permanence was evaluated in a similar manner, but using the data for amount of contamination removed in 100 years as the benefit. The "100 Years" line on

Figure 12 shows PB5 preferred over both STD and ECY. The incremental cost of PB5 declines much more rapidly (slope >> 1) than the incremental benefit lost when compared to STD, so PB5 is preferred over STD. The incremental cost of PB5 declines less rapidly than the incremental benefit lost when compared to ECY (slope << 1), so PB5 is preferred over ECY. Hence, PB5 is the remedy that is permanent to the maximum extent practicable with regard to Protectiveness.

It should also be noted, for comparative purposes, that the incremental benefit of ECY compared to PB4 is greater than the incremental cost. That is, ECY would be selected over PB4 even if PB4 met all other minimum regulatory requirements.

Effectiveness Over the Long Term – While the relative effectiveness of the various cleanup technologies is fairly clear, it is difficult to quantify. Excavation achieves defined results in a definite time frame. Enhanced bioremediation has both uncertain results and an uncertain time frame, and natural attenuation even more so. Both natural attenuation and enhanced bioremediation can be effective at low concentrations, but are unlikely to be effective at high concentrations, although both are more effective on the diesel contamination than on the Bunker-C contamination. Institutional controls to manage contamination remaining on-site over time vary greatly in effectiveness depending upon the type of control and the type of area where controls are applied. Institutional controls such as groundwater restrictions that can be implemented through long-standing government programs are among the more effective such controls, while placing restrictive covenants on multiple residential, small business, and small local government properties are of limited short-term effectiveness and are generally ineffective in the long term. Given such considerations at this Site in particular, Ecology believes that institutional controls to restrict access to soil are likely to be much more effective on BNSF's railyard facility property than on properties in other ownership. Hence, much longer restoration time frames can be considered for BNSF's railyard facility property.

From the standpoint of Alternatives STD, PB5, and ECY, STD achieves a permanent cleanup by excavating all soil exceeding the petroleum cleanup level of 22 mg/kg NWTPH-Dx. However, this includes excavation of a great deal of low concentration soil, soil with concentrations between 22 mg/kg NWTPH-Dx and 2,000 mg/kg NWTPH-Dx. Such concentrations do not pose a risk to residents via direct contact or air inhalation. Instead, the only risk at these levels may be that the soil acts as a continuing source of contamination to groundwater. Yet it is not certain that excavating this soil is necessary to achieve groundwater protection. Groundwater monitoring can be used to assess whether leaving this range of soil concentration behind is protective of groundwater. If it is not, as a contingency, enhanced bioremediation of groundwater will be performed. Enhanced bioremediation of groundwater has a much higher chance of working providing higher concentration soil has been excavated.

Because STD costs $88 million to implement, but may be overly conservative, Ecology believes the choice for the selected remedy is between alternatives PB5 and ECY. Ecology believes not all costs are represented by the cost estimates for the alternatives,

$44 million for ECY and $57 million for PB5. The main difference between these two alternatives is that PB5 requires removal of BNSF's mainline tracks and excavation beneath them and ECY does not. BNSF has expressed serious concerns about the impact of PB5 on railroad operations, and this qualitative "cost" is not reflected in the Feasibility Study's cost estimate for PB5. Therefore, Ecology has chosen ECY as the remedy that is permanent to the maximum extent practicable with regard to long-term effectiveness.

Consideration of Short-Term Risks, Implementability, and Public Concerns

In developing ECY, consideration was given to short-term risk, implementability, and public concerns. The following sections discuss how these concerns were incorporated into ECY.

Management of Short-Term Risks and Technical and Administrative Implementability – In the agency's qualitative judgment, short-term risks and technical and administrative implementability are less important in selecting an alternative for this Site, because each alternative can be more easily modified to reduce short-term risk and improve implementability, but the same is not true for long-term effectiveness. Cleanup actions will involve routine construction-type activities. Mitigation measures of associated health and safety risks are well-developed for such construction activities.

There are three primary concerns regarding implementability: (1) Excavation will require moving buildings. Although the techniques for moving buildings are well-established by firms specializing in this industry, moving the school poses much higher risks to the buildings integrity because the school is a masonry building. Therefore, Alternative ECY provides for using other techniques for cleaning up contamination under the school. (2) The three mainline tracks on the Railyard are one of BNSF's primary rail corridors. Closing them would cause disruption to BNSF's business. Therefore, Alternative ECY provides for using remedies for cleaning up contamination under BNSF's railyard facility property that will not close down the BNSF mainline. (3) Administering institutional controls in off-property areas under multiple ownership is one of the more administratively difficult aspects of site cleanup. This is particularly true when the institutional controls must be in place for a long time. Alternative ECY minimizes the need for institutional controls, particularly restrictive covenants, in off-property areas.

One of the primary implementation issues for ECY is the potential for individual property owners to choose not to allow excavation of their property, which will usually entail moving structures and dislocation of the residents for some months. This is not unique to ECY. Many of the alternatives presented in the Feasibility Study, including PB4, PB5, and STD share this concern. As stated in several places above, in such cases, it will be made clear to each property owner that they will have contamination remaining on their property and that it will be their responsibility to manage. When the interim action to clean up the Levee and portions of the NWDZ was conducted, all property owners allowed excavation to occur on their property. This entailed moving five houses.

Ecology believes this concern is valid, but can be dealt with on a case-by-case basis during the design phase of the cleanup.

Consideration of Public Concerns – Ecology has worked extensively with the community, and continues to do so, with the objective of learning what the public concerns are and addressing them. The community of Skykomish is both concerned that their community be cleaned up and about the short-term disruption it will cause. Many comments have been along the lines of, "... just get on with it, but don't impact us more than once." Ecology will continue to consider public concerns by implementing the cleanup in a community-based manner as described in the next chapter. All cleanup work will be discussed with the Town of Skykomish (the local government entity) and in public meetings. Cleanup of individual properties will be discussed with each owner on a one-to-one basis and agreements drawn up for the work to be done, how the homeowner will be compensated for costs associated directly with the cleanup work such as temporary relocation, and how the property will be restored after cleanup is complete.

5.5 Selected Remedy

Ecology's selected remedy for the BNSF Skykomish Site is ECY, presented in Chapter 4. This selection was made after careful review and consideration of all of the remedy selection requirements prescribed in the MTCA Cleanup Regulation, using the information and remedy alternatives presented in the Feasibility Study (RETEC, 2005) as well as of information developed by Ecology independently. It was developed after evaluating the strengths and shortcomings of the remedies presented in the Feasibility Study. Alternative ECY meets minimum regulatory requirements, and provides a better balance among using effective cleanup techniques (such as excavation), short-term and long-term disruption to residents of Skykomish, and cost, than the FS alternatives that meet minimum requirements (PB5 and STD).

The disproportionate cost analyses indicated that PB5 is the remedy that is permanent to the maximum extent practicable with respect to Protectiveness and Permanence. Consideration of the long-term effectiveness of using cleanup technologies presented in the FS at locations on the Site where each technique has the highest chance of being effective at this Site indicates ECY is the remedy that is permanent to the maximum extent practicable with respect to long-term effectiveness.

In Ecology's qualitative judgment, the analysis of Protectiveness and Permanence is informative, but does not capture some considerations better captured in the assessment of long-term effectiveness, as discussed above. Overall, the incremental cost of PB5 with respect to ECY is considered disproportionate to the incremental benefit gained due to BNSF's concerns about the impact of implementing PB5 on rail operations as discussed above.

The estimated cost for ECY is $44 million. This represents a $44 million dollar savings over STD ($88 million). ECY provides most of the benefits of a permanent remedy (STD) at about 50% of the cost.

Chapter 6 - Implementation of the Cleanup Action

6.1 Community-Based Cleanup: Integrating Community Concerns

Ecology, BNSF, and the Town of Skykomish are coordinating to ensure that the cleanup is community-based. In doing so, implementation of the cleanup action will recognize the current and the future socio-economic conditions that exist in the Town of Skykomish as well as those to which the Town aspires. To the degree possible, this cleanup will reflect the values of the Skykomish community and integrate and reflect their vision for their Town both now and in the future. Toward this end, the cleanup will be structured and undertaken in such a manner that furthers this vision and also provides for property owners to be responsible and accountable for their own properties by being provided certain choices for how the cleanup is implemented on their individual properties, as outlined below. Also toward this end, the cleanup will be coordinated with construction of the Skykomish community wastewater system to realize cost savings, efficiencies, and permitting and review of regulatory requirements.

Coupled with the Town's *Vision for Skykomish* (August 2005), and in consideration that the majority of the Town's infrastructure will need to be restored, the State is providing funding for a permanent waste water treatment system for the Town. This effort by the State reflects the unique nature of this Site and the cleanup, the responsibilities of BNSF under the state's cleanup law, and the current socio-economic condition of the Town. Further, this effort imbues a principle of partnership by which the State and the Town will work together to enable the cleanup to be successful and the community and its citizens to move forward.

The community-based cleanup will:

- Require the integration of property-specific cleanup decisions during each phase of cleanup.
- Require negotiation of fair and equitable access agreements between property owners and BNSF.
- Provide for the temporary relocation of residents and structures prior to and during cleanup. After relocation and upon completion of the cleanup and construction of the Skykomish community wastewater system, the Town will connect the pre-existing structures of each property owner who relocated to the community system free of a connection charge, subject to terms and conditions established for the community wastewater system by Town ordinance. (The property owner will be required to pay monthly sewer charges and meet other requirements set forth in the sewer code and rate structures established by the Town Council.)

The community-based cleanup approach was used to develop the communication tools and activities in the Public Participation Plan, Exhibit F of this Consent Decree.

The cleanup decisions by individual property owners will be critical in how this cleanup is undertaken and the future liability for cleanup and management of contamination by property owners and BNSF. Some property owners will be asked to relocate temporarily to allow for excavation under homes and other buildings. Such property owners will have the choice to relocate or not to relocate. For property owners who elect to move forward with the relocation, each property owner and BNSF will negotiate a fair and equitable access agreement that will outline and provide for necessary arrangements and relocation expense. If a property owner agrees in concept to relocate but is unable to reach agreement with BNSF on relocation terms, Ecology will make available mediation services to facilitate agreement being reached. Ecology also plans to make mediation services available in case relocation issues arise during cleanup implementation.

All residences and commercial buildings that are to be temporarily relocated, as well as any property disturbances made to conduct the cleanup, are to be restored to pre-existing conditions according to agreements made with each property owner. Current building and septic/wastewater code requirements are to be followed during all restoration work. If necessary, prior to the availability of community wastewater system infrastructure, temporary replacement septic systems will be installed by BNSF until the community wastewater system becomes available. Should construction of the collection and conveyance portion of the Town's wastewater system become available, BNSF may reach an agreement with the Town to use this system as an alternative to installing individual temporary systems provided that BNSF is responsible for all associated costs and operations of the temporary system until a fully completed and approved wastewater system is available. Such operations would include effluent conveyance, treatment and disposal.

During restoration work, BNSF shall coordinate the installation of wastewater infrastructure with the Town of Skykomish such that construction of the community wastewater system and connection of remediated properties to the system are done in the least disruptive and most efficient manner. This coordination shall ensure that any temporary septic systems installed prior to completion of the Town's wastewater system can be easily connected to the community system or reconfigured as necessary with minimal disruption and cost to the Town or the property owner.

During restoration of each residential or commercial property upon which there is a pre-existing structure, and upon which remediation resulted in relocation of the structure or removal of the pre-existing onsite septic system, BNSF shall provide all tanks, sewer lines, pumps, valves, vaults, power lines, electrical panels and connections, and any other residential or commercial appurtenances specified by the Town (including but not limited to grease traps or other pre-treatment facilities for commercial connections) for those pre-existing structures. It is intended that the Town of Skykomish will provide all wastewater collection, conveyance, treatment and disposal facilities downstream of check and shut-off valves on the effluent pipeline. These valves will be located at or near the property boundary as specified by the Town of Skykomish. If the Town determines that it is most-effective or technically advantageous to combine the tanks of more than one property in the public right of way, or to locate a single tank within the public right of

way, BNSF will provide all wastewater facilities and equipment located upstream of the check valve between the tank and the community wastewater collection pipeline.

After relocation and upon completion of the cleanup and construction of the Skykomish community wastewater system, the Town will connect the pre-existing structures of each property owner who relocated to the community system free of a connection charge, subject to terms and conditions established for the community wastewater system by Town ordinance. (The property owner will be required to pay monthly sewer charges and meet other requirements set forth in the sewer code and rate structures established by the Town Council.)

Property owners who choose not to relocate will still be required to provide access to their properties to allow cleanup actions to occur around existing residences or buildings, and must agree to record a restrictive covenant on their property. Access will be subject to fair and equitable terms in an access agreement negotiated with BNSF. If a property owner agrees in concept to provide access but is unable to reach agreement on specific terms with BNSF, Ecology will make available mediation services to facilitate agreement being reached. Ecology also plans to make mediation services available in case access issues arise during cleanup implementation. However, because contamination will remain on such properties, such access will be regulatorily required to allow for cleanup actions that are necessary to contain and control the contamination that will remain, avoid recontamination of adjoining properties to the extent feasible, and ensure the effectiveness and protectiveness of the cleanup. Containment structures are anticipated to be impermeable walls installed in the subsurface inside the perimeter of the property that isolate the contamination under the property and limit its movement; ancillary facilities to capture contamination may also be associated with such installations. Design will be on a case-by-case basis.

Restrictive covenants will also be regulatorily required for those properties where the owner chooses not to relocate and free product and/or high level contamination (above 3400 mg/kg NWTPH-Dx in soil) will remain after cleanup. The restrictive covenant serves as a means to notify future owners of the presence of contamination, of the need to maintain containment structures, and of the restrictions placed on use of the property. Since these properties will not be fully-excavated, restoration will only be to the extent necessary after installation of the containment structures. Moreover, since cleanup of the property will not occur, and because the cleanup construction activities and waste water treatment system construction activities will be closely coordinated, there will be no provision for using any public funding for connecting to the community waste water treatment system for that property. Operation and maintenance of containment structures will be the responsibility of BNSF.

In addition to property owners who are asked to temporarily relocate to make excavation of contaminated soil possible, there may be significant impacts to adjacent properties due to construction activities. Such property owners adjacent to the area of active construction may choose to request temporary relocation from Ecology. Such property owners should contact Ecology and BNSF representatives to discuss their concerns and

need to temporarily relocate. Ecology will carefully consider their concerns on a case-by-case basis and direct BNSF to take appropriate measures to mitigate construction impacts on such property owners. Such mitigation may include temporary relocation.

