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Dispersion of hydrogen sulfide from wastewater lagoons at a Kraft Pulp Mill Missoula Montana including the 2000 wildfire season. & Maximum Achievable Control Technology (MACT 1) phase 1 methanol analysis

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Dispersion of Hydrogen Sulfide from Wastewater Lagoons at a Kraft Pulp Mill, Missoula, Montana, Including the 2000 Wildfire Season

&

Maximum Achievable Control Technology (MACT 1) Phase 1 Methanol Analysis

by

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B.A. Carroll College, Helena, Montana, 1996

Presented in partial fulfillment of the requirements

for the degree of

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12/23/02

Date

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Dispersion of Hydrogen Sulfide from Wastewater Lagoons at a Kraft Pulp Mill, Missoula, Montana, Including the 2000 Wildfire Season

Advisor: Garon C. Smith GCS

Wastewater from Smurfit-Stone Container's Missoula mill is retained in an 800-acre landscape of ponds for treatment and subsequent release during spring runoff conditions. Anaerobic respiration by pond microbes leads to the emission of H_2S. The mill's operating permit limits H_2S emissions to 50 ppb on a continuous monitoring basis (1-hour averaging period). During the summer of 2000, a bloom of sulfur-reducing bacteria gave rise to increased H_2S emissions from the wastewater ponds. Normal circulation of air in the Missoula Valley would typically have been able to disperse the H_2S below the aesthetic permit limit. Smoke from wildland fires, however, created summertime inversions that prevented effective attenuation of H_2S emissions. Hourly averages of H_2S exceeded 50 ppb for a total of 158 times. Time/date charted data are presented to demonstrate typical H_2S dispersion, and the stagnant H_2S emissions seen in the summer of 2000. PM-10 data (measured simultaneously at a site 15 km SE) are also presented to illustrate the extent of the inversions.

Maximum Achievable Control Technology (MACT 1) Phase 1 Methanol Analysis

Advisor: Garon C. Smith GCS

In February 2000, Stone Container completed construction of the Maximum Achievable Control Technology (MACT) Phase 1 project. New equipment constructed includes: 1. a condensate collection system. 2. a low volume high concentration collection system for equipment venting 3. a steam stripper, 4. a direct fired oxidizer. The MACT Project was promulgated in response to regulations outlined in the 1998 Federal Cluster Rule, an enactment of the EPA initiated Clean Air Act. The mill must show that MACT equipment can capture and remove 92% of the methanol produced within the mill. Methanol is used as a tracer compound in the condensates. EPA studies allow the following assumptions: 1. all other hazardous air pollutants (HAPS) are less than or equal to the methanol concentration; 2. other HAPS are removed with the same efficiency that methanol is removed. Researchers at The University of Montana aided in demonstrating compliance to the State of Montana by analyzing condensate samples for methanol over a 6-month period, and by providing statistical analysis of a comprehensive MACT data set. Representative methanol concentrations were established at condensate collection sites throughout the mill. Process specific collection factors were calculated, allowing the mill to identify the amount of methanol collected in pounds per ton of pulp produced. With MACT equipment the mill collected and removed roughly 3 million pounds of methanol in 2001.

Acknowledgements

Many people contributed both directly and indirectly to the completion of this project. I'd like to first thank my research advisor, Garon Smith. Garon provided excellent guidance for the development of ideas and skills necessary to carry out and complete a professional research product. His involvement in local and state environmental committees has taught me the importance of applying good science and contributing to public policy making in my own community. Next I'd like to thank my committee members, Dr.'s Johnnie Moore, and Chris Palmer. Johnnie has been an extremely supportive co-advisor and never hesitated to help me get started on new projects. My sincerest thanks to Johnnie for helping me become a more objective scientist. I thank Chris for his enthusiasm and insightful suggestions.

Special thanks to Stone Container for providing funding toward my education and research. Thanks to Leif Griffin for allowing me to always put my family first, and teaching me essential project development, presentation, and engineering skills. Leif has been a true mentor and friend in helping me attain this degree. Additional thanks to Lisa Graham, Terry McLaughlin, Neil Marxer, Bob Boschee, Shane Mahn, and many others out at Stone.

Bruce King, Chris Wrobel, Dave Jones and Tony Ward have my thanks for their help and support, computer expertise and humor. I also thank the Smith lab; Paul Miller, Ryan Murray, Baron Arnone, and Erin Schoen. I thank Erin for always keeping me organized and helping me with endless sampling and analysis tasks.

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Last but not least I thank my family; my wife Stephanie, and kids Zachary, Matthew and Jaden, also my parents and siblings. They have made multiple sacrifices allowing me to return to school. They are undeniably my motivation and inspiration.

TABLE OF CONTENTS

Part A: Dispersion of Hydrogen Sulfide from Wastewater Lagoons at a Kraft Pulp Mill, Missoula Montana, Including the 2000 Wildfire Season

Part B: Maximum Achievable Control Technology (Mact 1) Phase 1 Methanol Analysis

List of Tables

List of Figures

List of Appendices

Part A

Dispersion of Hydrogen Sulfide from Wastewater Lagoons at a Kraft Pulp Mill, Missoula Montana, Including the 2000 Wildfire Season

Part A: Dispersion of Hydrogen Sulfide from Wastewater Lagoons at a Kraft Pulp Mill, Missoula, Montana, Including the 2000 Wildfire Season

1. Introduction

Odor control has been of great concern to pulp mills and is an aesthetic nuisance directly related to a mill's presence. Odorous compounds are emitted from both the plant and the effluent treatment system. While scrubbers can control stack emissions, it is more difficult to isolate and control emissions from the effluent treatment system.

Smurfit Stone Container Corporation owns and operates a kraft linerboard mill approximately 20 km northwest of Missoula and 7 km southeast of Frenchtown, Montana. The mill resides in a mountain valley at an elevation of about 930 m. Sufficient sulfates escape the kraft pulping recovery process that significant concentrations reach the wastewater treatment ponds. Microbial respiration by sulfate-reducing bacteria (SRB) in the ponds leads to production of reduced sulfur compounds, primarily hydrogen sulfide, and subsequent release into the ambient air. Releases of H_2S have the potential to offend community residents since odor thresholds for reduced sulfur compounds are between 5 ppb and 30 part per billion (ppb) for most people (Shusterman 1992).

The Missoula mill is subject to ambient air quality violations if hydrogen sulfide levels exceed 50 ppb. This is an aesthetic standard that was designed to minimize noxious odors from the mill. To demonstrate compliance, Stone Container operates two ambient air-monitoring stations near the Missoula mill. Ambient site 1A Moccasin Lane or (#1A) is equipped with meteorological equipment and a hydrogen sulfide monitor. Ambient site 2 well field, Frenchtown or (#2) is equipped with only a hydrogen sulfide monitor. Both ambient sites provide hourly data for H_2S. Data are reported to the

Montana Department of Environmental Quality (DEQ), and are eventually incorporated into EPA's Aerometric Information Retrieval System (AIRS) database.

Historically, H_2S data were only reviewed when levels approached compliance limitations. However, the mill recognized a need to suppress H_2S emissions from the ponds. A comprehensive review of historical data would allow the mill to envisage the behavior of H_2S emissions and identify any patterns. This would give the mill more insight for mitigating the production of H_2S in their wastewater treatment system.

For the past 10 years, the number of exceedances has been acceptably low. But during the summer of 2000, when Montana was experiencing a severe forest fire season, the mill registered 158 excursions above the 50 ppb permit limit over a 3-month period. This was of concern to mill management so they requested assistance from collaborative researchers at The University of Montana (UM) Chemistry Department to seek any connection between the fires and the high H_2S readings.

UM researchers performed data mining (careful review of historical data) on 11 years of H_2S emissions using the data from the mill's ambient monitor sites. Data were plotted on monthly date/time grids to reveal underlying time-of-day emission patterns. Furthermore, ten years of hourly data (1990-1999) were averaged to reduce the "noise" inherent in daily weather systems and emphasize fundamental patterns under non-fire summer conditions.

Hourly PM-10 (10 micron) particulate data were also extracted for the summer of 2000 fire season from the Montana Department of Environmental Quality (DEQ) air monitoring site at Boyd Park in Missoula (about 20 km east of the mill). During the summer months, PM-10 data are good surrogate measures of smoke particulates generated by wildland fires. These data were systematically analyzed for any evidence of correlation between fire smoke and high H_2S readings.

Purpose

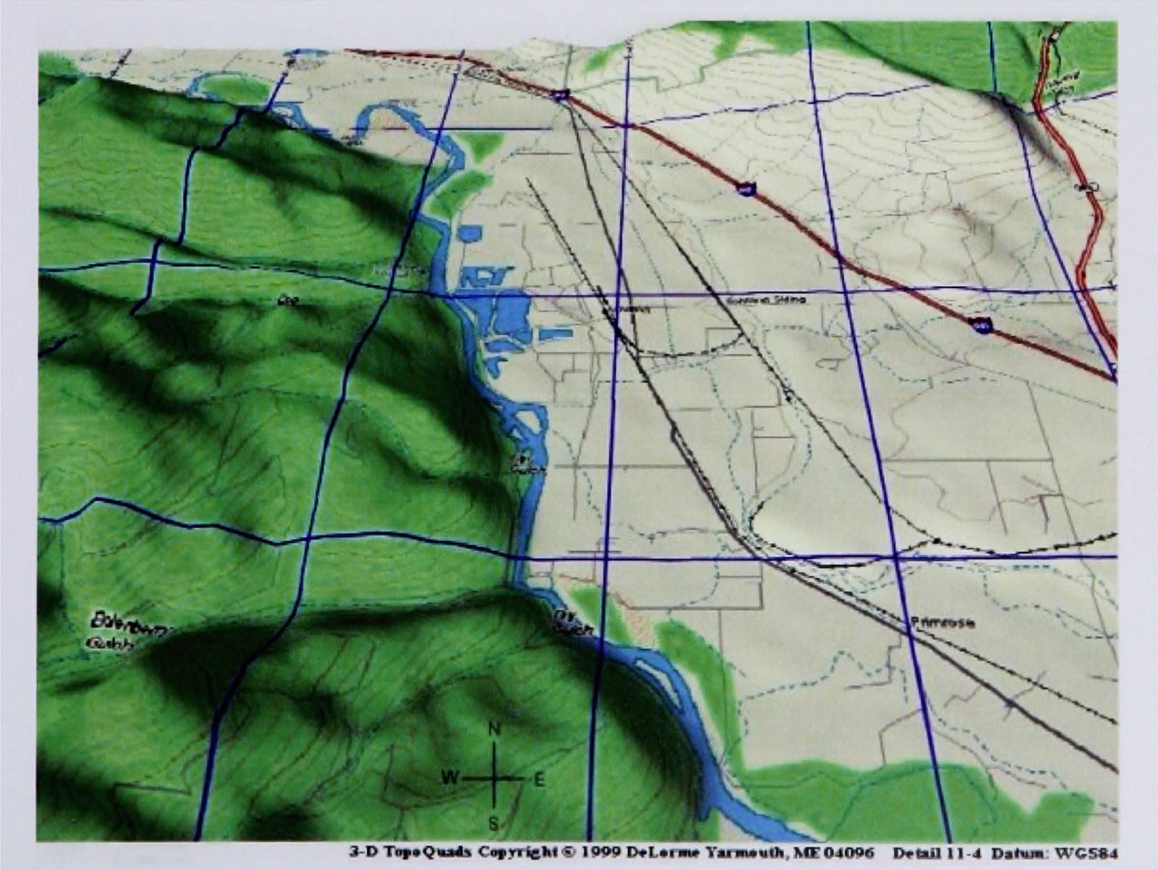
It was the purpose of this study to develop background information about the dispersion of H_2S gas from the Smurfit-Stone Container mill in Frenchtown and to identify any obvious trends concerning ambient H_2S emissions before and during the summer of 2000 wild land fire season.

2. Background

2.1 Site and Facility Description

The Smurfit-Stone Container pulp and paper mill is located in a mountain valley approximately 20 km northwest of Missoula, Montana and 7 km southeast of Frenchtown. Agricultural land borders the mill on the north, east, and south sides. The Clark Fork River borders the mill on the west side (Figure 2-1). The mill produces unbleached linerboard and uses the kraft process for producing virgin pulp. Additional pulp is produced from recycling old corrugated containers (OCC). With nearly 450 employees, the mill has been operating 45 years, and has a production capacity of more than 2700 oven dried tons of pulp per day (ODTPD). Currently the mill produces roughly 1100 ODTP per day.

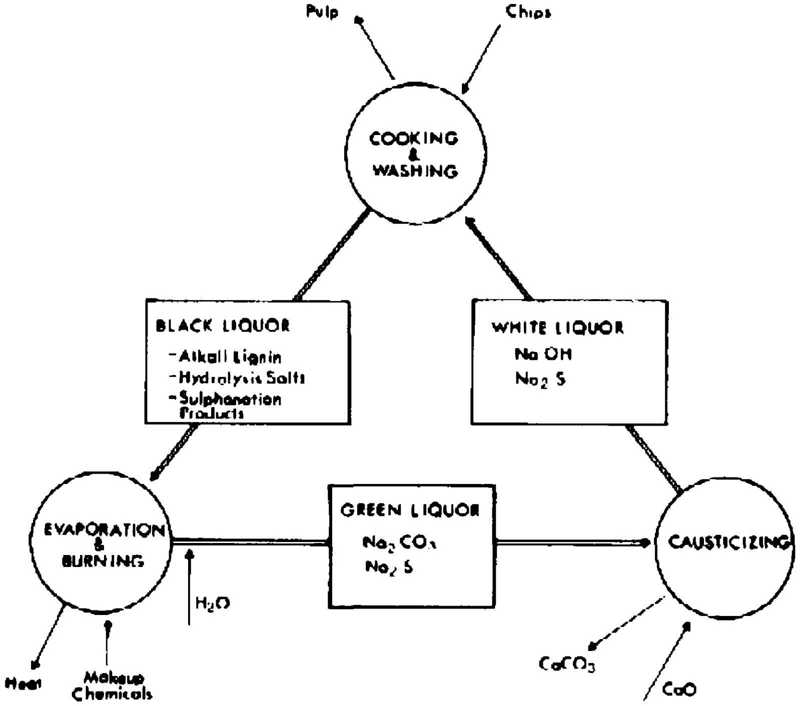
Figure 2-1 Smurfit Stone Container and Surrounding Geography



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 Detail 11-4 Datum: WGS84

The Missoula mill includes chipping, pulping, and linerboard production facilities. The kraft process is chemical intensive and requires a complex recovery system. White liquor containing active cooking chemicals (Na_2S and NaOH) is used for cooking wood chips. Swollen lignin in the chips is split into fragments by the hydrosulfide (SH^-) and hydroxide (OH^-) ions present in the liquor thereby freeing the wood fiber. Cooked fibers are washed and dried to make paper. Used cooking liquor (black liquor) is concentrated in a series of evaporators then flows to a recovery furnace where makeup chemicals are added (Na_2SO_4) and inorganic smelt (Na_2S, Na_2CO_3) is recovered. The smelt is dissolved in water to form green liquor and then enters the recausticizing plant where sodium bicarbonate is converted back to sodium hydroxide. The resulting white liquor is clarified and reused for cooking (Figure 2-2). Sulfur compounds in the mill wastewater primarily come from routine washer liquids and sludge released into lagoons from the recausticizing plant.

Figure 2-2 The Kraft Liquor Cycle (Smook 1992)

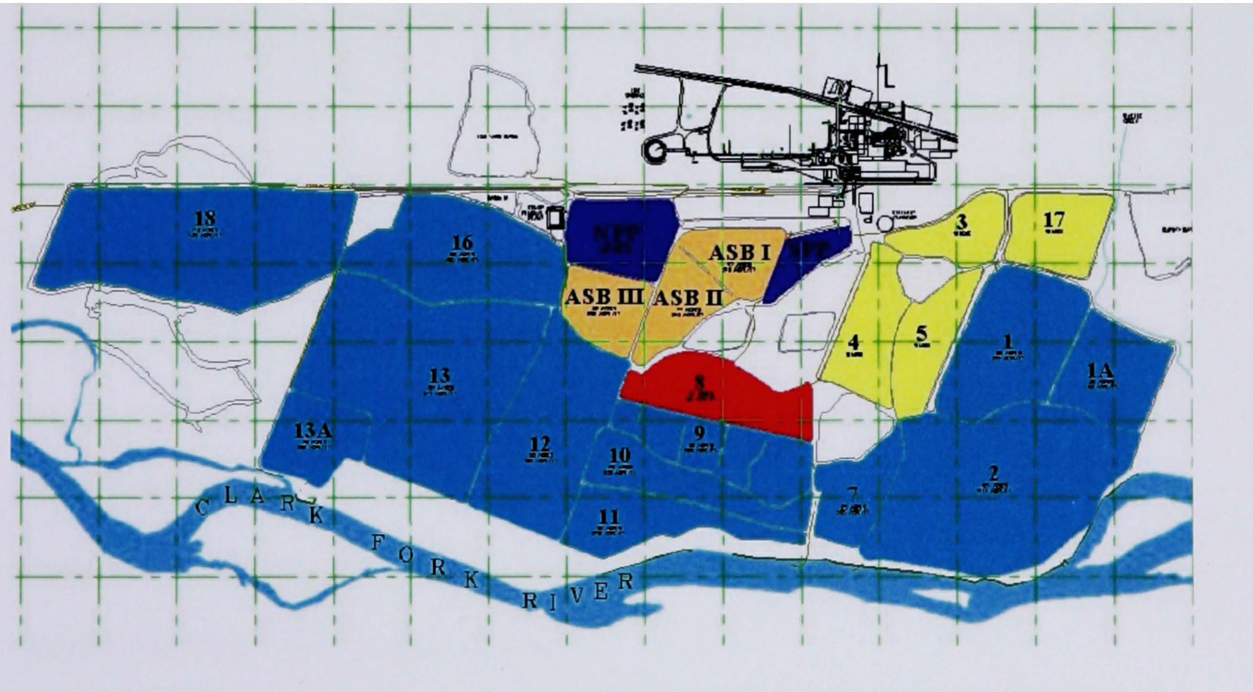


Effluent Treatment System

Two production well fields provide up to 25 million gallons of water to the mill per day. Water is recycled and reused throughout operations in the plant and wastewater is handled in extensive primary, secondary and tertiary treatment systems. Treated water seeps through unlined holding ponds, evaporates or is discharged into the adjacent Clark Fork River.

Nearly 800 acres of ponds are utilized for wastewater treatment. Figure 2-3 displays the pond complex. The diagram is color coded according to pond function; Holding ponds (blue), Sludge Ponds (yellow), Aeration Basins (orange), Polishing Ponds (purple), and the Auxillary Spill Pond (red).

Figure 2-3 Effluent Treatment System at Stone Container's Missoula Mill



After entering a common "intercept" ditch, mill effluent is pumped into a primary clarifier for solids (fiber) removal. The solids in the underflow from the clarifier are dewatered in a screw press then burned for energy recovery in the multi-fuel boiler, as allowed by permits #OP2589-01 and 2589, or stored in the mill's sludge ponds. Water from the dewatering plant is recycled back through the clarifier. If the dewatering plant is not operating, sludge flows to sludge ponds (3,4,5,17) (5 is currently being used) where solids naturally settle out. Ponds 3 and 17 collect raw sludge from the recausticizing plant. Recaust sludge has a high pH (9-11 su.) and also contains high levels of sulfide. (Tooke 2002).

The overflow from the clarifier gravity feeds to three aeration stabilization basins (ASB) for secondary treatment allowing aerobic bacteria to break down organic material (BOD and COD) in the effluent. Most of the organics initially present are consumed in the aeration basins. After sequentially traveling through the ASB system, the effluent enters the north then south polishing ponds to allow settling of biomass from the ASB system. Treated effluent from the polishing ponds is sent to the holding ponds (shown in blue in figure 2-3) where it eventually discharges directly, or through seepage, into the Clark Fork River.

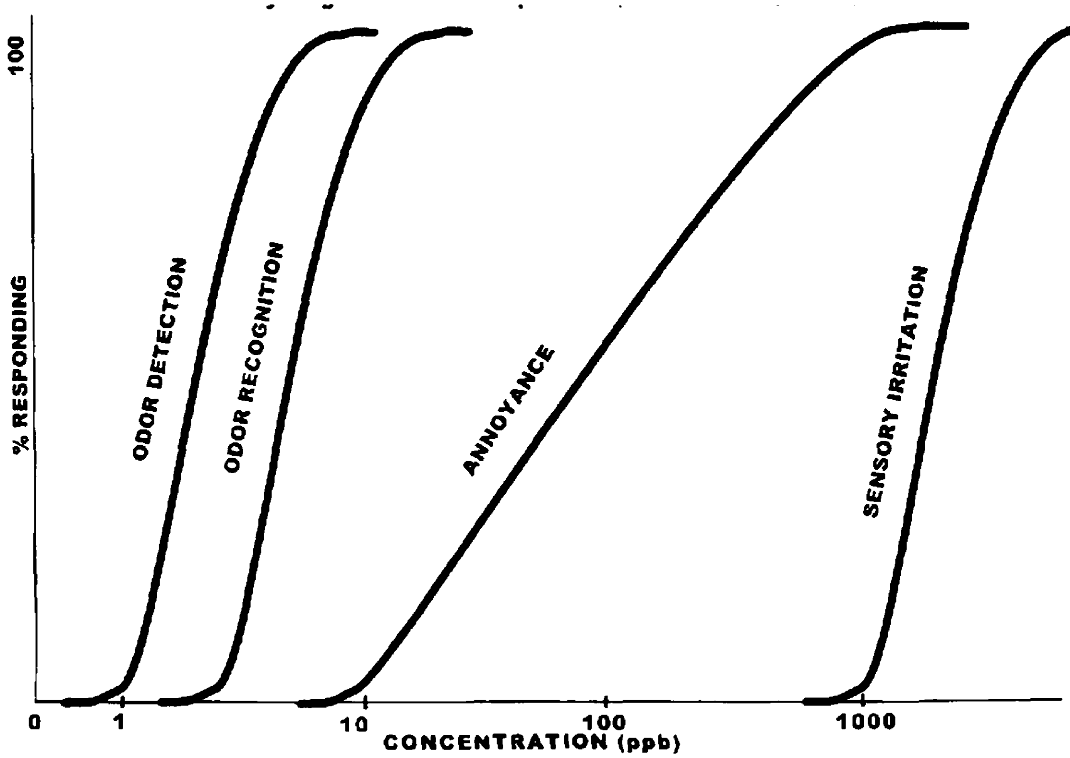
Pond 8 is an overflow storage pond. It also collects decant from the sludge ponds. Pond 8 liquids are eventually pumped back to the inlet of the ASB system to restart secondary treatment and settling. Pond 8 is the most likely source of H_2S emissions because it contains an apparent supply of sulfate (from the mill effluent), carbon, and nutrients necessary for sulfate reducing bacteria (SRB) to survive. Even though mechanical agitators are available in pond 8 to circulate the effluent, anaerobic conditions appear to develop readily in the sediment.

Pond 5 is currently being used to collect sludge when the sludge dewatering plant is not operating. High levels of sulfate and organic carbon make pond 5 a good potential candidate for H_2S evolution. The north polishing pond may also be a source due to the likely carry-over of biomass from ASB system, which provide a carbon source for the SRB, plenty of available sulfate, and the potential for anaerobic conditions in the nearly 15 feet deep pond.

Odors caused by emissions of H_2S and other reduced sulfur compounds, commonly referred to as total reduced sulfur (TRS), from pulp and paper facilities, including the Missoula Mill, have been a concern for many years because of the potential public nuisance. Odorous compounds such as TRS are potentially emitted from mills and their effluent treatment systems. While scrubbers on mill point sources are very efficient in removing TRS and continuous emissions monitors are required by regulatory agencies on many mill point sources to monitor TRS emissions (along with other parameters and pollutants), it is much more difficult to measure and control TRS emissions from area sources, such as effluent treatment systems.

Microbial respiration by SRB in the effluent treatment system results in the formation of TRS, primarily H_2S, with its subsequent release into ambient air. Emissions of H_2S have the potential to become public nuisances due to the low odor threshold of about 5 to 30 ppb for most people (Shusterman 1992). TRS emissions alone do not lead to respiratory irritation until levels exceed 1000 ppb (Shusterman 1992). The OSHA permissible workplace exposure limit on a time weighted average is 10 ppm (OSHA 1983). Communities near pulp mills have not shown elevated respiratory disease rates for asthma, bronchitis, or emphysema when controlling for mill employees. (Deprez, 1986; Stjernberg 1986) However, sensory annoyance is significantly related to odorant exposures from pulp mills (Jonsson et al. 1975). In 1977 investigators found that reported headaches and odor annoyance were associated with pulp mill proximity, while respiratory, gastrointestinal, and neurological symptoms associated with high TRS levels could not be correlated. Shusterman 1992 matches ambient H_2S concentrations with population response in Figure 2-4. H_2S odors can be detected by the nose between 1 and 5 ppb, and recognized as H_2S between 1 and 10 ppb. People are generally annoyed by the odor anywhere between 10 and 1000 ppb. Physical sensory irritation occurs at concentrations greater than 1000 ppb.

Figure 2-4 Hydrogen Sulfide Odor Response vs. Concentration (adapted from Shusterman 1992)



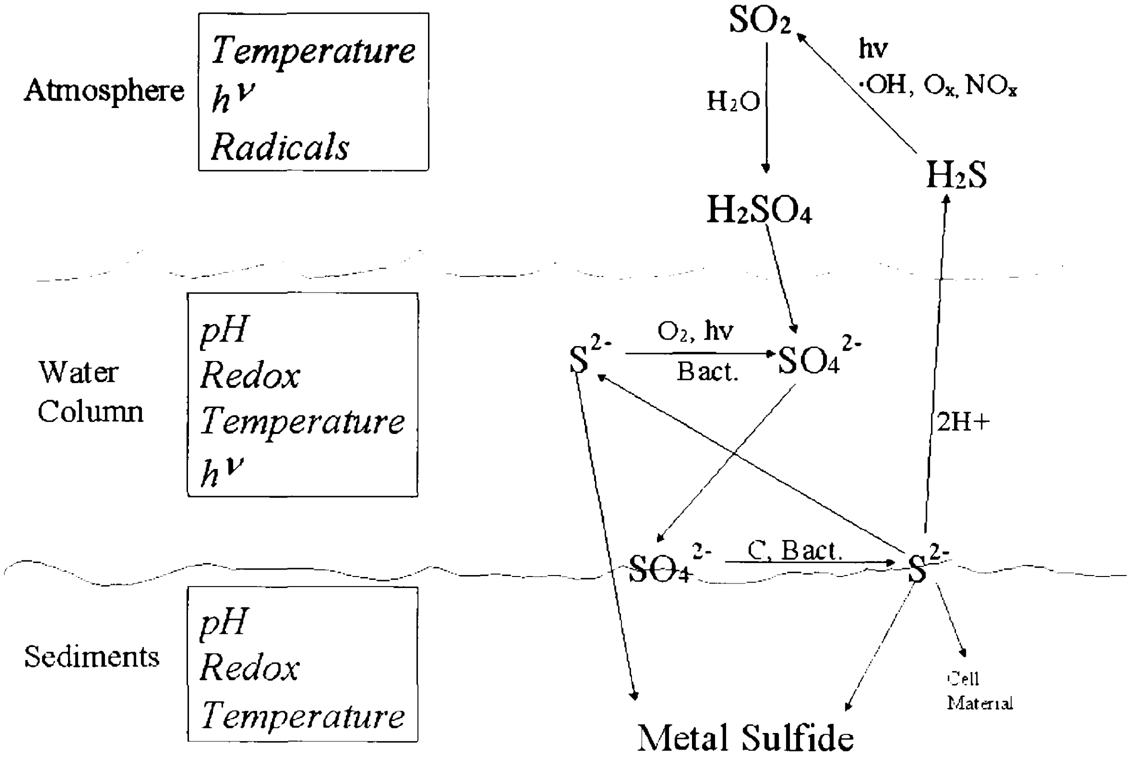
In order to prevent public nuisance from H_2S emissions, the state of Montana promulgated a rule limiting ambient H_2S concentrations to 50 ppb (MTDEQ 2002) a standard the mill must comply with in their air quality permits. This ambient H_2S standard is an aesthetic standard, and not based on the protection of human health. Though all Montana facilities are required to comply with the ambient H_2S standard, the Missoula Mill is the only Montana facility required by the DEQ to operate ambient H_2S monitoring systems and to report collected data. In order to demonstrate compliance with the ambient H_2S standard, the Missoula Mill operates ambient air monitoring systems located near the mill at two stations. Site 1A is equipped with meteorological equipment and an H_2S monitor, and Site 2 is equipped with only an H_2S monitor. Both ambient sites provide hourly average H_2S data. The Missoula Mill submits quarterly and annual reports of monitoring data to the DEQ, who incorporates the data into EPA's Aerometric Information Retrieval System (AIRS) database.

2.2 Odor Producing Mechanism

A combination of high sulfate levels, neutral pH, and warm temperatures exacerbates the evolution of H_2S from the wastewater treatment ponds located behind the Missoula Mill (Ainsworth 1995, Toprack 1997, Madigan 2000, Hsieh 1997, Esplin 1989). Microbial processes drive sulfur cycles in water and soil environments. Conversely, physical processes drive sulfur cycles in the atmosphere; i.e., solar intensity, scavenger molecules (primarily OH radicals) and temperature (Luke 1985, Hales 1973, Friedl 1985, Seinfield 1998). H_2S can remain stable in the atmosphere for up to 70 hours depending on meteorological factors (Seinfield 1998). A general representation of some major sulfur processes for all three mediums can be viewed in (Figure 2-5).

Sulfide is produced by sulfate reducing bacteria (SRB) when sulfate or other oxidized sulfur molecules are utilized as a terminal electron acceptor in anaerobic bacterial metabolism.

