BART DETERMINATION SUPPORT DOCUMENT FOR WEYERHAEUSER CORPORATION LONGVIEW, WASHINGTON

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EXECUTIVE SUMMARY

The Best Available Retrofit Technology (BART) program is part of the larger effort under the federal Clean Air Act Amendments of 1977 to eliminate human-caused visibility impairment in all mandatory federal Class I areas. Sources that are required to comply with the BART requirements are those sources that:

1. Fall within 26 specified industrial source categories.
2. Commenced operation or completed permitting between August 7, 1962 and August 7, 1977.
3. Have the potential to emit more than 250 tons per year (tpy) of one or more visibility impairing compounds.
4. Cause or contribute to visibility impairment within at least one mandatory federal Class I area.

The Weyerhaeuser Corporation (Weyerhaeuser) operates an integrated Kraft, thermomechanical, and recycled paper, pulp and paper mill that produces a wide range of paper products, including paperboard, corrugating medium, newsprint, and fine papers. The mill is located in Longview, Washington. The mill produces emissions of particulate matter (PM), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_X), and hydrocarbons. The pollutants considered to be visibility impairing are PM, SO_2, and NO_X.

Kraft pulp mills are one of the 26 listed BART source categories. A pulp mill began operation on the site in 1931. The current mill was constructed in 1948 and expanded in 1956/57, but it has had many modernizations and upgrades since then. The mill's potential emissions exceed 250 tpy for at least one of NO_X, SO_2, or PM_{10}. Three units are BART-eligible by construction or reconstruction date. They are the No. 10 Recovery Furnace, No. 10 Smelt Dissolver Tank, and the No. 11 Power Boiler.

Modeling of visibility impairment was done following the Oregon/Idaho/Washington/EPA-Region 10 BART modeling protocol.[1] Modeled visibility impacts of baseline emissions show impacts on the 8th highest day in any year (the 98th percentile value) of greater than 0.5 deciviews (dv) at five of the 12 Class I areas within 300 kilometers (km) of the plant.

Weyerhaeuser prepared a BART technical analysis using Washington State's BART Guidance.[2]

The Washington State Department of Ecology (Ecology) has determined that the current level of emissions control is BART for the three BART-eligible units. A wide variety of additional controls was investigated for each unit. However, all were determined to be either technically or economically infeasible.

[1] Modeling protocol available at http://www.deq.state.or.us/aq/haze/docs/bartprotocol.pdf.
[2] "Best Available Retrofit Technology Determinations Under the Federal Regional Haze Rule," Washington State Department of Ecology, June 12, 2007.

1. INTRODUCTION

1.1 The BART Program and BART Analysis Process

The federal Clean Air Act Amendments of 1977 (CAA) established a national goal of eliminating human induced visibility impairment in all mandatory federal Class I areas. The CAA requires certain sources to utilize Best Available Retrofit Technology (BART) to reduce visibility impairment as part of the overall plan to achieve that goal.

Requirements for the BART program and analysis process are given in 40 CFR 51, Subpart P, and Appendix Y to Part 51.[3] Sources are required to comply with the BART requirements if they:

1. Fall within 26 specified industrial source categories.
2. Commenced operation or completed permitting between August 7, 1962 and August 7, 1977.
3. Have the potential to emit more than 250 tons per year of one or more visibility impairing compounds including sulfur dioxide (SO_2), nitrogen oxides (NO_X), particulate matter (PM), and volatile organic compounds (VOCs).

Emission units that meet the source category, age, and potential to emit criteria must also make the facility "cause or contribute" to visibility impairment within at least one mandatory federal Class I area for the facility to remain BART applicable. Ecology has adopted the "cause and contribute" criteria that the United States Environmental Protection Agency (EPA) suggested in its guideline. BART-eligible units at a source cause visibility impairment if their modeled visibility impairment is at least 1.0 deciview (dv). Similarly, the criterion for contributing to impairment means that the source has a modeled visibility impact of 0.5 dv or more.

The BART analysis protocol in Appendix Y Sections III–V uses a 5-step analysis to determine BART for SO_2, NO_X, and PM. The five steps are:

1. Identify all available retrofit control technologies.
2. Eliminate technically infeasible control technologies.
3. Evaluate the control effectiveness of remaining control technologies.
4. Evaluate impacts and document the results.
5. Evaluate visibility impacts.

Ecology requires an applicable facility to prepare a BART technical analysis report and submit it to Ecology. Ecology then evaluates the report and makes a final BART determination decision. This decision is issued to the source owner as an enforceable Order, and included in the State's Regional Haze State Implementation Plan (SIP).

[3] Appendix Y to 40 CFR 51 – Guidelines for BART Determinations Under the Regional Haze Rule.

As allowed by the EPA BART guidance, Ecology has chosen to consider all five factors in its BART determinations. To be selected as BART, a control has to be available, technically feasible, cost effective, provide a visibility benefit, and have a minimal potential for adverse non-air quality impacts. Normally, the potential visibility improvement from a particular control technology is only one of the factors weighed for determining whether a control constitutes BART. However, if two available and feasible controls are essentially equivalent in cost effectiveness and non-air quality impacts, visibility improvement becomes the deciding factor for the determination of BART.

1.2 The Weyerhaeuser Corporation's Longview Mill

Weyerhaeuser operates an integrated timber products facility, including a Kraft pulp and paper mill located on the banks of the Columbia River in Longview, Washington. The facility produces a variety of timber, wood, pulp and paper products, including logs, dimensional lumber, bleached Kraft pulp, liquid packaging board, newsprint, and publication papers. Paper products are produced from bleached Kraft pulp, de-inked recycled paper, and thermomechanical pulp. The Kraft mill was constructed in 1948 and expanded in 1956/57, but it has had many modernizations and upgrades since then, including installation of a new Kraft Fiberline in 1993-1995. The combined Weyerhaeuser and NORPAC pulp and paper operations are regulated as a single facility operating under Air Operating Permit WA 000012-4. Ecology received a BART Analysis and Determination Report from Weyerhaeuser on December 20, 2007, which was revised and resubmitted on June 30, 2008.

1.3 BART-Eligible Units

A review of the emission at the facility found that:

1. Three of the plant's individual emission units are BART-eligible by construction date. They are the No. 10 Recovery Furnace, the No. 10 Smelt Dissolver Tank, and the No. 11 Power Boiler.

2. The three individual emission units in total have a potential to emit at least 250 tons/year of nitrogen oxides (NO_X), and sulfur dioxide (SO_2).

3. A Class I area visibility impact analysis was done using the maximum daily emissions during the 2003-2005 time period and the CALPUFF model. The model results indicated the visibility impact from the BART-eligible units exceeded the 0.5 dv contribution threshold in at least one Class I area.

1.3.1 Existing Recovery Furnace Emissions Control

Weyerhaeuser operates a non-direct contact evaporator (NDCE) recovery furnace with an electrostatic precipitator (ESP). The recovery furnace fires black liquor solids (BLS) and some fuel oil. The furnace is equipped with boiler tubes to recover thermal energy from the

combustion of black liquor. As a result of the continuous operation of the Kraft process, the recovery furnace operates continuously at approximately the same rate all the time (a.k.a. "baseload" operation). The steam generated is used to produce electricity and provide process heat and steam.

A chemical recovery furnace is not simply a "boiler" designed to burn fuel and produce steam. It is a complex device which serves as a chemical reactor, a chemical recovery unit, an internal high efficiency SO_2 scrubber, and an energy recovery unit. Recovery furnaces operate by spraying concentrated spent pulping chemical liquids (black liquor) into the furnace. The organic chemicals in the black liquor (mostly lignins) are combusted. Combustion provides the energy to recover the inorganic pulping chemicals (sodium sulfide) for reuse. As with most recovery furnaces, this furnace is equipped with boiler tubes to generate steam for electrical generation and process needs.