Finally, in order to further the integration of cleanup activities with installation of a community waste water treatment system, BNSF shall grant a reasonable and customary easement for sewage lines through BNSF property, subject to reasonable terms.

6.2 Schedule

Cleanup of the BNSF Skykomish Site will proceed in phases over a number of years. A schedule of due dates for the documents which control the work is presented in Exhibit C of the Consent Decree. The phased cleanup schedule is shown on Figure 13. This figure shows the areas to be cleaned up and the Work Year in which the most active construction in each area will begin. Planning will start the year before, and some construction activities (i.e., landscaping, final surface improvements) may occur in the following year. Pre- excavation explorations, discussions with stakeholders, results of confirmation sampling during construction, and time necessary to obtain access agreements may result in modification of some of the excavation boundaries shown on Figure 13. A summary of the activities by Work Year is as follows:

- 2008 – Construction of project-duration soil handling facility on the railyard. Begin excavation of NWDZ east of fifth street and along Railroad Avenue. Begin installation of hydraulic control and containment system along northern railyard boundary. Excavation of portion of NEDZ along Railroad Avenue. Excavation of metals in the NEDZ. Installation of air-sparging system to treat contaminated soil and groundwater in NEDZ.
- 2009 – Continue excavation of NWDZ. Extension of hydraulic control and containment system along northern railyard boundary if not completed in 2008. Excavation of petroleum and metals contaminated soil within 2 feet of the surface on the railyard (may be rescheduled, but will be completed by 2012).
- 2010 – Complete excavation of NWDZ and begin excavation or treatment beneath the school. Excavation of SDZ and part of FMC and installation of hydraulic control and containment system at FMC, if necessary. Complete FMC excavation. Cleanup around south abutment of Fifth Street Bridge (this work may be moved to 2011 and is subject to coordination with the Washington State Department of Transportation) and obtaining the permits to perform in-water work around the bridge.
- 2011 – Complete excavation of NWDZ. Complete school cleanup if not completed in 2010. Cleanup of the south abutment of the Fifth Street Skykomish Bridge if not performed in 2010. Any work not completed in prior years and dismantling of active cleanup operations. It is anticipated that the final surface improvements such as final sidewalks and final street driving surfaces will be completed this year.

- 2012 and following – Operation and maintenance of installed systems. Compliance monitoring. Excavation of additional smear and vadose zone soil within BNSF's railyard facility property boundary as necessary to reach a total of 7,500 cubic yards.

A number of follow-on documents are necessary for each phase of work and required by regulation. These include engineering design reports, construction plans and specifications, operation and maintenance plans, permits and substantive permit requirements, compliance monitoring plans; and as-built reports. Figure 14 summarizes the main follow-on documents. The *Groundwater Monitoring Plan* dated May 12, 2005, will be incorporated into the site-wide compliance monitoring plans. Plans may be combined as appropriate. Each plan is to be submitted to Ecology for review and approval. A detailed list of deliverables and schedule must be developed and approved by Ecology for each phase of the work.

Mitigating measures described in the Final Environmental Impact Statement (Ecology 2007) are to be incorporated in the engineering design report or other appropriate deliverables specified in Exhibit C of the Consent Decree.

Investigations to define the distribution of contamination in further detail have been ongoing at the Site during 2007. The results of this work will be summarized in the 2008 Engineering Design Report. This includes the following investigations:

- Former Maloney Creek Zone – This investigation will provide additional data to define the extent of TPH contamination in the former Maloney Creek Zone soil and sediment. In addition, the investigation will include preparation of a detailed topographic survey of the Former Maloney Creek zone including definition of the wetland boundaries and ordinary high water mark.

- South Developed Zone - This investigation will provide additional data to define the extent of soil contamination in the south developed zone.

- Northwest Developed Zone – This investigation will provide additional data to define the north, west and east boundaries of the free product plume and soil with TPH concentrations exceeding the remediation level (3,400 mg/kg NWTPH-Dx). These data will allow the extent of excavation to be more fully defined so that the impacts to properties in that zone can be predicted with more certainty.

- Northeast Developed Zone – This investigation will provide additional data to define the extent of free product and soil exceeding 30,000 mg/kg NWTPH-DX in the Northeast Developed Zone to the north of the railyard; this will better define the area that will require excavation during cleanup. This investigation will also provide additional data to define the extent of soil to the north of the railyard with TPH concentrations above the remediation level (3,400 mg/kg NWTPH-Dx); this will better define the area that will require air sparging.

- Fifth Street Skykomish Bridge South Abutment – This investigation will provide additional data to define the extent of petroleum hydrocarbons in the vicinity of

the south bridge abutment. The extent of TPH exceeding the remediation level (3,400 mg/kg NWTPH-Dx) and the cleanup level (22 mg./kg NWTPH-Dx), as appropriate, will be better defined to allow cleanup of the area in the immediate vicinity of the south bridge abutment to be designed. This investigation will be conducted when the river flow is at the seasonal low to allow drilling beneath the bridge.

- Railyard – This investigation will provide additional data to define the extent of lead and arsenic exceeding cleanup levels in soil within two feet of the ground surface on the east side of the railyard (in the 'Y"). Data from this investigation will supplement soil data from the RI and Supplemental RI and be used to assess whether shallow soil will require excavation in the investigation area.

Work plans for the following special design investigations will be included in the Engineering Design Report for 2008 work:

- Hotel Structural Survey – A survey will be conducted to evaluate whether the structural condition of the hotel will permit moving it or supporting it so that work can occur beneath it. A draft report of the survey results is due on October 30, 2009, subject to gaining access to the hotel. The report will include subsequent work to be done in either the case the hotel can be moved or supported or the case that it cannot. The final report will be due no later than December 31, 2009.

- Hydraulic Control and Containment System – Investigations and studies will be conducted to design the hydraulic control and containment system. The investigations and studies will include, but are not limited to, design, installation, operation, and maintenance of the groundwater interception trench; the barrier system capable of detecting leaks of free product that may occur anywhere along the length of the barrier system.; groundwater pumping rates and volumes necessary to maintain hydraulic control and containment of both free product and dissolved contamination; water treatment requirements; water re-injection rates, volumes, and locations; surface water discharge rates, volumes, and locations; groundwater elevation and quality monitoring (including free product monitoring); means of optimizing system performance; and any other parameters necessary to fully design, operate, maintain, and assess the performance of the hydraulic control and containment system. The draft report is due December 5, 2007. The final report is due no later than January 15, 2008.

- School Alternatives Evaluation Work Plan – An investigation will be required to assess how to clean up contamination beneath the school to the degree technically possible. The results of this investigation will be documented in a School Alternatives Evaluation Report. The report will evaluate means of thermally treating the contamination beneath the school in terms of the requirements for implementing thermal treatment and the impact of such implementation on school operations. The report may consider other technologies in addition to thermal treatment. Other technologies will be compared to thermal treatment in terms of

amount of contamination mobilized and removed, the degree of immobilization of contamination remaining after treatment, the time to perform the treatment, the impact of the treatment on school operations, mitigation of impacts on school operations, and any other criteria which arise from discussion among Ecology, the School Board, and BNSF during the development of the work plan for the investigation. Comparative physical testing will be required unless otherwise approved by Ecology. Comparative physical testing must include testing of thermal treatment unless otherwise approved by Ecology. Comparative physical testing also must be performed on other treatment technologies still under consideration after literature research to provide data to permit comparison of other treatment technologies with thermal treatment.

A draft work plan for the School Alternatives Evaluation is due September 30, 2007. The final School Alternatives Evaluation work plan is due November 30, 2007. A draft technology review report and work plan for comparative physical testing is due by January 31, 2008; the final technology review report and comparative physical testing work plan is due March 31, 2008. Comparative physical testing is anticipated to take about one year. A draft school comparative physical testing study report is due on April 1, 2009. The final comparative physical testing report is due May 1, 2009. A draft school alternatives evaluation report is due on June 1, 2009. The final school alternatives evaluation report is due on July 1, 2009. See Exhibit C.

In addition, the following two reports are required:

- FMC Wetlands Special Design Report – This report will specify the design of the wetlands to be constructed after cleanup of FMC. The final report will be due no later than June 30, 2008. There may be separate Special Design Reports for the "east" and "west" FMC wetland areas.

- Bridge Coordination Report – This report will provide sufficient design basis to begin coordination of cleanup around the south abutment of the Fifth Street Bridge with the Washington State Department of Transportation. The final report will be due no later than June 30, 2009.

As noted in Section 4.1, restrictive covenants and groundwater withdrawal restrictions will be required in certain areas and circumstances for the various cleanup zones. The covenants and groundwater withdrawal restrictions are to be developed as part of the Engineering Design Report for each phase of the work.

Each deliverable must be submitted in hard copy and electronic format. Ecology will specify the number of hard copies for each deliverable. In general, electronic submittals will be in Adobe Acrobat, Excel, Access, or AutoCAD format, as appropriate, or as otherwise specified by Ecology. Electronic formats appropriate for use in geographic information systems databases may also be required.

All submittals must follow the requirements of WAC 173-340-840, General Submittal Requirements.

6.3 Financial Assurances

Financial assurances shall be provided in accordance with Section XXII, Financial Assurances of the Consent Decree.

6.4 Overburden Management

Overburden soil is soil above the smear zone. Overburden soil with petroleum concentrations less than the 3,400 mg/kg NWTPH-Dx may be managed on site, but Ecology will leave the final decision to BNSF. However, soil within two feet of final grade must meet the petroleum cleanup level of 1,870 mg/kg NWTPH-Dx. This is to ensure soil petroleum concentrations are protective of soil biota in the near surface. In addition, backfill placed on the three properties whose owners did not approve a conditional point of compliance must have petroleum concentrations less than 22 mg/kg NWTPH-Dx, unless property owners approve a higher concentration.

Soil with dioxin/furan concentrations exceeding 6.67 ng/kg Total Toxicity Equivalent Concentration will be sent to an off-site disposal facility permitted to handle such waste. In no case will soil with arsenic concentrations exceeding 20 mg/kg, lead concentrations exceeding 250 mg/kg, PCB concentrations exceeding 0.65 mg/kg, or dioxin/furan concentrations exceeding 6.67 ng/kg Total Toxicity Equivalent Concentration be managed on-site. Calculation of dioxin/furan concentrations is to be done as specified in WAC 173-340-708(8)(d).

BNSF should consider the following in making this decision:

- Adequate sampling will be required to ensure overburden petroleum concentrations do not exceed the specified concentrations before being excavated and stockpiled. A sampling plan must be part of the engineering design documents.
- Overburden to be reused on-site must be kept separated from soil with petroleum concentrations exceeding the specified concentrations. The system for ensuring that mixing does not occur must be robust and a tracking system must be part of the engineering design documents.
- The replacement of overburden soil containing petroleum will add to the mass of petroleum remaining on site and increase the chance that more extensive future actions would be required as a result of confirmational monitoring. There is a risk that these soil concentrations may influence attainment of the groundwater remediation and surface water cleanup levels. Therefore, placement of these soils needs to be tracked.

Chapter 7 - References

ARGUS PACIFIC, 2007, *Air Remediation Criteria for BNSF Workers on the Rail Yard in Skykomish, Washington*: memorandum from Elisabeth Black of ARGUS PACIFIC to Halah Voges of The RETEC Group, Inc., dated April 12, 2007.

Assistant Chief Engineer, 1930, Letter from Assistant Chief Engineer to H. C. Satthias, Attorney for Western Washington, September 8, 1930, #1525.

Burgunder, 1930, Letter from Robert M. Burgunder, Prosecuting Attorney to Charles S. Albert, Attorney, December 22, 1930.

Ecology, 2007, *Final Environmental Impact Statement, BNSF Railway Former Maintenance and Fueling Facility, Skykomish, Washington: Washington State Department of Ecology, Bellevue, Washington.*

Ecology, 1995 (updated 2003), *Sediment Sampling and Analysis Plan Appendix: Guidance on the Development of Sediment Sampling and Analysis Plans Meeting the Requirements of the Sediment Management Standards* — Chapter 173-204 WAC: Prepared for the Washington Department of Ecology, Olympia, WA, by PTI Environmental Services, Bellevue, WA.

Game Commission for King County, 1926, Letter from W. J. Lunn, Chairman of the Game Commission to J. H. O'Neill, General Manager, Great Northern Railroad, February 9, 1926.

RETEC, 2007, *Development of air remediation level for Railyard Zone*: memorandum from Halah Voges of The RETEC Group, Inc. to Louise Bardy of Washington State Department of Ecology dated April 2, 2007.

RETEC, 2006, *Engineering Design Report – Levee Zone Interim Action for Cleanup*: The RETEC Group, Inc., Seattle, Washington, May 3, 2006.

RETEC, 2005, *Final Feasibility Study, Former Maintenance and Fueling Facility, Skykomish, Washington*: The RETEC Group, Inc., Seattle, Washington, March 15, 2005.

RETEC, 2002, *Supplemental Remedial Investigation: BSNF Former Maintenance and Fueling Facility, Skykomish, Washington*: The RETEC Group, Inc., Seattle, Washington, July 12, 2002.

RETEC, 1996, *Remedial Investigation for the Former Maintenance and Fueling Facility in Skykomish, Washington*: Remediation Technologies, Inc., Seattle, Washington, January, 1996.

Table 1: Summary of Cleanup Levels, Remediation Levels, and Points of Compliance.