Figure 2-5 A Few Major Sulfur Pathways in the Atmosphere, Water Column, and Underlying Sediments



Desufovibrio are one of the most common genera that carry out this process. The reaction is as follows:

$$2CH_2O + SO_4^{2-}(aq) + 2H^+ \rightarrow \mathbf{H_2S(g)} + 2CO_2(g) + 2H_2O \qquad (2\text{-}1)$$

where CH_2O represents a suite of possible organic molecules, the most common being lactate, pyruvate, ethanol, or other alcohols. Hydrogen is another possible electron donor (eqn 2-2). SO_4^{2-} is present at concentrations up to 700 mg/L in the ponds (Tooke 2002).

$$4H_2 + SO_4^{2-} + H^+ \rightarrow HS^- + 4H_2O \qquad (2\text{-}2)$$

Hydrogen sulfide forms in the slime layer of pipes and structure walls or in sludge deposits. The general reaction for the production of H_2S is as follows.

$$SO_4^{2-} + 2C + H_2O + (\text{Sulfate Reducing Bact.}) \rightarrow 2HCO_3^- + S^{2-} + CO_2 \qquad (2\text{-}3)$$

Redox potential and pH heavily influence the sulfur chemical species present in the water column. Figure 2-6 shows that with decreasing dissolved oxygen (lower redox potential), the dominant sulfur species shifts from sulfate to sulfide. Furthermore, figure 2-7 shows that the reduced sulfur species is controlled by the pH of the system. H_2S gas dominates when pH is low; HS^- appears in solution at higher pH's. S^{2-} is the dominant species dissolved in solution at very high pH. The Eh-pH diagram in figure 2-8 displays how different sulfur species dominate under various redox and pH conditions.

Figure 2-6 Aqueous Sulfur Species vs. Redox Potential

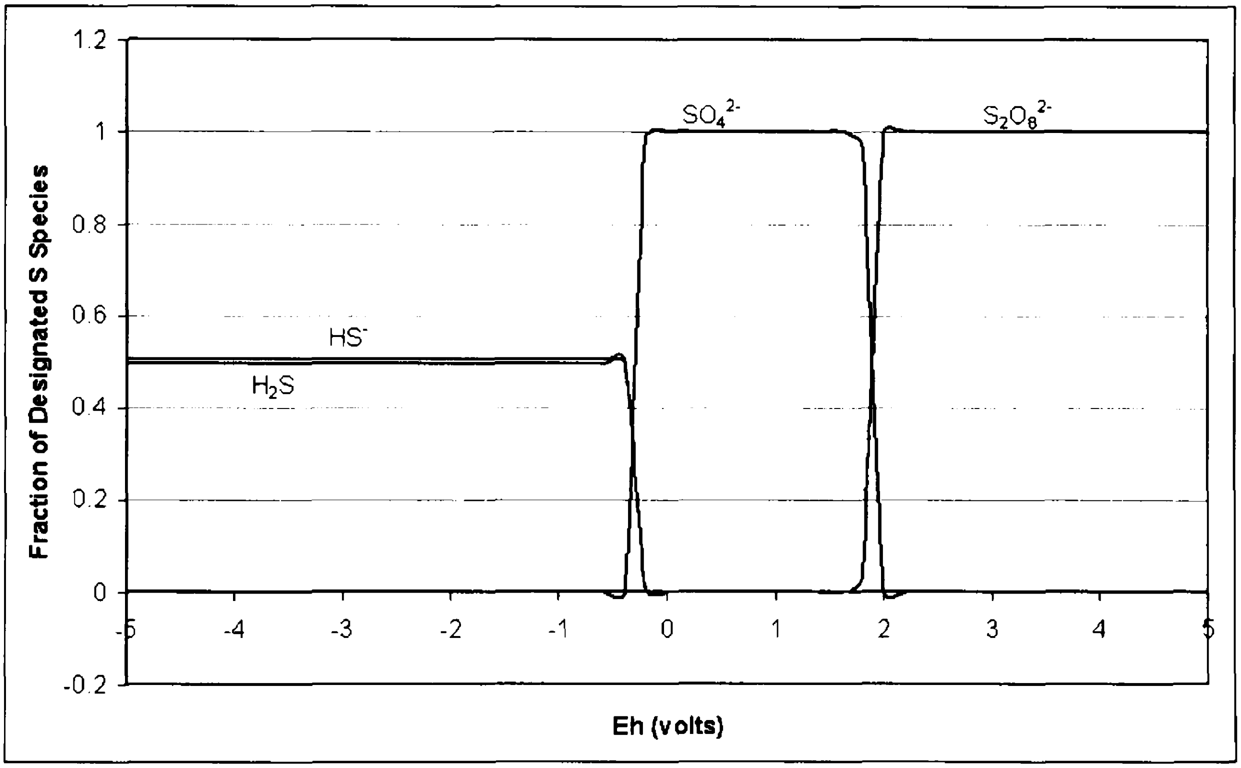
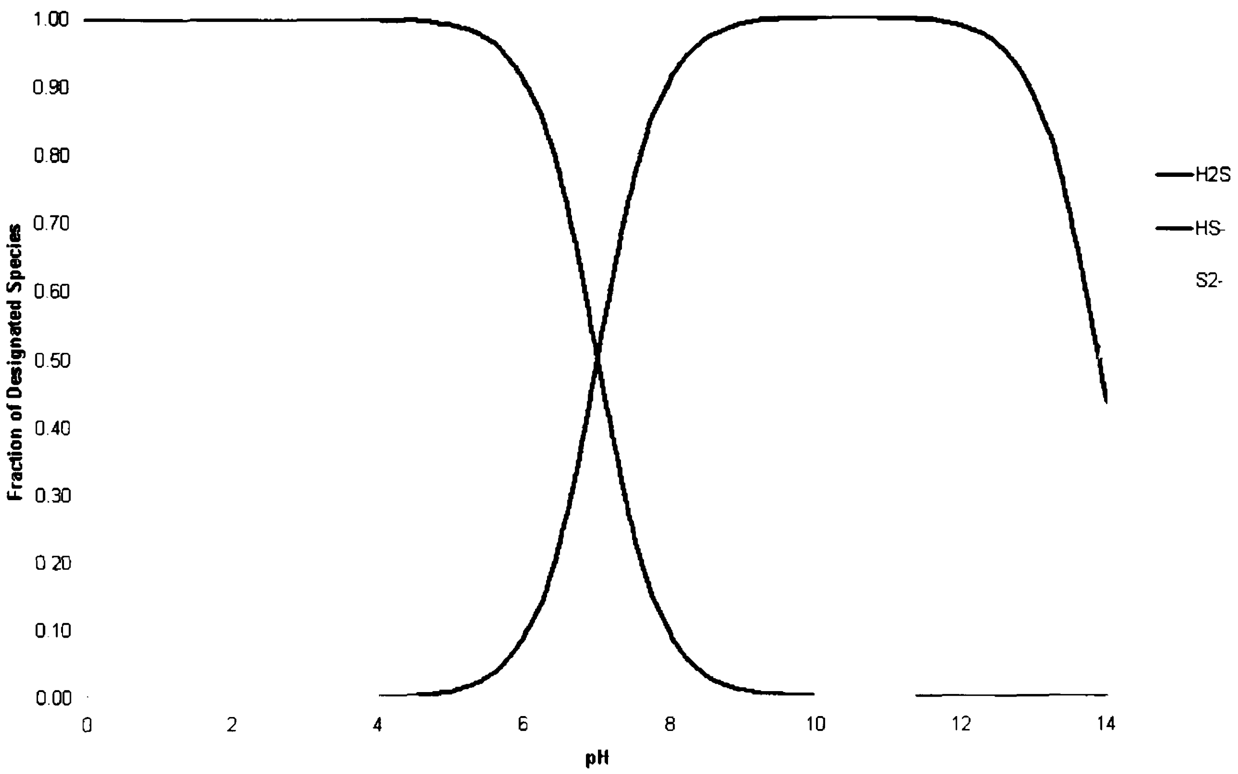


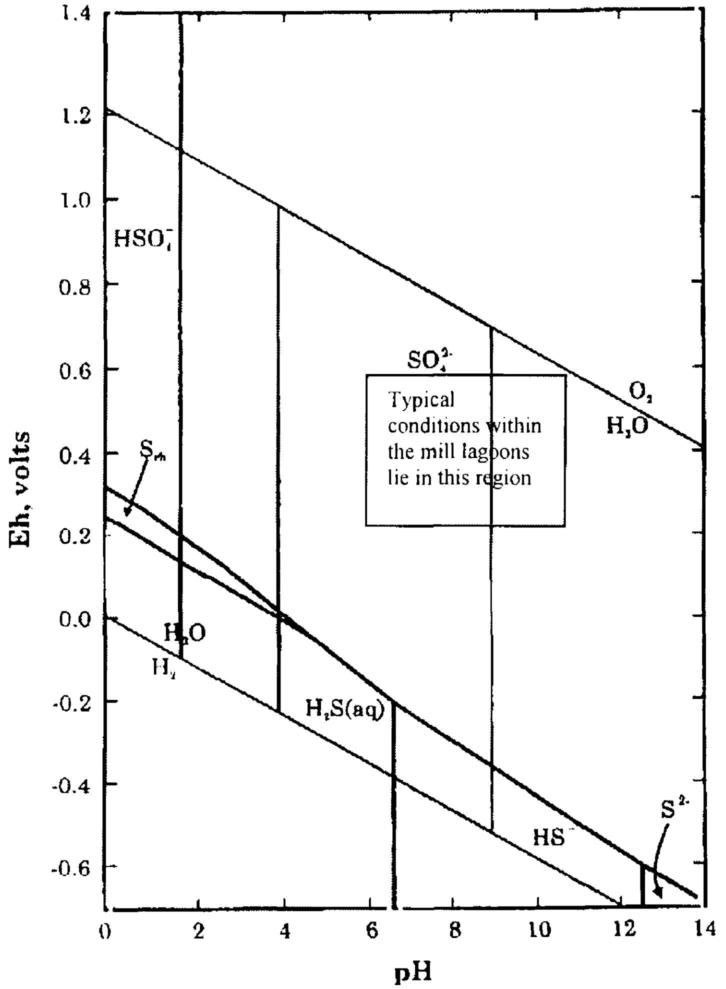
Figure 2-7 Aqueous Sulfide Species vs. pH



$S^{2-}(aq) + H^{+} \rightarrow HS^{-}(aq)$ (2-4)

$HS^{-}(aq) + H^{+} \rightarrow H_2S\ (g)$ (2-5)

Figure 2-8 Eh-pH Diagram for the Distribution of Sulfur Species Under Various Redox and pH Conditions



Hydrogen sulfide is readily generated when pH values are neutral or acidic. As H_2S percolates to the surface it can be reoxidized in the water column by sulfur oxidizing bacteria also known as purple and green sulfur bacteria (Equation 2-6a and 2-6b).

$$\mathbf{2H_2S(g)} + O_2 \rightarrow 2S^0 + 2H_2O \qquad (2\text{-}6a)$$

$$2S^0 + 2H_2O + 3O_2 \rightarrow 4H^+ + \mathbf{2SO_4^{2-}(aq)} \qquad (2\text{-}6b)$$

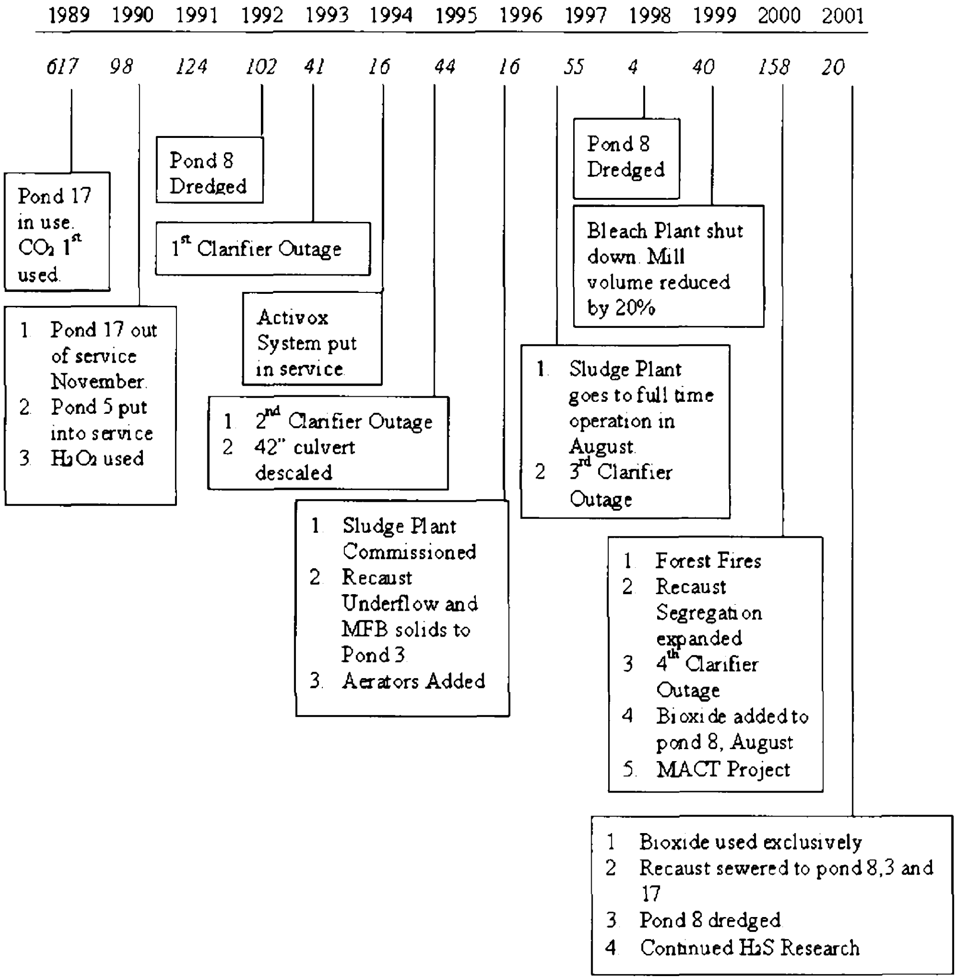
Chemical oxidants and other mechanisms have been used at the Missoula Mill to suppress H_2S emissions from pond 8 and function as in equation 7.

$$\mathbf{H_2S_{(g)}} + NaClO_{4\mathbf{(aq)}} \rightarrow \mathbf{SO_4^{2-}{}_{(aq)}} + Na^+ + Cl^- + 2H^+ \qquad (2\text{-}7)$$

Though oxidization of H_2S is a proven technology, the potential exists for some H_2S emissions. Odors result where this technology is used in systems with high levels of sulfate because of on-going SRB respiration and formation of H_2S that tends to overwhelm the effectiveness of the oxidant. The Missoula mill has made several attempts to chemically suppress H_2S evolution. The following is a brief summary of each of the control measures applied at the Missoula mill. See Figure 2-9 for a detailed timeline of control measure events between 1989 and 2001.

2.3 Control Measures

Figure 2-9 Timeline of Various Control Measure Events for Suppressing H_2S Emissions from the Effluent Treatment Plant.



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[1] Number of recorded exceedances for each year.

Much of the discussion on control measures was summarized from papers by Hambridge 1990 and Churchill 1999.

Hydrogen Peroxide

In 1990 the Missoula Mill used hydrogen peroxide to minimize odor emissions. H_2O_2 oxidizes H_2S to form elemental sulfur and water.

$$H_2S + H_2O_2 \rightarrow 2H_2O + S \tag{2-8}$$

This oxidant works best at pH <7.5. At pH > 7.5 the amount of H_2O_2 required is increased up to four fold (Hambridge 1990). The benefits of H_2O_2 are increased DO levels, chemical removal of H_2S, and reduction of slime layer. H_2O_2 acts as a disinfectant to kill the SRB. Conversely, H_2O_2 is expensive, it has a short lifetime once added to the wastewater thus requiring multiple injection sites, and it is hazardous to store.

Activox

In 1994 Stone Container implemented the activox system in pond 8. This system sprinkled sodium hypochlorite on the surface of the pond. In theory, when the hydrogen sulfide gas emerged to the top of the pond, the hypochlorite layer would oxidize it and drop sulfate back into solution. At a price of eighteen to twenty five thousand dollars per month in chemicals, this method has done little to minimize H_2S emissions.

Bioxide

Suppression of H_2S evolution can be accomplished by feeding nitrates into effluent systems containing SRB. The mill began using this technology in August of 2000. Many SRB can grow using (NO_3^-) as an electron acceptor reducing (NO_3^-) to NH_3 (Madigan 2000). Theoretically this suppresses the sulfate reduction and subsequent release of H_2S. The reaction is as follows:

$$\text{Organics} + NO_3^- + 9H^+ + (\text{bacteria}) \rightarrow NH_3 + 3H_2O. \qquad (2\text{-}9)$$

The Missoula mill currently uses Bioxide, a $CaNO_3$ compound that provides nitrate to the ponds. This method has not been used long enough to appraise its effectiveness. Bioxide was used in combination with dredging of pond 8 in August of 2001.

Aeration

Periodically pond 8 is aerated. It is difficult to tell whether this method has been successful. Aeration must be done on a regular basis in order to effectively suppress anaerobic bacteria. Successful aeration could lead to: 1. Oxidization of sulfides in the water column. 2. Inadequate environment for SRB metabolism in the sediments.

Metal Salts

Metal salts are used to precipitate metal sulfides. The general reaction is $H_2S + M^{2+} \rightarrow MS + 2H^+$. Transition metals form very insoluble complexes when bound to sulfides. Iron salts are favorable because they are relatively nontoxic and produce insoluble precipitates. Stone uses ferric and ferrous chloride when dredging. The salt is injected into the dredged sediment as it is pumped into the sludge holding areas. The reactions involving reduced sulfides are as follows:

$$2FeCl_3(aq) + 3S^{2-}(aq) \rightarrow Fe_2S_3(s) + 6Cl^-(aq) \qquad (2\text{-}10)$$

$$FeCl_2(aq) + S^{2-}(aq) \rightarrow FeS(s) + 2Cl^-(aq). \qquad (2\text{-}11)$$

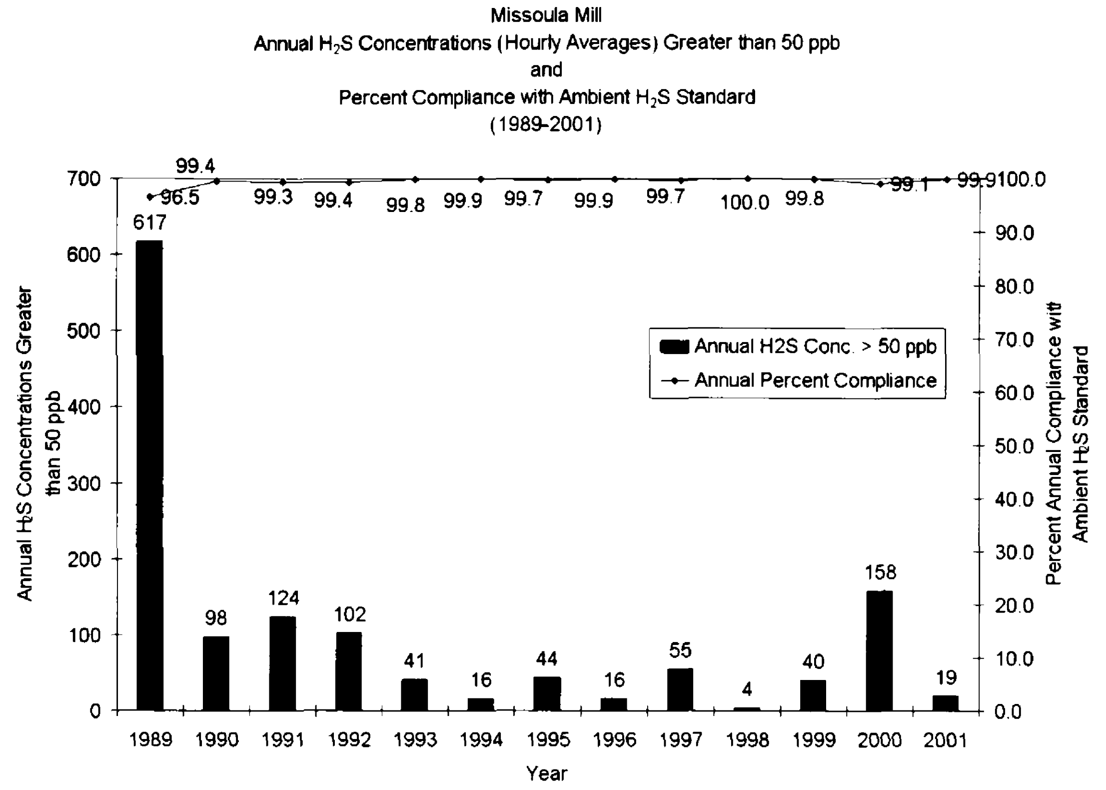
pH Adjustment

Alkaline chemicals such as $CaCO_3$ and NaOH can be added to improve hydrogen sulfide solubility in the water column and discourage sulfate reduction in the sediments. Theoretically sulfate reduction does not occur at pH less than 9.0. With proper mixing of the sediments this may be an effective tool for suppressing H_2S evolution. It may not be practical for some mills to continuously add large amounts of caustic solution to maintain high pH's. Also, as the effluent progresses to other ponds, CO_2 and organic acids are produced from bacterial metabolism of the carbonates thereby buffering the effect of the alkali. Canals can be shocked with alkali solution for temporary reduction of the slime layer, but bacterial populations recover within several days to a couple of weeks. The pH is typically high in the sludge ponds at the Missoula mill because sewer lines from the recaustisizing plant and boiler ash (reject from wastefuel boiler scrubbers) are piped directly into sludge pond 3. This has led to high solubility of sulfides in sludge pond #3. Currently pond 3 and 17 are directly receiving effluent from the recausticizing plant. Pond 8 receives effluent from pond 17. The impacts of this control measure on pond 8 are identified in a study during the summer of 2002.

2.4 Compliance History

Despite the use of the multiple control measures (described above), the mill has struggled with H_2S compliance issues for over a decade. The mill can be penalized with up to a $25,000 fine for each hour they exceed the 50ppb H_2S standard beginning with the second exceedance hour in a fiscal year. In 1989 the mill endured an all time high of 617 hours of ambient H_2S exceedances. The number plummeted to 98 the following year then ranged between 124 and 4 for the next 9 years until the year 2000 when the mill recorded 158 exceedences. It should be recognized that even when the mill is out of compliance for 100 hours of >50ppb H_2S, they are still in compliance more than 99% of the time. Figure 2-10 displays the compliance history for ambient H_2S exceedances over the past 12 years.

Figure 2-10 Compliance History for Ambient H2S Exceedances Over the Past 12 Years

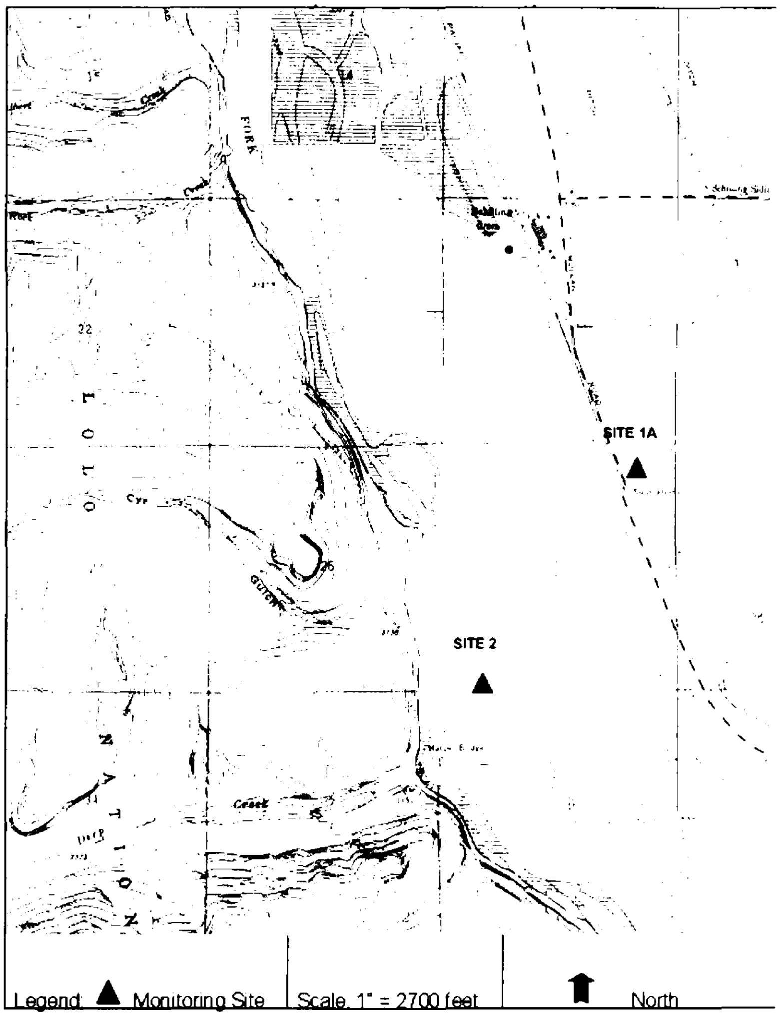


3. Data Collection and Methods

3.1 Ambient Stations

Two ambient monitoring stations are utilized in the vicinity of the mill (Figure 3-1). Ambient 1A contains instrumentation to monitor wind speed and direction, PM-10, and H_2S (Figure 3-2A). Ambient 2 contains instrumentation for monitoring PM-10 and H_2S (Figure 3-2B). PM-10 samples are collected every 3 days October – March, and every 6 days April – September. PM-10 data from this site were not utilized in this study because they were not on the same timescale as the H_2S data. PM-10 data used in this study were from a location in Missoula, which provided hourly data.

Figure 3-1 Ambient Stations 1 and 2 at the Missoula Mill.



Wind speed and velocity are monitored using a Climatronics 102083 anemometer and weather vane positioned 30 feet above ground level. Hourly averages are calculated from data recorded at 2-minute intervals. Meteorological sensors are audited annually by HKM Engineering (Butte, MT). The sensor error for wind velocity has been established at < 1.68 mph. Alignment error for wind direction is < 5 degrees. The meteorological station is checked for malfunction remotely on a continuous basis by Bison Engineering (Billings, MT). Specific audit QA/QC data can be found in quarterly reports issued to Stone container and MTDEQ by Bison Engineering.

Figure 3-2 Ambient Stations (A) 1A (Mocassin Lane), **(B) 2** (# 2 Well Field)

Hydrogen sulfide concentrations were analyzed using a TECO 45 H_2S Analyzer (spectrofluorometer) (Figure 3-3). The monitor operates by first scrubbing out SO_2 in the ambient sample stream. TRS emissions are then oxidized to SO_2 and detected using pulsed fluorescence. H_2S emissions are not distinguished from TRS emissions with this instrument. Common TRS compounds include; methyl mercaptan (CH_3-SH), dimethyl sulfide (CH_3-S-CH_3), and dimethyl disulfide (CH_3-S-S-CH_3). The TRS emissions recorded at the two ambient stations are primarily H_2S (Appendix A). The analyzer is audited annually by HKM engineering (Butte, MT) using NIST-traceable and/or other known standards and recording each instrument's response. Analyzers only pass quality assurance tests by responding to standards with a regression correlation (r^2) of ≥0.995, a single point error of less than 15%, and a full-scale error of less than 15%. Single point standards are checked at about 65 ppb (S^{2-}). Full-scale range is from 0 to 430 ppb (S^{2-}). Additionally, the H_2S analyzers run automatic zero/span checks every 23 hours. Mill workers run manual zero/span and precision checks weekly.

Figure 3-3 H_2S Analyzer (Ambient Site 2)

Calibrations are run quarterly by mill workers, and audits are conducted annually by MTDEQ. Detailed descriptions of Ambient monitoring equipment QA/QC can be found in the ambient air quality data report issued by Bison Engineering out of Billings to Stone Container and MTDEQ (Hofacker 2000). Data from the H_2S and weather monitors are eventually submitted to the EPA AIRS database via the Montana Department of Environmental Quality.

3.2 AIRS Database

H_2S

Careful review and management of the AIRS data is referred to hereafter as "data mining". Data is submitted to this database as an historic compliance record and is available for study by the public. A decade of data was reviewed in order to establish a norm for hydrogen sulfide levels in ambient air in the absence of wildland fires.

Hydrogen Sulfide data for the period Jan 1990 to present was extracted, analyzed and graphed for the two separate ambient air regulatory sites at the Stone Container Mill in Missoula, Montana. These data are available for open review upon request from MTDEQ and monthly summaries can be accessed via the World Wide Web at http://www.epa.gov/air/data/index.html. Ambient monitoring site locations are identified in the AIRS database by codes for state (30), county (63) and monitoring station (1A (0034)), (2 (0016)). Hourly data from these databases is space delimited and often missing hours or entire days of information. A java application was written to first check for missing data, fill in missing dates and comma delimit the repaired data. This application is called "preprocess.exe" and was written by an independent programmer Chris Walker (Walker 2001). A simple description of this program and installation instructions can be found in appendix E. A series of excel macros were then written to convert the rather inconvenient form of the data into easily read tables and graphs. (This software is available from the author by request). The macros are arranged in a simple toolbar which can be installed into any Microsoft excel version 95 or newer. Instructions for installing the AIRS toolbar into an excel program, and a brief description of each macro's function are found in appendix F. All graphs and charts described throughout this section can be reproduced using the above software. The macro's were designed specifically to manipulate hourly H_2S and meteorological data from the AIRS database. This software may not be limited to H_2S data. Attempts were made to write the software so that any hourly data in the AIRS database could be parsed and organized. However, data other than ambient H_2S and meteorological were not rigorously tested.

Individual worksheets were generated for each month where a data point for each hour of each day can be viewed (Table 3.1). Hour of the day is represented in the column headings from midnight (0) to 11 pm (23). The day of the month appears on each row of the spreadsheet (August 1, 1999 through August 31, 1999 as 990801 to 990831). The value listed in each cell of the grid is the TRS level expressed in ppb. Shaded squares indicate exceedances, (1-hour averages where the TRS level was more than 50 ppb). Maximum and mean values by date and hour of the day are also provided. A contour surface chart was generated for each month from the spreadsheet, where hours were plotted against days and the variation of hydrogen sulfide levels is indicated by color. The TRS data for August of 1999 2A are shown in Figure 3-4. Because the influence of storm systems can perturb the normal dispersion patterns, averages were computed for a given hour on a given date over a ten-year period (1990 – 1999) for both ambient sites. These were processed into monthly contour surface charts in the same manner as the individual months.