This furnace utilizes tertiary over fire air combustion to maximize chemical recovery and minimize emissions. The black liquor is concentrated prior to introduction into the furnace. Heat energy is recovered as steam used for production of electricity and plant steam needs.

The major pollutants emitted from the furnace are SO_2, NO_X, and PM_{10}. SO_2 is generated in the recovery furnace from the oxidation of inorganic and organic sulfur compounds contained in the black liquor and hydrogen sulfide losses from the chemical recovery portion of the furnace. Additional SO_2 results from the oxidation of sulfur in fuel oil which may be used during the combustion process. The chemical recovery process scrubs out most of the SO_2 generated in the chemical recovery/combustion process in the furnace. SO_2 emissions from the furnace represent a loss of process chemical and are not desirable, so the furnace operation is optimized to minimize the loss of process chemicals, primarily sodium and sulfur.

NO_X may form as fuel NO_X and thermal NO_X. Technical literature suggests that NO_X formation from the chemical recovery process is primarily fuel NO_X since recovery furnace temperatures are not high enough for significant thermal NO_X formation.[4] NO_X emissions from recovery furnaces are typically low due to the low nitrogen concentration in the black liquor solids (approximately 0.1 percent), the low overall conversion of liquor nitrogen to NO_X (10 to 25 percent), and the existence of sodium fumes that can participate in "in-furnace" NO_X reduction or removal.[5]

The majority of particulate emissions are in the form of particulate matter less than 10 microns in size (PM_{10}). The majority of the PM_{10} emissions from the recovery furnace are sodium salts with about 80 percent of the PM_{10} being sodium sulfate and smaller amounts of potassium

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[4] NCASI Special Report 99-01, *A Review of NO_X Emission Control Strategies for Industrial Boilers, Kraft Recovery Furnaces, and Lime Kilns,* April 1999.
[5] NCASI Special Report No. 03-06, *Effect of Kraft Recovery Furnace Operations on NO_X Emissions: Literature Review and Summary of Industry Experience,* October 2003.

sulfate, sodium carbonate, and sodium chloride.[6] These salts primarily result from the carryover of solids from the combustion and chemical recovery process plus sublimation and condensation of inorganic chemicals.[7] Some PM_{10} in the recovery furnace flue gas can be attributed to the combustion of fossil fuel. Most of the particulate generated in the furnace falls out in the economizer with the rest captured by the electrostatic precipitator. The particulate (known as "saltcake") captured in the economizer and ESPs, is recycled back to the process by mixing with black liquor before it enters the black liquor concentrators. The concentrated black liquor is then sent to the recovery furnace.

The recovery furnace is equipped with an electrostatic precipitator (ESP) to reduce PM/PM_{10}. The SO_2 and NO_X emissions are controlled through the design and careful operation of the recovery furnace's tertiary air system.

The NO_X, SO_2, and PM_{10} emissions from the No. 10 Recovery Furnace are subject to BACT emission limits in Prevention of Significant Deterioration (PSD) 92-03 and the requirements of 40 CFR 63 Subpart MM, as well as other less stringent limits. The most stringent of the applicable PM, NO_X, and SO_2 emission limits are shown in Table 1-1.

Table 1-1. RECOVERY FURNACE CURRENT EMISSION LIMITS

Pollutant	Emission Limit	Regulatory Basis
PM/PM_{10}	0.027 gr/dscf @ 8% O_2, and 0.020 gr/dscf @ 8% O_2 annual average	PSD 92-03, Amendment 4
NO_X	140 ppm @ 8% O_2	PSD 92-03, Amendment 4
SO_2	75 ppm @ 8% O_2	PSD 92-03, Amendment 4

1.3.2 Existing Smelt Dissolver Tank Emissions Control

A smelt dissolver tank is a part of the Kraft pulping chemical recovery process. Smelt is the molten chemicals collected in the bottom of a recovery furnace. Smelt is continuously withdrawn from the furnace into a smelt dissolver tank where it is dissolved in water and weak wash[8] to produce green liquor. Green liquor is mixed with lime from the lime kiln (not a BART-eligible unit at this plant) to produce white liquor for use in the chip digestion process.[9] During digestion, the white liquor is converted to black liquor.

PM/PM_{10} is the primary emissions from the smelt tank. The particulate is formed when the water solution is introduced to the hot smelt from the furnace. The relatively cooler water causes

[6] NCASI Technical Bulletin No. 725, *Particulate Matter Emissions from Kraft Mill Recovery Furnaces, Lime Kilns, and Smelt Dissolving Tanks,* November 1996.
[7] AP-42, Section 10.2, Chemical Wood Pulping, dated September 1990.
[8] This process water, also known as weak white liquor, is composed of all water used to wash lime mud and green liquor precipitates.
[9] The names of the various liquors denote their actual color.

the smelt to shatter prior to dissolving into solution. The particles that enter the exhaust stream are small; 90 percent by weight are PM_{10} and 50 percent by weight are less than one micrometer in aerodynamic diameter. Chemically the particles are composed of inorganic compounds used to prepare the pulping liquor, principally sodium sulfate and sodium carbonate. Since no combustion occurs in a smelt tank, there are no NO_X emissions and SO_2 emissions are minimal.

The No. 10 Smelt Dissolver Tank is currently controlled with a high-efficiency wet scrubber permitted as BACT in 1993.[10]

The Smelt Dissolver Tank is currently subject to the BACT emission limit in PSD 92-03, Amendment 4 and 40 CFR 63 Subpart MM. The applicable PM, NO_X, and SO_2 emission limits are shown in Table 1-2.

Table 1-2. SMELT DISSOLVER TANK CURRENT EMISSION LIMITS

Pollutant	Emission Limit	Regulatory Basis
PM/PM_{10}	0.20 lb/ton BLS	NESHAP Subpart MM, 40 CFR 63.862(a)(1)(i)(b)
	0.120 lb/ton BLS	PSD 92-03
NO_X	N/A	N/A
SO_2	N/A	N/A

1.3.3 Existing No. 11 Power Boiler Emissions Control

The No. 11 Power Boiler is a spreader-stoker type boiler firing wood-waste, dewatered wastewater treatment plant sludge, and supplemental low sulfur western coal. Low sulfur (< 2 percent by weight) No. 6 fuel oil may be burned during startup, shutdown, and malfunction operations. During 2006, the boiler was upgraded and now has a rated capacity of 575,000 lb steam/hr and 1,016 million British thermal units per hour (MMBtu/hr) heat input. Actual emissions did not increase as a result of the upgrade project due to increased combustion efficiency and the addition of a trona-based SO_2 control. Actual 2007 operating rates are lower than the rated capacity, averaging 413,000 lb steam/hr and 724 MMBtu/hr heat input. Weyerhaeuser operates this boiler in conjunction with No. 10 Recovery Furnace, to provide process steam and steam to generate electricity. The No. 10 Recovery Furnace normally operates at a constant rate and the No. 11 Power Boiler varies its operating rate so the pair matches the steam demand of the rest of the plant. However, when either recovery furnace or the No. 11 Power Boiler is out of operation, the other unit plus other boilers on site must increase operating rate to meet the plant heat needs.

PM/PM_{10} emissions from this boiler results from inorganic materials contained in the fuels and unburned carbon resulting from incomplete combustion.[11] NO_X emissions from boilers are formed by two mechanisms, fuel NO_X and thermal NO_X. In the case of this boiler, both

[10] PSD 92-03, Amendment 4.
[11] NCASI Technical Bulletin No. 884, *Compilation of Criteria Air Pollutant Emissions Data for Sources at Pulp and Paper Mills Including Boilers,* August 2004.

mechanisms exist, though it is expected that the fuel NO_X is the dominant source of the emissions.[12] SO_2 emissions primarily come from the coal and wastewater sludge. Some of the SO_2 formed is captured by the alkaline wood ash and removed by the ESP.[13]

Emission controls currently in place on the No. 11 Power Boiler are a multiclone to remove cinders and coarse particulate followed by dry trona[14] injection for SO_2, followed by a dry ESP for trona and fine particulates removal. The trona is injected into the flue duct on the boiler side of the ID fan and makes use of the ID fan to mix the trona with the fuel gas. NO_X emissions are controlled through use of good combustion practices to minimize emissions and maximize combustion efficiency.