Environmental Medium	Level Type	Chemical	Concen-tration	Point of Compliance
Surface Water	Cleanup	Petroleum	208 µg/L NWTPH-Dx and absence of sheen or free product	The point at which contaminated groundwater is released to the Skykomish River and Former Maloney Creek channel.
Sediment	Cleanup	Petroleum	40.9 mg/kg or "pass" of bioassay	Skykomish River: Sediment riverward of the OHWM, to a depth of 10 feet. Former Maloney Creek: Within the creek channel as delineated by the OHWM or the wetland boundary, to a depth of 4 feet.
Sediment	Cleanup	Dioxin/Furan	To be developed if necessary	Throughout the site to a depth of 15 feet.
Groundwater	Cleanup	Petroleum	208 µg/L NWTPH-Dx and absence of sheen or free product	Surface water boundary where contaminated groundwater enters surface water, that is, at the points where groundwater enters the Skykomish River and Former Maloney Creek. In the NEDZ, contaminated groundwater reaches the Skykomish River only in some areas; in the NEDZ, the groundwater point of compliance is the groundwater concentration contour for 208 µg/L. See Figure 4.
Groundwater	Remediation	Petroleum	477 µg/L NWTPH-Dx and absence of sheen or free product	From BNSF's railyard facility property boundary to the cleanup level point of compliance.
Soil	Cleanup	Petroleum	22 mg/kg NWTPH-Dx	Throughout the site to any depth.
Soil	Remediation	Petroleum	30,000 mg/kg NWTPH-Dx and no evidence of free product flowing into or accumulating in an excavation	Everywhere on site except within BNSF's railyard facility property boundary.
Soil	Remediation	Petroleum	Specified smear and vadose zone soil volume.	Selected areas on BNSF's railyard facility property.
Soil	Remediation	Petroleum	3,400 mg/kg NWTPH-Dx	Off the portion of the railyard owned by BNSF to any depth, except within 25 feet south of the OHWM of the Skykomish River and within 25 feet of the channel of Former Maloney Creek as delineated by the OHWM or the wetland boundary, where the cleanup level of 22 mg/kg NWTPH-Dx must be met to a depth of 4 feet.
Soil	Remediation	Petroleum	1,870 mg/kg NWTPH-Dx	Soil within two feet of the surface.
Soil	Cleanup	Arsenic	20 mg/kg	Throughout the site to a depth of 15 feet.
Soil	Cleanup	Lead	250 mg/kg	Throughout the site to a depth of 15 feet.
Soil	Cleanup	PCB	0.65 mg/kg	Throughout the site to a depth of 15 feet.
Soil	Cleanup	Dioxin/Furan	6.67 ng/kg Total Toxicity Equiva-lent Concentration	Throughout the site to a depth of 15 feet.
Air	Cleanup	Petroleum	1,346 µg/m^3 APH	Indoor and ambient air throughout the site outside of the BNSF facility property boundary.
Air	Cleanup	Petroleum	2,944 µg/m^3 APH	Indoor and ambient air throughout the site within the BNSF facility property boundary.

Table 2: Summary of Cleanup Actions.

	LEVEE	NWDZ	NEDZ	SDZ	FMC	RY
PETROLEUM CUL	40.9 mg/kg/bioassay sediment 22 mg/kg soil 208 µg/L GW & SW	22 mg/kg soil 208 µg/L and absence of sheen or free product GW	22 mg/kg soil 208 µg/L and absence of sheen or free product GW	22 mg/kg soil 208 µg/L and absence of sheen or free product GW	40.9 mg/kg/bioassay sediment 22 mg/kg soil 208 µg/L and absence of sheen or free product GW & SW	22 mg/kg soil 208 µg/L and absence of sheen or free product GW & SW
PETROLEUM REL	3,400 mg/kg soil below levee more than 25 feet south of OHWM	3,400 mg/kg soil 477 µg/L and absence of sheen or free product GW	30,000 mg/kg NWTPH-Dx and no evidence of free product flowing into or accumulating in an excavation 3,400 mg/kg soil 477 µg/L GW 208 µg/L GW entering FMC Zone.	3,400 mg/kg soil 477 µg/L and absence of sheen or free product GW	3,400 mg/kg soil	Excavate specified volumes of smear and vadose zone soil 1,870 mg/kg soil in top two feet 477 µg/L and absence of sheen or free product GW at BNSF's railyard facility property boundary
CLEANUP ACTION	Remove/reconstruct levee Habitat restoration	Excavate soil to 3,400 mg/kg, except under school if thermal treatment is implemented Remove lead[1] and arsenic[2] contaminated soils Isolation/control under school, other buildings if necessary Vapor protection Aggressive treatment or excavate to 3,400 mg/kg beneath school	Excavate free product and soil exceeding 30,000 mg/kg NWTPHDx Remove lead contaminated soils Air sparge and biovent to 3,400 mg/kg soil, 477 µg/L GW throughout zone, 208 µg/L GW at conditional point of compliance Isolation/control under buildings if necessary Vapor protection	Excavate soil to 3,400 mg/kg, 22 mg/kg within 25 feet of FMC to depth of 10 feet Isolation/control under buildings if necessary Vapor protection	Excavate sediment to 40.9 mg/kg and soil to 22 mg/kg Restore wetland and fish habitat Vapor protection	Groundwater control, containment, and treatment, if necessary, at BNSF's railyard facility property boundary or any functional gates to protect GW beneath town to 477 µg/L and GW entering FMC Zone to 208 µg/L Excavate two southern and far east free product areas in association with hydraulic controls and containment system installation. Excavate soil with petroleum concentrations exceeding 22 mg/kg NWTPH-Dx within 25 feet of FMC to depth of 4 feet and 3,400 mg/kg NWTPHDx within 25 feet of FMC below a depth of 4 feet. Excavate metals, PCB, shallow petroleum. Excavate 7,500 cubic yards of smear and vadose zone soil in selected areas within 20 years after effective date of consent decree Vapor protection

Notes:
CUL = Cleanup Level
REL = Remediation Level
GW = Groundwater
SW = Stormwater
[1]Arsenic cleanup level = 20 mg/kg
[2]Lead cleanup level = 250 mg/kg

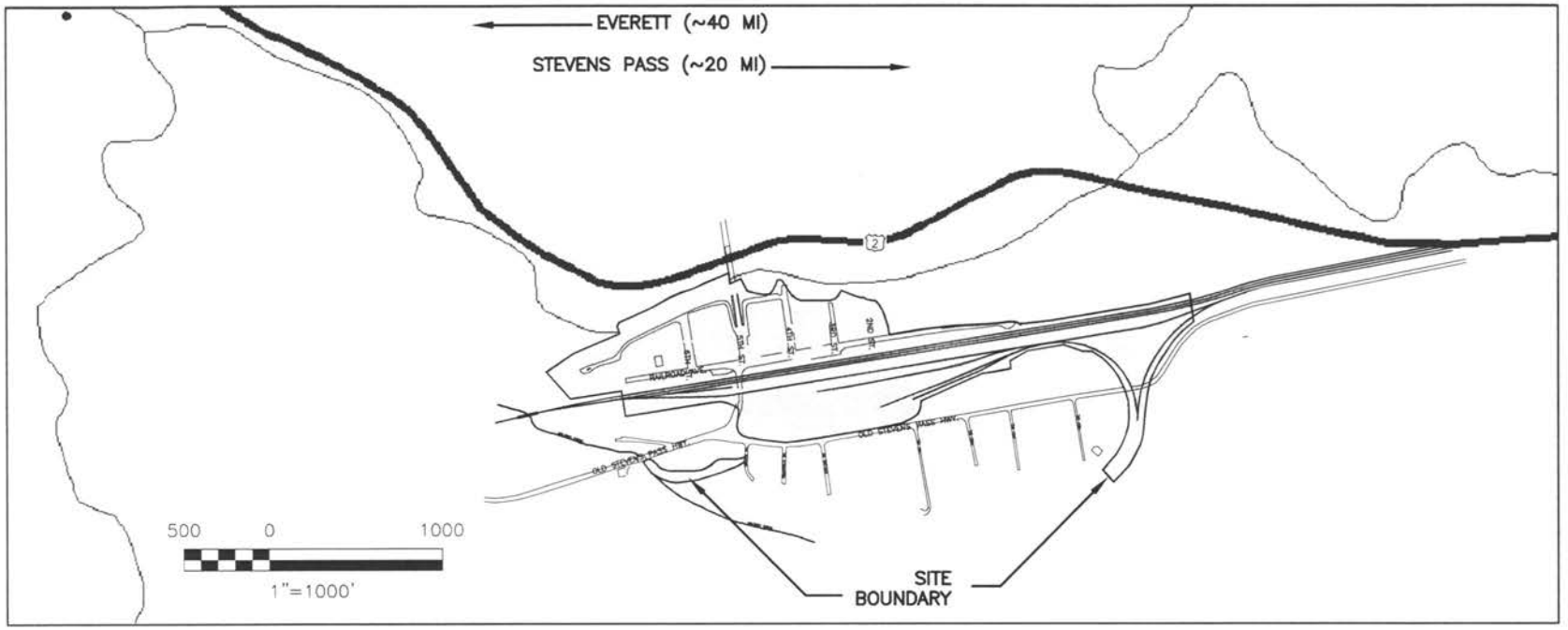
Table 3: Summary of Remedial Alternatives Considered in the Feasibility Study (From Retec, 2005, Table 8-3)

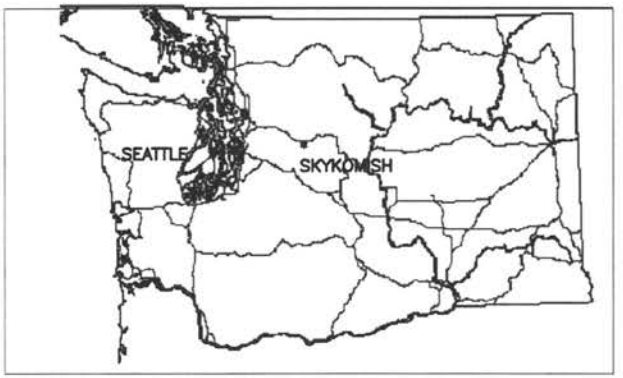
	SW1	SW2	SW3	SW4	PB1	PB2	PB3	PB4	PB5	STD	BNP
Levee	Boom Maintenance	Boom Maintenance	Excavate to soil RL (free product)	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL	Boom Maintenance	Excavate to soil RL (free product)	Excavation to soil RL (3,400 mg/kg Dx)/gw CUL	Excavation to soil RL (3,400 mg/kg Dx)/gw CUL	Excavate to soil RL (2,000 mg/kg Dx)/gw CUL	Excavate to CUL (22 mg/kg Dx)	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL
	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)			
			Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)		Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)	Remove Surface Sediment to CUL (bioassay)
Cost	$1,000,000	$1,000,000	$2,230,000	$4,190,000	$1,000,000	$2,230,000	$4,190,000	$4,190,000	$3,510,000	$3,940,000	$3,390,700
Fmr Maloney Creek	Natural Attenuation to gw RL (477 ug/L EPH/VPH)	Natural Attenuation to gw RL (477 ug/L EPH/VPH)	Natural Attenuation to gw RL (477 ug/L EPH/VPH)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)	Natural Attenuation to gw CUL (208 ug/L EPH/VPH)	Natural Attenuation to gw CUL (208 ug/L EPH/VPH)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)	Excavate to soil RL (2,000 mg/kg Dx)/gw CUL	Excavate to CUL (22 mg/kg Dx)	Excavate to soil RL (free product) at 2-A-B-8 and in former channel
				Remove surface sediment to RL (no damage to wetland trees)			Remove surface sediment to RL (no damage to wetland trees)	Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH) Remove surface sediment to RL (no damage to wetland trees)
Cost	$420,000	$420,000	$420,000	$1,060,000	$420,000	$420,000	$1,060,000	$1,480,000	$2,160,000	$2,600,000	$1,740,000
NE Developed Zone	Natural Attenuation to gw CUL (208 ug/L EPH/VPH at river)	Natural Attenuation to gw CUL (208 ug/L EPH/VPH at river)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH at river)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH at river)	Natural Attenuation to gw CUL (208 ug/L EPH/VPH at river)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH at river)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH at river)	Excavate to soil RL (free product) plus Enhanced Bio to gw CUL (208 ug/L EPH/VPH)	Excavate to soil RL (2,000 mg/kg Dx)/gw CUL	Excavate to CUL (22 mg/kg Dx)	Excavate to soil RL (free product) plus Enhanced Bio to gw CUL (208 ug/L EPH/VPH)
Cost	$420,000	$420,000	$600,000	$600,000	$420,000	$600,000	$600,000	$1,220,000	$3,910,000	$8,910,000	$1,220,000
South Developed Zone	Excavate to soil RL (free product) plus natural attenuation to gw RL (477 ug/L EPH/VPH)	Excavate to soil RL (free product) plus natural attenuation to gw RL (477 ug/L EPH/VPH)	Excavate to soil RL (free product) plus natural attenuation to gw RL (477 ug/L EPH/VPH)	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL	Excavate to soil RL (2,000 mg/kg Dx)/gw CUL	Excavate to CUL (22 mg/kg Dx)	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL
	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs
Cost	$520,000	$520,000	$520,000	$650,000	$650,000	$650,000	$650,000	$650,000	$700,000	$2,830,000	$650,000
NW Developed Zone	Existing Barrier Wall and Skimming System	Free product recovery trenches where accessible plus natural attenuation & inst controls	Excavate to soil RL (free product where accessible) plus natural attenuation & inst controls	Excavate to soil RL (free product) plus natural attenuation & institional controls	Excavate to soil RL (free product were accessible) plus enhanced bio to gw CUL (208 ug/L EPH/VPH) & inst controls	Excavate to soil RL (free product) plus enhanced bio to gw CUL (208 ug/L EPH/VPH) & inst controls	Excavate to soil RL (free product) plus enhanced bio to gw CUL (208 ug/L EPH/VPH) & inst controls	Excavation to soil RL (20,000 mg/kg) plus enhanced bio to gw CUL (208 ug/L EPH/VPH) & inst controls	Excavate to soil RL (2,000 mg/kg Dx)/gw CUL	Excavate to CUL (22 mg/kg Dx)	Excavate to soil RL (3,400 mg/kg Dx) to 135 feet from the river, free product recovery trenches elsewhere, natural attenuation & inst controls
	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL
				Excavate shallow smear zone where accessible to soil RL (3,400 mg/kg Dx)			Excavate shallow smear zone where accessible to soil RL (3,400 mg/kg Dx)	Excavate shallow smear zone where accessible to soil RL (3,400 mg/kg Dx)			
Cost	$990,000	$4,090,000	$6,780,000	$11,850,000	$7,350,000	$11,700,000	$12,730,000	$24,050,000	$23,830,000	$36,220,000	$9,210,000
Railyard	Free product recovery skimming at property boundary and natural attenuation	Free product recovery trenches at property bdry, skim free product interior areas, and natural attenuation	Free product recovery trenches at property bdry, skim free product interior areas, and natural attenuation	Free product recovery trenches at property bdry, skim free product interior areas, and natural attenuation	Free product recovery trenches at property bdry, skim free product interior areas, and natural attenuation to gw CUL (208 ug/L EPH/VPH)	Free Product Recovery trenches at all plumes, plus enhanced bio at property boundary to gw CUL (208 ug/L EPH/VPH)	Free Product Recovery trenches at all plumes, plus enhanced bio at property boundary to gw CUL (208 ug/L EPH/VPH)	Excav. 2 S'em, trenches at 2 N/western and eastern free product areas, enhanced bio. at property boundary to gw CUL (208 ug/L EPH/VPH)	Excavate to soil RL (2,000 mg/kg Dx)/gw CUL	Excavate to CUL (22 mg/kg Dx)	Free product recovery trenches at property boundary and natural attenuation
	Excavate surface metals impacts to RL (CUL to 2 feet)	Excavate surface metals impacts to RL (CUL to 2 feet)	Excavate surface metals impacts to RL (CUL to 2 feet)	Excavate surface metals impacts to RL (CUL to 2 feet) & TPH to RLs (2,700 mg/kg Dx to 2 feet)	Excavate surface metals impacts (2 feet) to CULs	Excavate surface metals impacts (2 feet) to CULs	Excavate surface metals impacts to RL (CUL to 2 feet) & TPH to RLs (2,700 mg/kg Dx to 2 feet)	Excavate surface metals impacts to RL (CUL to 2 feet) & TPH to RLs (2,700 mg/kg Dx to 2 feet)	Excavate surface metals impacts to RL (CUL to 2 feet) & TPH to RLs (2,700 mg/kg Dx to 2 feet)	Excavate surface metals impacts to RL (CUL to 2 feet) & TPH to RLs (2,700 mg/kg Dx to 2 feet)	Excavate surface metals impacts to RL (CUL to 2 feet) & TPH to RLs (2,700 mg/kg Dx to 2 feet)
Cost	$1,960,000	$3,660,000	$3,660,000	$4,380,000	$3,660,000	$4,130,000	$4,880,000	$4,840,000	$22,430,000	$33,190,000	$3,980,000
Long Term Monitoring	$524,000	$524,000	$524,000	$524,000	$524,000	$524,000	$524,000	$524,000	$524,000	$0	$524,000
TOTAL COST	$5,834,000	$10,634,000	$14,734,000	$23,254,000	$14,024,000	$20,254,000	$24,634,000	$36,954,000	$57,064,000	$87,690,000	$20,714,700