Table 3-1 Ambient H_2S Data Table for August 1999 at 2A

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Mean	Max
990801	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1		9	1	1	0	1	9
990802	9	25	[redacted]	14	3	3	4	6	5	1	3	1	6	5	2	1	2	1		6	3	0	0	0	7	52
990803	0	3	1	1	11	4	3	23					2	1	1	1	1		6	5	8	8	4	5	5	23
990804	7	1	1	4	2	1	3	17	42	11	26	23	17	3	1	1		2	1	1	1	1	1	1	7	42
990805	1	0	1	1	2	1	4	32	5	5	2	2	9	4	3		1	1	1	4	1	1	1	7	4	32
990806	1	1	1	1	1	1	2	23	[redacted]	13	9	10	8	2		5	1	3	15	2	1	0	0	0	7	52
990807	0	0	0	25	[redacted]	14	3	9	11	4	1	7	1		2	1	1	3	5	1	1	0	0	1	7	67
990808	4	0	1	1	2	3	2	9	6	2	1	1		2	5	4	1	3	0	0	0	0	1	0	2	9
990809	0	0	0	0	1	0	4	14	16	5	1		1	2	1	2	3	2	0	0	0	1	1	1	2	16
990810	1	2	2	3	2	2	2	8	5	2		2	1	4	5	4	0	7	2	0	0	0	0	1	2	8
990811	1	9	18	13	4	2	2	20	[redacted]		16	1	0	0	0	1	8	13	20	0	1	1	0	1	8	58
990812	2	1	1	1	1	1	2	37		10	2	1	1	0	0	0	0	0	0	0	1	4	2	7	3	37
990813	4	1	3	2	1	4	2		6	1	0	2	0	0	15	10	4	9	2	0	0	1	0	0	3	15
990814	0	0	2	1	0	0		31	25	5	2	3	4	2	2	2	5	12	3	6	0	0	1	33	6	33
990815	4	0	4	1	3		[redacted]	20	3	0	6	4	4	3	12	16	5	0	0	0	0	0	1	1	6	51
990816	3	5	2	2		1	1	2	7	3	1	0	3	0	1	0	0	0	0	0	0	2	2	1	2	7
990817	1	1	1		1	1	15	42	9	6	2	1	0	1	1	1	2	2	1	1	0	1	1	0	4	42
990818	1	1		3	4	4	17									1	1	1	1	8	1	2	10	1	4	17
990819	37		6	3	8	1	0	2	15	6	2	2	1	1	2	3	7	1	1	1	1	1	1	1	4	37
990820		2	2	2	5	4	4	18	[redacted]	16	3	1	1	1	1	1	1	1	1	1	1	1	1		6	61
990821	2	1	2	2	27	23	30	23	23	6	3	2	2	2	1	1	1	1	1	1	0	0		4	7	30
990822	2	3	7	3	2	2	2	4	9	7	3	1	1	5	5	3	3	3	1	1	1		2	1	3	9
990823	1	1	2	2	4	6	4	26	22	4	2	2		1	1	1	1	1	1	1		3	1	1	4	26
990824	1	2	2	1	2	2	9	37	[redacted]	46	21	23	11	3	1	2	1	1	1		2	5	4	4	10	50
990825	1	2	2	4	5	5	4	9	10	2	1	1	1	1	1	1	1	1		2	1	1	1	2	3	10
990826	9	8	14	13	33	47	25	10	15	7	2	1	1	1	1	1	1		2	1	1	3	2	1	9	47
990827	2	2	1	1	1	2	3	41	41	7	4	2	1	1	1	7		11	3	3	1	1	18	5	7	41
990828	20	4	6	14	5	6	4	9	[redacted]	[redacted]	24	1	1	1	1		2	1	1	1	1	1	11	1	13	119
990829	2	2	2	5	4	6	4	6	4	2	2	2	1	1		5	5	2	2	1	2	1	1	3	3	6
990830	4	3	6	9	5	7	12	[redacted]	48	39	17	19	34				1	1	1	1	0	0	1	0	13	64
990831	0	0	0	0	0	0	1	3	1	0	0	0		2	1	1	0	1	1	0	1	0	1	0	1	3
Mean	**4**	**3**	**5**	**4**	**7**	**5**	**7**	**19**	**24**	**10**	**6**	**4**	**4**	**2**	**2**	**3**	**2**	**3**	**3**	**2**	**1**	**1**	**2**	**3**		
Max	37	25	52	25	67	47	51	64	119	63	26	23	34	5	15	16	8	13	20	8	9	8	18	33		

Figure 3-5, for example, displays the average TRS readings over a decade of measurements at Ambient Site 2 for June, July and August. Ten year averages for all 12 months at both monitoring locations are displayed in Appendix B. The band of high H_2S readings migrates later and later in the 0700 hour with each day in the month. This is a function of the H_2S dispersion with successive sunrise. The reader can visualize the migration of higher H_2S levels successively later in the hour throughout each month by holding the plane of the paper at eye level and parallel to the floor. Notice how each band fades to the right from the bottom (beginning of the month) to the top (end of the month) of each month graph.

Figure 3-4 Hourly H_2S Concentrations for Ambient 2, August 1999 Plotted on a Contour Surface Chart

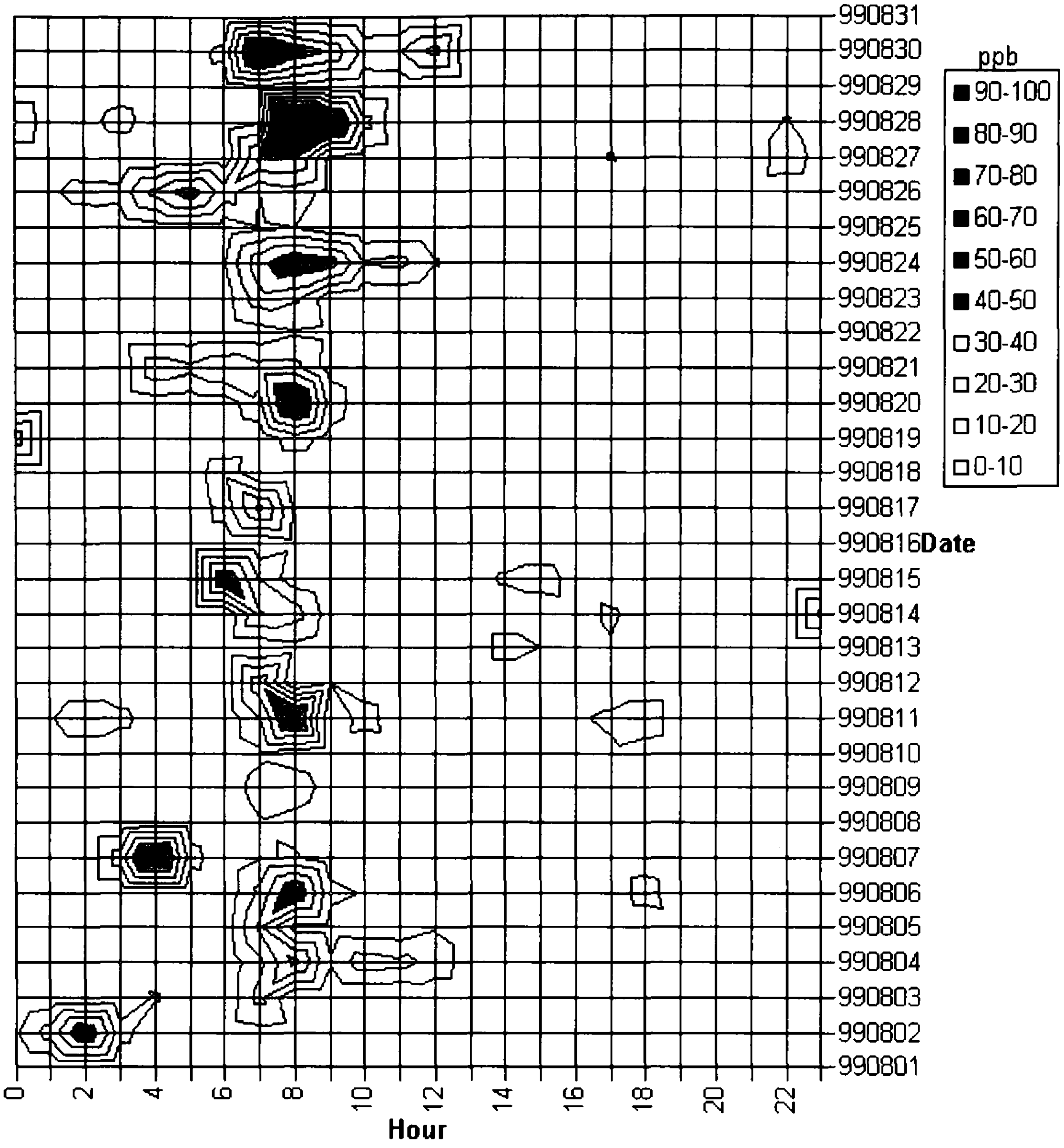
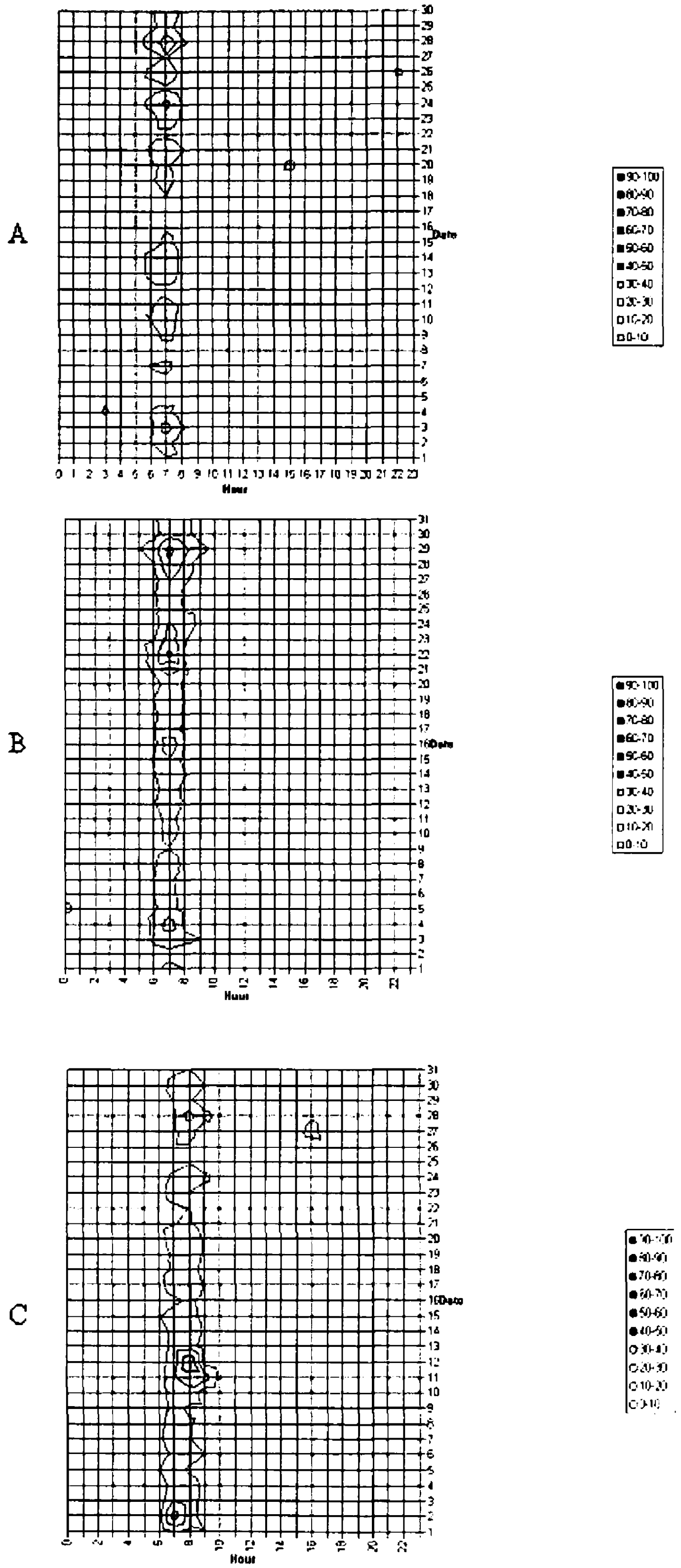


Figure 3-5 Contour Surface Plots for an Average of Ten Years of H_2S Data (1990- 1999) at Ambient Site 2 (June, July, August)



Compilations of Contour plots 1990 to 2000. (A) June, (B) July, (C) August.
ie: (A) is an average of the data for all the months of June in the period 1990 to 2000.

Meteorological Data

Wind data were acquired from a meteorological station at Ambient 1 via the AIRS database. The weather station is equipped with an anemometer, and weather vane only. Audits are performed annually by HKM engineering in Butte to calibrate equipment (Hofacker 2000). Bison engineering in Billings checks meteorological equipment and data quarterly.

Meteorological data were acquired from the AIRS database for ambient site 1 between the years 1996 and 2001. Wind maps were designed in an effort to visually identify wind patterns over the same time scale as the H_2S data. A grid of hourly data was formatted in the same manner as the H_2S data (figure 3-6). Individual grid cells were colored according to the average wind direction for that particular hour. Four quadrants were used to identify wind direction. The values displayed in the grid are wind velocities. The quadrants were divided as is shown in Table 3-2A.

Table 3-2 Color (A) and Number (B) Descriptors for Wind Directional Quadrants

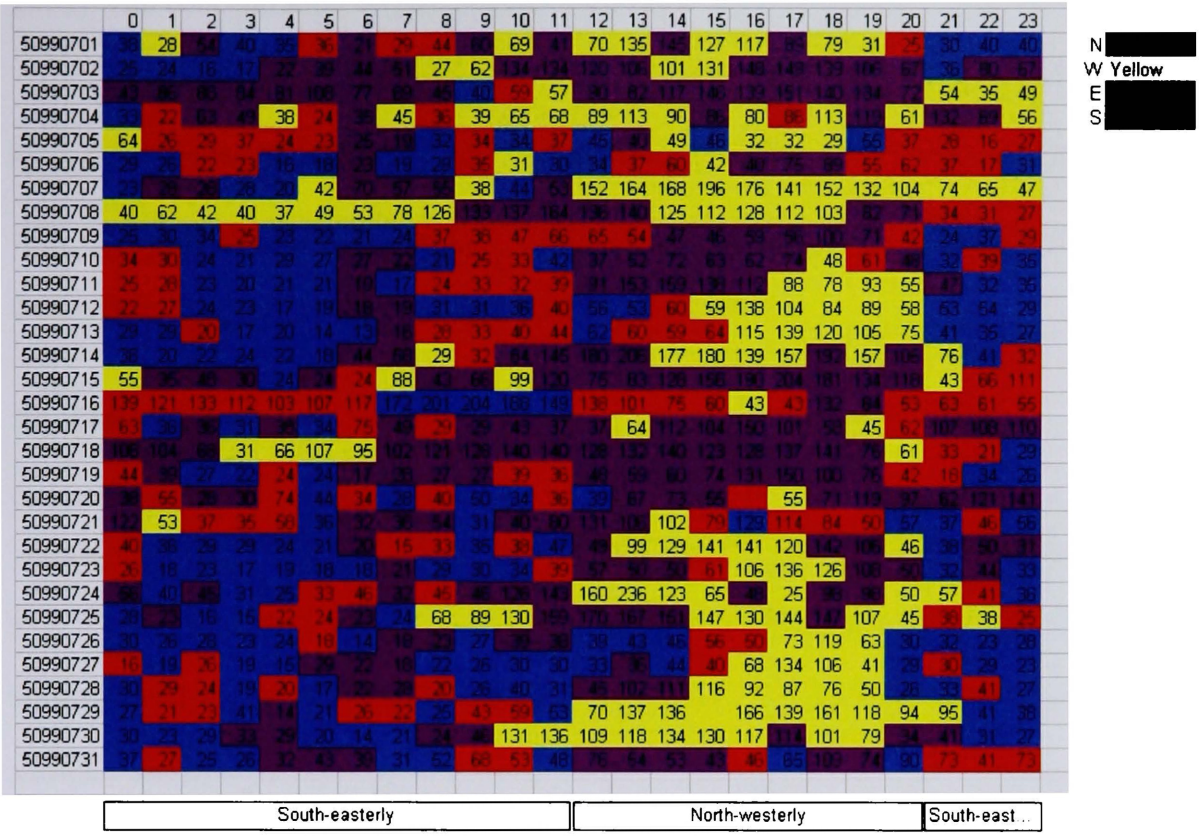
A

Quadrant	Degrees	Color
North	315-45	Purple
East	45-135	Blue
South	135-225	Red
West	225-315	Yellow

B

Quadrant	Degrees	Integer
North	315-45	4
East	45-135	2
South	135-225	1
West	225-315	3

Figure 3-6 Wind Map for July of 1999



Additionally, temporal charts were prepared to match wind direction and velocity to H_2S concentrations at 1A and 2A. Hourly wind direction data for the month of July 1997 to 1999, and 2001 were normalized by assigning the integers 1 through 4 to represent the four directional quadrants (Table 3-2B). Average wind direction values were established by taking the mode of the quadrant integers for a particular hour during the month. In this manner 24 directional averages were acquired from 30 to 31 days of hourly data, making wind direction data more manageable. Hourly averages for wind velocities were acquired by calculating the means. Temporal plots were prepared by placing the hours on the abscissa and velocity or direction on the ordinate. Plots of H_2S

concentrations at ambient 1A and 2 were prepared for the same time period 1997-1999, 2001) with concentration on the ordinate and hours on the abscissa.

Daily average temperature data were available from 1996 to 2001 and were acquired from the Missoula International Airport approximately 8 km southeast of the mill. Temperature data for July and August 2000 were correlated with ambient H_2S data using linear regression analysis (*least squares*).

3.3 Other Data

Jerome Ambient H_2S Handheld Sensor

Ambient H_2S levels were identified in the pond complex using a handheld Jerome 631-X H_2S analyzer. The analyzer utilizes a thin gold film sensor, which undergoes an increase in electrical resistance proportional to the mass of hydrogen sulfide in an air sample. An internal pump pulls air over the gold film sensor for a precise period of time. The sensor absorbs and integrates the H_2S, then displays the result in ppm. From 50 to 500 hundred samples can be taken before the sensor reaches saturation. At that point a 10-minute cycle is used to regenerate the sensor. The instrument is manually zeroed following regeneration. Sensor regeneration was done before and after each sampling day. The Jerome 631-X is capable of measuring ambient H_2S as low as 5ppb, with a precision of $\pm$ 2%. The instrument is calibrated semi annually by the manufacturer.

For the period (10/13/00 – 6/20/01) analysis was done once per week at 24 different sites in the pond complex. Specific sampling locations and data for this study can be viewed in Appendix C. The Jerome sensor was used to indicate areas in the pond complex where ambient H_2S levels were highest.

PM10 Data

Hourly PM-10 data were acquired from a TEOM (Tapered Element Oscillating Microbalance) monitor at Boyd Park located in Missoula Montana. Boyd Park is approximately 20 km southeast of Stone Container. The TEOM operates by capturing 10 micron particulate on a filter, which is supported by a piezoelectric crystal. Alterations in the crystal's oscillation directly correlate to the mass of particulate collected on the filter. PM-10 readings were used as a surrogate for wildfire smoke concentrations. A baseline level of particulate during the summer months was calculated using five years of summer TEOM data prior to the 2000 wildland fires. For example, the mean value was calculated using data from five July's, 1995-1999, to be 19 ug/m^3. Baseline data were limited to five years because hourly TEOM data were not available prior to 1995. See Appendix D for specific TEOM operation and quality control.

Production

Ambient TRS emissions were matched against production levels graphically to see if there was any resemblance of pattern. Production levels at the mill were established by acquiring 1999/2000 data for: 1. Paper tons produced; 2. Virgin fiber tons used; and 3. Old Corrugated Cardboard (OCC) used. Feedstock for linerboard at the Missoula mill is roughly 40% OCC, 60% virgin fiber.

4. Results and Interpretation

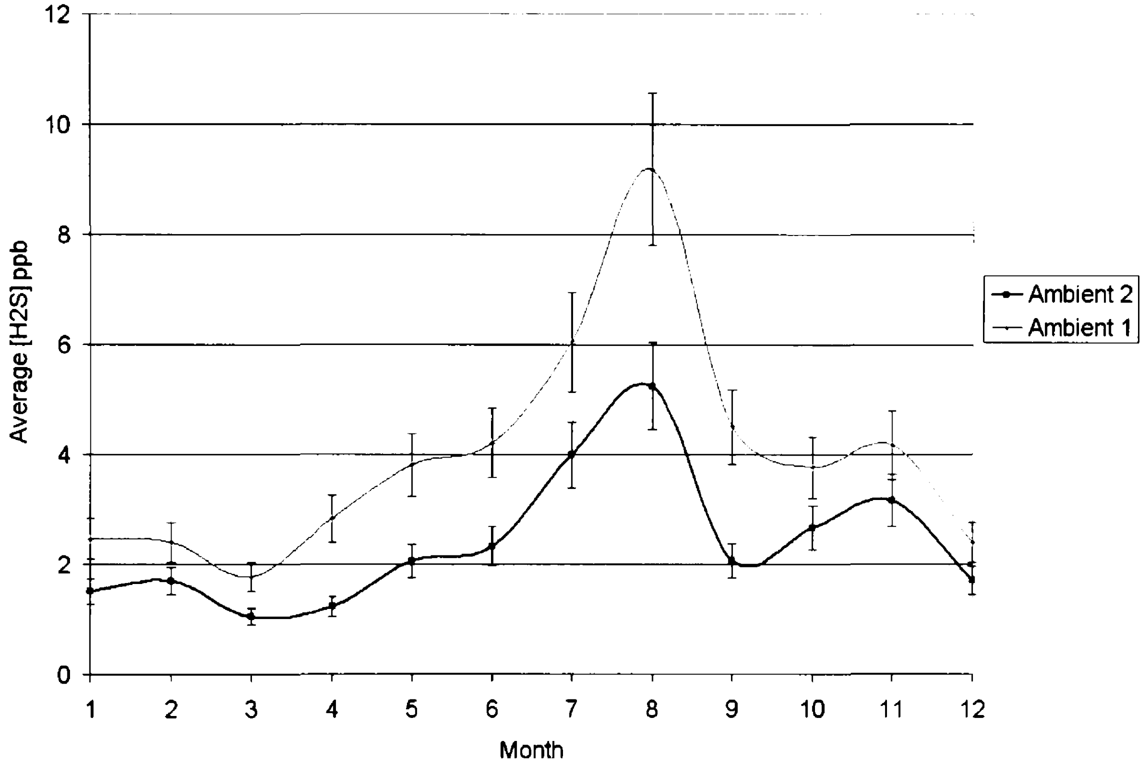
4.1 Ambient TRS

Distinct seasonal and diurnal trends dramatically appeared when ten years of ambient H_2S data were plotted on time/date grids. First, the ambient TRS concentrations are noticeably low in the winter. Emissions increase in the spring and peak in the summer. Second, during the summer months, high concentrations were routinely detected at both 1A and 2 between 6 am and 9 am. High concentrations were also visible during the nighttime hours 8pm – 12am at 1A only. Ten years of annual data were compiled into averages for each month of each year. This allowed for clearer visual inspection of the data by removing some of the anomalies seen in day to day weather systems and seasonal perturbations. The patterns described above became more apparent.

Two Puffs a Day

Contour surface charts were chosen in an effort to develop hourly H_2S data into a form that could be reviewed for patterns. By graphing a decade of H_2S concentrations by date and time, both diurnal and seasonal trends became visible. These data are shown in Appendix C. Monthly charts show low emission levels in the decade-averaged data for the cold months. But beginning in April and becoming stronger in May is a distinct band of higher readings in the morning hours – a morning "puff" of H_2S. These reach maximum concentrations during the height of summer and then fall off as October progresses (figure 4-1). This correlates to the seasonal population patterns that the sulfate-reducing bacteria go through. They are slow to reproduce in the winter and not very active. When summer weather approaches, they go through a rapid population growth phase and respire more actively. (Widdel 1992). It can also be interjected that the mechanism for H_2S plume development and dispersion changes as seasons change such that diurnal variation is less obvious in the winter months (Anquetin 1999).

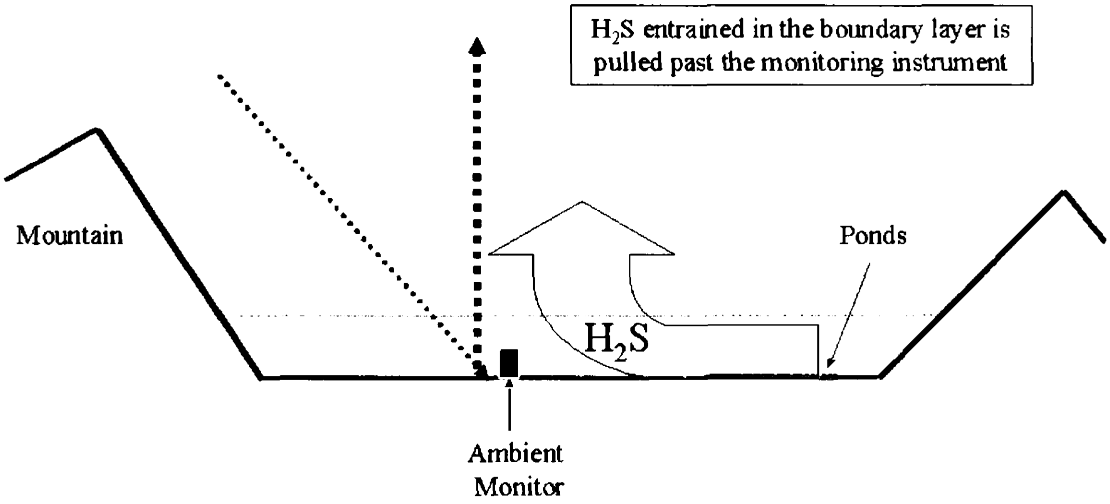
Figure 4-1 1999 H_2S Trends for Ambient Sites 1 and 2



Diurnal patterns are displayed as morning and evening "puff" features on the monthly contour charts. High TRS concentrations are routinely detected at both monitors in the morning hours 6-9 am. This constitutes the morning puff (an air mass entrained with H_2S from the ponds that moves across the ambient monitors). This puff occurs in the earliest part of the morning in June during the summer solstice. In July and August when the sun rises successively later, the band migrates to slightly later times. This strongly suggests that the morning "puff" is associated with time of sunrise. (figure 3-5).

A basic pattern of differential heating is demonstrated here. As the sun rises, it begins to heat various parts of the valley at different rates. The specific heat of water is ~ 1 cal/g °C while that of soils is approximately 0.2 cal/g °C (Handbook of Chem. & Phys. 1968). Consequently, land surfaces heat more rapidly than water. The differences in albedo between water and land surfaces also contribute to heating/cooling rates. Assuming the land and water were receiving equal levels of radiation and there were no other interferences, the land would heat up nearly 5 times faster than the water. A difference in temperature between these two mediums leads to uprising convection cells of warmer air over land surfaces, or *thermals*. At the mill, thermals are established to the south and east of the wastewater ponds over land. As that air mass rises, it is replaced by boundary layer air that has been residing over the ponds. The entrained H_2S is drawn past the 1A and 2 monitors as the air mass moves toward the location of the thermal (Figure 4-2). The morning puff is apparent in meteorological data from ambient 1A as a light northerly wind (figures 4-3, 4-6).