The ESP was installed as part of a boiler upgrade project in 2006 and replaced the last electrified gravel bed particulate control device remaining in Washington. The trona injection was installed as part of the 2006 boiler upgrade project to assure that the post upgrade SO_2 emissions would not be higher than the pre-project emissions.

The No. 11 Power Boiler is currently subject BACT emission limitations in a state NSR permit and to 40 CFR 60 Subpart D NSPS. The most stringent applicable PM, NO_X, and SO_2 emission limits are shown in Table 1-3.

Table 1-3. NO. 11 POWER BOILER'S CURRENT EMISSION LIMITS

Pollutant	Emission Limit	Regulatory Basis
PM/PM_{10}	0.10 lb/MMBtu	NSPS Subpart D, 40 CFR 60.42(a)(1)
	0.050 gr/dscf @ 7% O_2	Ecology Order 94AQ-I080[15]
NO_X	0.30 – 0.7 lb/MMBtu, depending on fuel mixture	NSPS Subpart D, 40 CFR 60.44(a)
SO_2	0.80–1.2 lb/MMBtu, depending on fuel mix	NSPS Subpart D, 40 CFR 60.43(a)
	1000 ppmv, 1-hr average	WAC 173-400-040(11)(b)

1.4 Visibility Impact of the Weyerhaeuser Mill's BART-Eligible Units

Class I area visibility impairment and improvement modeling was performed by Weyerhaeuser using the BART modeling protocol developed by Oregon, Idaho, Washington, and EPA Region

[12] NCASI Corporate Correspondent Memorandum No. 06-0142006, *Information on Retrofit Control Measures for Kraft Pulp Mill Sources and Boilers for NO_X, SO_2 and PM Emissions*, June 2006.
[13] NCASI Technical Bulletin No. 884, *Compilation of Criteria Air Pollutant Emissions Data for Sources at Pulp and PaperMills Including Boilers*, August 2004.
[14] Trona is a natural mineral primarily composed of sodium carbonates.
[15] Weyerhaeuser requested a numerical limit be established under WAC 173-400-091 to replace a narrative limit in the original NOC approval. To assure clear limitations and enforceability within the AOP, the regulatory order established this numerical limitation.

10.[16] This protocol uses three years of metrological information to evaluate visibility impacts. As directed in the protocol, Weyerhaeuser used the highest 24-hour emission rates that occurred in the 3-year period to model its impacts on Class I areas. The modeling indicates that the emissions from the three BART-eligible units at this plant cause visibility impairment on the 8th highest day in any one year and the 22nd highest day over the three years that were modeled.[17] For more information on visibility impacts of this facility, see Section 3.

2. BART TECHNOLOGY ANALYSIS

The Weyerhaeuser BART technology analysis was based on the five step process defined in BART guidance and listed in Section 1.1 of this report.

The following three tables identify and summarize control options considered in the BART Determination analysis for PM_{10}, NO_X, and SO_2 emissions from the Weyerhaeuser Mill. Sections 2.1 through 2.4 discuss emissions from each BART emissions unit.

Table 2-1. PM/PM_{10} CONTROL TECHNOLOGIES EVALUATED

Control Technology	Available for Emission Unit (Yes/No)[18]		
	No. 10 Recovery Furnace	Smelt Dissolver Tank	No. 11 Power Boiler
Fabric Filters (baghouse)	No	N/A[a]	Yes
Cyclone Separator (multiclone)	N/A	N/A	Currently used
Wet Scrubber	Yes	Currently used	Yes
Wet ESP	Yes	N/A	Yes
Dry ESP	Currently used	N/A	Currently used
Venturi Scrubber	Yes	Yes	Yes
[a] Not Applicable or Not Available			

Table 2-2. NO_X CONTROL TECHNOLOGIES EVALUATED

Control Technology	Available for Emission Unit (Yes/No)		
	No. 10 Recovery Furnace	Smelt Dissolver Tank	No. 11 Power Boiler
Staged Combustion	Currently used	N/A	Currently used
Good Operating Practices and Proper Design	Currently used	N/A	Currently used
Selective Non-Catalytic Reduction (SNCR)	No	N/A	Yes
Selective Catalytic Reduction (SCR)	No	N/A	Yes

[16] A copy of the modeling protocol is available at http://www.deq.state.or.us/aq/haze/docs/bartprotocol.pdf.
[17] A source causes visibility impairment if its modeled visibility impact is above one deciview, and contributes to visibility impairment if its modeled visibility impact is above 0.5 deciview.
[18] Availability based on whether control technology can be considered for each emission unit and has been applied in practice on this type of unit, not on technical feasibility.

Table 2-3. SO_2 CONTROL TECHNOLOGIES EVALUATED

Control Technology	Available for Emission Unit (Yes/No)		
	No. 10 Recovery Furnace	Smelt Dissolver Tank	No. 11 Power Boiler
Flue Gas Desulfurization (FGD) with Wet Scrubber	Yes	No	Yes
FGD – Semi-Dry Lime Hydrate Slurry Injection with ESP or Baghouse	Yes	No	Yes
FGD – Semi-Dry Lime Hydrate Powder Injection with ESP or Baghouse	Yes	No	Yes
FGD – Spray Drying with ESP or Baghouse	Yes	No	Yes
FGD Dry Trona Injection with ESP	No	No	Currently used
Good Operating Practices/Inherent Dry Scrubbing	Currently used	No	N/A
High efficiency wet scrubber	N/A	Currently used	No

2.1 No. 10 Recovery Furnace Control Options

2.1.1 PM/PM_{10} Control Options

As discussed in Section 1.3.1, particulate emissions from the No. 10 Recovery Furnace are controlled by an ESP.

As noted in Section 1.3, the No. 10 Recovery Furnace is subject to BACT emission limitations that are more stringent than the standard for PM (used by EPA as a surrogate for hazardous air pollutant (HAP) metals) contained in 40 CFR Part 63 Subpart MM, *National Emission Standards for Hazardous Air Pollutants for Chemical Recovery Combustion Sources at Kraft, Soda, Sulfite, and Stand-Alone Semichemical Pulp Mills*. Compliance with the BACT limitation is achieved by the inclusion of a dry ESP for particulate control.

Of the available particulate emission controls for the recovery furnace, Weyerhaeuser was unable to locate an existing recovery furnace with either a wet ESP or a baghouse as the particulate control technology. They noted that the use of a fabric filter would not work due to the "sticky" nature of the particulate that would be collected; removing it from a fabric filter would be extremely difficult compared to the proven technique of an ESP.

Use of a **wet ESP** is feasible, but would not provide any greater particulate removal than is provided by the dry ESP currently installed. Weyerhaeuser was unable to locate an installation of a wet ESP on a Kraft recovery furnace.

Similarly, the EPA's BACT/RACT LAER Clearinghouse shows that over the last 15 years, no U.S. recovery furnace has had a **venture scrubber or other wet scrubber** installed as the

particulate control device as the result of new source permitting requirements. The primary reason is that wet scrubbers are not as effective at particulate removal as an ESP.

Weyerhaeuser did evaluate two options to further reduce particulate emissions from the recovery boiler. They evaluated **adding a venturi scrubber after the ESP** to further reduce condensable particulate and adding an additional field to the ESP to further enhance removal efficiency of primary particulate.

Adding a venturi scrubber to remove about 27 lb/hr (118.3 tpy) of condensable and additional solid particulate at an estimated cost effectiveness of $28,000/ton of PM reduced. The cost analysis did not include an evaluation of the potential impacts to the wastewater treatment system of receiving water from this scrubber.