Table 4: Initial Assessment of Feasibility Study Alternatives (X = Fails to meet one or more minimum requirements)

	SW1	SW2	SW3	SW4	PB1	PB2	PB3	PB4	PB5	STD	BNP
Levee	Boom Maintenance X	Boom Maintenance X	Excavate to soil RL (free product) X	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL	Boom Maintenance X	Excavate to soil RL (free product) X	Excavation to soil RL (3,400 mg/kg Dx)/gw CUL	Excavation to soil RL (3,400 mg/kg Dx)/gw CUL	Excavate to soil RL (2,000 mg/kg Dx)/gw CUL	Excavate to CUL (22 mg/kg Dx)	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL
	Enhanced Bio to gw CUL (208 ug/L EPH/VPH) X	Enhanced Bio to gw CUL (208 ug/L EPH/VPH) X	Enhanced Bio to gw CUL (208 ug/L EPH/VPH) X	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH) X	Enhanced Bio to gw CUL (208 ug/L EPH/VPH) X	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH)			
			Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)		Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)	Remove Surface Sediment to CUL (bioassay)
Cost	$1,000,000	$1,000,000	$2,230,000	$4,190,000	$1,000,000	$2,230,000	$4,190,000	$4,190,000	$3,510,000	$3,940,000	$3,390,700
Fmr Maloney Creek	Natural Attenuation to gw RL (477 ug/L EPH/VPH) X	Natural Attenuation to gw RL (477 ug/L EPH/VPH) X	Natural Attenuation to gw RL (477 ug/L EPH/VPH) X	Enhanced Bio to gw CUL (208 ug/L EPH/VPH) X	Natural Attenuation to gw CUL (208 ug/L EPH/VPH) X	Natural Attenuation to gw CUL (208 ug/L EPH/VPH) X	Enhanced Bio to gw CUL (208 ug/L EPH/VPH) X	Enhanced Bio to gw CUL (208 ug/L EPH/VPH) X	Excavate to soil RL (2,000 mg/kg Dx)/gw CUL	Excavate to CUL (22 mg/kg Dx)	Excavate to soil RL (free product) at 2-A-B-8 and in former channel
	X	X	X	Remove surface sediment to RL (no damage to wetland trees) X	X	X	Remove surface sediment to RL (no damage to wetland trees)	Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)	Remove surface sediment to CUL (bioassay)	Enhanced Bio to gw CUL (208 ug/L EPH/VPH) X Remove surface sediment to RL (no damage to wetland trees)
Cost	$420,000	$420,000	$420,000	$1,060,000	$420,000	$420,000	$1,060,000	$1,480,000	$2,160,000	$2,600,000	$1,740,000
NE Developed Zone	Natural Attenuation to gw CUL (208 ug/L EPH/VPH at river) X	Natural Attenuation to gw CUL (208 ug/L EPH/VPH at river) X	Enhanced Bio to gw CUL (208 ug/L EPH/VPH at river) X	Enhanced Bio to gw CUL (208 ug/L EPH/VPH at river) X	Natural Attenuation to gw CUL (208 ug/L EPH/VPH at river) X	Enhanced Bio to gw CUL (208 ug/L EPH/VPH at river) X	Enhanced Bio to gw CUL (208 ug/L EPH/VPH at river) X	Excavate to soil RL (free product) plus Enhanced Bio to gw CUL (208 ug/L EPH/VPH) X	Excavate to soil RL (2,000 mg/kg Dx)/gw CUL	Excavate to CUL (22 mg/kg Dx)	Excavate to soil RL (free product) plus Enhanced Bio to gw CUL (208 ug/L EPH/VPH) X
Cost	$420,000	$420,000	$600,000	$600,000	$420,000	$600,000	$600,000	$1,220,000	$3,910,000	$8,910,000	$1,220,000
South Developed Zone	Excavate to soil RL (free product) plus natural attenuation to gw RL (477 ug/L EPH/VPH) X	Excavate to soil RL (free product) plus natural attenuation to gw RL (477 ug/L EPH/VPH) X	Excavate to soil RL (free product) plus natural attenuation to gw RL (477 ug/L EPH/VPH) X	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL	Excavate to soil RL (2,000 mg/kg Dx)/gw CUL	Excavate to CUL (22 mg/kg Dx)	Excavate to soil RL (3,400 mg/kg Dx)/gw CUL
	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs	Excavate surface soil to CULs
Cost	$520,000	$520,000	$520,000	$650,000	$650,000	$650,000	$650,000	$650,000	$700,000	$2,830,000	$650,000
NW Developed Zone	Existing Barrier Wall and Skimming System X	Free product recovery trenches where accessible plus natural attenuation & inst controls	Excavate to soil RL (free product where accessible) plus natural attenuation & inst controls	Excavate to soil RL (free product) plus natural attenuation & institional controls	Excavate to soil RL (free product were accessible) plus enhanced bio to gw CUL (208 ug/L EPH/VPH) & inst controls X	Excavate to soil RL (free product) plus enhanced bio to gw CUL (208 ug/L EPH/VPH) & inst controls X	Excavate to soil RL (free product) plus enhanced bio to gw CUL (208 ug/L EPH/VPH) & inst controls X	Excavation to soil RL (20,000 mg/kg) plus enhanced bio to gw CUL (208 ug/L EPH/VPH) & inst controls X	Excavate to soil RL (2,000 mg/kg Dx)/gw CUL	Excavate to CUL (22 mg/kg Dx)	Excavate to soil RL (3,400 mg/kg Dx) to 135 feet from the river, free product recovery trenches X elsewhere, natural attenuation & inst controls
	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL	Excavate surface metals to CUL
	X	X	X	Excavate shallow smear zone where accessible to soil RL (3,400 mg/kg Dx)	X	X	Excavate shallow smear zone where accessible to soil RL (3,400 mg/kg Dx)	Excavate shallow smear zone where accessible to soil RL (3,400 mg/kg Dx)			X
Cost	$990,000	$4,090,000	$6,780,000	$11,850,000	$7,350,000	$11,700,000	$12,730,000	$24,050,000	$23,830,000	$36,220,000	$9,210,000
Railyard	Free product recovery skimming at property boundary and natural attenuation X	Free product recovery trenches at property bdry, skim free product interior areas, and natural attenuation X	Free product recovery trenches at property bdry, skim free product interior areas, and natural attenuation X	Free product recovery trenches at property bdry, skim free product interior areas, and natural attenuation X	Free product recovery trenches at property bdry, skim free product interior areas, and natural attenuation to gw CUL (208 ug/L EPH/VPH) X	Free Product Recovery trenches at all plumes, plus enhanced bio at property boundary to gw CUL (208 ug/L EPH/VPH) X	Free Product Recovery trenches at all plumes, plus enhanced bio at property boundary to gw CUL (208 ug/L EPH/VPH) X	Excav. 2 S'em, trenches at 2 N/western and eastern free product areas, enhanced bio. at property boundary to gw CUL (208 ug/L EPH/VPH) X	Excavate to soil RL (2,000 mg/kg Dx)/gw CUL	Excavate to CUL (22 mg/kg Dx)	Free product recovery trenches at property boundary and natural attenuation X
	Excavate surface metals impacts to RL (CUL to 2 feet) X	Excavate surface metals impacts to RL (CUL to 2 feet) X	Excavate surface metals impacts to RL (CUL to 2 feet) X	Excavate surface metals impacts to RL (CUL to 2 feet) & TPH to RLs (2,700 mg/kg Dx to 2 feet)	Excavate surface metals impacts (2 feet) to CULs X	Excavate surface metals impacts (2 feet) to CULs X	Excavate surface metals impacts to RL (CUL to 2 feet) & TPH to RLs (2,700 mg/kg Dx to 2 feet)	Excavate surface metals impacts to RL (CUL to 2 feet) & TPH to RLs (2,700 mg/kg Dx to 2 feet)	Excavate surface metals impacts to RL (CUL to 2 feet) & TPH to RLs (2,700 mg/kg Dx to 2 feet)	Excavate surface metals impacts to RL (CUL to 2 feet) & TPH to RLs (2,700 mg/kg Dx to 2 feet)	Excavate surface metals impacts to RL (CUL to 2 feet) & TPH to RLs (2,700 mg/kg Dx to 2 feet)
Cost	$1,960,000	$3,660,000	$3,660,000	$4,380,000	$3,660,000	$4,130,000	$4,880,000	$4,840,000	$22,430,000	$33,190,000	$3,980,000
Long Term Monitoring	$524,000	$524,000	$524,000	$524,000	$524,000	$524,000	$524,000	$524,000	$524,000	$0	$524,000
TOTAL COST	$5,834,000	$10,634,000	$14,734,000	$23,254,000	$14,024,000	$20,254,000	$24,634,000	$36,954,000	$57,064,000	$87,690,000	$20,714,700

File: H:\16423\ECOLOGY\6-4-07\FIG_1-SITE_LOCATION.dwg Layout: FIG 1 User: emarshall Plotted: Jun 04, 2007 - 4:28pm Xref's:





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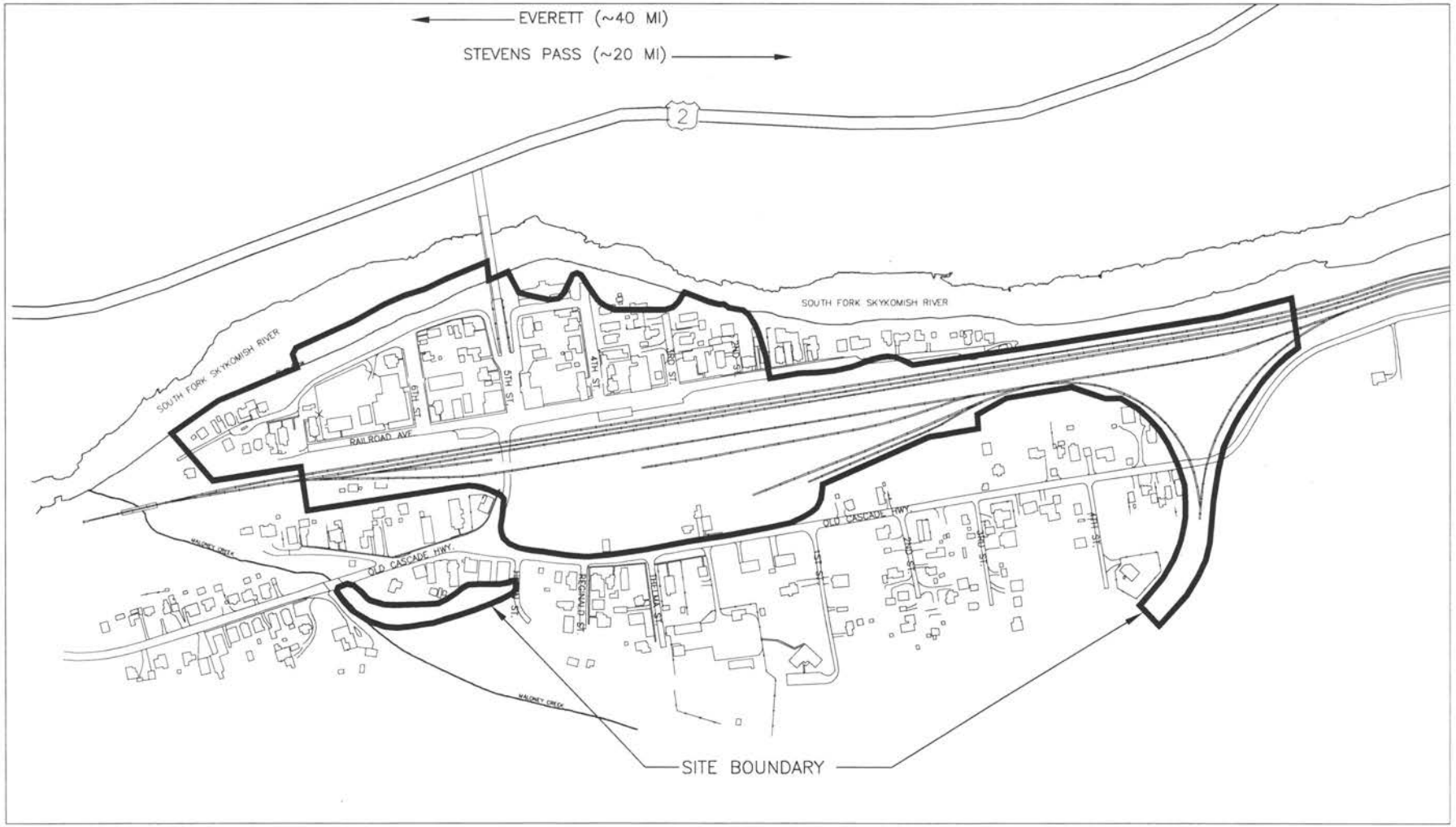
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BNSF RAILWAY SITE
SKYKOMISH, WA