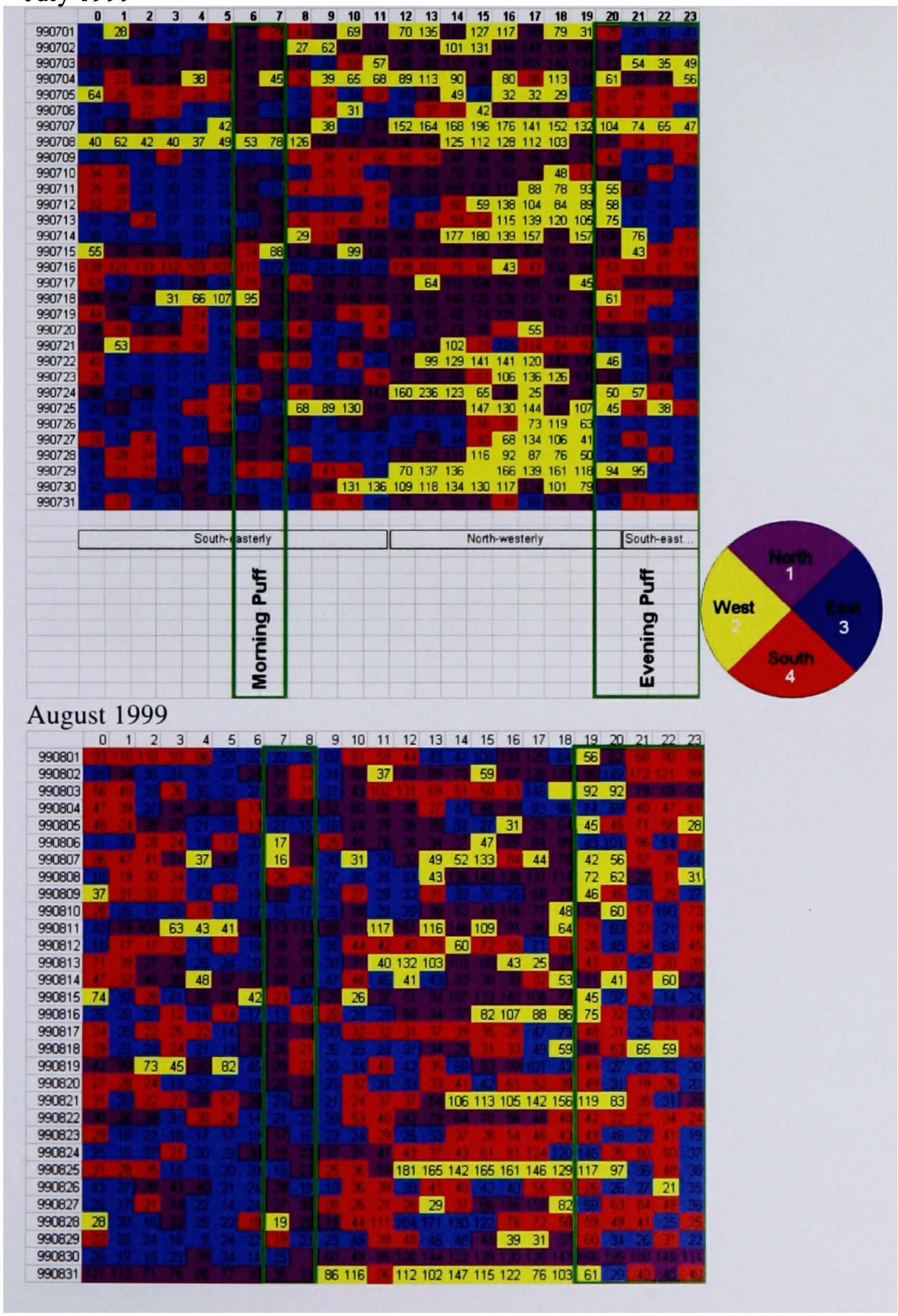
Figure 4-2 Air Circulation Resulting from Thermals at Land/Water Interfaces. (Oke 1978)

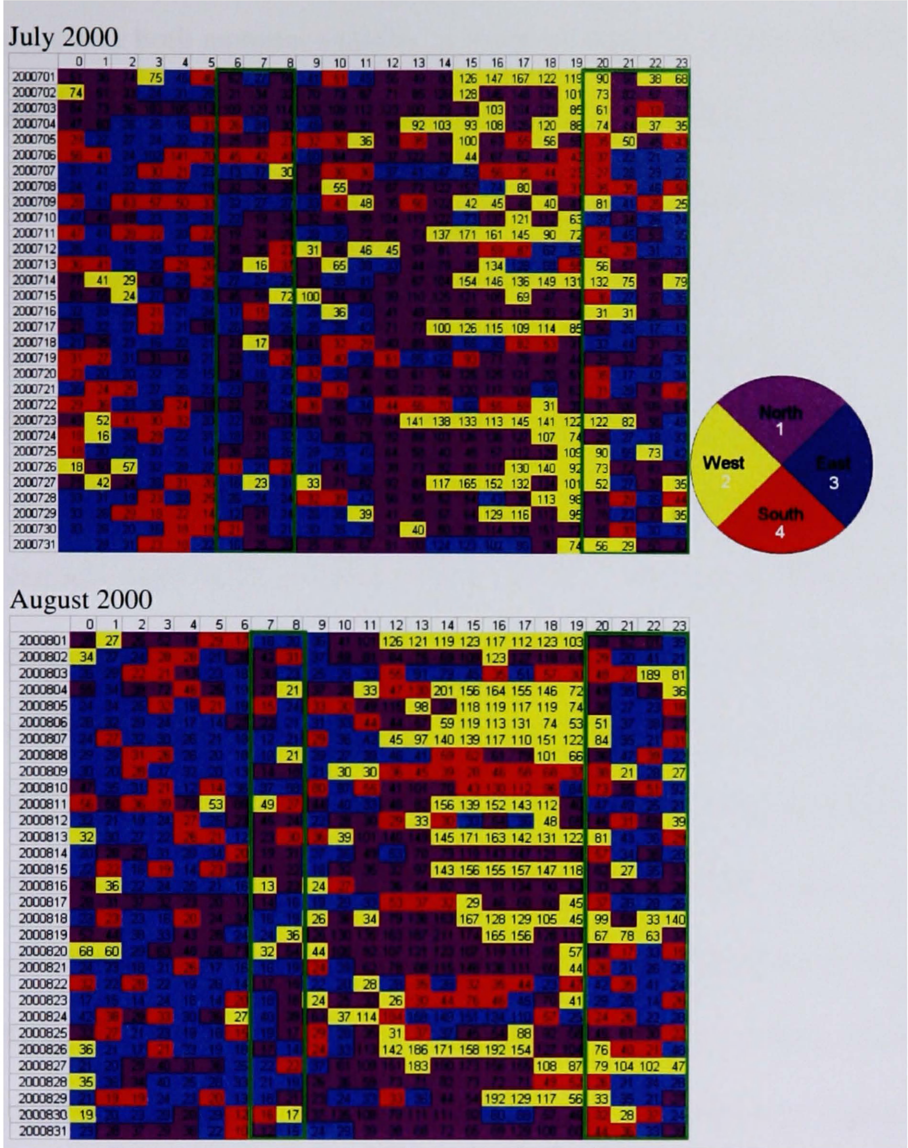


An evening "puff" of H_2S is also seen in the data from Site 1A, although not quite as defined, it appears between 2000 and 2300 hours most markedly in July. Mountains border the Mill property to the west. Daily mountain valley wind patterns are the cause of high evening H_2S levels at 1A. Mountain valley wind patterns are apparent from meteorological station data.

Figure 4-3 Wind Maps for the Months of July and August, 1999 and 2000

July 1999

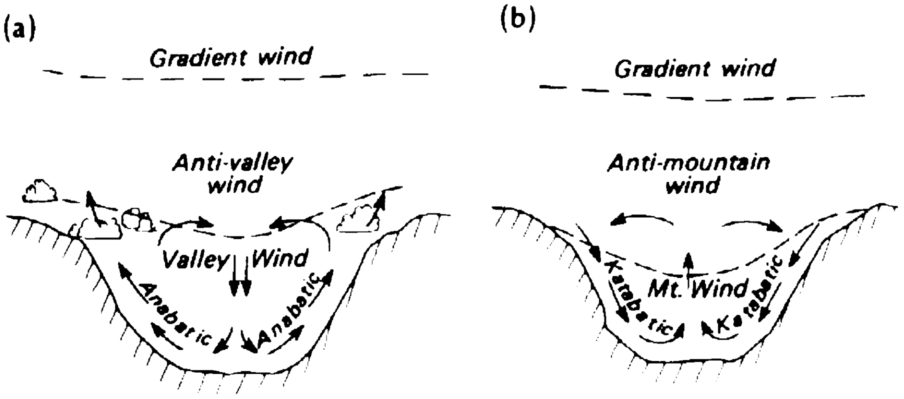




Wind maps were developed to help demonstrate typical wind patterns on the same timescale as the H_2S data. Wind velocities and directions were organized into charts similar to the ambient contour charts. Direction is identified according to color-coded quadrants. Velocities are displayed in the date/hour cells. Wind behavior for the months of July and August 1999, and 2000 are displayed in figure 4-3 A to D. Influences of a mountain valley wind system are evident from the wind maps. South-easterly winds dominate at night and early in the morning, northerly winds dominate in the afternoon, westerly winds dominate in the late afternoon and early evening. A band of northerly winds appears between 0600 and 0900 hours (thermals) right when higher H_2S levels appear at both ambient stations. A band of westerly winds routinely appear between 1800 and 2100 hours at the beginning of the period when higher H_2S levels register at ambient 1A. Observations from the wind maps suggest a typical mountain valley wind system. These trends can also be seen in figure 4-7. The behavior of air movement common to mountain valley systems is well described by several authors (i.e., Whiteman, 1982; Banta, 1985; Neff and King. 1987; Stull, 1989).

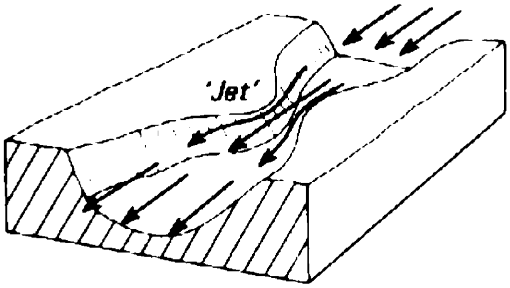
Up-slope (anabatic) winds occur when the mountain slopes are exposed to sunlight early in the morning (figure 4-4 a). A thermal gradient develops as the mountain heats up first and cool air from the valley floor is drawn up the slope. This produces an easterly wind at the mill. Northerly winds dominate in the afternoon as air masses tunnel down the valley from Frenchtown to Missoula. A proficient explanation for these afternoon *valley winds* is described in Oke 1978. During the day, air overlying the slopes and mountain bases is heated to a temperature exceeding the air overlying the valley center. This produces shallow, unstable, anabatic-type winds, which circulate high above the valley and sink into the center. These center winds form a stream down the valley from the northwest (Frenchtown) to the southeast (East Missoula) in the Missoula valley (Figures 4-4 A, 4-6).

Figure 4-4 (A) Anabatic and Valley Winds, (B) Katabatic and Mountain Winds (Oke 1978)



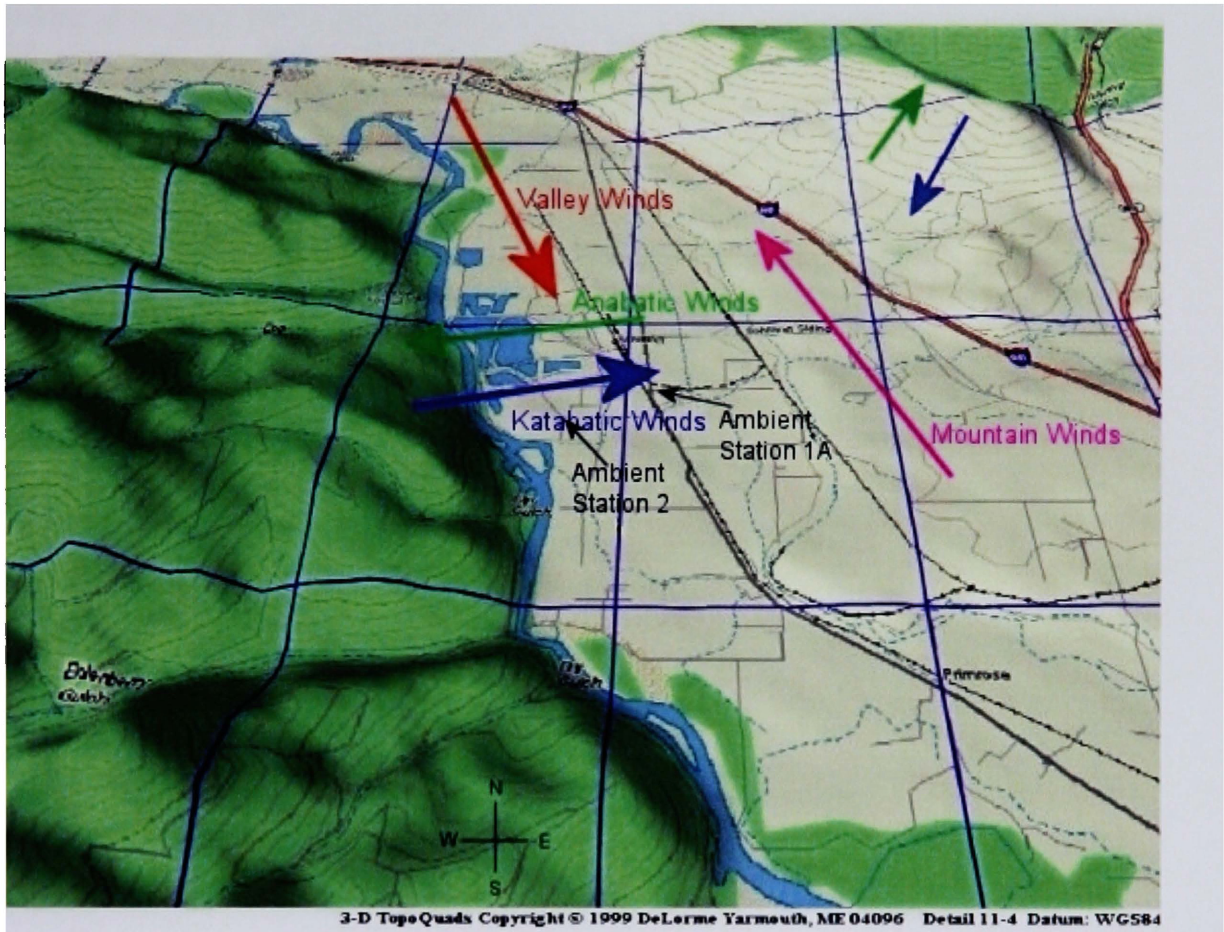
Additionally, specific regional conditions can strengthen, weaken or prevent the mountain valley winds. When air is forced to pass through a constriction in the valley it forms a jet of high wind speeds. The Missoula valley narrows on the southeast end which leads to this behavior. (Figure 4-5). The highest winds velocities appear during the afternoon from this jet affect in the Missoula valley (figures 4-7, 4-8).

Figure 4-5 Valley Wind Jet Constriction (Oke 1978)



Down-slope (katabatic) winds occur in the evening as the slopes cool down (figure 4-4b). When the slopes radiate heat, the overlying air conductively looses heat and drains to the valley floor. This produces a westerly wind at the mill. Furthermore, nighttime south-easterly winds predominate due to an effect opposite to the afternoon valley winds. The nighttime system is explained as having *mountain winds*, which are a reversal of valley winds due to a domination of katabatic winds rather than the afternoon anabatic winds (figure 4-4b). A representation of the Missoula valley and its wind behavior can be see in figure 4-6.

Figure 4-6 Geographic Map of the Missoula Valley and its Associated Wind Behavior



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 Detail 11-4 Datum: WGS84

Differential heating and valley breathing events are evident from the hourly H_2S data and meteorological data recorded at the Mills' two ambient stations. Figure 4-7 displays hour averages of wind direction and velocity, and ambient H_2S concentrations for all the July's 1997 – 2001, excluding the year 2000. The year 2000 data was excluded because of a SRB bloom and the severe wildfire smoke incursions. The same patterns are apparent when individual July's are graphed but averaging the data suppresses some of the anomalies. Years prior to 1997 were not included due to lack of available meteorological data at the mill.

Figure 4-7 Temporal Courses for hourly average wind direction, velocity and ambient H_2S data during all the July's 1997 to 2001 excluding 2000.

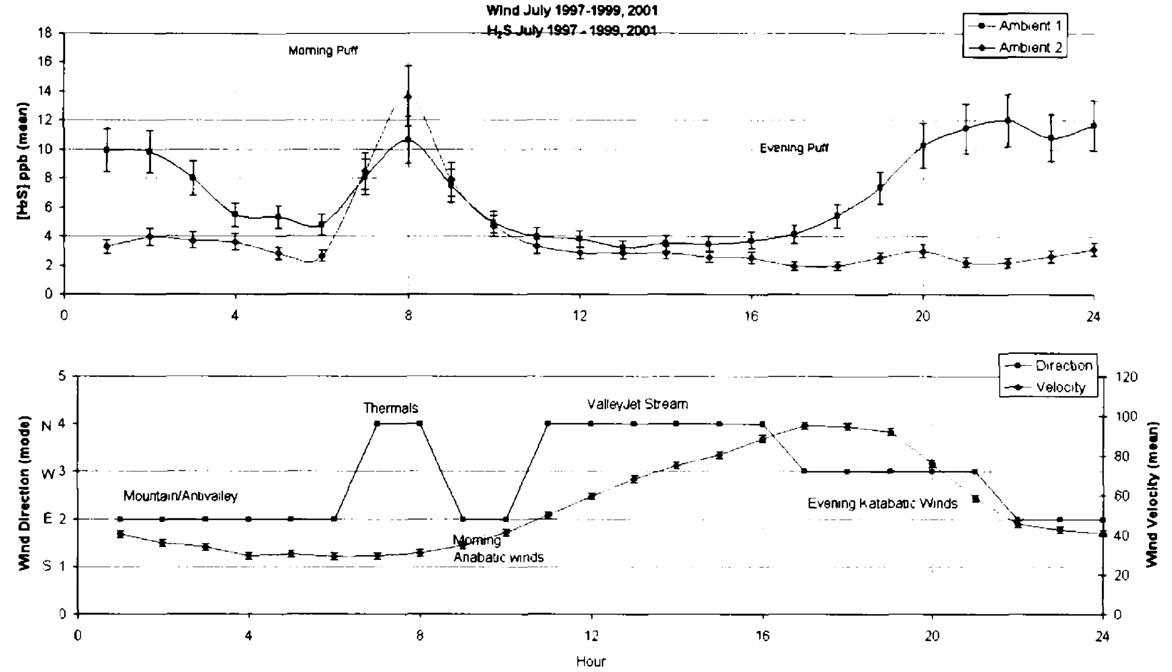
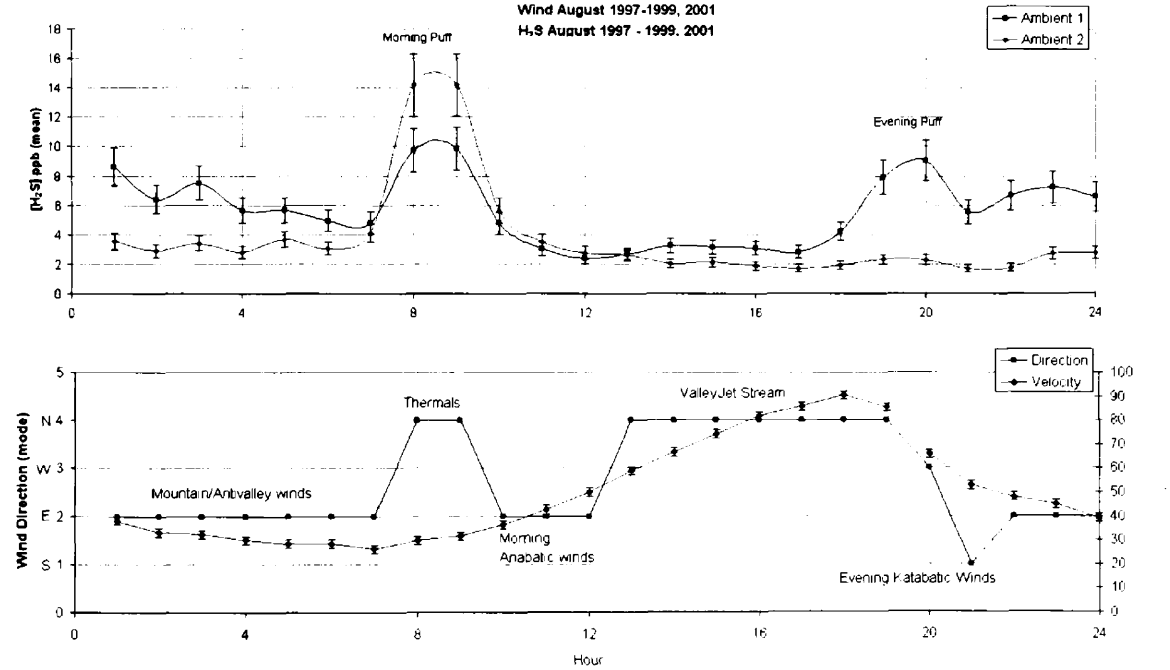


Figure 4-8 Temporal Courses for hourly average wind direction, velocity and ambient H_2S data during all the Augusts 1997 to 2001 excluding 2000.



The manner in which these data are displayed was inspired by graphical formats used in Baumbach and Vogt 1999.

August data were organized in the same manner and are displayed in figure 4-8. The northerly winds at 7-8am can be explained by differential heating. H_2S movement accompanies these winds from the ponds to the ambient stations. A taller peak is seen at ambient 2 because it is closer to the pond complex. The analyzer at 1A detects a more dispersed H_2S cloud. A predominance of southeasterly winds at 10am indicates an *up-slope* system. Northerly winds dominate the afternoon and can be defined as *valley winds*. The highest wind velocities are typically recorded in the afternoon system. H_2S is well dispersed during this period and ambient concentrations rarely exceed the 50 ppb limit. Direct westerly winds from 5 to 9 pm indicate a *down-slope* system. As cooler, heavy air drains down the mountainside to the west of the mill; it displaces H_2S from the ponds past the Site 1A monitor. Higher H_2S concentrations can be seen associated with the katabatic wind patterns beginning at about 8 pm, and continue till about midnight when *mountain winds* begin to dominate.

When plots were made for July and August of 2000, wind patterns were consistent with previous years, but distinctly different H_2S patterns were displayed. (figure 4-9 and 4-10). The morning and evening puffs are still visible, but high ambient levels occurred in the afternoon as well for the months of July and August.

Figure 4-9 Temporal Courses for hourly average wind direction, velocity and ambient H_2S data during July 2000.

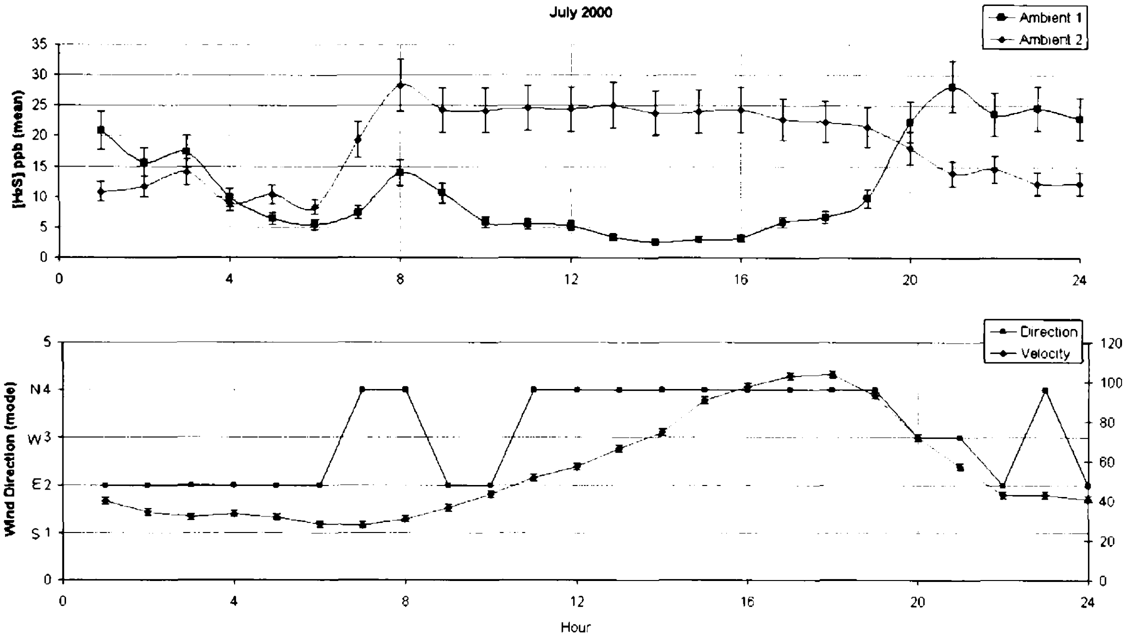
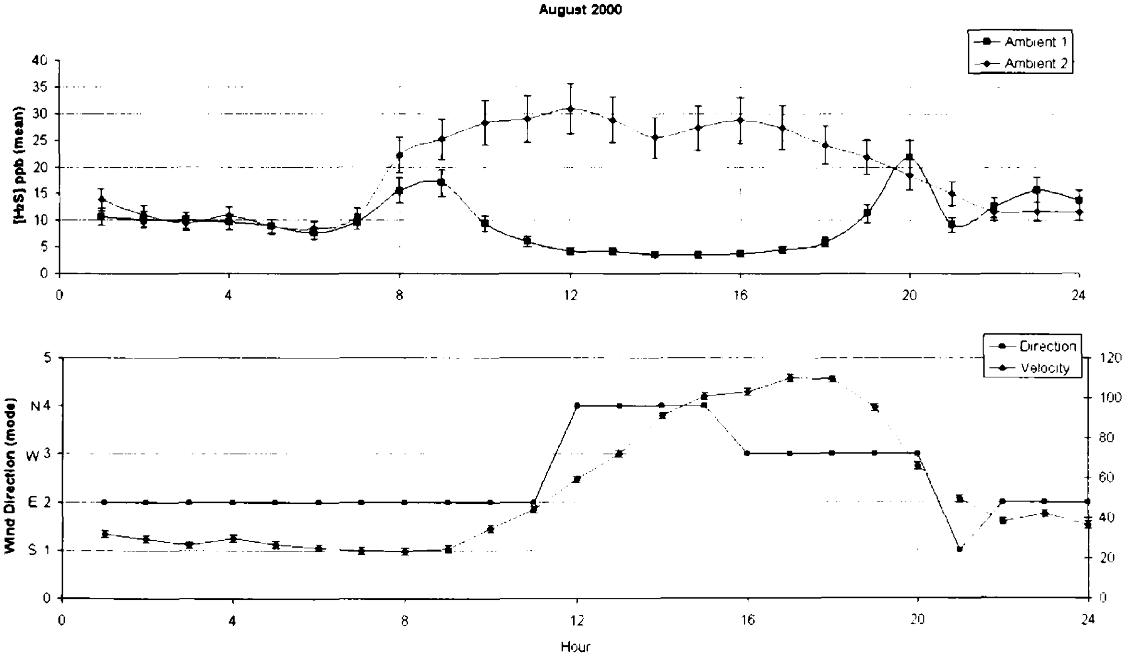


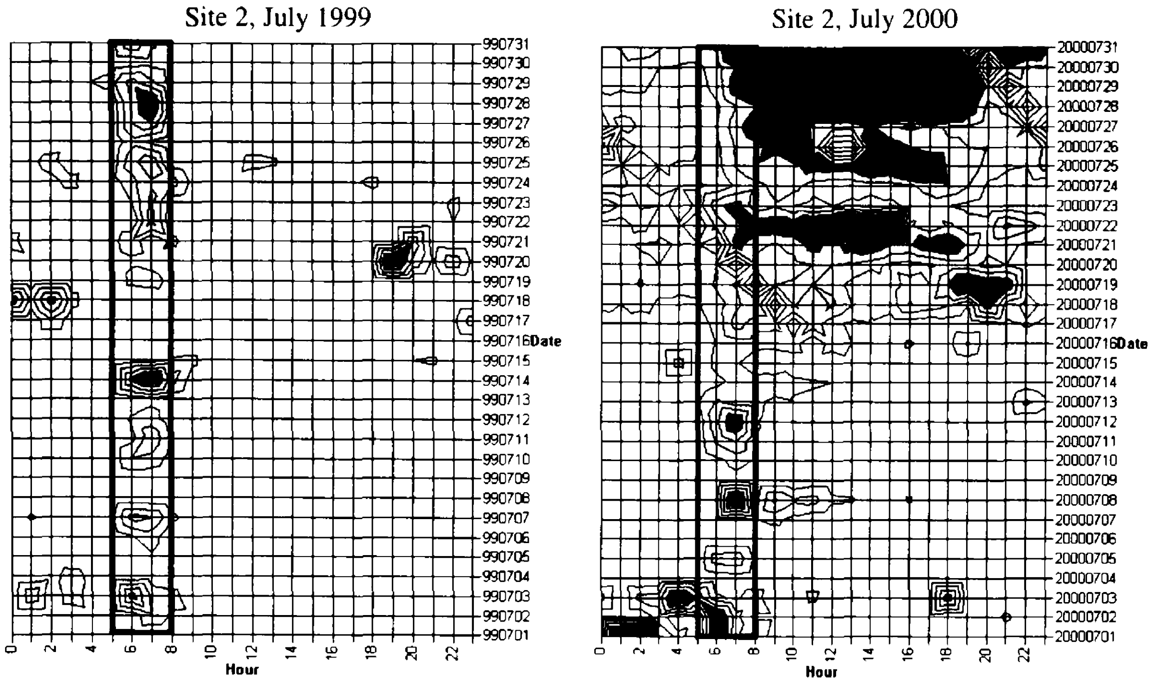
Figure 4-10 Temporal Courses for hourly average wind direction, velocity and ambient H_2S data during August 2000.



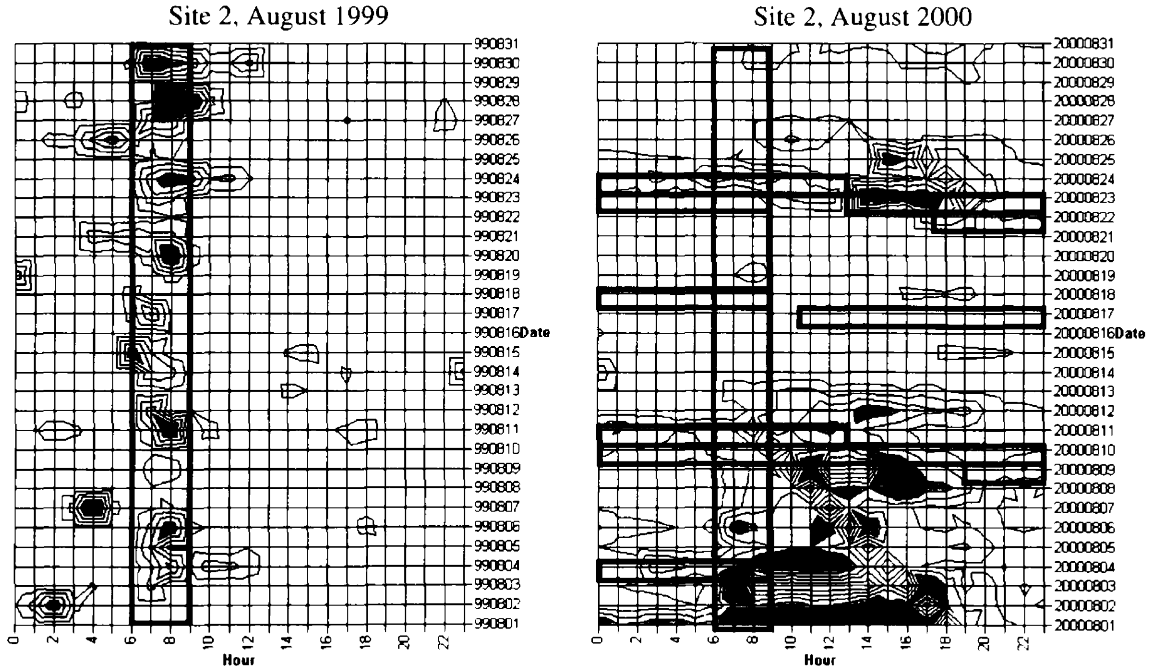
Distinct fire season

H_2S dispersion appears to be suppressed during July and August of 2000. Patterns of peak daily H_2S levels do not match with previous years. 1999 H_2S data represent typical ambient H_2S behavior patterns at both ambient stations. Figure 4-11 displays a comparison between the contour charts of July and August, 1999 vs. July and August of 2000 from data generated at ambient station 2. In the 2000 data, high levels of H_2S throughout the afternoon clutter typical morning and evening patterns shown in the 1999 data.