Adding an **additional field to the ESP** is a more involved project than adding the venturi scrubber. Additional details on this option are given in Weyerhaeuser's BART Analysis Report. This alternative is estimated to reduce emissions by an additional 50 percent, or about 7.5 lb/hr (32.8 tpy) at a cost effectiveness of $122,000/ton PM reduced.

Weyerhaeuser considers the current BACT emission limit and dry ESP on the No. 10 Recovery Furnace PM as BART.

2.1.2 NO_X Control Options

To control NO_X from a recovery furnace, there are a limited number of options. The recovery furnace process utilizes staged combustion in order to maximize the recovery of the expensive pulping chemicals. As part of this chemical recovery process, the thermal NO_X emissions are minimized. In the Kraft process, the black liquor is already low in fuel nitrogen, further limiting the quantity of NO_X emitted.

Weyerhaeuser currently utilizes **"tertiary" staged combustion t**o maximize chemical recovery and minimize NO_X emissions. The addition of tertiary air in 1995 required extensive modification of the fire box. The modification required removal and lengthening the lower section of the furnace to increasing the volume of the primary combustion zone and allow space to add a third level of over fire air. Tertiary over fire air is considered the normal design for the best performing existing and most new recovery furnaces.

There are a few new recovery furnaces that have included a 4th stage of over fire air. This 4th stage has been shown to further increase chemical recovery and quality while reducing emissions of SO_2, NO_X and carbon monoxide. In order for Weyerhaeuser to add a 4th stage of combustion air would require the furnace to be rebuilt again to lengthen the fire box. The company believes such a project may also require the overall height of the recovery furnace building to be increased to accommodate a taller furnace. Whether the added height is provided at the top or bottom of the furnace, this would be a significant construction project, and put the Kraft portion

of the plant out of operation for the duration of the construction project. The cost and potential emission reduction of this change was not determined.

"Boiler tuning" was briefly evaluated, but the potential effectiveness of this option to reduce NO_X is unknown. In "boiler tuning," the quantity of air supplied at each stage is adjusted to optimize the chemical recovery efficiency and minimize the NO_X and SO_2 emissions. At the conclusion of the project to add tertiary over fire air, boiler tuning was performed as part of the project. As a result, additional significant reductions are not anticipated.

SCR and SNCR have been reviewed for applicability on this recovery furnace. Weyerhaeuser and National Council for Air and Stream Improvement (NCASI) have both been unable to find a current installation of SCR or SNCR on a Kraft recovery furnace. A major impediment to the inclusion of SNCR on a recovery furnace is the effect of introducing ammonia into the chemical recovery process through addition of the ammonia contaminated fly ash to the smelt dissolver tank. The use of SCR on a recovery furnace results with questions about the potential of catalyst poisoning or blinding from the alkaline particulate from the furnace and difficulties in removing that particulate from the catalyst material. Since no known installation of SCR exists on a Kraft recovery furnace, to what degree the potential for the adverse affects would actually occur is unknown.

In 2003, NCASI specifically evaluated the options for reducing NO_X emissions from recovery furnaces. Their evaluation indicated that no operating Kraft recovery furnace currently utilized post-combustion control (such as SCR or SNCR) and there a very limited number of other NO_X reduction techniques are available.[19] A subsequent NCASI Corporate Correspondence Memorandum states:[20]

> Optimization of the staged combustion principle within large, existing Kraft recovery furnaces to achieve lower NOx emissions might be the only technologically feasible option at the present time for NOx reduction . . . Ultimately, the liquor nitrogen content, which is dependent on the types of wood pulped, is the dominant factor affecting the level of NOx emissions from black liquor combustion in a recovery furnace. Unfortunately, this factor is beyond the control of pulp mill operators.

Weyerhaeuser concluded that the current NO_X emission limitation and currently installed system of staged combustion is BART for this furnace.

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[19] NCASI Special Report No. 03-06, *Effect of Kraft Recovery Furnace Operations on NO_X Emissions: Literature Review and Summary of Industry Experience,* October 2003.

[20] NCASI Corporate Correspondent Memorandum No. 06-014, *Information on Retrofit Control Measures for Kraft Pulp Mill Sources and Boilers for NO_X, SO_2 and PM Emissions*, June 2006.

2.1.3 SO_2 Control Options

Weyerhaeuser considered the addition of wet and dry SO_2 control options along with the possibility of combustion controls to further reduce the SO_2 emissions from the recovery furnace. Recovery furnaces are by definition chemical recovery units since sodium and sulfur are the major chemicals recovered from the used black liquor sent to the furnace. As a result of their primary purpose, a well designed and properly operated recovery furnace emits little SO_2 under normal, steady state operation. New recovery furnaces can be expected to have essentially no SO_2 emissions during steady state operations while existing recovery furnaces have continuous low rate SO_2 emissions. All recovery furnaces experience uncontrolled, highly sporadic, unpredictable, and short duration "spikes" in SO_2 emissions. The steady-state emissions occur most operating hours of the year. As a result, a wet lime or limestone scrubber would not actually remove much SO_2.

NCASI reports that neither a **wet lime nor a limestone scrubber** has been successfully demonstrated on a recovery furnace in the United States.[21] As a result, the ability of such a scrubber to reduce SO_2 emissions is theoretical, not demonstrated.

While the addition of a **Semi-Dry or Dry sorbent injection** system preceding the existing ESP is available technology, Weyerhaeuser did not evaluate this option in depth since this would not provide a substantial emission reduction compared to the existing system. A spray dryer system removes SO_2 by injecting a sorbent such as lime or sodium bicarbonate into the flue gas. The existing recovery boiler flue gas handling system inherently acts like and achieves comparable results to an add-on sorbent injection system. As noted earlier, the particulate collected emitted by the recovery furnace is composed largely of sodium carbonate and bicarbonate. These sodium salts are present in excess of the quantity of SO_2 in the flue gas and act as an acid gas sorbent scrubbing agent. The reacted flue gas particulate is then collected by the recovery furnace economizer and ESP and returned to the Kraft chemical recovery process. The addition of an external sodium based dry sorbent injection system or injection of sodium based sorbent into the furnace would be redundant to the sodium based scrubbing system existing in the recovery furnace.

Injection of calcium based sorbent in the flue gas would render the recovered saltcake unusable. The presence of calcium would cause unmanageable scaling and plugging in the black liquor mix tanks, black liquor concentrators, furnace feed lines, boiler tubes, and economizer passages, saltcake collection hopers, the smelt dissolving tank and associated piping. The contaminated saltcake is anticipated to become a waste requiring disposal rather than a recovered byproduct. The ash disposal costs have not been evaluated in detail, but Weyerhaeuser believes the costs would be considerable due to the large volume of material involved.

[21] Ibid.

At this time, there are no known installations of semi-dry or dry sorbent injection to control SO_2 from a recovery furnace. Weyerhaeuser does not consider these technologies as technically feasible.

Weyerhaeuser proposes that the existing operations of the recovery furnace including tertiary air deliver and black liquor concentrators be considered as BACT for SO_2 from this furnace.

2.1.4 Weyerhaeuser's BART Proposal for the Recovery Furnace

For PM/PM_{10} control, Weyerhaeuser proposed BART is the existing ESP with an emission limit of 0.02 grain/dscf as BART.

For NO_X control, Weyerhaeuser proposed proper operation BACT of the existing tertiary, staged combustion system meeting the BACT emission limitation of 140 ppm NO_X as BART for control of NO_X emissions from the Recovery Furnace.

For SO_2 control, Weyerhaeuser proposed proper operation of the existing tertiary, staged combustion system meeting the BACT emission limitation of 75 ppm SO_2 as BART for control of NO_X emissions from the Recovery Furnace.