SITE LOCATION MAP

DATE: 6/5/07 | DRWN: | | | FIGURE 1

File: H:\16423\ECOLOGY\6-4-07\FIG_2-TOWN_STREET.dwg Layout: ANSI_A1-CP User: emarshall Plotted: Jun 04, 2007 - 4:31pm Xref's:



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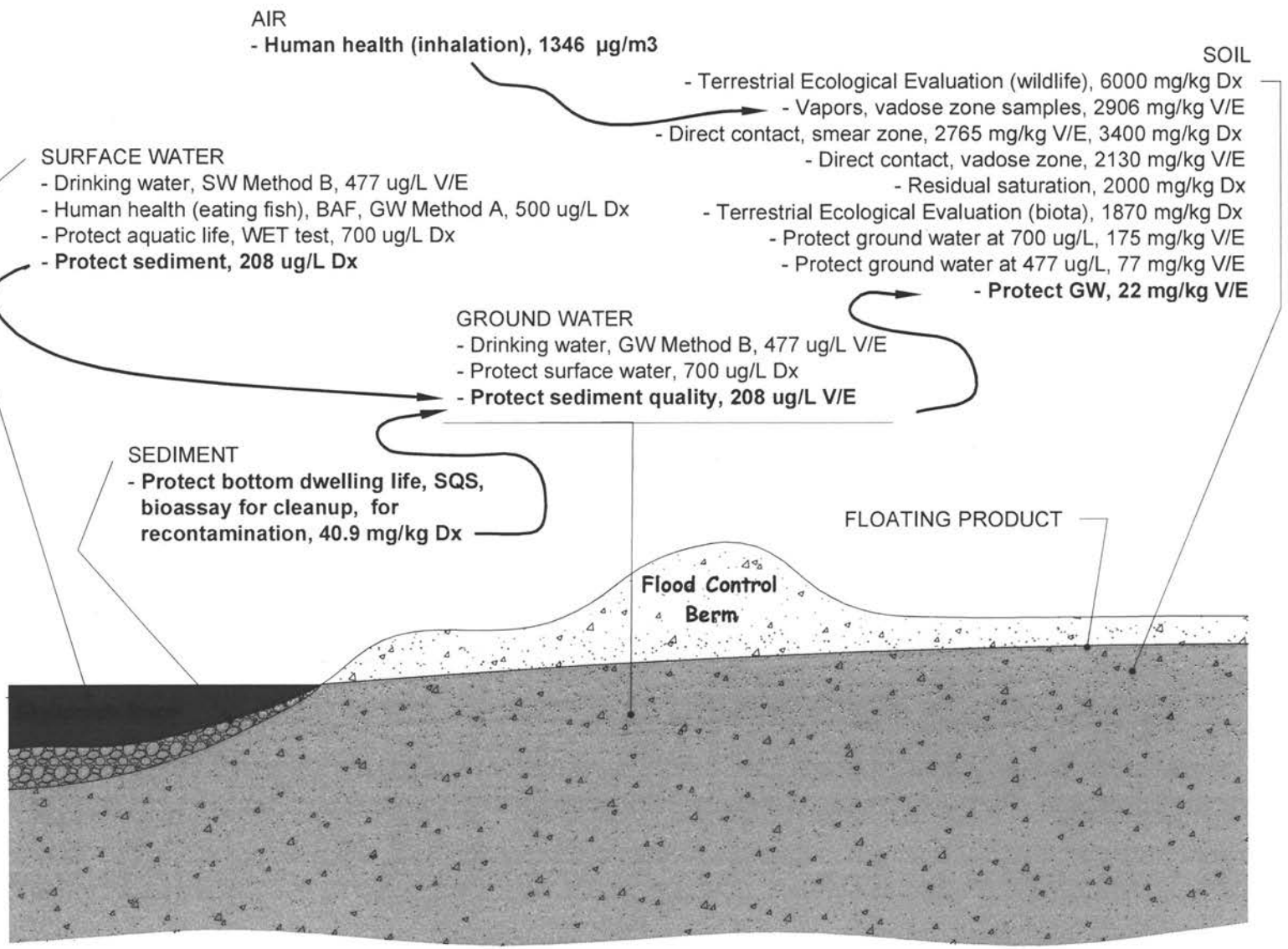
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250 0 500

1"=500'

BNSF RAILWAY SITE SKYKOMISH, WA			TOWN STREET PLAN
DATE: 6/4/07	DRWN:		FIGURE 2

File: H:\16423\ECOLOGY\6-4-07\FIG_3-PETROLEUM_CLEANUP.dwg Layout: FIG 3 User: emarshall Plotted: Jun 04, 2007 - 4:32pm Xref's:



Notes: SW = Surface Water, GW = Ground Water, BAF = Bioaccumulation Factor, WET = Whole Effluent Toxicity, SQS = Sediment Quality Standards, Dx = NWTPH-Dx method, V/E = VPH/EPH method

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BNSF RAILWAY SITE SKYKOMISH, WA			**CONCEPTUAL SITE DIAGRAM WITH PETROLEUM CLEANUP LEVELS**
DATE: 6/4/07	DRWN:		**FIGURE 3**

File: H:\16423\ECOLOGY\6-4-07\FIG_4-PETROLEUM_DIST.dwg Layout: FIG 4 User: emarshall Plotted: Jun 05, 2007 - 11:38am Xref's:



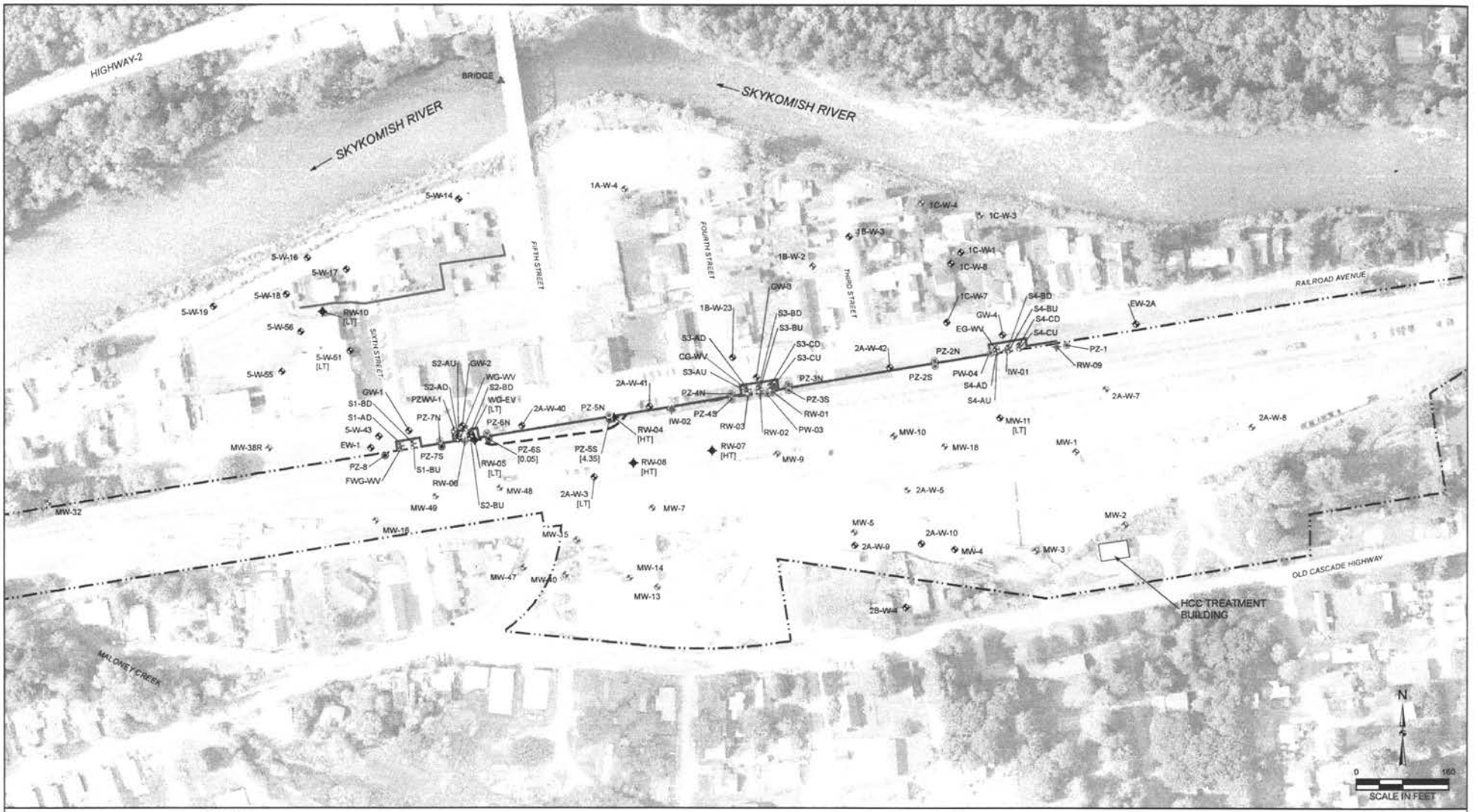
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BNSF RAILWAY SITE
SKYKOMISH, WA

SITE PETROLEUM DISTRIBUTION

DATE: 6/5/07 | DRWN:

FIGURE 4



LEGEND

- 2A-W-41 MONITORING WELL
- RW-04 RECOVERY WELL
- PZ-5S PIEZOMETER
- IW-02 INJECTION WELL
- BRIDGE BRIDGE MEASURING POINT

LOCATIONS SHOWN IN GRAY NOT GAUGED IN JUNE 2020.

- HYDRAULIC CONTROL AND CONTAINMENT SYSTEM SHEET PILE BARRIER WALL AND GATES
- BNSF RAILYARD BOUNDARY
- MECHANICALLY STABILIZED EARTH WALL

- ESTIMATED EXTENT OF LNAPL AS INDICATED BY MEASURABLE LNAPL THICKNESS ON GROUNDWATER SURFACE
- [HT] HEAVY TRACE - OBSERVED ON INTERFACE PROBE BY FIELD STAFF; NO MEASURABLE LNAPL THICKNESS GREATER THAN 0.01 FOOT
- [LT] LIGHT TRACE - OBSERVED ON INTERFACE PROBE BY FIELD STAFF; NO MEASURABLE LNAPL THICKNESS GREATER THAN 0.01 FOOT
- [1.15'] MEASURABLE LNAPL THICKNESS IN FEET
- LNAPL LIGHT NONAQUEOUS-PHASE LIQUID

IMAGERY SOURCE: KING COUNTY PICTOMETRY 2015

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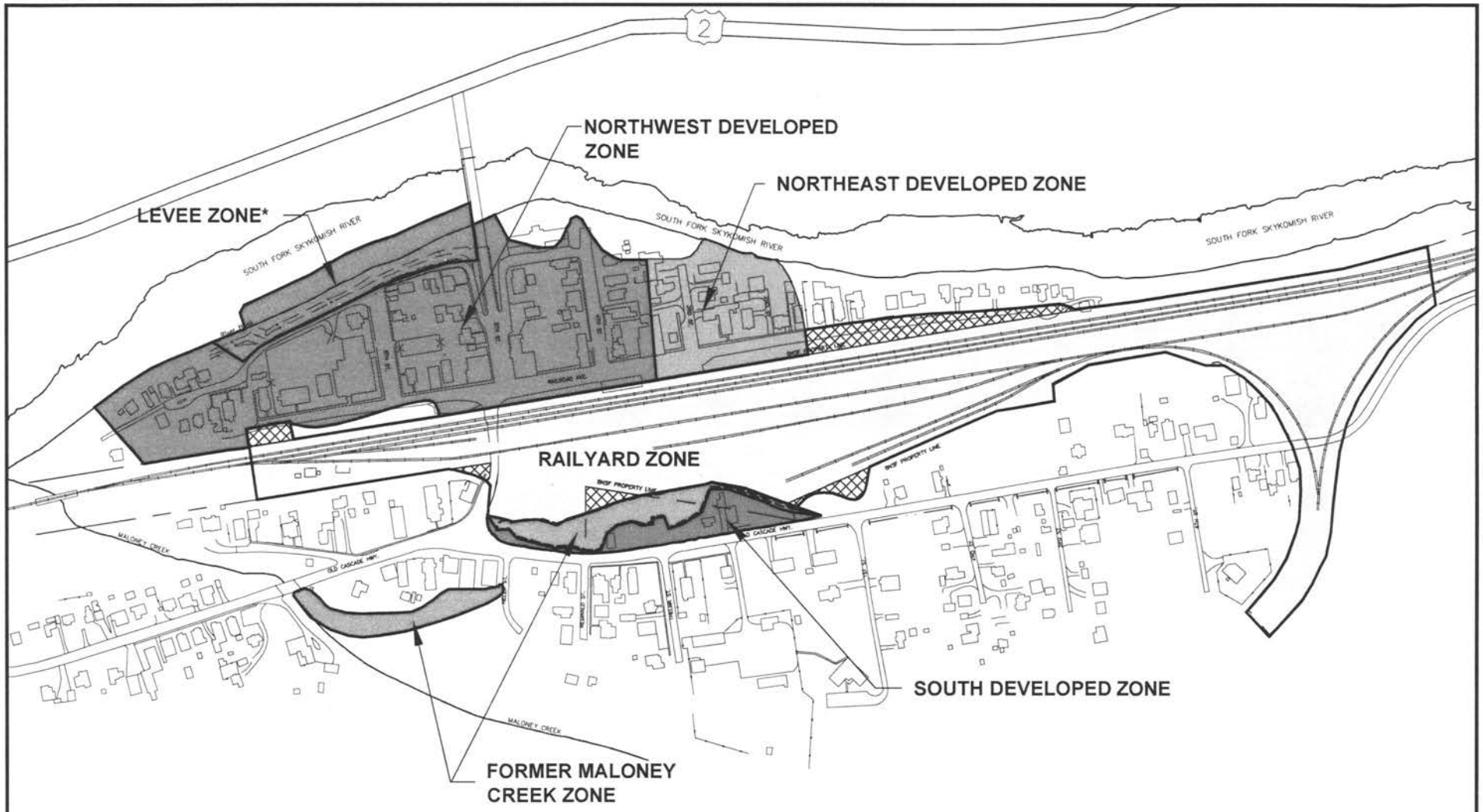
FIGURE 4A