Figure 4-11 Comparison of 1999 July/August vs. 2000 July/August Contour Charts


Site 2, July 1999

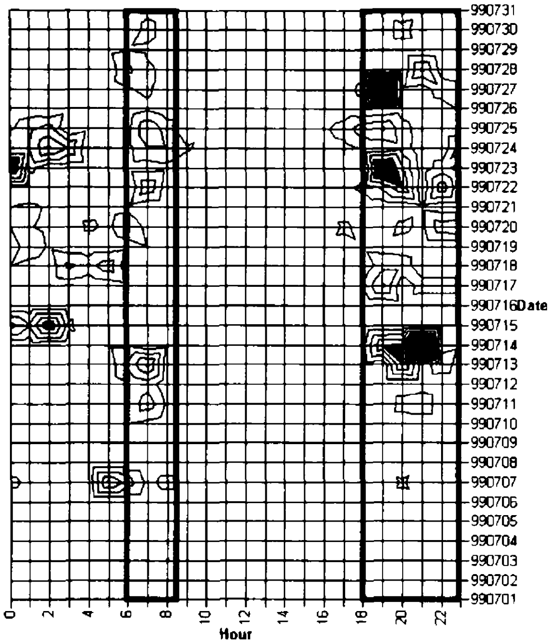
Site 2, July 2000


Site 2, August 1999

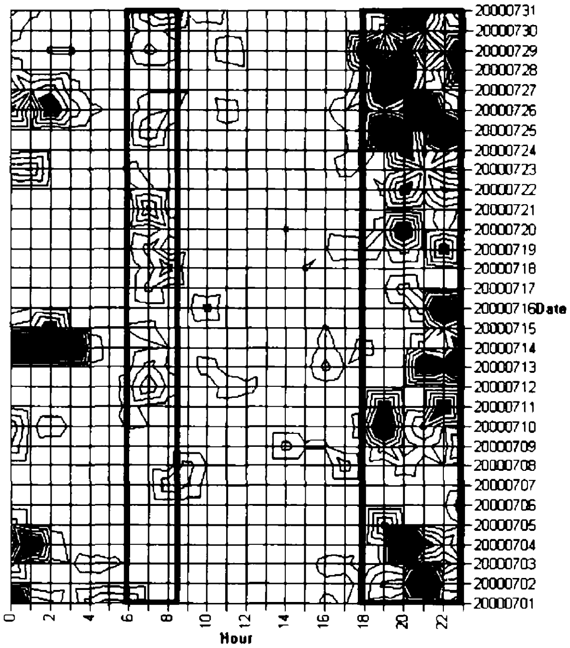
Site 2, August 2000

Morning puff's are highlighted in green, stage II air alerts in Missoula are highlighted in red.

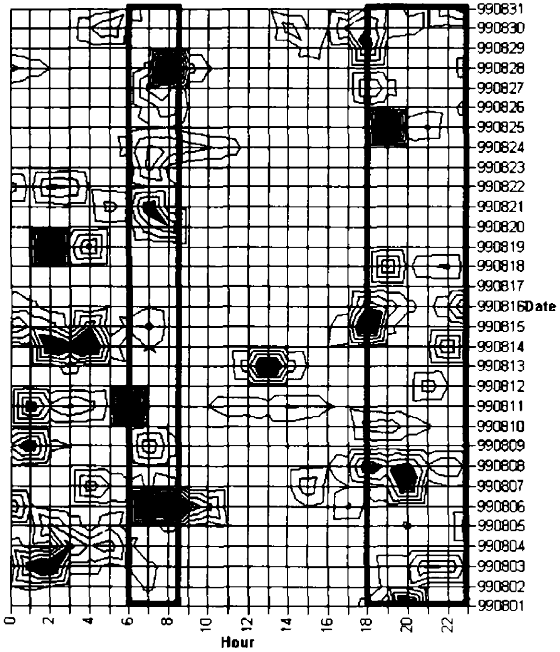
Site 1A, July 1999



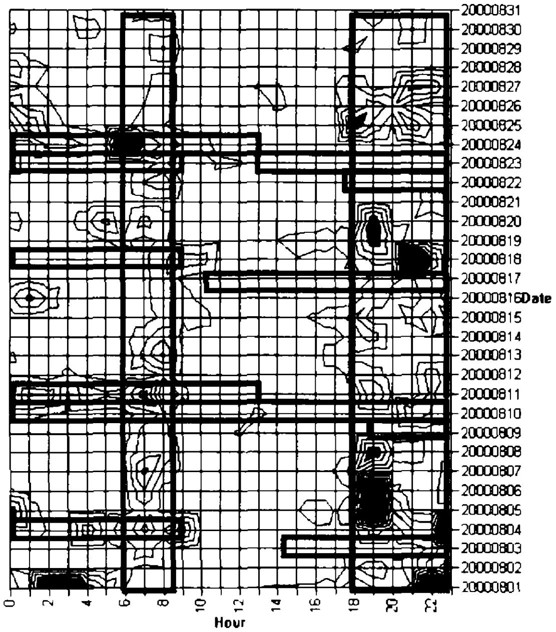
Site 1A, July 2000



Site 1A, August 1999



Site 1A, August 2000



Morning and evening puff's are highlighted in green, stage II air alerts in Missoula are highlighted in red.

In Idaho and Montana during the summer of 2000 nearly 4000 fires burned an estimated 2.2 million acres (Ward 2001). Wildland fires were predominant in the local area during July, August and September. Several fires burned in the Bitterroot Mountains approximately 80 km south of Missoula at the Sula Complex, Valley Complex, and Blodgett Canyon. Additional fires burned west of Missoula at the Flat Creek Complex, Clear Creek, and Ninemile Divide Complex. Smoke frequently moved downwind into the Missoula valley (Figure 4-12 A, B and C).

Figure 4-12 (A) Missoula Valley Smoke (B) Southeast of Hamilton (C) Sula Montana, August 9, 2000

Billings Gazette photo/LARRY MAYER

Thick smoke from forest fires fills mountain valleys near Missoula, Mont., early Wednesday, Aug. 23, 2000. Visibility in Missoula ranged between two and three miles most of the day.

Associated Press photo/DOUGLAS C. PIZAC

A helicopter with a load of water manuevers into position to dowse a flareup Friday, Aug. 25, 2000, southeast of Hamilton, Mont., within the Skalkaho fire region.

Accumulation of smoke in the Missoula valley led to eleven stage I air alerts and six stage II warnings. The first stage II air alert for smoke in the Missoula valley was called on August 3rd. A listing of air alerts and their corresponding dates and times are shown in table 4-1.

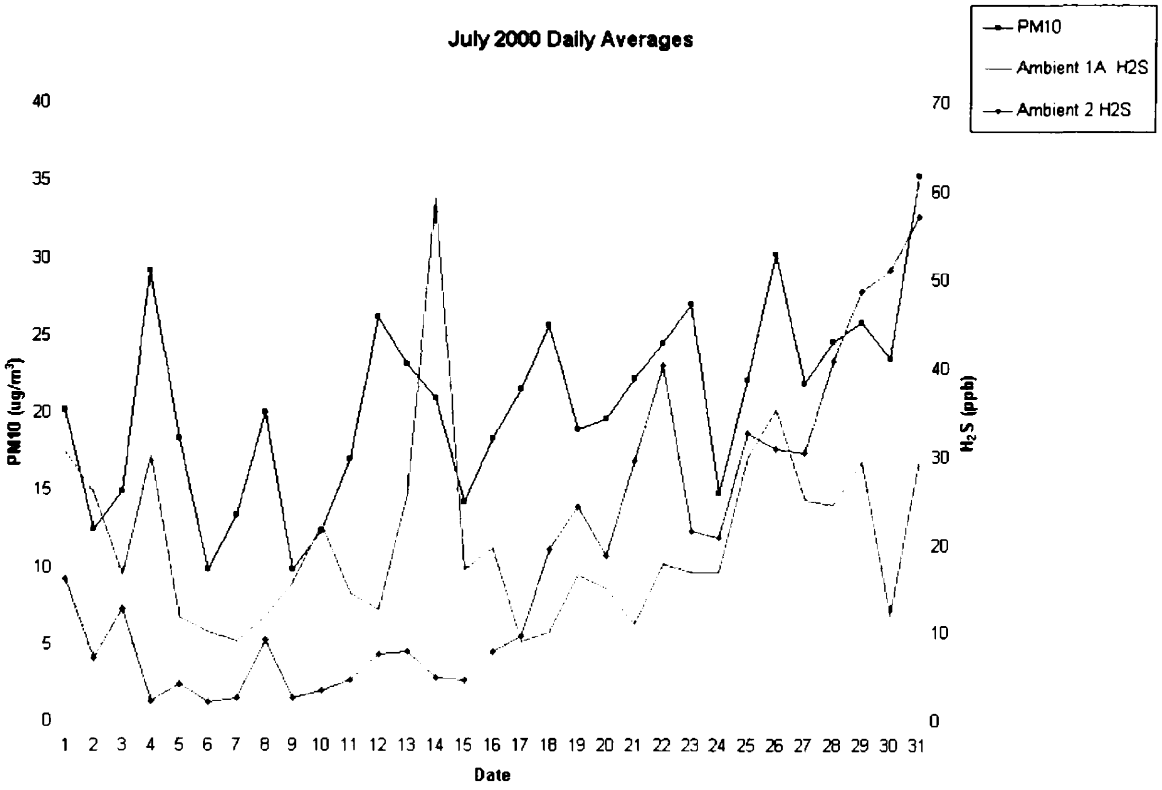
Table 4-1 List of Stage I Alert and Stage II Warnings Called During the Year 2000 Fire Season in Missoula

August 3:	Stage I at 12:30 PM Stage II at 2:30 PM	August 16:	Stage I at 9:00 AM Called off at 3:00 PM
August 4:	Stage I at 9 :00 AM Called off at 4:45 PM	August 17:	Stage I at 9:00 AM Stage II at 11:30 AM
August 9:	Stage I at 2:00 PM Stage II at 8:00 PM	August 18:	Stage I at 9:00 AM Called off at 4:00 PM
August 10:	Stage II all day	August 22:	Stage I at 1:00 PM Stage II at 5:30 PM
August 11:	Stage I at 9:00 AM Called off at 1:00 PM	August 23:	Stage I at 9:00 AM Stage II at 1:00 PM
August 12:	Stage I at 1:00 PM	August 24:	Called off at 1:00 PM
August 13:	Called off at 9:00 AM	August 25:	Stage I at 3:00 PM Called off at 4:30 PM

Stage 1 alerts are announced when PM-10 particulate levels exceed 80 ug/m^3 over an 8-hour period. Stage II warnings are announced when PM-10 particulate levels are expected to exceed 150 ug/m^3 over an 8-hour period. PM10 particulate was used as a surrogate for smoke in this study. Above average particulate levels were first detected on July 23rd in the Missoula valley. PM-10 in July reached as high as 142 ug/m^3. Mean values were calculated using data from 1996 to 1999 for July and August. They are 18 and 19 ug/m^3 respectively. These data were taken from the TEOM analyzer at Boyd Park. High ambient H_2S emissions registered on the mill's monitors on July 17th. But the first major smoke influx was not measured at Boyd Park until July 21st. This is evidence that increased H_2S levels were not initiated by fire events but were exacerbated by them.

In figures 4-13 and 4-14 the daily averages and daily maximums for H_2S and PM-10 are matched to draw out any possible correlation. Both parameters follow a similar pattern of peaks and valleys such that a correlation is suggestible, but not conclusive. The absolute error associated with these values is less than 15 percent. Comparison of these two parameters is problematic due to the distance between the mill and Boyd Park. By attempting to correlate PM-10 and H_2S data it must be assumed that the same variables influence both locations. Particulate levels recorded on the TEOM are dependent on meteorological conditions, so it must be assumed that meteorology is the same at both locations. There is a significant error associated with this assumption and due to the absence of a meteorological station at Boyd Park, weather variability cannot be confirmed between the two locations. Between August 12th and 19th the H_2S data at both sites do not follow the same trend as the PM10 data. Some data in August (2A) is missing; this is due to instrument malfunctions from the high occurrence of smoke (Ball 2000). Wind velocities increased during period 8/12 to 8/19 suggesting that air currents dispersed the concentrating H_2S emissions while assuming the influx of smoke remained constant. The overall dependence of H_2S behavior on smoke is unclear when considering PM-10 data alone. Meteorological data at Boyd Park would be useful for truly identifying the presence or absence of correlation between the PM10 and H_2S data used. While there appears to be no direct correlation between H_2S and PM10 data, the coincidence of smoke in the valley along with an unusual amount of H_2S exceedances suggests circumstances independent of controllable mill operations.

Figure 4-13 Daily Average PM10 vs. H2S for July and August 2000 at Ambient 1A and 2



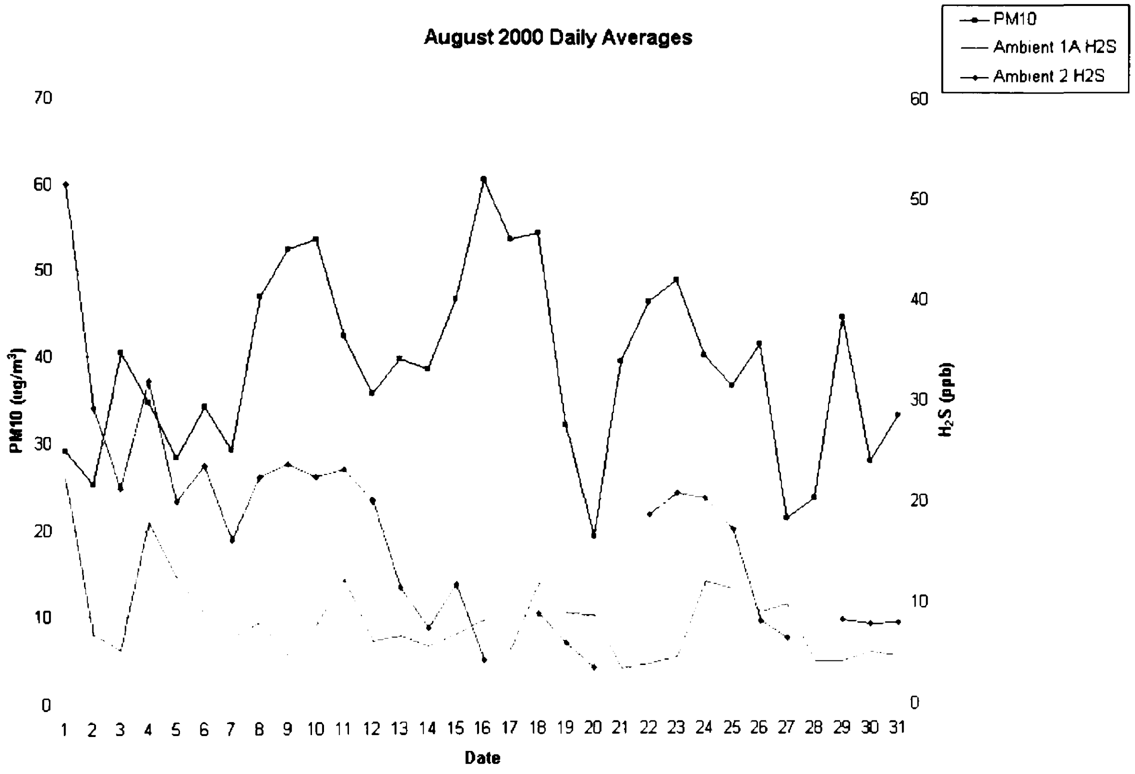
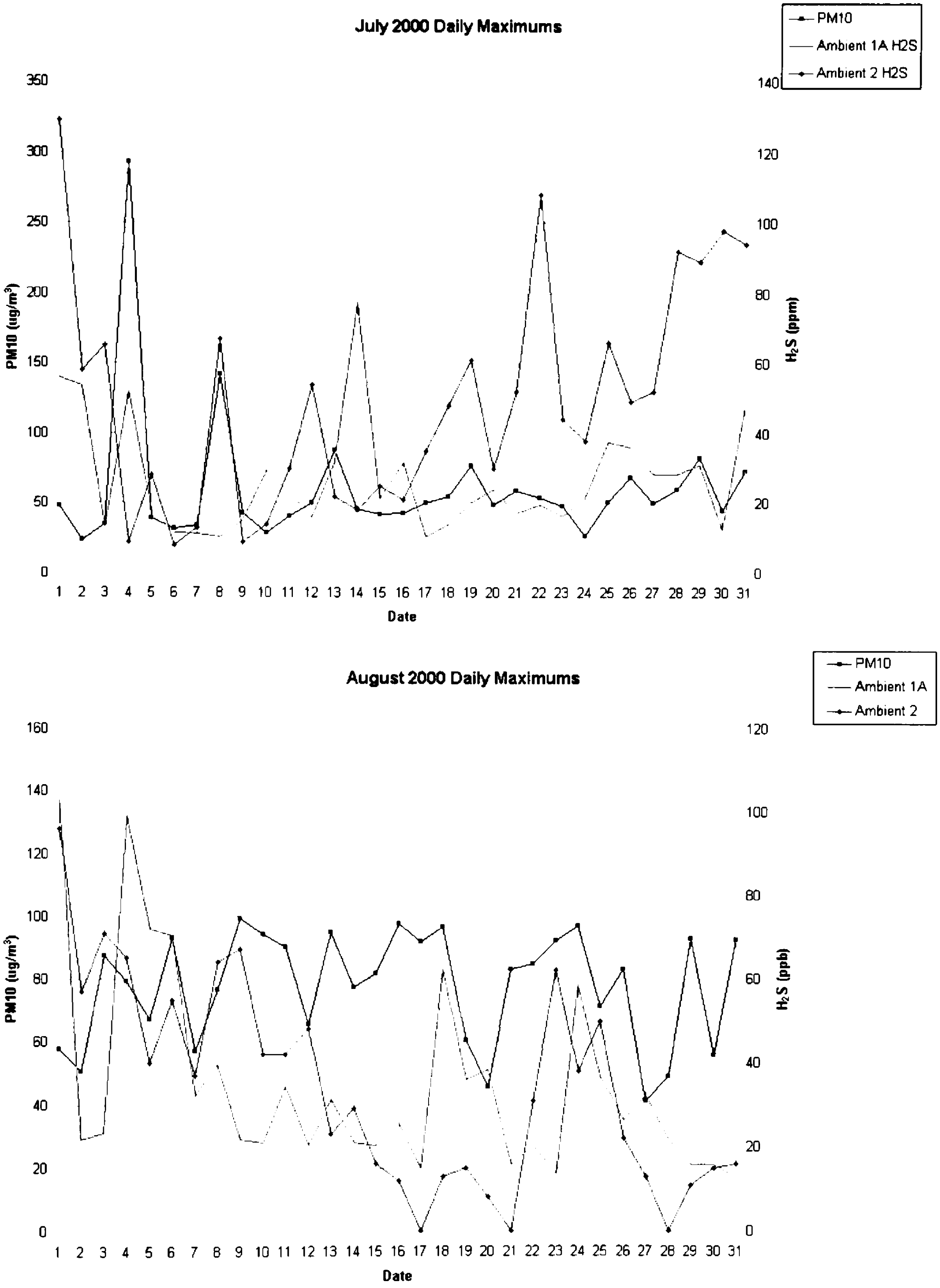


Figure 4-14 Daily Maximum PM10 vs. H_2S for July/August 2000 at Ambient 1A and 2



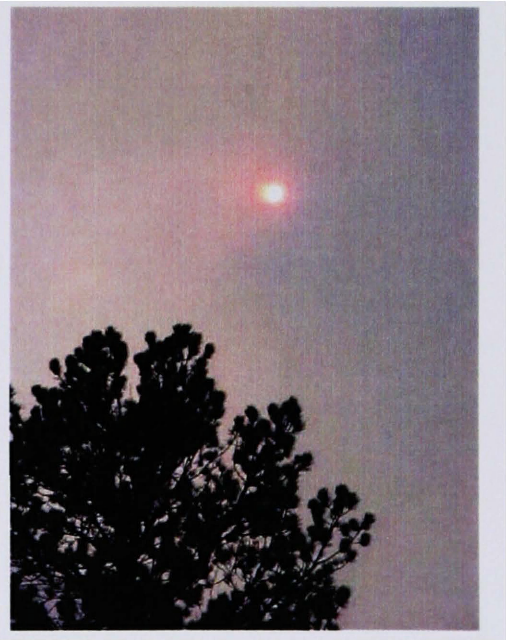
While sulfates are abundant, sulfides are not a typical component of forest fire smoke (Andreae 1998, Hegg 1987). Therefore, the abundance of ambient TRS was not supplied by the smoke but typical atmospheric scavenging and dispersion may have been suppressed by the smoke.

During the month of August 2000, overcast of smoke prevented sunlight from penetrating to the valley floor. The heavy layer of smoke induced a stable system. As can be seen by comparing figure 4-8 and 4-10, the typical morning northwesterly gust from the formation of convection cells to ventilate the valley were stymied, so H_2S remained in place. Furthermore, atmospheric photochemistry in the region may have been suppressed. H_2S is normally oxidized to SO_2 by reaction with photolytically generated hydroxyl radical (Seinfield 1998) thereby producing SH radical (Equation 4-1).

$$H_2S + OH^{\cdot} + h\nu \rightarrow SH^{\cdot} + H_2O \qquad (4\text{-}1)$$

The atmospheric lifetime of H_2S by equation 4-1 is about 70 hours. SH radical then proceeds through a series of reactions ultimately forming SO_2 (Friedl 1985). Sunlight was suppressed by smoke from reaching lower valley levels (figure 4-15), so hydroxyl radical was only being produced at the cloud tops (Kaufman 1998). Once made, it had little chance of diffusing downward and reacting with H_2S. Moreover, OH radicals may have been used up scavenging organics in the smoke particulates (Mount 1992), thus becoming depleted before it could ever encounter H_2S.

Figure 4-15 Midday Sunlight Blockage from Heavy Smoke Clouds in the Missoula Valley.



H_2S data show the best direct correlations to ambient air temperature. For July and August 2000 there is a significant linear correlation between temperature and ambient H_2S concentrations (figures 4-16 and 4-17). At ambient site 2, H_2S concentrations can be explained using temperature data alone 71% of the time in July and 85% of the time in August. A temperature correlation is reasonable. The solubility of H_2S in water dramatically declines with increasing temperature (Handbook of Chem. and Phys. 1968).

Figure 4-16 Linear Correlation of Ambient Temperature and H_2S, July/August 2000 at Site 2

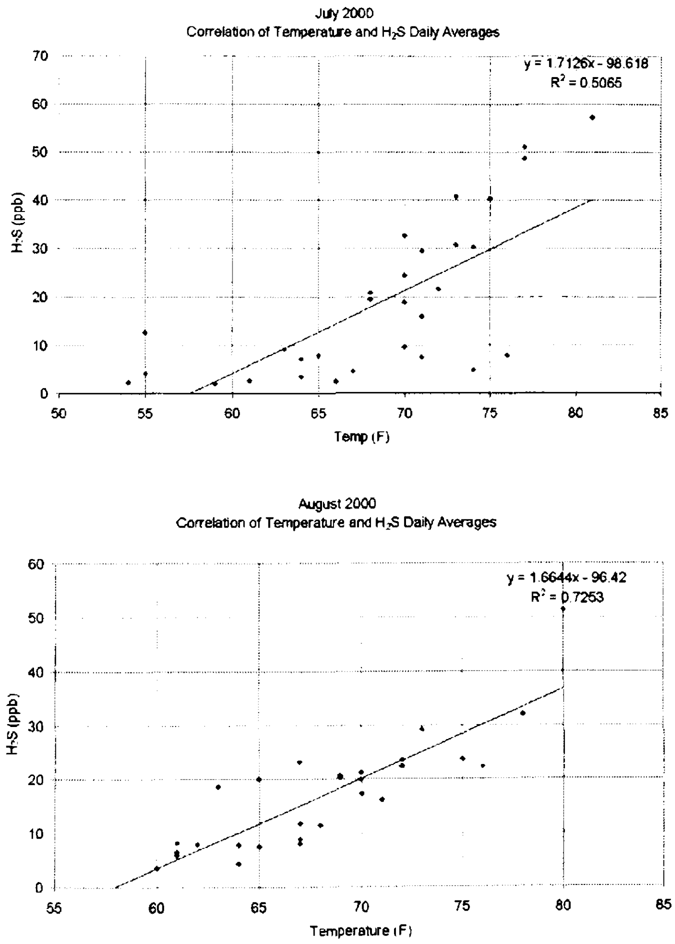
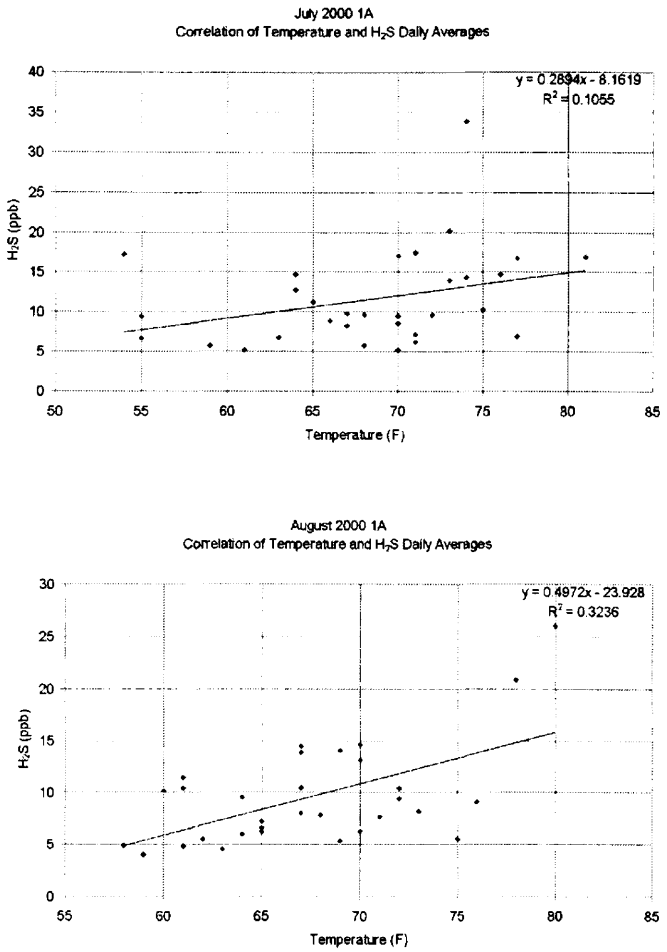


Figure 4-17 Linear Correlation of Ambient Temperature and H_2S, July/August 2000 at 1A



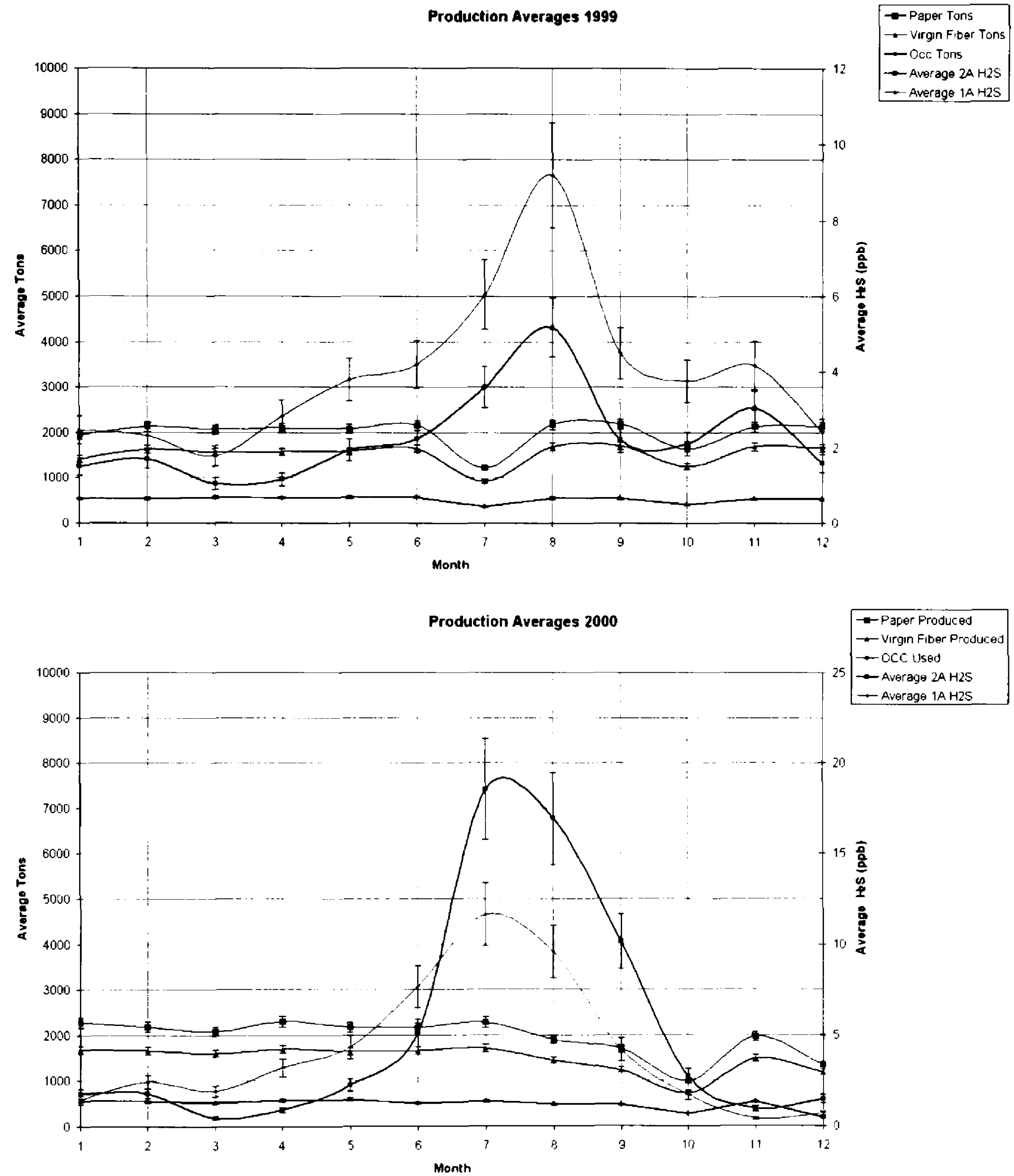
Additionally, SRB respiration is greatest at warmer temperatures. Optimum temperature for metabolism by *Desulfovibrio* is between 30 and 38 °C. There is a plethora of sulfate reducers that can optimally respire anywhere between 20 and 83 °C (Widdel and Hansen 1992). Correlations between ambient H_2S and temperature are limited by the amount of dispersion due to wind. The poorer coefficients at site 1A (figure 4-16) compared to 2 are likely a result of the proximity of site 2 to the ponds. The H_2S plume is better dispersed at 1A because it's further away from the pond complex.