2.2 No. 10 Smelt Dissolver Tank Control Options

As discussed in Section 1.3.2, a wet scrubber is currently used to reduce PM/PM_{10} emissions. This wet scrubber also provides some reduction of sulfur compound emissions. A smelt dissolver tank's exhaust stream has high moisture content (typically 25 to 40 percent) and almost no flow rate, eliminating many control options that require a positive air flow for operation.

2.2.1 PM_{10} Control Options

For smelt dissolver tanks, various wet scrubbing systems are considered BACT level of control. The current BACT emission control system is a high efficiency wet scrubber. The No. 10 Smelt Dissolver Tank has a BACT emission limitation of 0.120 lb/ton black liquor solids. This is the most stringent BACT limitation in the EPA RACT/BACT/LAER database of permitted and constructed emission controls in the U.S. and is more stringent than the federal MACT standard of 0.20 lb/ton black liquor solids.

Weyerhaeuser did not evaluate improvements to or replacement of the current particulate control technology on the No. 10 Smelt Dissolver Tank.

Weyerhaeuser proposed the current particulate control system meeting the BACT emission limit of 0.12 lb/ton black liquor solids as BART for particulate emissions from the No. 10 Smelt Dissolver Tank.

2.2.2 NO_X Control Options

NO_X control technologies are not evaluated for the Smelt Dissolver Tank. It is not a combustion source, and the materials processed are not a source of NO_X.

2.2.3 SO_2 Control Options

Smelt dissolver tanks are a negligible source of SO_2. As such, Weyerhaeuser did not evaluate additional controls in detail; though they note that adding a wet ESP could be technically feasible, but would likely result in an increase in reduced sulfur compound (odor) emissions. A smelt dissolver tank's exhaust stream has high moisture content (typically 25 to 40 percent) and almost no flow rate, making usage of a spray dryer/dry ESP system technically infeasible.[22]

2.2.4 Weyerhaeuser's BART Proposal for the No. 10 Smelt Dissolver Tank

For PM/PM_{10} control, Weyerhaeuser proposed to continue using the existing high efficiency scrubber meeting the BACT emission limitation of 0.120 lb PM/ton black liquor solids fired as BART. Weyerhaeuser proposes no additional controls for SO_2 or NO_X, as the No. 10 Smelt Dissolver Tank is not a source of those pollutants.

2.3 No. 11 Power Boiler Control Options

As discussed in Section 1.3.3, the No. 11 Power Boiler has an over fire air system to provide for efficient combustion. A multiclone followed by an ESP is currently used to reduce PM/PM_{10} emissions. Trona injection after the multiclone and before the ESP is used for SO_2 reductions and combustion control is used to achieve NO_X control.

2.3.1 PM/PM_{10} Control Options

Table 2-1 lists six identified PM/PM_{10} control technologies along with Good Operating Practices. Since the No. 11 Power Boiler currently uses a multiclone and an ESP, only those controls that provide at least as much control as the multiclone/ESP combination were considered in detail.

The use of **fabric filters** to control particulate matter emissions from wood-fired and combination fuel boilers has rarely been implemented. Their use on pulverized coal-fired utility boilers is relatively common, but there are operational and boiler exhaust temperature differences that reduce the comparability of these two uses. The use of fabric filters on wood-fired units is a potential fire hazard due to the potential of burning cinders escaping the multiclone, temperature excursions, and/or operating upsets. In pulverized coal boilers, there are no cinders as combustion is complete and there are exhaust gas cooling operations (economizers, air

[22] NCASI, *Corporate Correspondence Memo CC-06-14: Information on Retrofit Control Measures for Kraft Pulp Mill Sources and Boilers for NO_X, SO_2, and PM Emissions*, June 4, 2006.

preheaters, feed water heaters) that may not exist on wood-fired units. Fabric filters can ignite or melt depending on the fabric used and the quantity of combustible particulate on the filters. Because of this, fabric filters are rarely used on wood-fired and combination fuel boilers.

Fabric filters have been successfully used on some wood-fired boilers that burn wood residue or bark stored in salt water because the salt reduces the fire hazard. Weyerhaeuser does not use significant amounts of wood waste that has been stored in salt water. Therefore, the use of fabric filters to control particulate matter emissions from the No. 11 Power Boiler is proposed to be technically infeasible due to fire hazard.

The existing **dry ESP** was permitted in 2003/04 and began operation in 2006 as a RACT control technology. This new ESP installation replaced an old electrified gravel bed system. As part of this BART evaluation, Weyerhaeuser did evaluate adding an additional field to the new ESP system. Prior to looking at costs, Weyerhaeuser discounted the option due to the lack of space to install an additional field to the ESP. The site in the area of the ESP is very constrained due to underground and overhead utilities, the new stack, vehicle turning areas, and rail lines. More details are available in Weyerhaeuser's BART Analysis Report.

While replacing the current dry ESP with a **wet ESP** is an available approach in some cases, Weyerhaeuser did not evaluate that option. Wet ESPs work well in situations with large amounts of condensable particulate or high resistivity ashes. The removal efficiency of a wet ESP is the same as a dry ESP. This boiler with its multiclone system and the use of multiple fuels does not generate a high resistivity ash or a lot of condensable particulate matter. A wet ESP has a wastewater discharge that must be addressed. There is no advantage to the use of a wet ESP in this situation or increase in particulate removal to be achieved.

Weyerhaeuser proposed their current multiclone/dry ESP system, meeting an emission limit of 0.050gr/dscf, as BART for the No. 11 Power Boiler.

2.3.2 NO_X Control Options

As noted before, the No. 11 Power Boiler is a load-following spreader-stoker combination fuel boiler. It combusts wood-waste, sludge, western sub-bituminous coal, and No. 6 fuel oil. The spreader-stoker design uses a simple form of staged combustion, providing under fire air (air supplied under the fire grate), a small amount of air to spread the fuel in the boiler and one stage of over fire air above the elevation of the spreaders. Most combustion occurs on the fire grate at temperatures that favor fuel bound NO_X formation over thermal NO_X.

As part of the 2006 boiler upgrade project that resulted in installation of the new ESP, Weyerhaeuser also **replaced the air distribution system** in the No. 11 Power Boiler. The size and location of over fire air ports changed as well as the total quantity of air delivered to the firebox. The previous over fire air distribution system was undersized and provided little mixing of the over fire air with combusting fuel in the boiler. The revised over fire air system uses

fewer air ports, and higher velocity air to allow the over fire air to penetrate to the center of the combustion zone and improve overall combustion efficiency.

As a follow-up to the over fire air system changes, Weyerhaeuser implemented a program to optimize the distribution of combustion air between the new over fire air system, the under fire air system, and the air used to spread the fuel on the grate. The optimization focused on reduction of emissions and maximizing fuel combustion efficiency. This has lead to a moderate reduction in NO_X emissions (10 to 20 percent) from the boiler compared to the pre-modification condition. Weyerhaeuser did not evaluate any additional combustion modifications that might reduce NO_X concluding it would be technically infeasible to implement any of the remaining available combustion modifications.

As part of their BART evaluation, Weyerhaeuser looked closely at the installation of **SCR and SNCR** on this boiler. They evaluated installation of an SCR unit between the boiler and the ESP and the addition of SNCR to the boiler.

SCR involves the injection of an ammonia or urea solution into the hot fuel gases prior to a catalyst. The catalyst reduces the temperature at which the reaction of nitrogen oxides and ammonia occurs. The nitrogen oxides and ammonia react to form nitrogen gas and water. Standard NO_X catalysts operate at approximately 850ºF while low temperature catalysts operate at about 450ºF.

Weyerhaeuser's evaluation of SCR indicated that to obtain the correct temperature for the standard catalyst to operate would require removal of some of the current boiler tubes. This would have the effect of reducing the maximum quantity of steam produced by this boiler requiring a non-BART boiler to be operated to replace the missing steam. There are construction and difficulties as well as issues related to installation location for an SCR unit placed immediately after the boiler. This area of the plant is very congested with underground utilities, overhead conveyors, and truck and rail routes. A cost evaluation of an SCR system in the boiler that would provide 75 percent reduction in NO_X would have a cost effectiveness of about $13,000/ton NO_X reduced, for a reduction of 1,146 tons/year.