JUNE 2020 ESTIMATED EXTENT OF MEASURABLE LNAPL
BNSF FORMER MAINTENANCE AND FUELING FACILITY
SKYKOMISH, WASHINGTON

FARALLON PN: 683-071

Drawn By: TPerrin | Checked By: AM | Date: 9/8/2021 | Disc Reference:
Document Path: Q:\Projects\683 BNSF\071 Groundwater_HCC 2020\MapFiles\GW_TPH_2020\Figure-04_Estimated_extent_LNAPL_0620.mxd

File: P:\CADD\BNSF-Skykomish\ECOLOGY\10-11-07\FIG_5-SITE_ZONES.dwg Layout: FIG 5 User: emarshall Plotted: Oct 16, 2007 - 10:07am Xref's:



Areas within Railyard Zone not owned by BNSF

Note:

* As defined in the Feasibility Study (2005)

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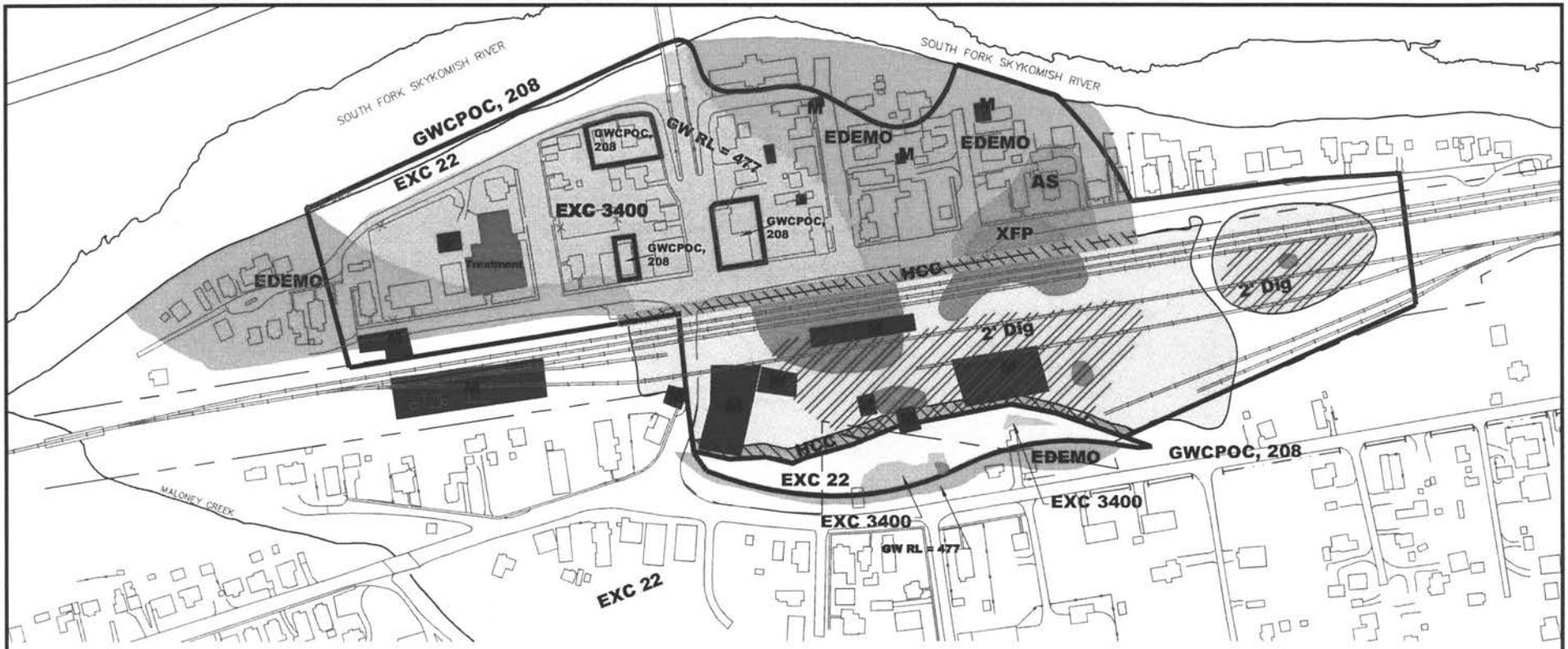
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200 0 400

1"=400'

BNSF RAILWAY SITE SKYKOMISH, WA			SITE ZONES
DATE: 6/5/07	DRWN:		FIGURE 5

File: H:\BNSF-Skykomish\ECOLOGY\10-11-07\FIG_6-CLEANUP-ACTIONS.dwg Layout: fig 6 (8.5X11) User: emarshall Plotted: Oct 12, 2007 - 10:58am Xref's:



GWCPOC, 208 Groundwater Conditional Point of Compliance, 208 µg/L

HCC Hydraulic Control and Containment System

XFP Excavate Free Product

EXC 3400 Excavate soil with petroleum exceeding 3,400 mg/kg

EXC 22 Excavate soil with petroleum exceeding 22 mg/kg

AS Air Sparge soil with petroleum between 3,400 mg/kg & free product; air sparge groundwater

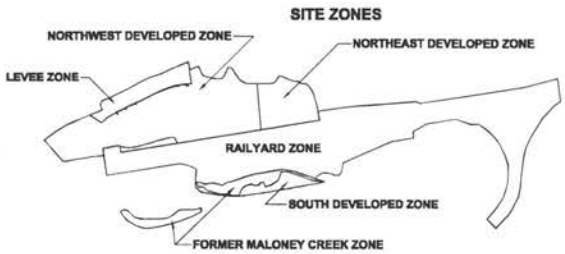
EDEMO Empirical Demonstration that leaving soil in place with petroleum between 22 and 3,400 mg/kg is protective of groundwater

Excavate surface metals contamination

2' DIG Excavate petroleum-contaminated soil within 2 feet of the surface where petroleum exceeds 1,870 mg/kg

Treatment under the school

Excavate selected areas of contaminated soil on the Railyard



Note: Groundwater remediation level of 477 µg/L expected to be met in the SDZ and inside the GWCPOC in the NWDZ and NEDZ (see text for discussion)

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N

150 0 300

1"=300'

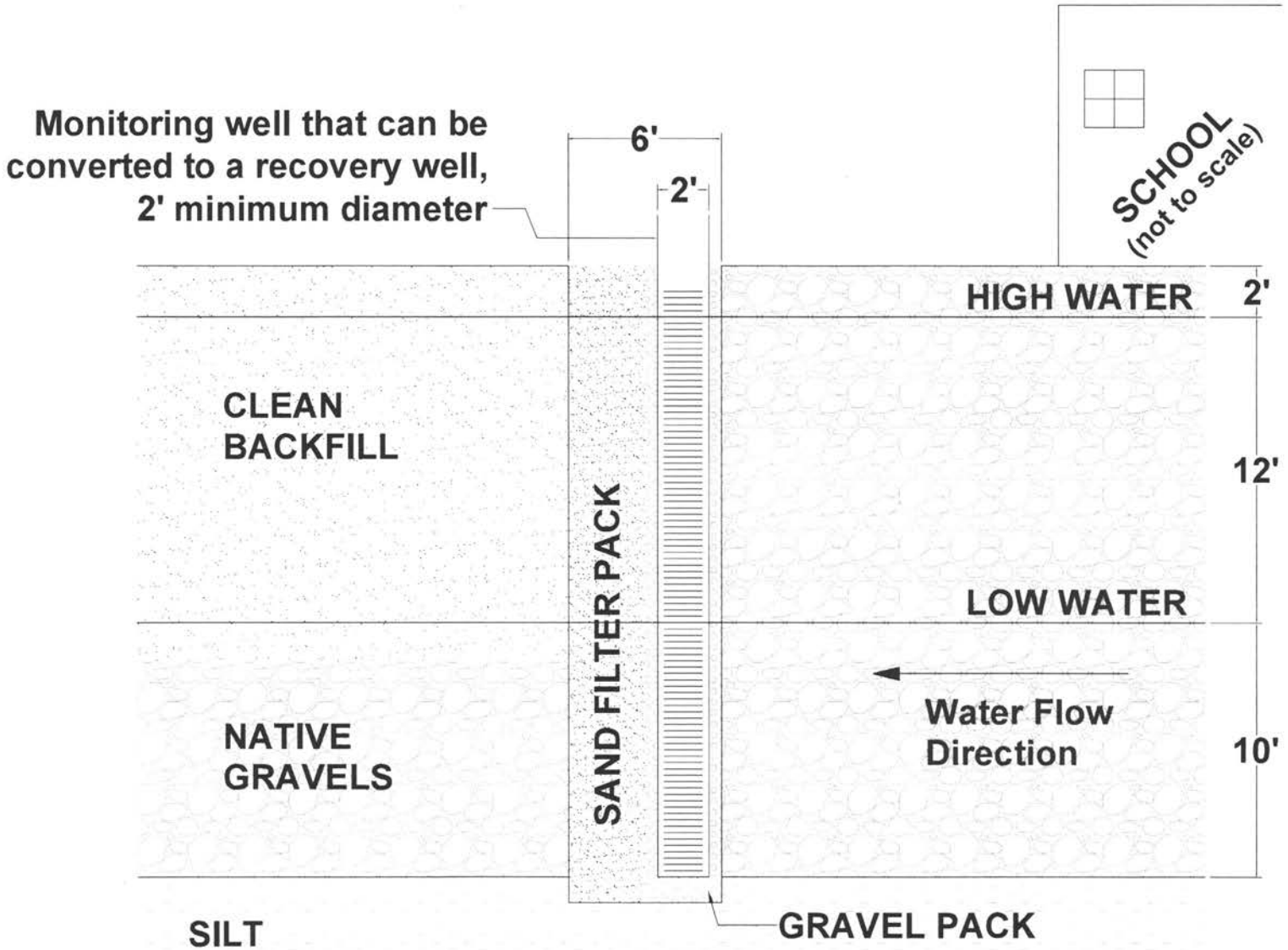
BNSF RAILWAY SITE
SKYKOMISH, WA

SUMMARY MAP OF CLEANUP ACTIONS

DATE: 10/11/07 | DRWN:

FIGURE 6

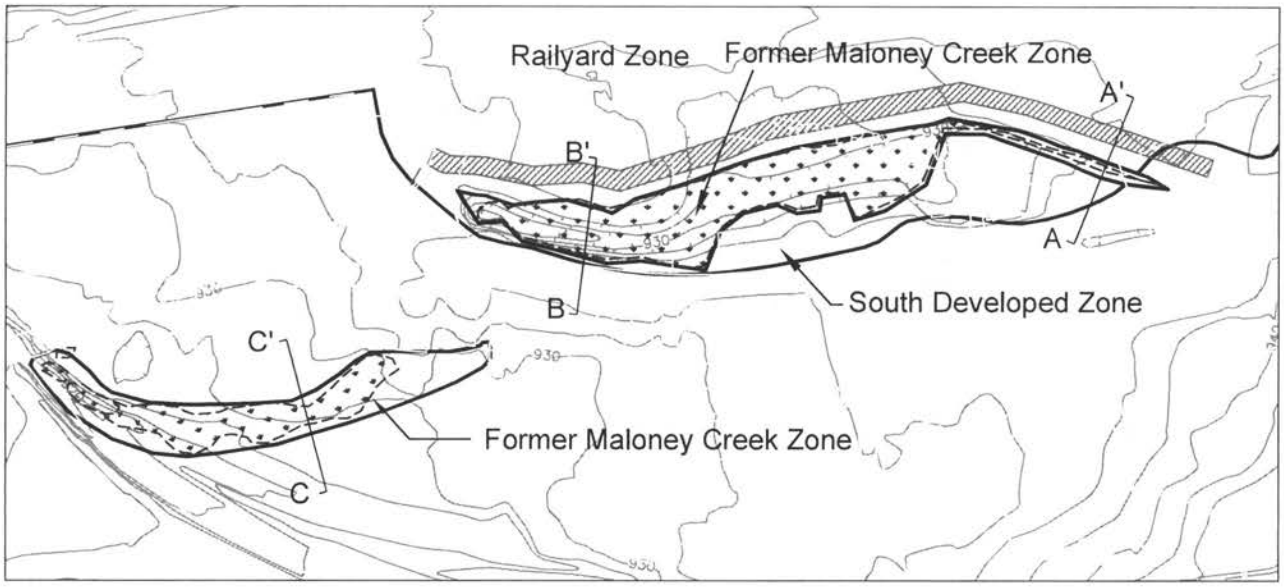
File: H:\16423\ECOLOGY\6-4-07\FIG_7-MONITOR-RECOVERY_TRENCH_CONCEPT.dwg Layout: ANSI_A1-CP User: emarshall Plotted: Jun 05, 2007 - 11:42am Xref's:

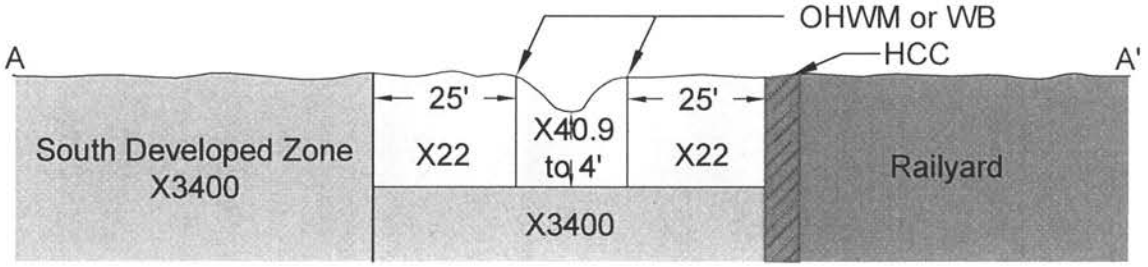


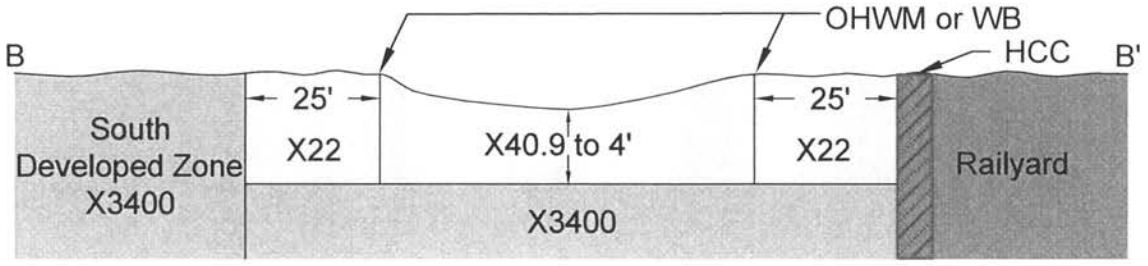
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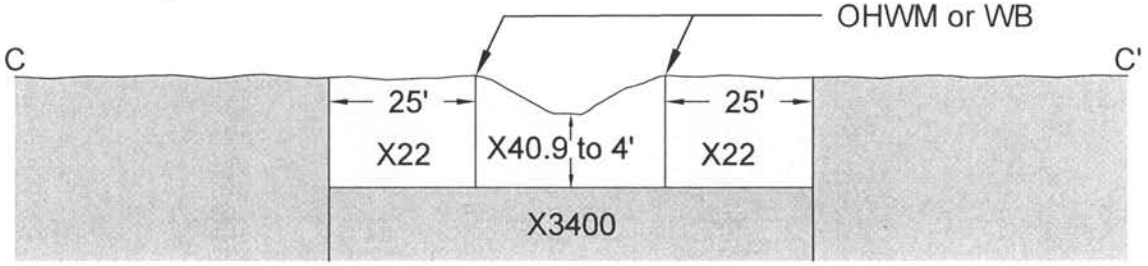
BNSF RAILWAY SITE SKYKOMISH, WA		CONCEPTUAL DIAGRAM OF PETROLEUM MONITORING AND RECOVERY TRENCH DOWNGRADIENT FROM SCHOOL TREATMENT AREA
DATE: 6/5/07	DRWN:	FIGURE 7

Cleanup requirements overlap into adjacent zones







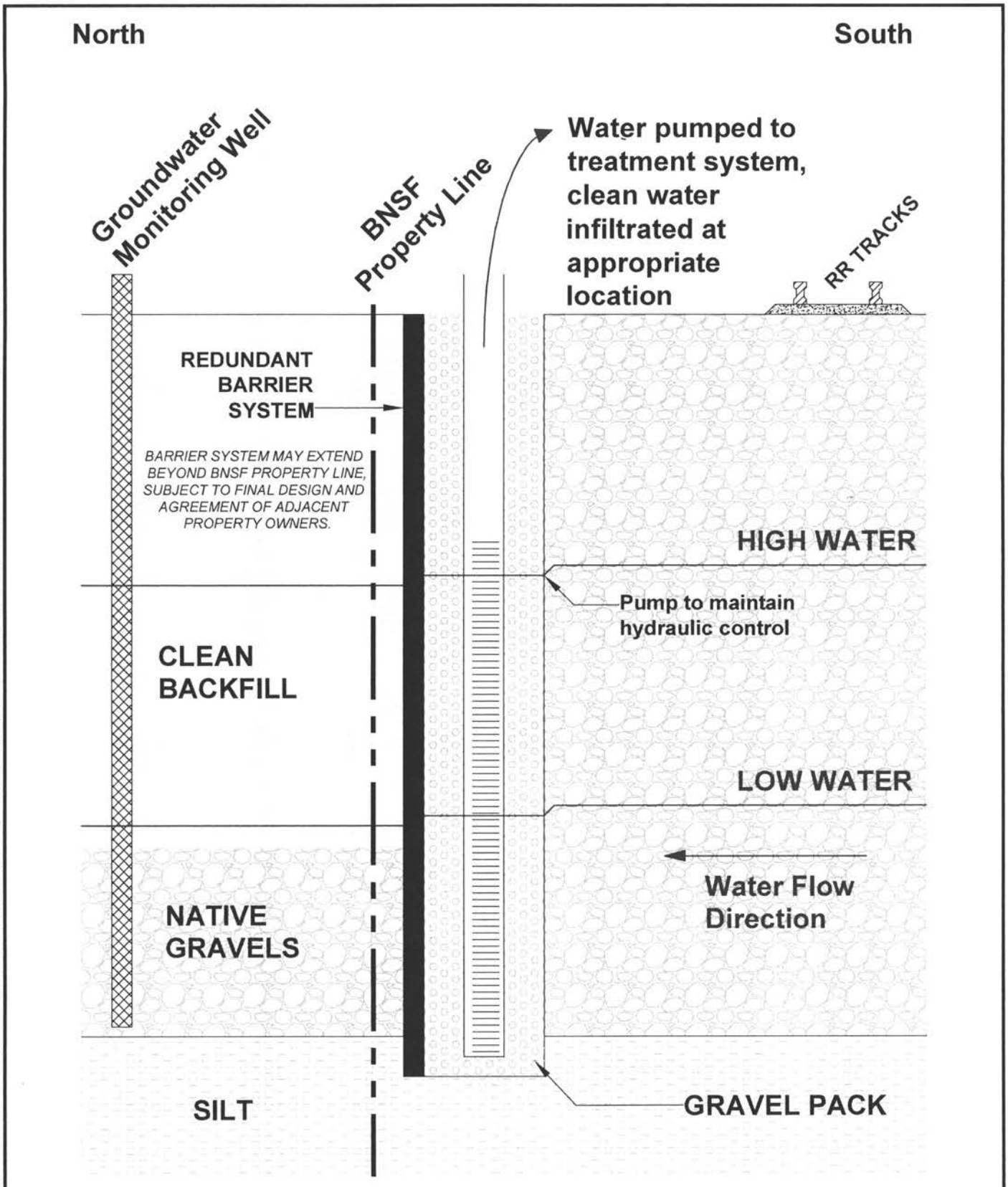


X3400 = Excavate to 3,400 mg/kg NWTPH-Dx
X22 = Excavate to 22 mg/kg NWTPH-Dx
X40.9 = Excavate to 40.9 mg/kg NWTPH-Dx
OHWM or WB = Ordinary High Water Mark or Wetland Boundary
HCC = Hydraulic Control and Containment System

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BNSF RAILWAY SITE SKYKOMISH, WA			FORMER MALONEY CREEK CLEANUP REQUIREMENTS
DATE: 6/5/07	DRWN:		FIGURE 8

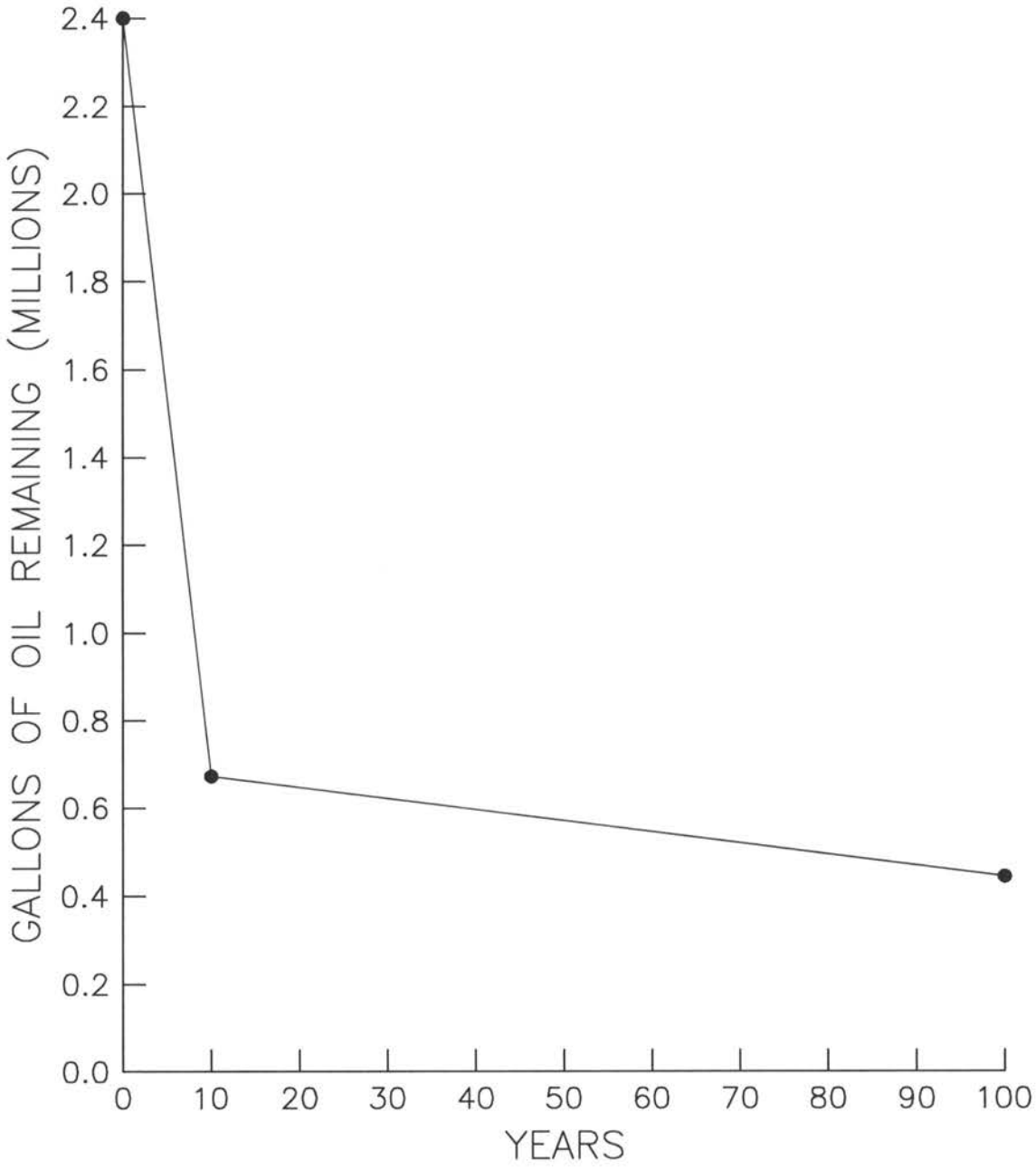
File: H:\16423\ECOLOGY\6-4-07\FIG_8-MALONEY-CREEK-CLEANUP.dwg Layout: FIGURE 8 User: emarshall Plotted: Jun 05, 2007 - 11:41am Xref's:



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BNSF RAILWAY SITE SKYKOMISH, WA		CONCEPTUAL HYDRAULIC CONTROL AND CONTAINMENT SYSTEM - GROUNDWATER BARRIER TRENCH DESIGN
DATE: 10/11/07	DRWN:	FIGURE 9

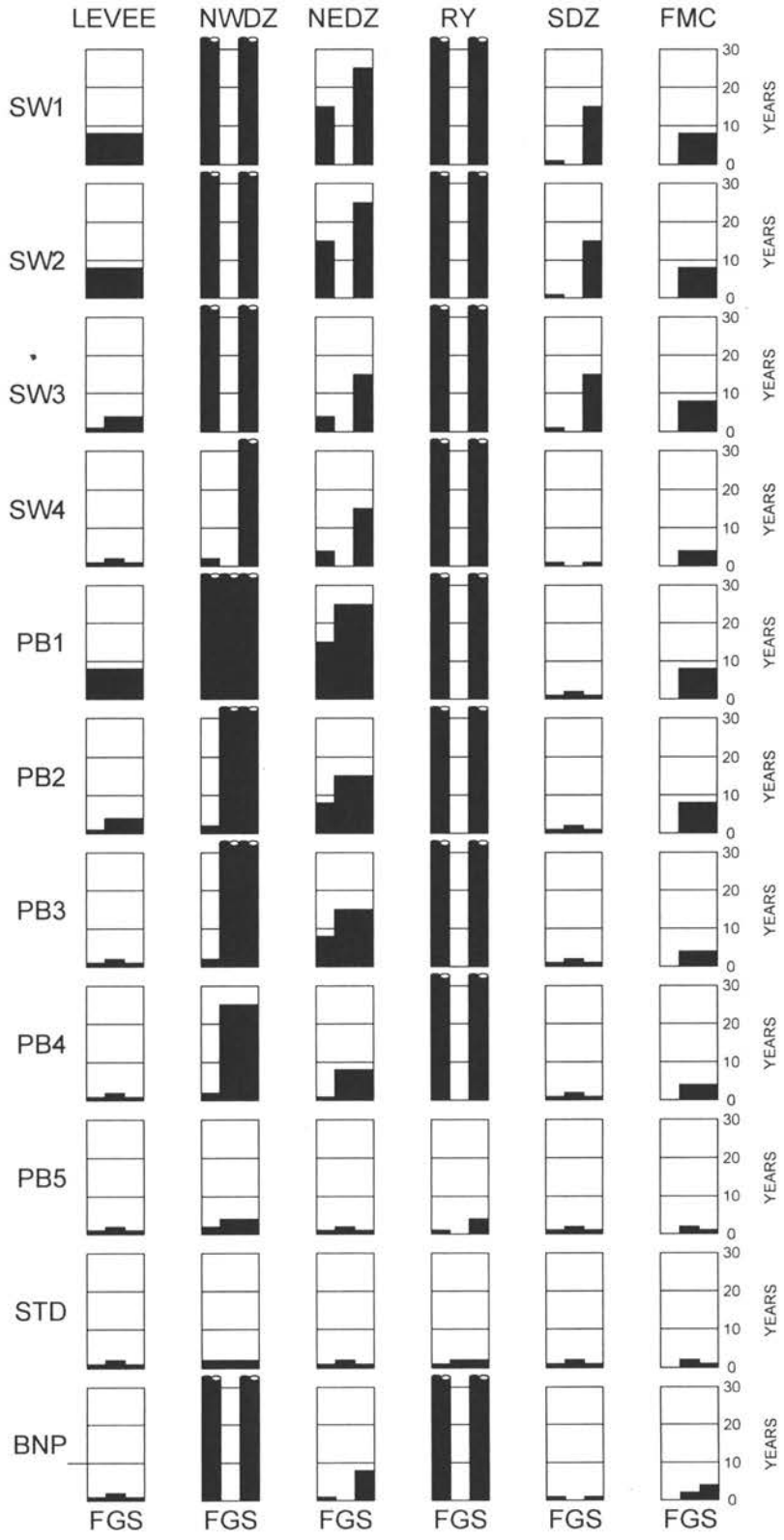
File: H:\BNSF-Skykomish\ECOLOGY\10-11-07\FIG_9-GW-BARRIER_TRENCH_DESIGN.dwg Layout: ANSI_A\T-CP User: emarshall Plotted: Oct 12, 2007 - 8:26am Xref's:



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BNSF RAILWAY SITE SKYKOMISH, WA			**AMOUNT OF PETROLEUM REMAINING ON-SITE (ALL ZONES) OVER TIME**
DATE: 6/5/07	DRWN:		**FIGURE 10**

File: H:\16423\ECOLOGY\6-4-07\FIG_10-PETROLEUM_REMAINING.dwg Layout: FIGURE 10 User: emarshall Plotted: Jun 05, 2007 - 12:02pm Xref's:

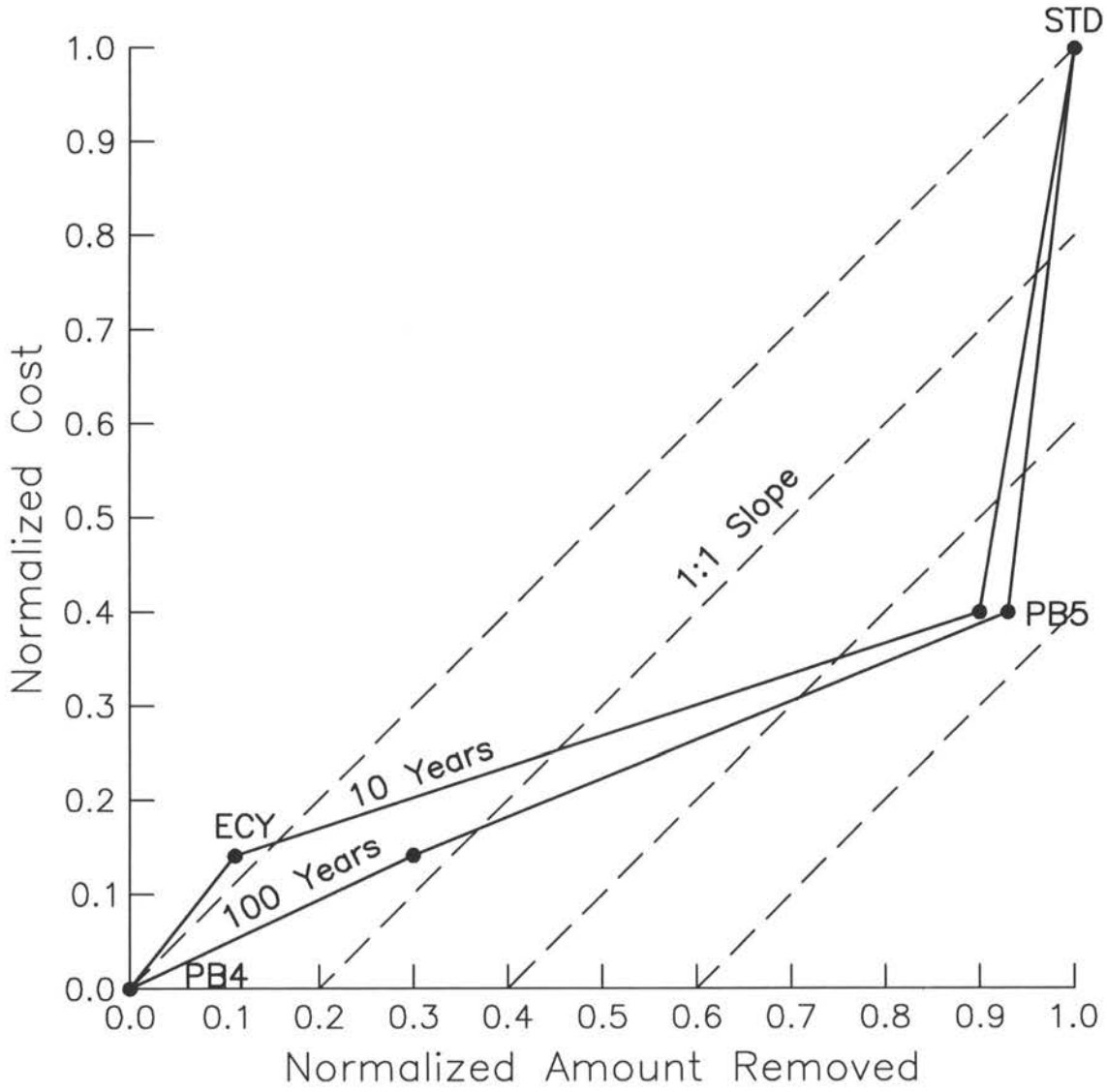


F = Free Product; G = Ground water; S = Soil

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BNSF RAILWAY SITE SKYKOMISH, WA		**FEASIBILITY STUDY** **ALTERNATIVE RESTORATION** **TIME FRAME**
DATE: 6/5/07	DRWN:	**FIGURE 11**

File: H:\16423\ECOLOGY\6-4-07\FIG_11-RESTORATION-TIMEFRAME.dwg Layout: FIGURE 11 User: emarshall Plotted: Jun 05, 2007 - 10:48am Xref's:



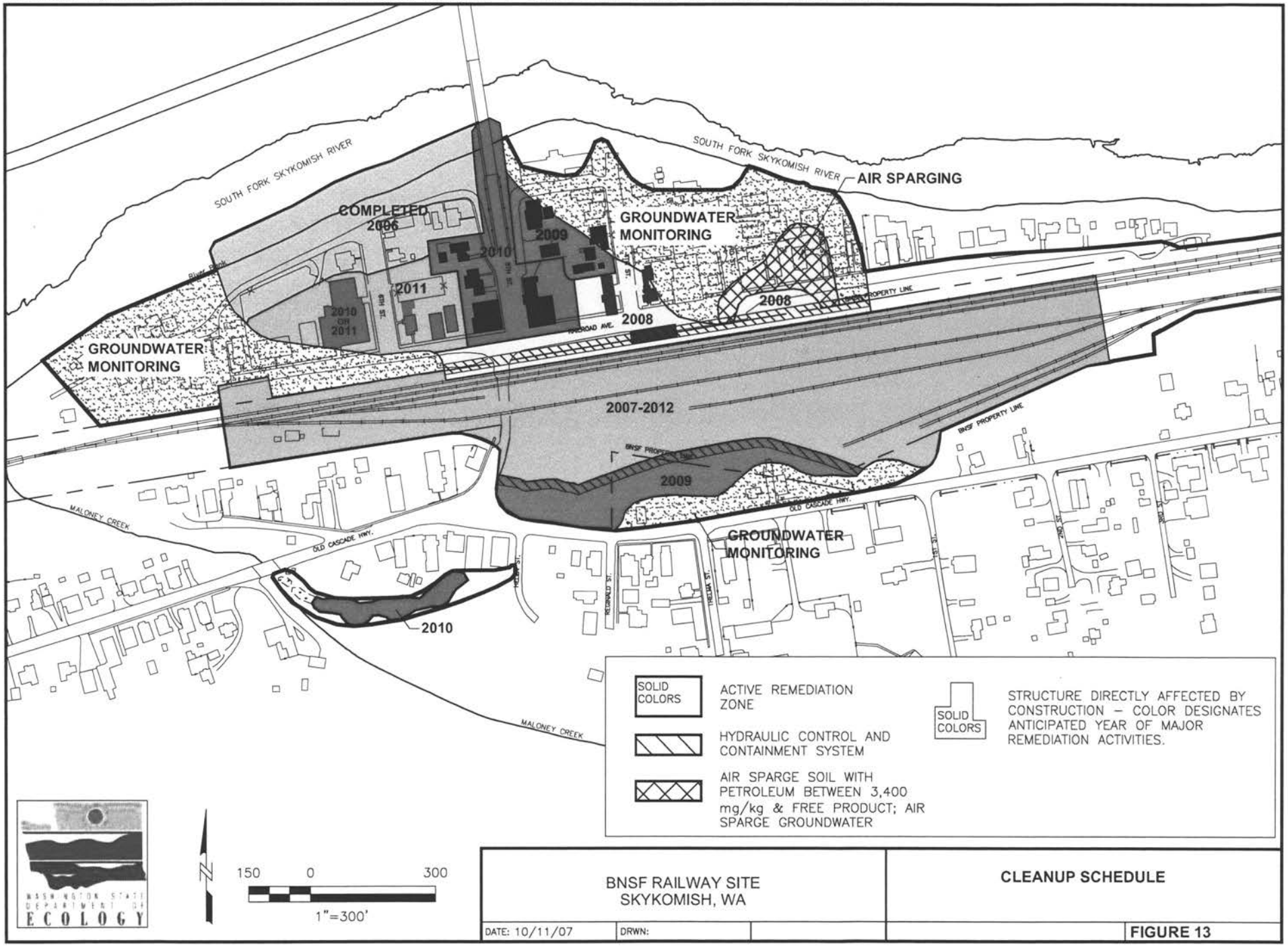
Note: PB4 does not meet minimum regulatory requirements and cannot be selected. It is included for comparison purposes only. The cost increase of ECY relative to PB4 is for the cleanup actions which must be added to those in PB4 to develop an alternative which meets the minimum regulatory requirements. See text for further discussion.

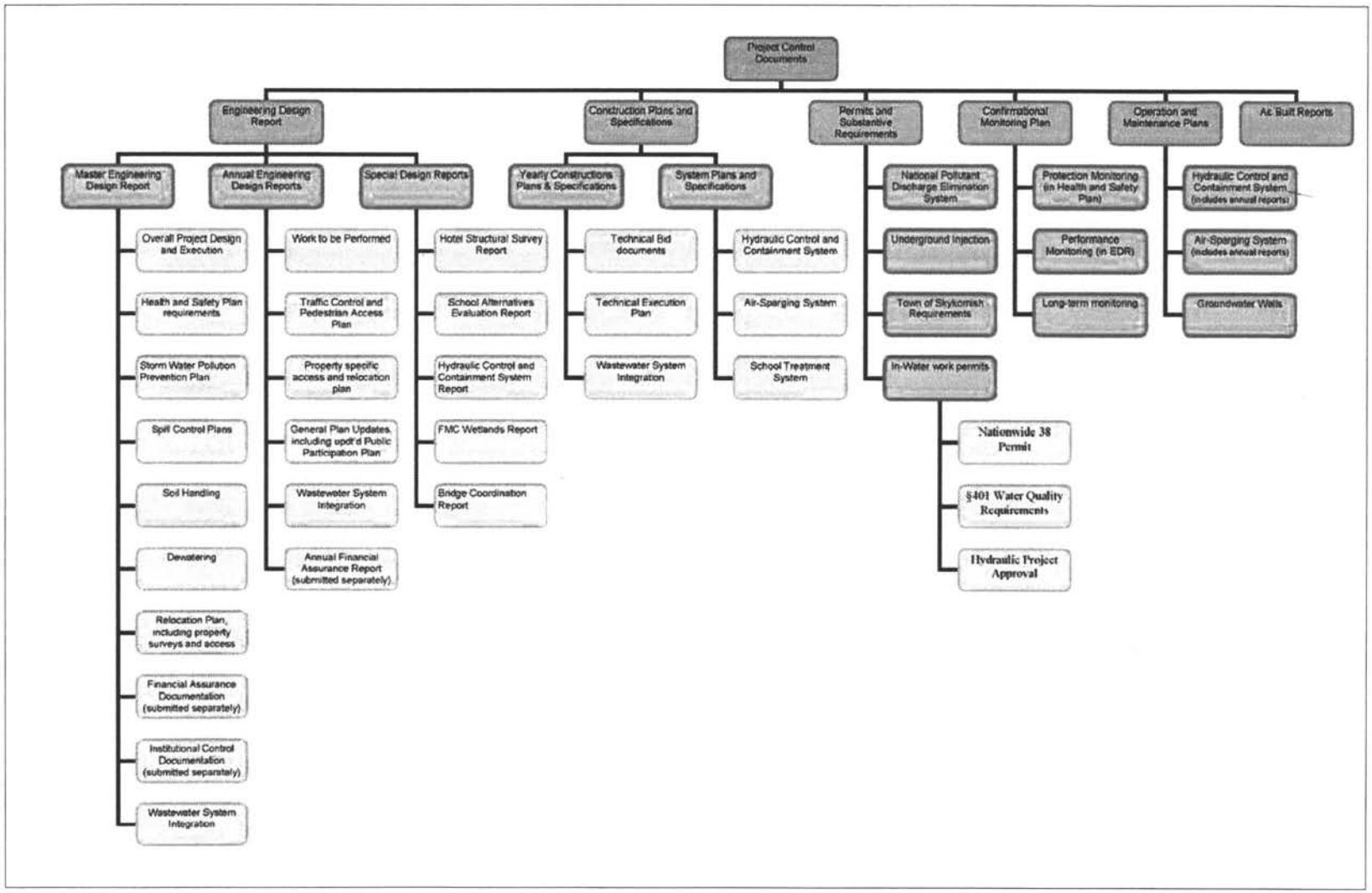
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BNSF RAILWAY SITE SKYKOMISH, WA	EVALUATION OF PROTECTIVENESS (10 YEARS) AND PERMANENCE (100 YEARS) FOR ALTERNATIVES ECY, PB5, AND STD
DATE: 6/5/07 DRWN:	FIGURE 12

File: H:\16423\ECOLOGY\6-4-07\FIG_12-EVALUATION.dwg Layout: FIGURE 12 User: emarshall Plotted: Jun 05, 2007 - 12:05pm Xref's:

File: H:\BNSF-Skykomish\ECOLOGY\10-11-07\FIG_13-SCHEDULE.dwg Layout: FIG 13 User: emarshall Plotted: Oct 12, 2007 - 9:42am Xref's:





BNSF RAILWAY SITE SKYKOMISH, WA		PROJECT CONTROL DOCUMENTS
DATE: 6/5/07	DRWN:	FIGURE 14