4.2 Production Data

A question arises concerning the relationship between mill production levels and ambient emissions. Are they related and if so, in what manner? Obviously, there would be no H_2S emissions if the mill ceased to exist. However, there is some concern whether fluxuation in mill production leads to fluxuation in ambient emissions. There are two potential processes at the mill, which could indirectly or directly supply ambient H_2S emissions. First, mill effluent supplies SRB in the ponds with oxidized sulfur compounds and organic compounds necessary for growth. Fluctuations in effluent feedstock for the SRB may lead to fluctuations in H_2S emissions (Ainsworth 1995). Second, stack emissions at the Missoula Mill release total reduced sulfur compounds (TRS) at the part per million levels. These emissions could directly affect ambient readings.

A simple method was used to compare production levels to ambient emissions. Production levels were established using major input (feedstock) and output (product) quantities. Fluctuations in production parameters were compared to ambient H_2S emissions from each ambient site in 1999 and 2000. (figure 4-18). It is obvious from these data that while production levels remain relatively constant, the ambient emissions display a seasonal pattern of high levels in the summer and low in the winter. This suggests that mill production levels are not a primary factor affecting ambient emissions. Generally speaking, stack emissions follow the same trend as production data. They are relatively constant throughout the year.

Figure 4-18 Annual H_2S and Production Averages (A) 1999, (B) 2000



It is suspected that stack emissions impact ambient emissions on a temporary basis when meteorological conditions allow. Stack emissions may be a reason why ambient emissions cannot be completely explained with meteorological data alone. Each ambient H_2S exceedance is investigated by both mill and state personnel. All investigations report that stack emissions were no higher than normal during ambient exceedance hours throughout the past ten years (Wilson 2001). Additional studies are needed to review all hourly data, not just exceedance hours, and describe any possible impacts of stack emissions on ambient monitors. Industrial source complex models, and tracer analysis may provide the necessary data to reveal these impacts.

5. Conclusions and Recommendations

Definitive correlations were observed in the 10 years of ambient H_2S monitoring data at the Smurfit-Stone Container mill in Missoula. First, there is a seasonality effect during the winter months. Ambient H_2S levels were virtually undetectable between November and April with the exception of a couple years where ambient H_2S was detectable in February. These were probably due to heavy inversion conditions. The highest H_2S concentrations are historically measured mid-summer. The H_2S concentrations decrease during the fall and reach typical winter readings by October. The increases of ambient H_2S concentrations during the spring months, peaking during the summer months, and decreasing during the fall months seem to correlate with the seasonal SRB population.

Additional analysis of historical ambient H_2S emissions revealed that meteorological valley ventilation is responsible for two "puffs" (air-mass movements over the ambient monitors) of H_2S a day being recorded at the mill's monitoring system. The morning puff is created in response to convection cells of air forming south of the mill. The evening puff results from katabatic winds (valley drainage of cool evening air). Consequently, meteorological conditions are typically responsible for the increased H_2S concentrations recorded at the mill's two ambient stations. When data for the year 2001 were reviewed, all exceedances landed within the two puffs.

During the summer of 2000, western Montana wildfires led to an influx of smoke in the Missoula Valley. Ambient H_2S behavior diverged from typical daily trends and the number of hours exceeding 50 ppb skyrocketed over previous years. Hourly PM10 data were used as a surrogate for smoke. PM10 data were matched against H_2S data to test for correlation. While a statistical correlation was not conclusive, both parameters follow a similar pattern of peaks and valleys when daily averages were matched. The fires of 2000 instigated unique circumstances where ambient H_2S emissions were not dispersed like previous years. As a result of research efforts, a notice of violation for 158 H_2S exceedances was never issued by the MTDEQ to the Missoula mill.

Generation of hydrogen sulfide from the pond complex is the byproduct of a microbial response to high aqueous sulfate levels. This is an essential mechanism that leads to natural dispersion of sulfur in aquatic ecosystems. While H_2S gas poses a nuisance to local residents, this mechanism is justifiably the simplest way to control sulfate in the ponds until technology can be developed to disallow sulfate from ever entering the ponds.

The maximum hydrogen sulfide level detected at the ambient stations throughout the 10-year historical record (1990-2000) was less than 0.200 ppm. The maximum level detected between June and August using the handheld *Jerome* 1 cm above the surface of various ponds was less than 2.000 ppm (Tooke 2002). The OSHA limitation for an 8-hour workday is 10 ppm. There is no evidence that H_2S emissions from the ponds pose a health issue to local residents or mill workers. The ambient standard of 50 ppb is an aesthetic standard designed to regulate nuisance odors only. Evidence from this study suggest that H_2S flux detected by the ambient monitors is a function of a mountain-valley meteorological system. The location of the two ambient stations has proved useful for characterizing local meteorological conditions and H_2S dispersion patterns. Stone container should continue to use the ambient monitors as remote detectors. During summer months, moderately high ambient H_2S levels are expected during morning and evening puff periods. Action should be taken in the event that high ambient H_2S levels occur outside the periods indicated by the morning and evening puffs. Currently, ambient exceedences that register at both stations within a given hour are subject to fines as separate events. Evidence from this study suggests that H_2S dispersion is governed by a common local meteorological system and exceedances at both detectors within the same hour should be treated as a single event.

The mill can check stack emissions, effluent sulfur concentrations, and production levels to indicate direct answerability for above average ambient H_2S emissions. Additionally, mill employees could use the *Jerome* sensor to establish the source of highest emissions from the pond complex. If mill conditions were the cause then the mill would be subject to compliance within a reasonable period of time to make proper process corrections. In the event that a prolonged exceedance event occurs, the mill could initiate a control measure to suppress pond emissions. The overall use of the ambient monitors should be re-evaluated by the Montana DEQ. An option should be in place such that mill activities are not automatically blamed for all exceedances.

The monitoring/visualization tools developed in this study (wind maps, contour charts, and temporal charts) can be used to identify whether recent ambient patterns match with typical patterns. A comprehensive study of the effluent treatment system is necessary to formally identify the largest H_2S contributors and recognize any variables that can be directly controlled by mill operations to minimize H_2S emissions. Mill stack emissions are continuously monitored, but a study which models the impact of these emissions on the ambient monitors needs to be completed. An Industrial Source

Complex Model (ISC) could be used to trace point source TRS emissions and identify their impact on the ambient monitors. Additional insight can be gained concerning odor problems if the mill can associate their activities with odor complaints in the Missoula valley. Human noses are extremely sensitive to reduced sulfur compounds. Future studies could utilize volunteers as a network of (nose) detectors to help verify the association or disassociation of odors in Missoula with mill activities. From preliminary logging of odor reports, odors associated with the Missoula wastewater treatment plant and a local rendering plant are often falsely attributed to the mill.

Part B

Maximum Achievable Control Technology (MACT 1)
Phase 1 Methanol Analysis

Part B: Maximum Achievable Control Technology (MACT 1) Phase 1 Methanol Analysis

6. Introduction

The Smurfit Stone Container Mill completed the addition MACT 1 Phase 1 pollution control technology in the fall of 2000 in response to Federal Air pollution regulations contained in 40CFR Part 63, Subpart S also known as the Cluster Rule for the Pulp and Paper Industry. The Cluster Rule was devised as a late 1990's enactment of the 1972 Clean Air Act. The Clean Cir Act was initially drafted to regulate ambient air, which was difficult due to the large assortment of emitters and pollutants. By 1990 only about a dozen pollutants were being regulated. Furthermore, the typical industrial mechanism for removing air pollutants was to partition them back into water. The 1998 cluster rule divided all emitters into 189 categories, and required the destruction of organic air pollutants rather than simple partitioning. The pulp and paper industry comprises one of the 189 categories. Stone has implemented Maximum Achievable Control Technology (MACT) to collect and remove hazardous air pollutants. MACT equipment includes extensive piping to collect evaporator condensate and low volume high concentration (LVHC) gases, a steam stripper, and a direct-fired oxidizer (DFO). Condensate tanks collect gases from multiple-effect evaporators where black liquors are concentrated. Hazardous air pollutants (HAP's) are stripped out of the condensate in the steam stripper and repartitioned into the gas phase. Stripper off gas (SOG's), noncondensable gases from the mill (NCG's), and LVHC gases are fed into the DFO to be completely combusted.

Stone Container must demonstrate the efficiency of MACT equipment to the State of Montana Department of Environmental Quality (MTDEQ). The EPA has determined that methanol is the primary HAP in the Kraft pulping process and can be used as a tracer molecule for demonstrating collection and removal effectiveness. The EPA has also determined that total organic HAP's are essentially collected and removed with the same efficiency as methanol. In order to comply with MTDEQ regulations, Stone must demonstrate collection of 7.2 pounds of methanol per oven dried ton of pulp produced (ODTP). Stone must also demonstrate to MTDEQ that the steam stripper removes methanol from condensate with an efficiency of 92 % or better.

To demonstrate compliance with MTDEQ regulations, Stone drew condensate samples from 10 collection streams over a 165-day period. Additional samples were collected before and after the steam stripper. These samples of untreated and stripped condensate were used to establish stripper efficiency. Samples were analyzed for methanol at the University of Montana using a modified National Council for Air and Stream Improvement NCASI method, DI/MeOH –94.03 (NCASI 2002). Condensate flow rates, production data, and other mill operating conditions were logged during the sampling period. Many acronyms are used in the following text to shorten equipment names and other long titles. Appendix I is provided as a quick reference for commonly used acronyms and other terms in this paper.

6.1 Purpose

The purpose of this research was to develop a comprehensive database of representative methanol concentrations for condensate streams leading to a foul condensate tank that flows directly into a steam stripper. These concentrations were then used to provide a model with process unit-specific condensate capture factors so that the impact of equipment upgrades or expansions could be computed with reasonable assurance. From these benchmarks, the mill can demonstrate to the state of Montana the ongoing effectiveness of their control technology for the removal of HAP's from their condensate without the need for rigorous and continuous sampling efforts. The model will not only act as an analytical solution but can also serve as a potential construct from which to develop automated control monitoring systems.

It was also the purpose of this work to help prepare a sampling schedule for mill personnel to assure on-going MACT 1 compliance. Periodic sampling will provide a platform for which the model can be recalibrated with new collection factors.

7. Background

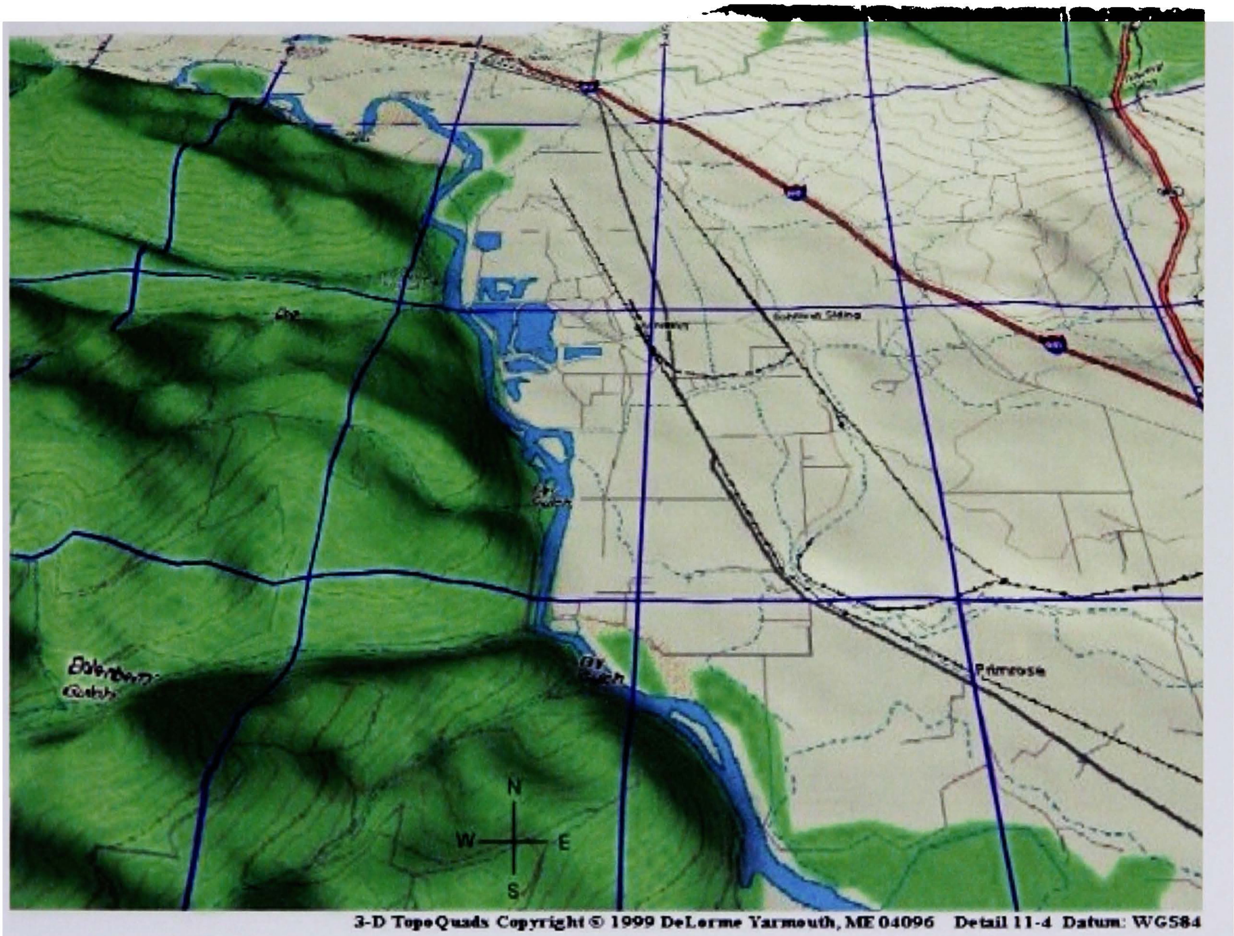
7.1 Site and Facility Description

The Smurfit Stone Container pulp and paper mill is located in a mountain valley approximately 15 km north of Missoula Montana and 7 km south of Frenchtown. The mill is bordered by agricultural land (north, south, and east) and the Clark Fork River (west) (Figure 7-1). The mill produces unbleached linerboard and uses the kraft process for producing virgin pulp. Additional pulp is produced from recycling old corrugated containers (OCC). The mill has been operating 45 years, and has a production capacity of more than 2700 oven dried tons of pulp per day (ODTPD). Currently the mill produces roughly 1100 oven dried tons per day.

At full production three paper machines process about 175 truckloads or 3700 tons of raw materials per day. The mill supplements two parts raw material with one part recycled containerboard. On an average year, the mill uses more than 222,500 tons of OCC. In an average day the mill recycles more containerboard than the city of Missoula (pop. 50,000) produces in a year. Steam for the mill is provided by burning "Hog fuel" (bark, sawdust, and reject chips) and OCC rejects, in a waste fuel boiler.

Approximately 450 people work in the mill's production facilities and maintain nearly 800 acres of wastewater treatment ponds. The kraft process is chemical intensive and requires a complex recovery system. This system includes multiple effect evaporators, recovery boilers, smelt dissolving tanks, and lime kilns. Two production well fields provide up to 25 million gallons of water to the mill per day. Water is recycled and reused throughout operations in the plant and wastewater is handled in an extensive treatment system including a clarifier, dewatering plant, three stages of aeration basins, and more than a dozen holding ponds. Treated water seeps through unlined holding ponds, evaporates or is discharged into the adjacent Clark Fork River during turbulent flow conditions each spring.

Figure 7-1 The Missoula Mill (location and facilities picture)



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 Detail 11-4 Datum: WGS84

In 1999 the mill began implementing maximum achievable control technology (MACT) to remove HAP's from their condensate streams and low volume high concentration air streams.

7.2 Cluster Rule

Federal regulations for MACT 1 are found in 40 CFR Part 63 Subpart S otherwise known as the "Cluster Rule" for air improvement. The new regulations were promulgated in 1998 as a continuing enactment of the Clean Air Act. The Cluster Rule sets new baseline limits for the release of xenobiotic pollutants to air and water. With these new regulations, the EPA required mills to capture and treat pollutant emissions that occur during the cooking, washing and bleaching stages of the pulp manufacturing processes. Implementation and operation of MACT 1 equipment at Stone Container has led to compliance with the standards listed in the Cluster Rule. An overview of the cluster rule, its environmental benefits, and health benefits can be found at the EPA website (http://www.epa.gov/ost/pulppaper/fact.html).

7.3 MACT1 Components

The Missoula mill began construction activities for the MACT 1 Pollution Control Project during the summer of 1999. However, the kraft process must first be explained to underscore the importance of MACT 1 equipment and how it was incorporated into the existing equipment.

Kraft Pulping Process

The kraft process is complex. For practical purposes, this section will be limited to a short summary. A detailed description of kraft pulping can be found in Smook 1992. The overall goal of pulping is to delignify and break down wood chips into fibers. This can be accomplished in either a batch or continuous mode. Delignification is done under high pressure and temperature in the presence of white liquor (a solution of Na_2S and NaOH). Digested fibers are cleaned with water in brown stock washers. Effluent from the washers is called weak black liquor (dilute white liquor with roughly 15% solids and large amounts of lignin). The fibers are spread on a wire mesh and dewatered to make paper. The rest of the process involves recovery of the cooking chemicals.

Weak black liquor passes through multiple-effect evaporators, which serve to concentrate the liquor. The recovered water is captured in large condensate tanks. Strong black liquor (~ 70 – 75% solids) is incinerated in a recovery furnace to form inorganic smelt (mostly Na_2CO_3). Sulfur compounds, which were oxidized in the digestion process, are also reduced back to sulfide in the furnace. Incomplete combustion of carbon and carbon monoxide allow them to act as reducing agents for the reduction of sulfur. Inorganic furnace smelt is dissolved in weak wash (weak white liquor) to form green liquor. The green liquor is clarified to remove dregs (large clusters of inorganic material) then reacted with lime (CaO) to form NaOH. An exchange reaction occurs between the sodium carbonate and calcium hydroxide to form sodium hydroxide and calcium carbonate (equations 7-1,7-2).

$$CaO + H_2O \rightarrow Ca(OH)_2 \tag{7-1}$$

$$Na_2CO_{3\,(aq)} + Ca(OH)_{2\,(aq)} \rightarrow 2NaOH_{(aq)} + CaCO_{3(s)} \tag{7-2}$$

The white liquor is clarified to remove any precipitated lime mud ($CaCO_3$), and then is ready to be reused for cooking. The calcium carbonate is burned in a kiln and calcium oxide is recovered.

Phase 1 MACT Equipment

There are two phases planned for the MACT 1 project. MACT 1 Phase 1 equipment was developed to collect and treat LVHC and SOG streams. MACT 1 Phase 2 equipment will collect and treat high volume low concentration (HVLC) streams, such as those produced by the brown stock washers.

In phase 1 there were major changes to the existing condensate collection system including the addition of extensive piping for collection of condensate, LVHC and

NCG's; a foul condensate tank; steam stripper; and direct fired oxidizer for phase 1. Construction activities were completed in January 2001. Many HAP's (including large amounts of methanol) are released from the liquor in the evaporation process and then condense with water. The MACT project was designed to remove HAP's from the condensate. Ten condensate collection streams were routed to a foul condensate tank. These streams are listed in Table 7-1. The condensate streams are all derived from evaporators or concentrators. Concentrators are often placed in line following multiple effect evaporators. They act as a single stage evaporator to further concentrate the black liquor. Foul condensate is fed into the steam stripper, which removes HAP's from the condensate and routes them to the DFO as stripper off gas (SOG). Low volume high concentration (LVHC) gases, which are primarily NCG's, are also collected from various points in the mill. These gases are piped directly to the DFO (figures 7-2, 7-3). There are several low point drains in the LVHC system to catch condensate. These drains are piped to the No. 1 Concentrator.

Table 7-1 Missoula Mill Condensate Streams for Segregation and Collection

1. No. 1 and 2 Evaporators Foul Condensate
2. No. 3 Evaporator Combined Condensate
3. LVHC-NCG Line Drains
4. No. 4 Evaporator 2nd Effect Stand Pipe Foul Condensate
5. No. 4 Evaporator Foul Condensate
6. No. 2 Concentrator Foul Condensate
7. No. 1 Concentrator Foul Condensate
8. Turpentine Decanter Condensate
9. Batch Digester Blow Heat Condenser
10. Accumulator Overflow

The direct-fired oxidizer was designed specifically for complete oxidation of LVHC-NCG's and SOG's. The DFO complies with MACT requirements by combusting these gases for at least 0.75 seconds at a minimum temperature of 1600°F.

Figure 7-2 Block Diagram of the MACT 1 LVHC and Condensate Collection System

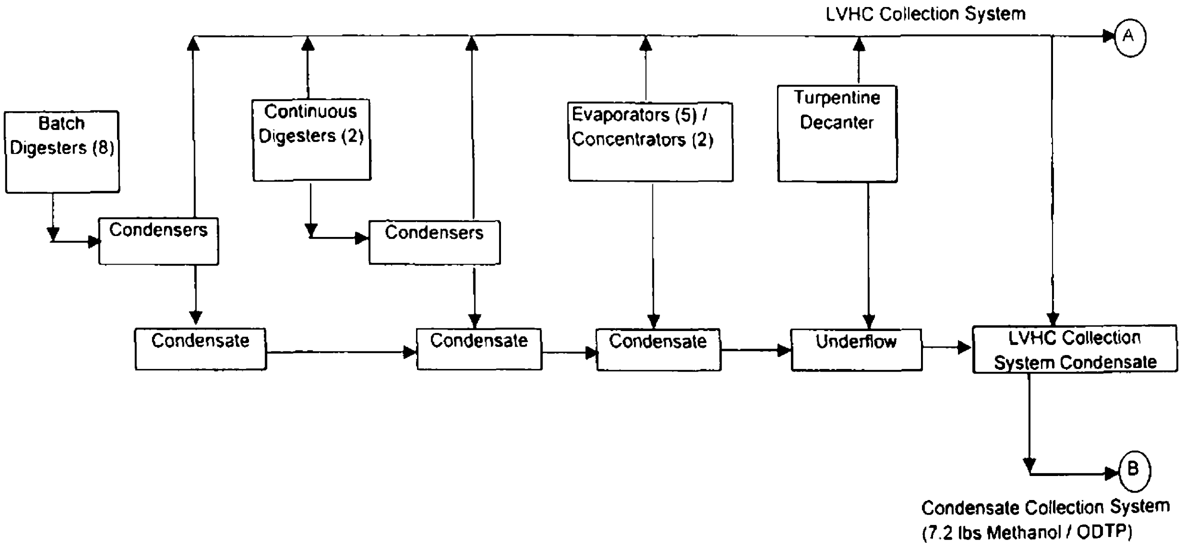
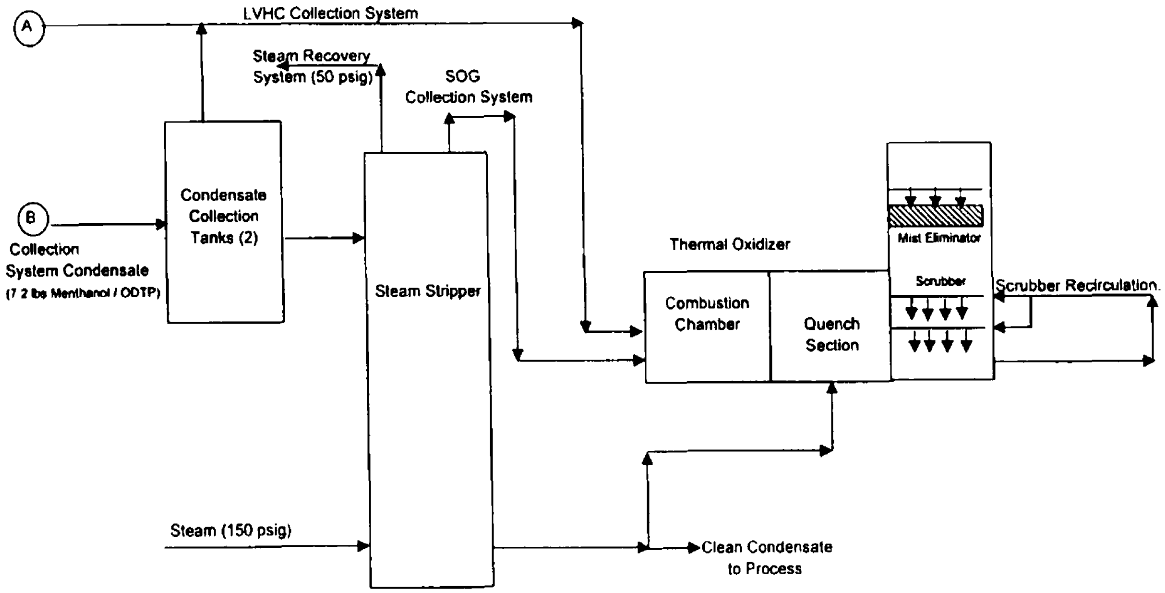


Figure 7-3 Block Diagram of the MACT 1 LVHC and Condensate Treatment System



7.4 MeOH as a Tacer compound

It was decided by EPA officials that methanol could be used as a suitable surrogate to identify and trace the activity of hazardous air pollutants in the condensate (NCASI 1999). Methanol is in the highest concentration of all the HAP's. Based on experimentation it is assumed that other HAP's behave similar to methanol in the collection and removal processes (NCASI 1999). Table 7-2 displays a list of HAP's to be collected and removed in the MACT system. Hazardous air pollutants are specified as SARA 313[1] chemicals for the pulp and paper industry.

Table 7-2 List of SARA 313 Chemical (1997) and Their Concentrations in the Non-Aqueous Portion of the Condensate to be Removed by MACT Equipment

Compound	**Concentration in the Condensate (%)**
Methanol	78
Acetaldehyde	4.6
Ammonia	4.6
Chloroform	3.2
m-, p-, o-Xylene	1.5
Formaldehyde	1.3
Methyl ethyl ketone	0.74
Toluene	0.1
Phenol	0.06
Catechol	<0.1

There are several other compounds that will be removed with the MACT equipment. These compounds are listed in Table 7-3; the sulfur containing compounds are often recognized as nuisance pollutants due to their distinct odors.

Table 7-3 Additional Compounds Being Removed by MACT Equipment

	Compound	**Odor**
1	Dimethyl disulfide	(vegetable sulfide)
2	Dimethyl sulfide	(vegetable sulfide)
3	Methyl mercaptan	(rotten cabbage)
4	Hydrogen sulfide	(rotten eggs)
5	Various Terpenes	(fresh cut wood)

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[1] **S**uperfund **A**mendments and **R**eauthorization **A**ct of 1986, section 313 (SARA 313)

7.5 Compliance Requirements

Collection

The Missoula mill is obligated to collect at least 7.2 pounds of methanol per oven dried ton of pulp (lbs MeOH/ODTP) on a 60-day rolling average in segregated condensate streams (Griffin 2001). The collected streams are sent to the foul condensate tank prior to treatment. The steam stripper is used as the primary device for condensate treatment. If the steam stripper is not operational or if the foul condensate tank contains black liquor, then the condensate is pumped to the back-up condensate system. Condensate containing black liquor or turpentine cannot be treated in the steam stripper due to safety considerations. The back-up condensate system includes the #1 Black liquor spill tank (vented to the mill's NCG system), and the multiple effect evaporator systems. EPA 40 CFR 63.446 defines the evaporators as a LVHC system. Recycling of condensate back to the evaporators is a condensate treatment option allowed in MACT 1 requirements (EPA 40 CFR 63.446(e)(1)). In the event that the black liquor spill tank is full, condensate may be sewered. The duration of sewering must be recorded and may not exceed 10 percent of the time spent collecting condensate on a semi-annual basis (EPA 40 CFR 63.446(g)).

Removal

The mill must demonstrate the steam stripper removes 92% of the methanol in the collected condensate (Griffin 2001). Compliance is demonstrated by displaying the efficiency of the steam stripper on a 60-day rolling average. Determining efficiency and charting a 60-day rolling average are discussed in chapter 9. When the steam stripper is not operating, condensate is recycled through the evaporators as opposed to being discharged to the effluent treatment system.

Mill Production During Compliance Demonstration

The mill experienced a variety of changes during the compliance demonstration period. High electricity and poor market conditions led to curtailment of pulp production. The mill maintains a number of digester units; a Kamyr continuous chip digester, eight batch digesters, and one M&D sawdust digester. The M&D Digester did not operate at all during the compliance-sampling period. Due to the high electricity needs of this digester, the mill does not plan to operate it in the immediate future. The batch and Kamyr digesters operated during the compliance-sampling period from 2/1/01 through 5/21/01. The Kamyr operated alone thereafter and is the only digester currently operating. Specific condensate collection sites are associated with the different digesters. Table 7-4 displays collection sites and their associated digesters.

Table 7-4 Condensate Collection Sites and their Associated Digesters

Kamyr Digester	Abbreviation
1. #4 Evaporator Hot well	4EH
2. #1 Concentrator Hot well	1CH
3. #4 Evaporator 2nd Effect Stand Pipe	4E2ESP
4. #1,2 Evaporator A/C Hot well	1,2EAH

Batch Digesters	Abbreviation
1. #3 Evaporator Combined Condenser	3ECC
2. Accumulator Overflow	AO
3. Secondary and Tertiary Blow Heat Tank	S&TBHT
4. #3 Evaporator Hot well	3EH
5. Turpentine Decant Underflow	TDU

Cluster Rule regulations required the mill to collect samples for a minimum of 60 days in order to produce representative data for calculating collection factors. Due to significant fluxuations in mill operations, samples were taken for 165 days. This allowed for a better representation of methanol concentrations under different digestion processes Digestion processes did prove to have a large impact on methanol collection. This impact will be discussed in chapter 9, results and discussion.