They did evaluate installation of the SCR unit after the ESP, but noted that the temperature at this location is below the optimum range for a low temperature catalyst and would require the combustion of fuel (probably natural gas) to reheat the flue gas to the necessary temperatures. Weyerhaeuser does not consider an SCR in this location to be technically feasible. As noted before, space in this area of the plant is limited.

SNCR was also evaluated for this boiler. In SNCR process, ammonia, an ammonia water solution, or a urea water solution is sprayed into the combustion zone at a location where the temperature is in the range of 1600 to 1800ºF. Since this boiler is a load-following boiler (while the recovery furnace is operated as a base load boiler), there will need to be several levels of ammonia injection into the flue gases.

To date, there are no installations of SNCR on boilers of this type in the pulp and paper industry. There are load-following boilers in other industries that utilize SNCR. Their experience has provided the operational and design information necessary to successfully implement SNCR on load-following boilers. In spite of potential operational difficulties, Weyerhaeuser did evaluate the cost effectiveness of installing SNCR on this boiler. At an estimated removal efficiency of 25 percent, the cost effectiveness is estimated to be $6,686/ton NO_X reduced. The reduction in NO_X would be 382 ton/year.

Weyerhaeuser proposed to utilize its existing combustion control system as BART for NO_X emissions.

2.3.3 SO_2 Control Options

Weyerhaeuser currently operates a **dry sorbent (trona) injection system** on the No. 11 Power Boiler. This was installed as part of the boiler upgrade project and provides a small removal of SO_2 from the flue gas.

The current trona-based system is designed to remove 25 percent of the SO_2 from the boiler. The uncontrolled concentration of SO_2 in the boiler exhaust is 80 ppm. Trials after installation were made and the trona injection rate optimized to meet the removal guarantee. Trona was selected as the preferred sorbent due to cost and simplicity of equipment required compared to use of sodium bicarbonate or calcium based sorbents.

In addition to the SO_2 control provided by the trona system, boilers utilizing wood plus other fuels exhibit lower SO_2 emissions than a boiler burning only coal or fuel oil. This is due to the production and presence of calcium and sodium oxide from the minerals in the wood and dirt on the wood. The calcium and sodium oxides react with the SO_2 in the flue gas and produce sulfites and sulfate particulates that are removed by the particulate system.[23]

Continuous emission monitoring indicates the trona system and the fly ash SO_2 removal result in a controlled SO_2 emission rate of about 164 lb/hour or about 0.23 lb/MMBtu. Weyerhaeuser evaluated use of **low sulfur fuels** and the installation of a wet calcium scrubber instead of the current dry sorbent injection.

The primary fuels used in this boiler are waste wood, pulp mill sludges, low sulfur western coal, and No. 6 fuel oil. As a result of the sulfur content of the No. 6 oil and coal, Weyerhaeuser looked at the feasibility of replacement with lower sulfur fuel.

Weyerhaeuser is a small purchaser of coal. As a result, it is unable to negotiate for lower, preferred pricing or easily dictate coal contract terms. This limits its ability to acquire the lowest sulfur coal available on the market. The current coal they use is a Powder River Basin sub-

[23] National Council for Air and Stream Improvement, Technical Bulletin 640, Sulfur Capture in Combination Bark Boilers.

bituminous coal with 0.4 to 0.5 percent sulfur by weight. The coal used during the baseline emissions period was also a Powder River Basin coal from a different mine with a sulfur content of 0.5 to 0.9 percent.

All other boilers at the mill are equipped to utilize either natural gas or No. 6 fuel oil supplied by a single 30,000 gallon fuel tank. The No. 6 oil is used in the No. 10 Recovery Furnace for startup and flame stabilization when needed and for startup of the No. 11 Power Boiler. For the No. 11 Power Boiler, fuel oil supplies less than 0.5 percent of the annual heat input to the boiler. The current No. 6 oil is specified to contain less than two percent sulfur by weight. Any changes to the fuel oil supply to reduce SO_2 from the No. 11 Power Boiler would also affect the SO_2 emissions from all other boilers. Conversion of the system to use a lighter, lower sulfur fuel oil such as No. 2 oil would entail extensive replacement and upgrading of pumps, burners, and fittings to accommodate the less viscous, lighter fuel oil. Due to the low usage rate of fuel oil plant-wide, Weyerhaeuser concluded that converting the fuel oil system to handle a lighter, lower sulfur fuel oil would provide negligible SO_2 reductions from this boiler (and all other boilers capable of using fuel oil at the plant). As a result, Weyerhaeuser did not pursue this option further.

The opportunity to **replace the existing trona system** was evaluated. The primary option considered would substitute the dry trona injection system with a hydrated lime injection system. The damp lime dries quickly in the hot flue gases and is effective in removing SO_2 from the flue gas. Weyerhaeuser determined that the injection of hydrated lime would present some technical difficulties. If they were to utilize the available space for a hydrated lime system where the trona system currently exists, the hydrated lime would be injected upstream of the induced draft (ID) fan and utilize the ID fan for mixing of the sorbent with the flue gas.

The primary difficulty anticipated to occur would be the dried and drying lime collecting on the ID fan blades causing the ID fan to fail or be prone to significantly increased maintenance needs. Loss of the ID fan would cause the boiler to shutdown to prevent unsafe or explosive conditions from occurring in the boiler. Loss of the ID fan would result in the boiler being taken out of service until the fan was repaired. Catastrophic loss of the ID fan could cause boiler to explode or require emergency shutdown of the boiler so the fan blades could be cleaned or replaced. Such a shutdown would require other fossil fueled boilers at the plant be started up and used to provide necessary steam at the plant, adding significant costs to plant operations. These operational and cost difficulties caused Weyerhaeuser to conclude this option is not technically feasible.

Two **wet lime/limestone technologies** were evaluated for cost effectiveness using the EPA CUECost emission control cost model. A wet limestone/forced oxidation and a lime spray dryer system were evaluated for cost effectiveness. The wet limestone/forced oxidation system was based on using a conventional wet scrubber such as a spray tower with limestone slurry as the scrubbing liquor. In a lime spray dryer, the wet scrubber is replaced with a slurry injection into the flue duct and the resulting dry material is collected in the ESP. The capital cost to add a wet

scrubber/forced oxidation system on the No. 11 Power Boiler is estimated to be about $75 million. The lime spray dryer technology is estimated to be at about $55 million.

In both cases, the cost effectiveness is above $17,000/ton and is not considered cost effective by Weyerhaeuser. One additional constraint not entirely accounted for in the CUECost model is the amount of existing new and old equipment that would need to be demolished to provide adequate space for the new wet scrubber and particulate control. Due to the location of this boiler, its support equipment and other plant process structures and underground piping, Weyerhaeuser has concerns if there is adequate space to install additional emission controls on this boiler.

Weyerhaeuser also evaluated installation of a wet lime/limestone scrubber after the ESP. Using a cost estimate for another Weyerhaeuser facility, scaling it to this boiler's size, but not including costs to relocate existing equipment and above and underground structures, indicates a cost effectiveness of $24,000/ton.

After considering the available control options, Weyerhaeuser proposed that the existing trona system combined with the existing low sulfur fuel mix as BART for SO_2 from this boiler.

2.3.4 Weyerhaeuser's BART Proposal for the No. 11 Power Boiler

For PM/PM_{10} control, Weyerhaeuser proposed continued use of the existing multiclone/ESP system meeting a limit of 0.050 grain/dscf as BART.

For NO_X control, Weyerhaeuser proposed continued operation of the boiler's current staged combustion system and fuel mix as BART.

For SO_2 control, Weyerhaeuser proposed continued use of low sulfur fuels and operation of the existing trona dry sorbent injection system as BART.