7.6 Demonstrating Compliance

The Missoula mill was obligated to demonstrate compliance for an initial 60-day period and must continue demonstrating compliance for the duration of their Title V permit with the MACT 1 condensate requirements. In order to demonstrate compliance for proper collection of condensate the following objectives were met:

- Collect representative methanol concentrations from each condensate collection site.
- Calculate collection factors (lbs. MeOH/day) using the representative methanol concentrations and flow data (from sources listed in Table 8-1).
- Demonstrate that the mill is in initial compliance (60-day rolling average) by collecting 7.2 lbs. methanol per ODTP for condensate collection.

It was also the mill's objective to collect proper data to calculate the efficiency of methanol removal in the steam stripper. These objectives were carried out through rigorous sampling and analysis extending for 165 days and nearly 6 months of data organization and model preparation. Databases were designed to maintain daily methanol concentrations and flow rates at each condensate collection site. Additional databases maintained records for pulp production and mill operating conditions (*i.e.*, the status of the evaporators and concentrators).

8. Methods

8.1 Field Sampling

The objectives of field sampling during the compliance demonstration period were to collect data representative of mill operating conditions in order to determine collection factors. Mill employees collected grab samples in 40 mL volatile organic analysis (VOA) bottles from the condensate streams listed in Table 8-1. The quantity of samples taken per twenty-four hour period was dependent on the number of shifts worked. Three samples were taken from each site during each shift. Two 12-hour shifts are worked Saturday through Thursday. Three 8-hour shifts are worked on Friday. Sampling was done in 2.5 to 4-hour intervals. Therefore, six samples were taken over a 24-hour period Saturday through Thursday, and nine samples were taken from each site on Friday.

A sample number, date and time were assigned to each sample. Chain of Custody forms were used to maintain records between the mill and the analytical laboratory. Mill operations that affected condensate composition or flow rate during the time of sampling were logged and input into a database at the mill. Flow rates from the sources were also logged. Flow meters were present at some sites and were networked into the mills distributive control system (DCS). Other sites required daily drawdown measurements to be taken in order to calculate flow rates (table 8-1).

Table 8-1 Missoula Mill Condensate Streams and Methods for Determining Condensate Flow

	Sample Location	Method for Condensate Flow Rate Determination
1	No. 1 and 2 Evaporators After Condenser Hotwell	Drawdown
2	No. 3 Evaporator Combined Condensate	Installed Flow Meter
3	Accumulator Overflow	Installed Flow Meter
4	No. 3 Evaporator Hotwell	Drawdown
5	No. 4 Evaporator Stand Pipe Condensate from Effect #2	Installed Flow Meter
6	No. 4 Evaporator Hotwell	Installed Flow Meter
7	No. 2 Concentrator Hotwell	Drawdown
8	Turpentine Decant Underflow	Installed Flow Meter
9	Secondary and Tertiary Blow Heat Condenser	Installed Flow Meter
10	No. 1 Concentrator Hotwell	Drawdown
11	Foul Condensate to the Steam Stripper	Installed Flow Meter
12	Stripped Condensate from the Steam Stripper	Installed Flow Meter

[1] Condensate from LVHC and NCG drains was collected and measured from the No. 1 concentrator.

Sample integrity was maintained by refrigerating samples after collection at 6°C until analyzed. No preservative was necessary. Samples were transported to The University of Montana within 12 hours of the last daily sample taken. Field duplicates were collected to assess potential variation in field activities. Blind field duplicates (anonymous to the laboratory) were also provided to test lab reproducibility.

Three tests were carried out to establish steam stripper performance. Samples were taken at the inlet and outlet of the steam stripper with condensate flows to the stripper at 200, 250, and 300 gpm. The stripper testing was planned for effective-steam-to-condensate-flow ratios of 0.23, 0.21, 0.19, 0.17, and 0.15. NCASI defines the *effective steam* as in equation 8-1:

$$\textit{Effective steam} = [(\text{Feed steam}) - (\text{Condensate flow}) \text{ x } (T_1 - T_2)]/1000 \qquad (8\text{-}1)$$

Where, T_1 is the stripper bottom temperature (°F), and T_2 is the condensate feed temperature (°F).

Each test was performed by setting the condensate flow to the stripper, then adjusting the steam flow to attain the desired ratio. The stripper was allowed to operate for roughly one hour before collecting samples at the inlet and outlet. Duplicate samples were collected for each test. Additionally, steam flow, condensate flow, condensate feed temperature, and stripper bottom temperature were measured and recorded in a log book during each test.

8.2 Methanol Analysis

Methanol analysis by GC/FID is outlined in detail in Appendix J. Six to nine grab samples from each site for each day were composited at the University laboratory into one sample, giving one combined sample for each source on each sample day. Composited samples were analyzed for methanol using a GC-FID (modified NCASI Method DI/MeOH-94.03) with butanol as an internal standard.

Samples from the foul condensate tank, and stripped condensate samples were not composited in order to observe daily variation. Occasionally, samples were not composited at other collection sites for the same purpose. Approximately 70 samples were processed daily, and 22 samples were analyzed after composites were made; not including QA/QC samples. Methanol concentrations fell into the part per million (ppm) ranges and were reported to the mill on a daily basis.

Error Analysis

Determination of precision and accuracy for analysis done on the Varian CP3800 GC are best explained in the Methanol Analysis by GC/FID plan (Appendix J). Seven injections of two certified standards were analyzed to develop QA/QC control charts.

The low level standard chosen was 1 ppm methanol in water. The mid range standard chosen was 500 ppm methanol in water.

For each group of seven injections; a mean, standard deviation, and confidence interval were calculated. These data are displayed in (Table 8-2). The precision for methanol at mid range concentrations was calculated to be ± 4.7 ppm (0.9% error). The precision at low levels was ± 0.12 ppm (8.3% error). The precision for butanol (internal standard) was determined as ± 1.8 ppm. Precision was assessed using duplicate samples in each analytical batch. Analytical batches did not exceed 18 samples. Duplicates were not to exceed a percent difference greater than 10%. Accuracy was determined per analytical batch using spikes. Samples chosen for duplicate analysis were also used for spikes. A duplicate spike was also prepared. Analytical results of spiked samples were required to show recovery of at least 85% of the true value.

Table 8-2 Precision Analysis for (A) Methanol and (B) Butanol using GC-FID

A	Sample ID	Methanol (ppm)	Mean	s	Confidence	
1	500qc	563.08				t = 3.707
2	500qc001	559.13				n = 7
3	500qc002	565.87				
4	500qc003	555.59	559.47	4.77	4.64	
5	500qc004	552.01				
6	500qc005	562.56				
7	500qc006	558.02				

	Sample ID	Methanol (ppm)	Mean	s	Confidence	MDL	
1	1qc	1.40					t = 3.707
2	1qc001	1.28					n = 7
3	1qc002	1.36					
4	1qc003	1.17	1.24	0.12	0.12	0.44	
5	1qc004	1.07					
6	1qc005	1.14					
7	1qc006	1.28					

MDL - Method Detecton Limit
s - Standard Deviation
Confidence - 99% Confidence Interval
t - Students t for 99% Confidence Level

B	Sample ID	Butanol (mV/sec)	Mean	s	Confidence	
1	500qc	31.40				t = 3.707
2	500qc001	30.80				n = 7
3	500qc002	29.50				
4	500qc003	31.50	30.90	0.89	0.87	
5	500qc004	32.20				
6	500qc005	30.20				
7	500qc006	30.70				

	Sample ID	Butanol (mV/sec)	Mean	s	Confidence	
1	1qc	28.80				t = 3.707
2	1qc001	30.80				n = 7
3	1qc002	30.90				
4	1qc003	33.90	29.90	2.38	2.32	
5	1qc004	28.10				
6	1qc005	26.50				
7	1qc006	30.30				
		Total:	Mean	RSD	Confidence	
			30.40	1.80	1.24	t = 3.169
						n = 14

s - Standard Deviation
Confidence - ± 99% Confidence Interval
t - Students t for 99% Confidence Level

A method detection limit (MDL) was also calculated for the low level standard using the formula MDL = $s^*t_{(n-1 \text{ degrees freedom, } 99\% \text{ confidence level})}$. Where s is the standard deviation, n is the number of injections (7) and t is the student's t, corresponding to 6 degrees of freedom and the 99% confidence interval. The MDL was calculated at 0.44 mg/L. The practical quantifiable limit used was 1 mg/L.

8.3 ODTP

Wet pulp tons are quantified by the pulp and paper division at the mill and reported to the DCS system daily. Oven dried pulp tons are calculated by multiplying wet pulp tons by 0.93, assuming wet tons average 7 percent water. There is an error of less than 5% associated with quantifying pulp tons produced (2002 Marxer).

8.4 Flow

Drawdown

A basic drawdown (bucket/stopwatch) method was used to establish flow rates at sites; 1,2 EAH, 3EH, 1CH and 2CH. The method has an associated error of less than 5%.

Flowmeter

Flow meters were used at all other sites. Instrument specifications suggest a potential error of less than 5% for these meters. (Marxer 2002)

8.5 Calculations

Calculating a Collection Factor

A collection factor (CF) is defined as the amount of methanol collected in pounds per day. CF's are a function of methanol concentrations, flow rate, and time.

$$CF = f_{([MeOH],\ flow,\ time)} \qquad (8\text{-}3)$$

$$CF = (mg/L)(L/gal)(lbs/mg)(gallons/min)(min/day) = lbs/day \qquad (8\text{-}4)$$

$$CF = ([MeOH] mg/L)(0.012)(flow\ gpm) \qquad (8\text{-}5)$$

Calculating lbs/ODTP

Collection factors are divided by daily production figures for oven dried tons of pulp to calculate lbs/ODTP.

Calculating Collection Totals

The total amount of methanol collected is calculated by summing the collection factors from each collection site associated with a particular digester. For example, during the Kamyr period, collection factors were added together for 1CH, 1,2EAH, 4E2ESP, and 4EH. The sum can then be divided by the daily ODTP to give pounds of methanol collected per ODTP (lbs/ODTP).

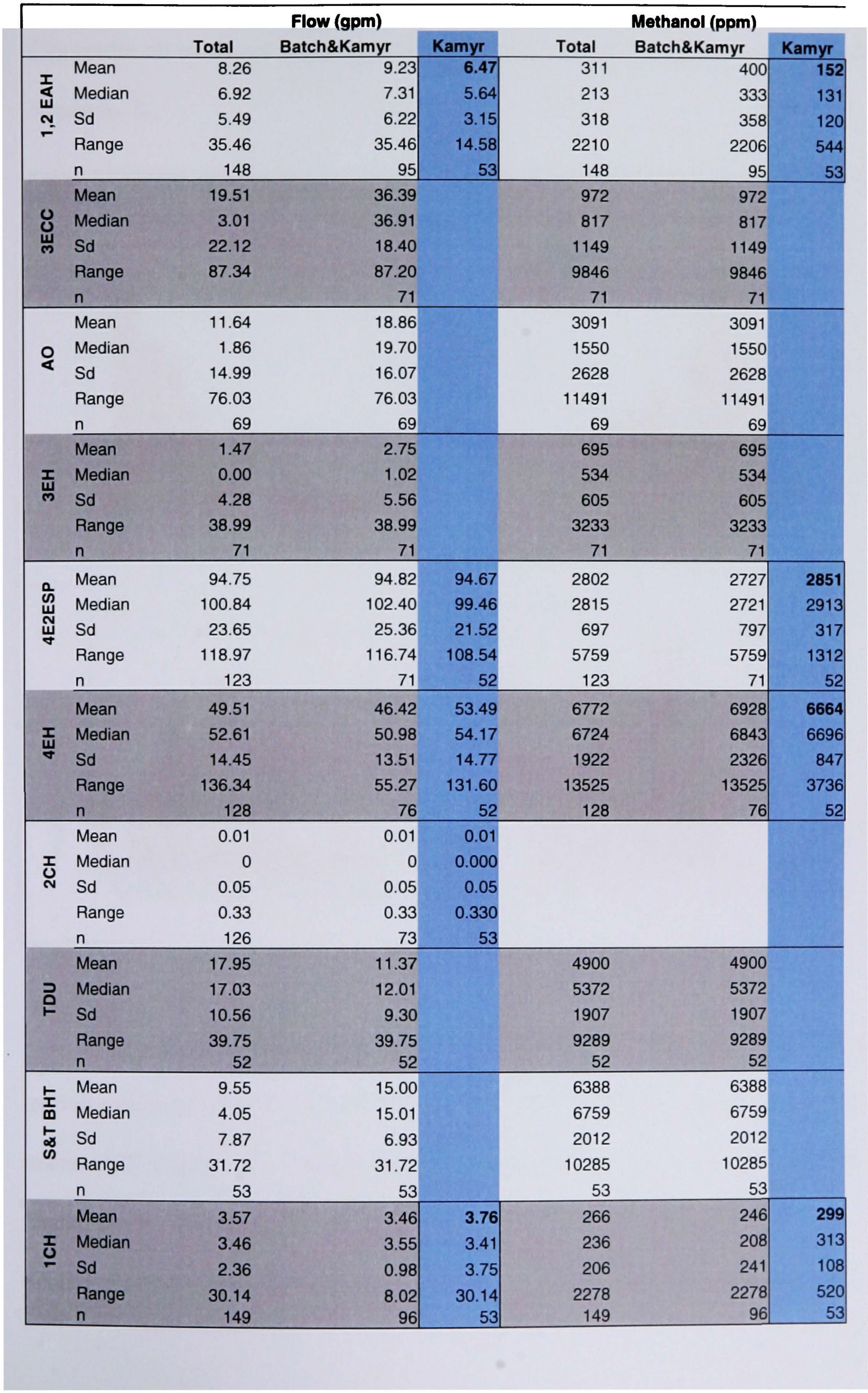
9. Results and Discussion

9.1 MeOH Data

Methanol concentrations ranged from 100 ppm to 10,000 ppm between collection sites. There was also a great deal of variability within each collection site. Histograms were developed for each collection site to view the distribution of data. As stated in chapter 7, the mill underwent operational changes during the compliance demonstration period. Curtailment led to the use of only the Kamyr (continuous) digester as opposed to using both the Kamyr and the Batch digester systems. In order to recognize any impacts on condensate collection, the methanol data were separated for review in each digestion period (2/2/01 – 5/21/01 Batch & Kamyr), (5/22/01-7/15/01 Kamyr only). Data were also charted for the entire 165-day demonstration period. These three data review periods will be referred to as the B&K period, the Kamyr period, and the Total period hereafter. Stone Container is currently operating with the Kamyr digester alone and has no plans for operating with the batch digesters in the near future. The mill intends to use data from the Kamyr period to design the comprehensive collection and removal model. Consequently, detailed discussion will be limited to data taken in the Kamyr period. However, data collected when the batch digesters were operating is available for use. The model can be easily recalculated with new representative methanol concentrations upon the return of the batch digesters in their active operations.

Histograms were developed for the methanol and flow data during the Kamyr period to establish the presence or absence of a normal distribution. The distribution of methanol concentrations can be viewed in figure 9-1 A,B,C and D. It should be noted that collection sites are directly related to digestion systems. Sites are matched up with digesters in Table 7-4. A mean, median, standard deviation and range were calculated for each series of data. The statistical summary information can be viewed in Table 9-1.

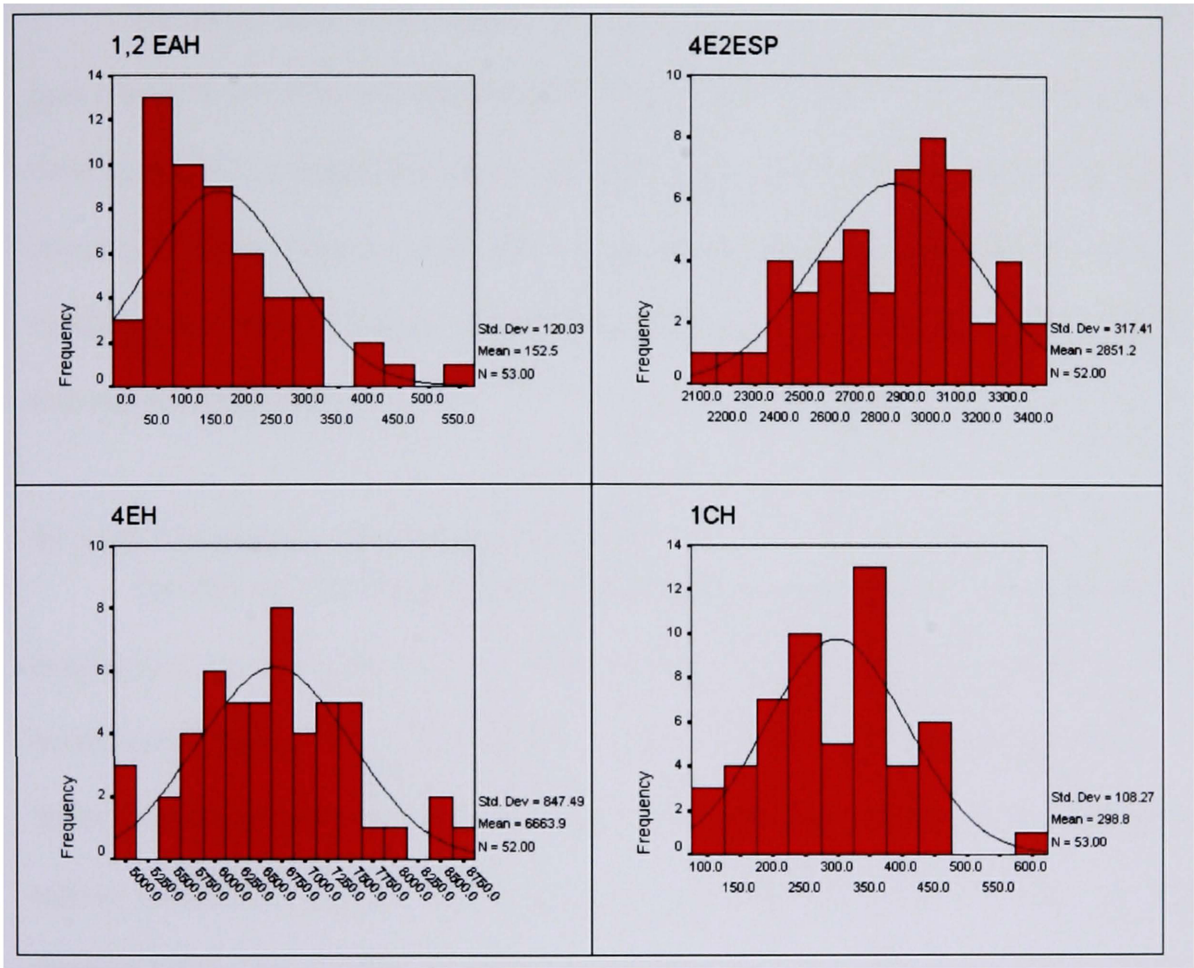
Table 9-1 Statistical Analysis of Methanol Collection Data



		Flow (gpm)			Methanol (ppm)		
		Total	Batch&Kamyr	Kamyr	Total	Batch&Kamyr	Kamyr
1,2 EAH	Mean	8.26	9.23	**6.47**	311	400	**152**
	Median	6.92	7.31	5.64	213	333	131
	Sd	5.49	6.22	3.15	318	358	120
	Range	35.46	35.46	14.58	2210	2206	544
	n	148	95	53	148	95	53
3ECC	Mean	19.51	36.39		972	972	
	Median	3.01	36.91		817	817	
	Sd	22.12	18.40		1149	1149	
	Range	87.34	87.20		9846	9846	
	n		71		71	71	
AO	Mean	11.64	18.86		3091	3091	
	Median	1.86	19.70		1550	1550	
	Sd	14.99	16.07		2628	2628	
	Range	76.03	76.03		11491	11491	
	n	69	69		69	69	
3EH	Mean	1.47	2.75		695	695	
	Median	0.00	1.02		534	534	
	Sd	4.28	5.56		605	605	
	Range	38.99	38.99		3233	3233	
	n	71	71		71	71	
4E2ESP	Mean	94.75	94.82	94.67	2802	2727	**2851**
	Median	100.84	102.40	99.46	2815	2721	2913
	Sd	23.65	25.36	21.52	697	797	317
	Range	118.97	116.74	108.54	5759	5759	1312
	n	123	71	52	123	71	52
4EH	Mean	49.51	46.42	53.49	6772	6928	**6664**
	Median	52.61	50.98	54.17	6724	6843	6696
	Sd	14.45	13.51	14.77	1922	2326	847
	Range	136.34	55.27	131.60	13525	13525	3736
	n	128	76	52	128	76	52
2CH	Mean	0.01	0.01	0.01			
	Median	0	0	0.000			
	Sd	0.05	0.05	0.05			
	Range	0.33	0.33	0.330			
	n	126	73	53			
TDU	Mean	17.95	11.37		4900	4900	
	Median	17.03	12.01		5372	5372	
	Sd	10.56	9.30		1907	1907	
	Range	39.75	39.75		9289	9289	
	n	52	52		52	52	
S&T BHT	Mean	9.55	15.00		6388	6388	
	Median	4.05	15.01		6759	6759	
	Sd	7.87	6.93		2012	2012	
	Range	31.72	31.72		10285	10285	
	n	53	53		53	53	
1CH	Mean	3.57	3.46	**3.76**	266	246	**299**
	Median	3.46	3.55	3.41	236	208	313
	Sd	2.36	0.98	3.75	206	241	108
	Range	30.14	8.02	30.14	2278	2278	520
	n	149	96	53	149	96	53

The values enlarged and in bold are currently being used for the model. The complete data set for all methanol analysis during the Kamyr period to current can be found in Appendix K.

Figure 9-1 Data Distribution for (A) 1,2EAH, (B) #4E2ESP, (C) #4EH, and (D) #1CH during the Kamyr Period



#4 Evaporator 2nd Effect Stand Pipe

The methanol data demonstrate a rough normal distribution over the Kamyr period with a standard deviation of 317 ppm, a relative standard deviation of 11% and a mean of 2851 ppm. The distribution curve at this site is narrow (figure 9-1B). The maximum for this series is 3427 ppm. The minimum for this series is 2115 ppm. Outlying points were not removed due to an overall uncertainty of traceable error. It was determined by mill engineers that the high and low anomalies at this site are physically reasonable concentrations for mill equipment (Stengle 2001). This site provides nearly half of the collected methanol required for compliance.

#4 Evaporator Hotwell

The distribution of this data is also relatively narrow and has a minimum of 4971 ppm (figure 9-1C). The maximum was 8707ppm. The mean value for this series was 6664 ppm with a standard deviation of 847 ppm, giving a relative standard deviation of about 13%. Concentrations at this site are roughly twice the amount measured at the standpipe, but flows are lower. This site provides nearly half of the collected methanol required for compliance.

#1 and #2 Evaporator's After/Condenser Hotwell

The data at 1,2EAH are highly dependent on the operational status of the two evaporators, and this is the reason for the asymmetry and poor precision of the distributions (figure 9-1A). The maximum for this site was 551 ppm, the minimum 7ppm. The mean was calculated as 152 ppm with a standard deviation of 120 ppm and a relative standard deviation of 79%. This site collects an insignificant amount of methanol compared to the #4 evaporator sites. The asymmetry of the distribution leading to poor statistical analysis is reviewed in later in this section.

#1 Concentrator Hotwell

The #1CH site also collected very little methanol compared to the #4 evaporator sites. This site produced a relatively normal distribution, but had a high degree of variability (figure 9-1D). The mean methanol concentration at this site was 300 ppm, with a maximum of 600 ppm and a minimum of 80 ppm. The standard deviation was 108 ppm and the relative standard deviation was 36%.

9.2 Flow Data

Flow data to be used in the model are taken on a continual basis from the DCS system for the two sites #4EH and #4E2ESP and are dynamic in the model. Data from #1CH and 1,2EAH were taken from averaged drawdown data. These data will not be dynamic in the model. Complete flow data during the Kamyr period can be viewed in Appendix K.

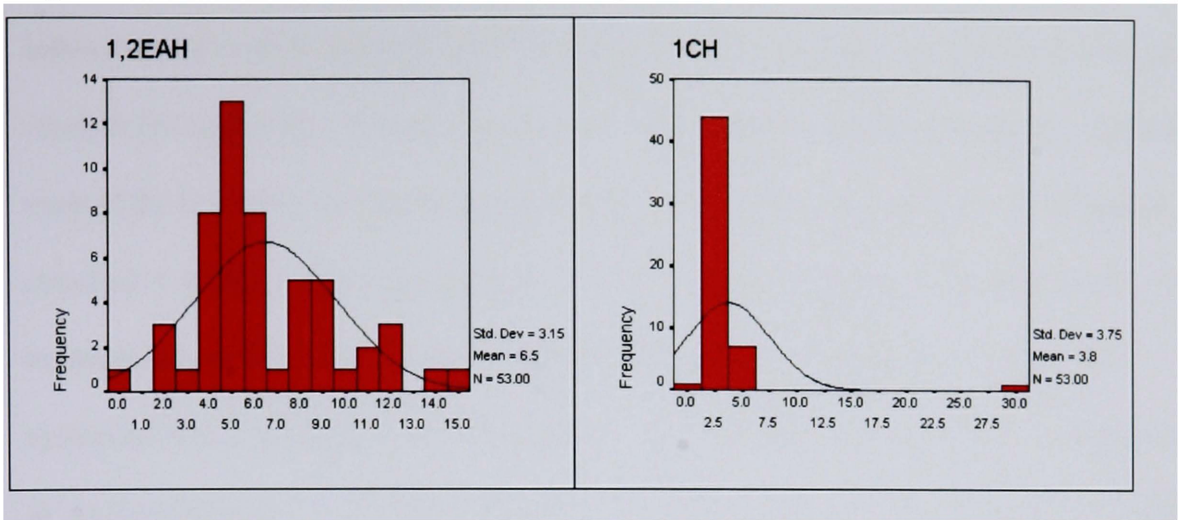
1,2 EAH Histogram and Statistics

The flow data distribution for this site were relatively normal, with a mean of 6.47 gpm a standard deviation of 3.15 gpm and a relative standard deviation of 49%. The maximum for this series was 14.58 gpm and the minimum was 0.00 gpm (figure 9-2).

1CH Histogram and Statistics

The flow data distribution for this site were normal, with a mean of 3.76 gpm a standard deviation of 3.75 gpm and a relative standard deviation of 99%. The maximum for this series was 30.14 gpm and the minimum was less than 0.10 gpm (figure 9-2).

Figure 9-2 Flow Rate Histograms for Sites 1,2EAH, and 1CH



It is reasonable to simply estimate the flows from these two sites using acquired data, with some negligence to accuracy, because methanol contributions are insignificant for compliance purposes even when maximum flows are used to calculate collection factors.

9.3 ODTP Data

Approximately 806 ODTP per day were produced when the Kamyr was operating alone. Production ranged from 12 to 982 tons during the compliance demonstration period (Kamyr). The complete series of daily ODTP data during the Kamyr period can be viewed in Appendix K.

9.4 Organization of Data

Again, the purpose of collecting methanol data was to establish representative methanol concentrations for various condensate collection sites throughout the mill. When concentrations are combined with flow rates and production data, pounds of methanol collected per ton of paper produced can be calculated. If the analytical measurements for methanol concentrations (x) were subject only to random errors then it would be reasonable to expect the limiting distribution to be Gaussian $[f_{X,\sigma}(x)]$ centered on some true value X having a width σ. Kamyr period data was used exclusively. These data are most representative of current mill operations. Attempts were made to minimize indeterminate error by maximizing the number of samples taken, thereby improving the chances for capturing a normal distribution. More than 70 samples were analyzed from each of the four sites during the Kamyr period. The recovery equipment (evaporators, concentrators, etc.) used during this period was not altered and did not malfunction. It is reasonable to believe that the great majority of error was indeterminate, but some systematic error was likely unaccounted for. Major factors that could lead to variability in the data include: 1. Varying feedstock, 2. Sampling error, 3. Analytical error, 4. Data input error.

Feedstock

The mill receives up to 3700 tons of raw material per day. Feedstock is purchased from many different sources and may lead to very different methanol concentrations in the condensate. It would be very difficult to match feedstock with methanol variability and unreasonable to attempt to do this on a continuous basis. The purpose of the model was to simplify continual demonstration of methanol collection and removal. For this reason, it was decided not to test methanol variability by monitoring differing feedstock.

Sampling, Analysis and Data Input

Samples were collected by mill personnel, and analyzed by University personnel. Data were reported to the mill on a weekly basis, then entered into a database by mill personnel. Both sampling and analysis personnel followed protocols to minimize errors, *i.e.*, field duplicates, field blanks, analytical duplicates, spikes and blanks. The uncertainty associated with the sample the GC-FID analysis alone was ± 5 ppm giving a relative uncertainty of less than 1%. Field duplicates varied by as much as 10% (Tooke 2001). Lab duplicates varied by up to 10%. A 15% difference was deemed acceptable for analytical spikes (Table 9-2). Error associated with flow meter data is less than 5% (Marxer 2002). Quantification of pulp tons has an associated error of less than 5% (Marxer 2002). Propagation of error for calculating pounds of methanol per ODTP is displayed in equation 9-1.

Table 9-2 Parameters for Calculating Collection, and their Associated Error

Parameter	Uncertainty
Methanol Concentrations	< 10%
Flow	< 5%
ODTP	< 5%

$$\% \text{ error} = [(10\%)^2 + (5\%)^2 + (5\%)^2]^{1/2} = 12\% \qquad \text{(Taylor 1982)} \qquad (9\text{-}1)$$

While calculating uncertainties can help one estimate some degree of error in the data, a significant amount of human error is still probable and difficult to identify at this point. The data were checked for accuracy by matching the database entries with lab reports prior to being statistically analyzed, but it is possible that reporting errors still exist. After much discussion with mill and academic personnel it has been decided to include all anomalous data along with reasonable data in the distribution. No data were eliminated using a t or q test even if they were justifiably statistical outliers.

Normal distribution curves are evident in the histograms of methanol concentrations at the highest contribution sites (4E2ESP, and 4EH). There is some degree of skewness with the 1,2EAH site and the #1 concentrator site. But, the skewness is within reason for a normal distribution. Skewness offers a method to calculate the degree of asymmetry of the distribution. In general, skewness can be used as a test for normality. A ratio of skewness to its standard error greater than 2 or less than -2 is evidence for rejection of normality. (Taylor 1982)

Similarly, kurtosis offers a way to calculate the degree to which data cluster around a particular value. Kurtosis can also be used as a test for normality. A ratio of kurtosis to its standard error greater than 2 or less than –2 is evidence for rejection of normality. Skewness and kurtosis are calculated for the four collection sites during the Kamyr period in Table 9-3.