2.4 Weyerhaeuser's Proposed BART

A summary of the emission controls and emission limitations proposed as BART by Weyerhaeuser is shown in Table 2-4.

Table 2-4. SUMMARY OF WEYERHAEUSER'S PROPOSED BART

Pollutant	Emission Unit	Proposed BART Control Option	Control Option Emissions Level or Control Efficiency
PM_{10}	No. 11 Power Boiler	Existing ESP	0.050 grain/dscf @ 7% O_2 (current limit)
	No. 10 Recovery Furnace	Existing ESP	0.027 gr/dscf, per test, and 0.020 grain/dscf, annual average (current BACT limits in PSD 92-03, Amendment 4)
	Smelt Dissolver Tank	Existing High Efficiency Wet Scrubber	0.120 lb/BLS (current BACT limit in PSD 92-03, Amendment 4)
NO_X	No. 11 Power Boiler	Existing Combustion System	(0.30x + 0.70y)/(x + y) lb per MMBtu (derived from solid fossil fuel, liquid fossil fuel and wood residue) (40 CFR 60.44(b) which also defines the variables)
	No. 10 Recovery Furnace	Existing Staged Combustion System	140 ppm @ 8% O_2 (current BACT limit in PSD 92-03, Amendment 4)
	Smelt Dissolver Tank	N/A	No limit required
SO_2	No. 11 Power Boiler	Fuel mix and trona injection system	1000 ppm @ 7% O_2, 1-hour average, (0.8y +1.2z)/(y +z) lb per MMBtu. (derived from burning a mixture of liquid and solid fossil fuel) (40 CFR 60.43(b) which also defines the variables)
	No. 10 Recovery Furnace	Good Operating Practices	75 PPM @ 8% O_2 (current BACT limit in PSD 92-03, Amendment 4
	Smelt Dissolver Tank	N/A	No limit required

3. VISIBILITY IMPACTS AND DEGREE OF IMPROVEMENT

A Class I area visibility impact analysis was performed on the BART-eligible emission units at Weyerhaeuser using the CALPUFF model with four kilometer grid spacing as recommended by Washington's BART modeling protocol. The modeled 24-hour average visibility impacts at each Class I area within 300 km of the Weyerhaeuser Mill and the Columbia River Gorge National Scenic Area are shown in Table 3-1.

Table 3-1. BASELINE VISIBILITY MODELING RESULTS

Class I Area	8th High 2003 Δdv	8th High 2004 Δdv	8th High 2005 Δdv	2003/05 22nd High Δdv
North Cascades National Park	0.127	0.223	0.227	0.218
Glacier Peak Wilderness Area	0.214	0.287	0.206	0.248
Olympic National Park	0.470	0.654	0.638	0.583
Alpine Lakes Wilderness Area	0.274	0.513	0.398	0.400
Mount Rainier National Park	0.540	0.973	0.572	0.595
Goat Rocks Wilderness Area	0.384	0.535	0.457	0.457
Mount Adams Wilderness Area	0.433	0.440	0.436	0.440
Mount Hood Wilderness Area	0.725	0.677	0.628	0.689
Mount Jefferson Wilderness Area	0.440	0.375	0.287	0.367
Mount Washington Wilderness Area	0.303	0.345	0.229	0.289
Three Sisters Wilderness Area	0.340	0.361	0.257	0.291
Diamond Peak Wilderness Area	0.203	0.224	0.148	0.192
Class II Area Evaluated				
Columbia River Gorge National Scenic Area	0.809	0.662	0.637	0.675

The results presented in Table 3-1 indicate that the 98th percentile visibility impact calculated exceeds the 0.5 dv contribution threshold for five of the 12 Class I areas within 300 km of the plant (the shaded cells). The maximum 98th percentile visibility impact occurs at Mt. Rainier National Park.

The maximum 24-hour emission rates that were modeled are shown in Table 3-2. These are the maximum rates during the 2003-2005 time period and do not reflect any reductions that may have been achieved at the No. 11 Power Boiler through the replacement of the electrified gravel bed particulate control with the current ESP and trona injection system in 2006. This project occurred after the period of time modeled for visibility impacts, but did not result in the imposition of any new or lower emission limitations. As a result, no emission reduction was modeled to reflect this replacement control equipment.

Table 3-2. MAXIMUM 24-HOUR AVERAGE ACTUAL EMISSION RATES

Emission Unit	NO_X (lb/hr)	SO_2 (lb/hr)	H_2SO_4 (lb/hr)	Filterable PM_{10}[a] (lb/hr)	Total PM_{10}[b] (lb/hr)
Recovery Boiler	222	2	4	10	22
Smelt Dissolver Tank	0	0	0	4	6
No. 11 Power Boiler	426	344	3	48	63

[a] Filterable PM_{10} represents the sum of the modeled filterable PM speciation groups of PMC, PMF, and EC.
[b] Total PM_{10} (TPM_{10}) represents the sum of the modeled filterable and condensable PM, including sulfuric acid (H_2SO_4).

Net Visibility Improvement

Weyerhaeuser did not evaluate the potential visibility reductions that could accrue from the emission controls evaluated. None of the controls evaluated were technically or economically feasible in Weyerhaeuser's opinion. As explained above, the actual emission reductions from the upgrades and modifications completed in 2006 to the No. 11 Power Boiler were also not modeled.

4. ECOLOGY'S BART DETERMINATION

Ecology has reviewed the information submitted by Weyerhaeuser. Ecology agrees with the analyses performed by Weyerhaeuser and has determined that the current levels of control are BART for the three BART-eligible process units. The controls and emission limitations are summarized in Table 2-4 and repeated in Table 4-1 below.

As noted above, Weyerhaeuser has noted a lack of physical space to install certain controls such as additional controls on the No. 11 Power Boiler. In February 2008, Ecology made a site inspection of all the BART eligible units at the Weyerhaeuser facility. Based on that inspection, we agree that there are site constraints on the No. 11 Power Boiler that prevent or would require costly modifications to existing infrastructure to provide space for upgrades and modifications to the particulate and SO_2 controls currently installed.

Table 4-1. ECOLOGY'S DETERMINATION OF EMISSION CONTROLS THAT CONSTITUTE BART

Pollutant	Emission Unit	Proposed BART Control Option	Control Option Emissions Level or Control Efficiency
PM_{10}	No. 11 Power Boiler	Existing ESP	0.050 grain/dscf @ 7% O_2 (current limit)
	No. 10 Recovery Furnace	Existing ESP	0.027 gr/dscf, per test, and 0.020 grain/dscf, annual average (current BACT limits in PSD 92-03, Amendment 4)
	Smelt Dissolver Tank	Existing High Efficiency Wet Scrubber	0.120 lb/BLS (current BACT limit in PSD 92-03, Amendment 4)
NO_X	No. 11 Power Boiler	Existing Combustion System	(0.30x + 0.70y)/(x + y) lb per MMBtu (derived from solid fossil fuel, liquid fossil fuel and wood residue) (40 CFR 60.44(b) which also defines the variables)
	No. 10 Recovery Furnace	Existing Staged Combustion System	140 ppm @ 8% O_2 (current BACT limit in PSD 92-03, Amendment 4)
	Smelt Dissolver Tank	N/A	No limit required
SO_2	No. 11 Power Boiler	Fuel mix and trona injection system	1000 ppm @ 7% O_2, 1-hour average, (0.8y +1.2z)/(y +z) lb per MMBtu. (derived from burning a mixture of liquid and solid fossil fuel) (40 CFR 60.43(b) which also defines the variables)
	No. 10 Recovery Furnace	Good Operating Practices	75 PPM @ 8% O_2 (current BACT limit in PSD 92-03, Amendment 4
	Smelt Dissolver Tank	N/A	No limit required

4.1 No. 10 Recovery Furnace BART Determination

For PM_{10} emissions control, Ecology determined that BART is the current level of control provided by the existing ESP and BACT established emission limitation. No new technologies

for controlling PM have become available since the BACT limitation was established, so Ecology accepts this BACT limit as BART.

For NO_X control, Ecology determined that BART is the current level of control established in PSD 92-03, which is proper operation of the existing tertiary, staged combustion system to both promote optimum combustion and control the Kraft recovery sodium sulfate reactions. Good combustion practices that optimize the staged combustion inherent in the design of the furnace are the only available technology for control of NO_X. All alternative NO_X control technologies were found to be technically or financially infeasible.

While not evaluated by Weyerhaeuser, the potential to install a LoTOx® system on the recovery furnace was evaluated by Ecology using information acquired through evaluations for its potential use at an oil refinery. To date, Ecology has been unable to find any other location that uses the LoTOx system on any combustion unit outside of the oil refining industry except for one lead smelter.

The principle problems with the use of the LoTOx technology on the Weyerhaeuser recovery furnace is the retrofit costs, determining where to locate the equipment, and what impacts may occur on the wastewater treatment system resulting from the new stream of nitrates being added. LoTOx operates best at a maximum temperature below 300°F. The installation of LoTOx on the recovery furnace would entail at a minimum rerouting of the ducting from the ESPs to the stack to the location of the new unit, installation of water supply, oxygen/ozone supply equipment, installation of the LoTOx reactor/scrubber and either a new stack or routing the wet scrubber exhaust to the existing stack. It is more likely that a new stack would be needed to handle the corrosion issues resulting from the "wet stack" conditions that will occur after the wet scrubber portion of the LoTOx system.

Ecology has not done an exhaustive cost analysis for installation of LoTOx on this furnace. We have reviewed the cost analysis performed for the CO boiler at the Tesoro Refinery and cost analyses performed in Texas as part of their cement kiln study and other reviews of the technology. Based on that review, we have found that given an equivalent "new" installation or where LoTOx is not required to add to or replace an existing control system that LoTOx and SNCR are approximately equal in cost effectiveness in $/ton removed. However, the much more extensive retrofit costs associated with this installation lead us to the conclusion that the cost will be much higher. We agree with Weyerhaeuser that the cost to install and use SNCR of $6,600/ton removed not cost effective for SNCR. With the cost for LoTOx anticipated to be higher yet, we conclude the technology while available and technically feasible is not financially feasible.

Again, for add-on SO_2 control, Ecology has also evaluated the opportunity to add a new wet scrubber to the recovery furnace system. Unlike the statements by NCASI that there are no SO_2 scrubbing systems operating on Kraft recovery furnaces, Ecology is aware that there are at least

two such units operating in Washington.[24] In one case, an SO_2 emission limitation of 10 ppm was imposed by Ecology in permitting. In the other case, no emission removal credit was given to the unit, establishing an emission limit of 150 ppm based on capability of the recovery furnace. As with the LoTOx system, this would require extensive rerouting of fuel ducts from the existing dry ESPs to a new wet scrubber (or even to insert a wet scrubber between the furnace and the ESPs). As noted above, the existing stack is designed for "dry" conditions and is unlikely to be able to sustain continuous operation with a saturated flue gas before suffering corrosion failure. As a result, we do not believe that adding a "water only" wet scrubber for additional SO_2 control is an option.

For SO_2 control, Ecology has determined that BART is operation of the furnace using a tertiary air system, use of "good operating practices" and meeting the emission limitation in PSD 92-03, Amendment 4. Good operating practices entail promoting the efficient recovery of sulfur by maintaining the char bed at a level that results in maximum retention of sulfur in the smelt, and minimize emissions of SO_2. No add on SO_2 control technology was found to be technically or financially feasible for installation on this recovery furnace.

4.2 No. 10 Smelt Dissolver Tank BART Determination

For PM_{10} control, Ecology determined that BART is the current level of control provided by the existing wet scrubber to comply with the existing BACT limit of 0.120 lb PM_{10} per ton BLS. Since the No. 10 Smelt Dissolver Tank is not a source of NO_X and a negligible source of SO_2 no additional controls are required for those pollutants.

4.3 No. 11 Power Boiler BART Determination

For PM/PM_{10} control, Ecology determined that BART is the current level of control provided by the recently installed dry ESP. Ecology agrees with Weyerhaeuser that there are no new emission controls available that will remove more particulate matter than the current system. For NO_X control, Ecology determines that BART is to continue using good operation of the boiler's staged combustion system BART as optimized in 2006/07. Ecology agrees with Weyerhaeuser's analysis that no other NO_X reduction technology exists that is both technically and financially feasible for installation on this unit.

We have also evaluated the option to install a LoTOx system on this boiler. We believe that this technology is available and technically feasible for use on this power boiler. However, we could find no installation of the technology on a boiler using solid fuels. This then brings the technology transfer of this technique into question.

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[24] The units are advertised as heat recovery systems (heat recovery scrubbers) intended to provide hot water at about 140 to 150°F for use in plant processes. Prior to the hot water production, an alkaline scrubbing section is included to remove SO_2 and any particulates remaining after the particulate control system. In one case, Ecology recognized that the process removed SO_2 and issued a permit reflecting that situation. In another case, Ecology accepted the company's proposal that no additional removal was provided by the heat recovery scrubber system.

The area where a LoTOx system could be installed is already highly constructed with underground and overhead utilities and structures. The wet, potentially acidic nature of the exhaust gas from the control is incompatible with a dry ESP system. There is no opportunity on this boiler to add it to the outlet of the ESP system due to the simple lack of space to install it. For these and the reasons given for the recovery furnace, Ecology does not consider a LoTOx system to be a cost effective emission control system to install on this power boiler.

For SO_2 control, Ecology determines that BART is continued operation of the existing trona dry sorbent injection system, and to continue to practice good operation of the boiler aimed at minimizing fuel oil firing.

APPENDIX A. PRINCIPLE REFERENCES USED

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APPENDIX B

Cost effectiveness calculation for SO_2 controls at Weyerhaeuser's No. 11 Power Boiler.

The values in the table are copied from the CUECost model output included in the Weyerhaeuser BART Analysis Report and are reformatted and converted into the annualized cost effectiveness value. The CUECost model is a conservative cost analysis model developed for EPA and is suitable for planning level cost analyses.

Interest Rate			0.07	based on annual average lb/hr rate.			
CRF			0.0944				
	Removal rate	Capital Costs (CUECost)	Annualized capital	O&M costs (CUECost)	Total annual cost	Controlled emissions	$/ton Controlled
LSFO	0.95	74193089	7003827.6	6305121	13308949	682.404	$ 19,503
LSD	0.9	55437854	5233333.4	5824429	11057762	646.488	$ 17,104

APPENDIX C. ACRONYMS/ABBREVIATIONS

BACT	Best Available Control Technology
BART	Best Available Retrofit Technology
BLS	Black Liquor Solids
dv	Deciview(s)
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
ESP	Electrostatic Precipitator
FCCU	Fluid Catalytic Cracking Unit
FGR	Flue Gas Recirculation
LAER	Lowest Achievable Emission Rate
LNBs	Low-NO_X Burners
MMBtu	Million British Thermal Units
NCASI	National Council for Air and Stream Improvement
NDCE	Non-Direct Contact Evaporator
NO_X	Nitrogen Oxides
NWCAA	Northwest Clean Air Agency
PM	Particulate Matter
ppm	Parts per Million
ppmdv	Parts per Million Dry Volume
ppmv	Parts per Million by Volume
RACT	Reasonably Available Control Technology
SCR	Selective Catalytic Reduction
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulfur Dioxide
SRU	Sulfur Recovery Unit
SWS	Sour Water Stripper
Tesoro	Tesoro Refining and Marketing Company
TGU	Tail Gas Unit
tpy	Tons per Year
ULNBs	Ultra-low-NO_X Burners
VOC(s)	Volatile Organic Compound(s)