The histograms for three sites (#1CH, #4E2ESP, and #4EH) have only one peak. In each case it is relatively precise, and relatively symmetrical. The distribution of methanol concentrations at 1,2EAH is positively skewed but still normal. It is essential to establish the best estimate for the methanol concentrations at these four sites in order to accurately identify the amount of methanol being collected. Mean concentration is justifiably a reasonable estimate because tests for normality indicate that these distributions are indeed Gaussian. Furthermore, it is necessary to recognize uncertainties associated with the means. While repeated measurements typically reduce uncertainty, they cannot always be relied on to reveal uncertainties in the distribution. The standard error of the mean ($\sigma_{\bar{X}}$) was calculated for each site to provide the level of uncertainty. The calculation is done using equation 9-2. Calculated values for the four collection sites are listed in Table 9-3.

$$\sigma_{\bar{X}} = \sigma_X / \sqrt{N} \qquad (9\text{-}2)$$

Where, σ_X is the standard deviation of the distribution at a particular collection site, and N is the number of measurements taken.

Table 9-3 Descriptive Statistics for Condensate Collection Sites During the Kamyr Period (ppm)

Site		1,2EAH	4E2ESP	4EH	1CH
N	*Statistic*	53	52	52	53
Range	*Statistic*	523	1312	3736	548
Minimum	*Statistic*	7	2115	4971	80
Maximum	*Statistic*	530	3427	8707	628
Mean	*Statistic*	**152**	**2845**	**6658**	**303**
	Std. Error	16	44	119	15
Std. Deviation	*Statistic*	119	316	855	111
Skewness[1]	*Statistic*	1.215	-0.264	0.247	0.225
	Std. Error	0.327	0.330	0.330	0.327
	Ratio[1]	3.712	-0.800	0.747	0.687
Kurtosis[2]	*Statistic*	1.315	-0.509	-0.012	0.156
	Std. Error	0.644	0.650	0.650	0.644
	Ratio[2]	2.041	-0.783	-0.018	0.242

[1] If $-2 <$ Skewness/Std Error < 2 then a normal distribution is justifiable.

[2] If $-2 <$ Kurtosis/Std Error < 2 then a normal distribution is justifiable.

The two low level contribution sites (1CH and 1,2EAH) have less defined distributions. 1,2EAH is particularly skewed and does not cluster well around the mean. There is slightly less concern with finding the best estimate for these low level contributors. Presently it is more reasonable to choose a conservative value at these sites because each of these collection sites contributes less than 0.02 lbs of methanol per ODTP, compared to the two #4 evaporator sites, which collect roughly 5.0 lbs/ODTP each. Compliance with Montana regulations for methanol collection can be demonstrated even when the two low-level collection sites are excluded.

#1 and 2 After-Condenser Hotwell

There is a great deal of asymmetry and poor precision of the distribution at 1,2EAH. Operational factors play a large role in the reported methanol concentrations for this site. The sampling location for this condensate is at the hotwell after the condenser, which trails both #1 and #2 evaporators, hence the name No. 1 and 2 after condenser hotwell (1,2EAH). There are periods where the #1 evaporator operates but #2 is down or vice versa, or both are up or both are down. Operational status for these two evaporators was documented during the entire sampling period. Parametric functions were used to prepare descriptive statistics for the data assuming the distribution would be normal. Methanol concentrations were reviewed depending on the status of these two evaporators. Furthermore, data were separated according to digester period (Table 9-4).

Table 9-4 Descriptive Statistics for #1 and #2 Evaporators

	1evaps	**2 evaps**	**Both**	
Mean	586	239	601	
Median	579	158	552	B&K Period
Mode	264	32	32	2/1/01 to 5/21/01
sd	326	243	393	
range	1292	1316	1292	
n	33	245	21	
Mean	207	137		
Median	206	86		
Mode	#N/A [1]	145		Kamyr Period
sd	68	132		5/22/01 to 7/15/01
range	244	522		
n	8	29	0	
Mean	535	233	583	
Median	538	145	540	
Mode	264	32	32	
sd	335	241	392	Total observation period
range	1292	1316	1292	
n	41	274	21	

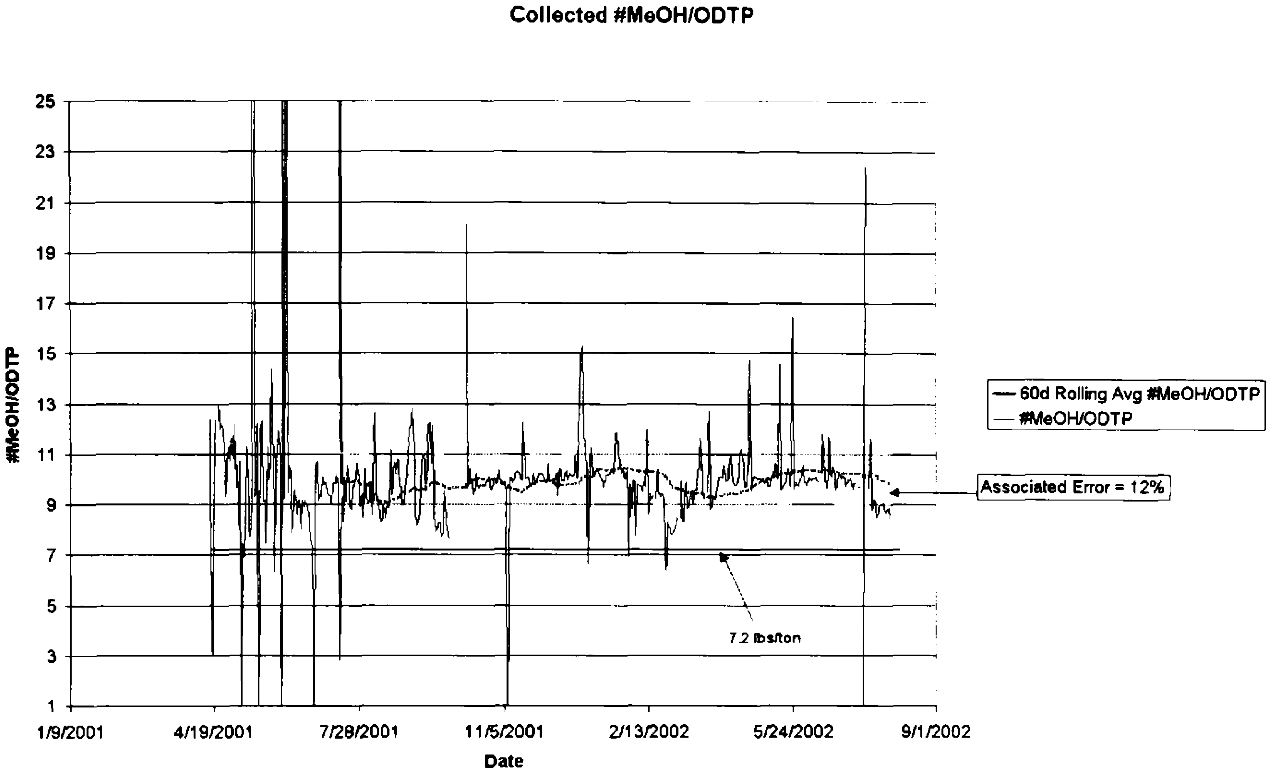
[1] Multiple modes were reported.

The data displayed in Table 9-4 under **1 evaps** are those instances when only the #1 evaporator was operating, **2 evaps** displays when only #2 evaporator was operating, and **Both** indicates when both evaporators were operating. The #1 evaporator consistently drew out more methanol than the #2 evaporator so in order to properly estimate this collection site the status of the evaporators should be accounted for. However, it is uneconomical to attempt to document and include this operational status into a model, so a more simple solution is desirable. Simply calculating the mean methanol concentration during the Kamyr period without regard to evaporator operational status gives 152 ppm methanol for this site. This number could be as high as 207 ppm or as low as 137 ppm depending on the operational status of the evaporators. However, when flow rates and production levels are taken into account and a methanol concentration of 152 ppm is used, this site only collects 0.02 lbs/ODTP per day. Comparatively, each #4 evaporator sites collect more than 4 lbs/ODTP per day. In order for collection at 1,2EAH to be significant, the average concentration would have to be one to two orders of magnitude higher. Therefore, the asymmetry of the distribution, and poor precision were ignored due to the insignificance of this collection site for compliance purposes. 152ppm was chosen without regard to which evaporator was operating as a simple conservative methanol estimate for the model.

9.5 Demonstrating Collection Compliance

Compliance was demonstrated to the State of Montana using flow rates and representative methanol concentrations from each collection site to calculate collection factors. Collection factors were then combined with production rates to calculate pounds of methanol collected per oven dried ton of pulp produced. Once representative methanol concentrations were established, a MACT 1 database was prepared to incorporate flows and production rates and perform all necessary calculations for demonstrating compliance to MTDEQ. Appendix L displays the datasheets for these calculations up through July 31, 2002 for each of the four collection sites. Total collected methanol was calculated by summing pounds of methanol per ODTP from each of the four collection sites. Total collected pounds MeOH per ODTP is highly variable on a daily basis because of its high dependence on condensate flow rates and inconsistent production rates. Therefore, the mill negotiated compliance demonstration using a 60-day rolling average (Figure 9-3).

Figure 9-3 Total Methanol Collection per ODTP



The mill must collect at least 7.2 pounds of methanol per ODTP. Between April 15, 2001 and July 31, 2002 the mill collected more than 9 lbs. MeOH per ODTP on a 60-day rolling average. Compliance is demonstrated to the MTDEQ by sending updated reports including figures such as 9-3, and spreadsheet data from the prepared MACT 1 database.

9.6 Demonstrating Removal Compliance

Generating an Efficiency Curve

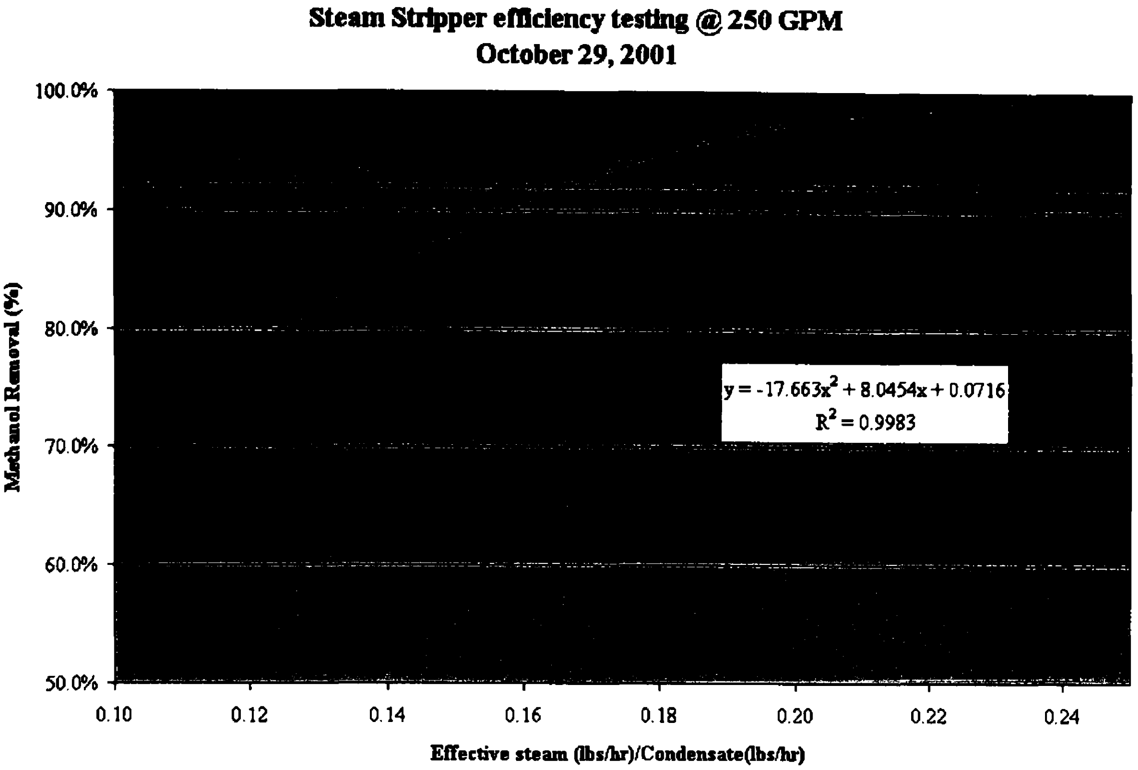
Foul condensate enters a steam stripper where HAP's (primarily MeOH) are partitioned back into the gas phase. Stripper off-gas then enters the DFO where complete combustion occurs. The efficiency of the steam stripper was determined by experimentally varying both the influx of steam and condensate. Several condensate samples were taken at the inlet and outlet of the steam stripper while varying the ratios of effective steam (lbs/hr.) to condensate flow (lbs/hr). Condensate flows typically range between 200 and 300 gallons per minute (gpm). Percent methanol removal was determined by calculating the difference between the inlet and outlet methanol concentrations (Table 9-4).

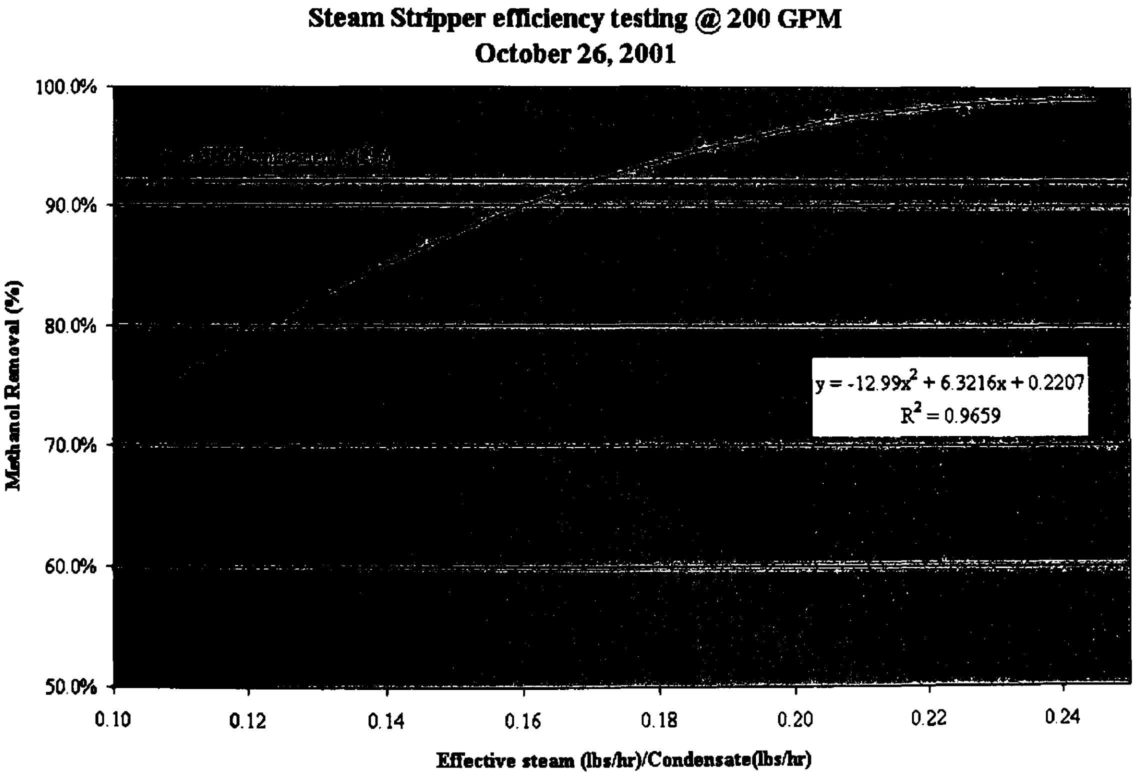
Table 9-5 Steam Stripper Efficiency Samples

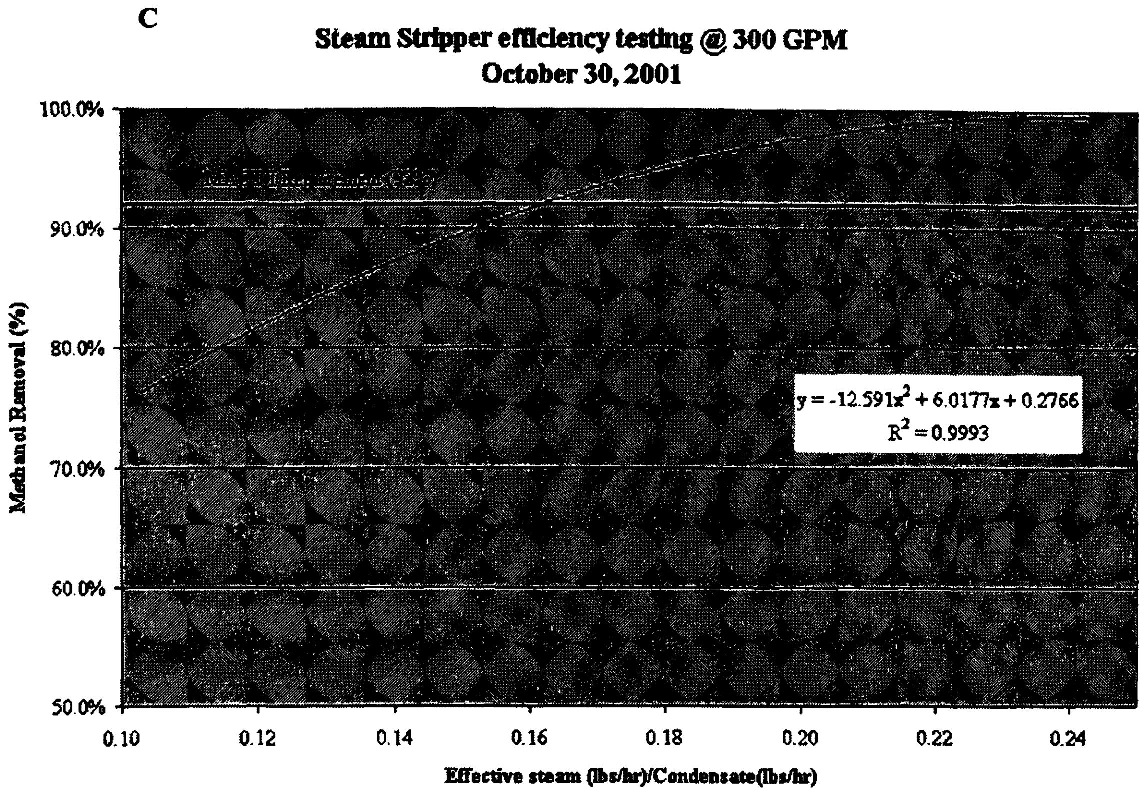
Date	Time	Foul Cond. Feed (GPM)	Eff. S/C Ratio	Inlet Sample ID	Inlet Conc. (PPM)	Outlet Sample ID	Outlet Conc. (PPM)	%Methanol Removal
10/26/2001	10:30	200	0.15	7DF	3952	12CD	514	87.0%
				7DI	3938	12CE	508	
10/26/2001	11:15	200	0.17	7DJ	3270	12CF	334	89.6%
						12CG	348	
10/26/2001	12:15	200	0.19	7DK	3830	7DL	187	95.4%
				12CH	4243			
10/26/2001	13:00	200	0.21	7DM	5751	12CI	138	97.7%
						12CJ	132	
10/26/2001	13:45	200	0.23	7DN	3738	12CK	69	98.1%
				7DP	3699			
10/29/2001	9:00	250	0.15	7DQ	3799	12CL	416	89.1%
				7DR	3833			
10/29/2001	9:45	250	0.17	7DS	4013	12CN	251	93.8%
				7DT	4004	12CO	249	
10/29/2001	10:30	250	0.19	7DU	4050	12CP	127	96.9%
						12CQ	126	
10/29/2001	11:15	250	0.21	7DV	3980	12CR	72	98.2%
				7DW	3926			
10/29/2001	12:00	250	0.23	7DX	3304	12CS	39	98.8%
						12CT	38	
10/30/2001	8:30	300	0.15	7DY	3999	12CU	393	90.3%
				7DZ	4115			
10/30/2001	9:15	300	0.17	7EA	3883	12CV	236	93.9%
						12CW	235	
10/30/2001	10:00	300	0.19	7EB	4372	12CX	125	97.0%
				7EC	4041			
10/30/2001	10:45	300	0.21	7ED	3616	12CY	47	98.7%
						12CZ	47	
10/30/2001	11:30	300	0.23	7EE	3804	12DA	20	99.5%
				7EF	4117	12DB	19	

Three efficenciey curves were prepared at condensate flows of 200 gpm, 250 gpm and 300 gpm respectively. Percent removal was plotted on the y-axis and steam to condensate ration on the x-axis. A second order polynomial regression curve gave good fits with each of the three condensate flows (Figure 9-4 A, B, C).

Figure 9-4 Efficiency Curves at Three Condensate Flows for the Steam Stripper; (A) 200 gpm, (B) 250 gpm, (C) 300 gpm


Steam Stripper efficiency testing @ 250 GPM
October 29, 2001


Steam Stripper efficiency testing @ 200 GPM
October 26, 2001



Efficiency Equation

Since foul condensate flow routinely varies between 200 and 300 gpm, the mill chose to average the three efficiency curves into one curve, giving equation (9-3).

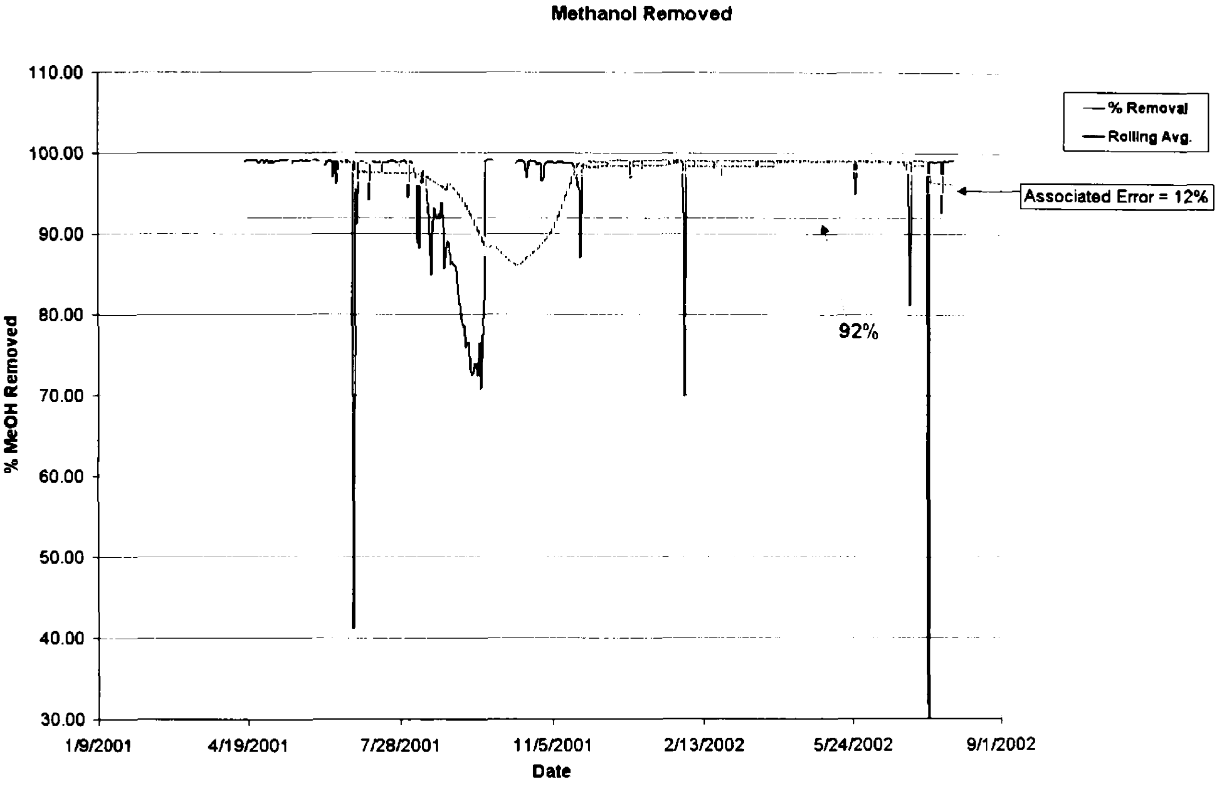
$$y = -14.99x^2 + 7.03x + 0.17 \qquad (9\text{-}3)$$

Where, y is the percent methanol removal and x is the effective steam (lbs/hr) to condensate (lbs/hr) ratio.

Steam and condensate flows are acquired daily from the mills DCS system and an effective steam to condensate ratio is calculated in the MACT 1 database. Percent methanol removal is calculated by substituting the effective steam to condensate ratio into equation 9-3. The mill uses an average daily ratio of effective steam flow to condensate flow to determine the corresponding average daily methanol removal by the steam stripper. Appendix L displays the results for methanol removal efficiency between

April 16, 2001 and July 31. 2002. The mill is required to demonstrate that at least 92 percent of the collected methanol is removed. The steam stripper routinely removes more than 97% of the methanol collected. The mill negotiated compliance demonstration using a 60-day rolling average due to inherent variability of the steam to condensate ratio. Figure 9-5 displays the steam stripper's methanol removal efficiency.

Figure 9-5 Steam Stripper Efficiency



Performance of the stripper plummeted between August 1 and September 19, 2001 due to a fouling of the reboiler. The reboiler serves to provide additional steam from stripped condensate by efficiently boiling the already hot, clean condensate. Initially, the MACT technology did not allow bypassing the reboiler, should fouling occur. Consequently the steam to condensate ratio decreased and methanol removal failed compliance requirements. When bypass valves were incorporated, the mill was able to maintain necessary steam flows without the reboiler and methanol removal levels returned to greater than 92%.

10. Summary, Conclusions and Suggestions

10.1 MACT System

During the summer of 1999, the Missoula Mill began construction on MACT 1 in response to regulations outlined in the 1998 federal cluster rule. The purpose of MACT 1 equipment is to collect and remove HAP's from the mill's LVHC and evaporator condensate systems. Methanol was chosen by the EPA as the most appropriate tracer molecule for identifying the fate of HAP's in the MACT system. Methanol was used by the Missoula Mill to demonstrate to the State of Montana that more than 7.2 pounds of HAP's were collected per oven dried ton of pulp produced. Additionally, more than 92 percent of the collected HAP's are removed by the steam stripper and completely combusted in the DFO. Samples were taken at various condensate collection sites prior to entering a foul condensate tank. Condensate samples were analyzed at The University of Montana for methanol. The resulting data were used to establish representative methanol concentrations at the various sampling sites. Representative methanol concentrations and dynamic flow rates were used to calculate the pounds of methanol collected at a particular site on a particular day. Production rates were then introduced to allow the calculation of methanol collected per ODTP. Various stripper tests were run to establish a stripper efficiency equation correlating *percent methanol removed* to *effective-steam-to-condensate ratios*. From this equation, the amount of methanol removed can be calculated. A comprehensive MACT database was designed and personnel were appropriated to maintain data in the database. Collection and removal values are automatically calculated on a daily basis with in the database.

Graphs were developed to represent calculated data for collection and removal of methanol on a 60-day rolling average. The graphs indicate that the mill has successfully collected more than 7.2 pounds of methanol per ODTP and removed more than 92% of the collected methanol from May 22, 2001 to present on a 60-day rolling average with the exception of a short period in late August, early September 2001 when the reboiler experienced some fouling. The mill operates roughly 350 days per year. The average quantity of methanol removed per day between May 22, 2001 and July 31, 2002 was 9.87 lbs per ODTP. The average ODTP produced daily for that same period was 883 tons. By performing a simple calculation (equation 5-1) it can be demonstrated that the mill has collected more than 3 million pounds of methanol in a year.

$$\left(\frac{9.87\text{ lbs MeOH}}{\text{tons pulp}}\right)\left(\frac{883\text{ tons pulp}}{\text{day}}\right)\left(\frac{350\text{ days}}{\text{year}}\right)=\frac{3{,}050{,}632\text{ lbs MeOH}}{\text{year}} \qquad \text{Collected} \quad (10\text{-}1)$$

$$\left(\frac{3{,}050{,}632\text{ lbs MeOH}}{\text{year}}\right)(98\%\text{ efficiency})=\frac{2{,}989{,}620\text{ lbs MeOH}}{\text{year}} \qquad \text{Removed} \quad (10\text{-}2)$$

Furthermore, the mill has demonstrated that methanol is being removed from the collected condensate with an efficiency of 98%. By applying this factor to the collected value it can be shown that the mill is removing nearly 3 million pounds of methanol per year.

10.2 Suggestions for Maintaining Compliance

It was the purpose of this project to help the mill reach MACT 1 goals. A continuous sampling program is expensive and impractical for generating compliance data. A parametric model has been developed such that only periodic methanol analysis and model recalibration must be done. Sampling should be done every time the mill makes major operational changes (such as changes to the digesters or evaporators) and to periodically test the efficiency of the steam stripper.

Samples should be taken to indicate any potential changes at each condensate collection site. At least three separate samples should be taken six hours or more apart for each site. Collection factors should be tested once or twice annually, or whenever major operational changes occur at the mill. The mill is not obligated to test collection factors more than once every five years, but intends to do so annually. It is recommended this be done one to two months after the annual outage. This allows operational conditions to stabilize from any changes made during the outage. If collection factors vary by more than 15%, a comprehensive sampling plan should be reinitiated that includes at least 30 data points, six or more hours apart for each collection site. From these data, new representative methanol concentrations will be established to calculate new collection factors. New steam stripper efficiency curves should also be established annually by taking 10 to 20 inlet and outlet samples at a series of steam to condensate ratios (as described in the methods section).

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Appendix A

Speciation of Ambient TRS Compounds

On September 12th 2000, three evacuated suma canisters were placed in various locations throughout the pond complex. Additionally, one canister was placed at each ambient station. The canister's interiors were lined with Teflon so that no sulfides came in contact with metal surfaces. The canisters drew a 24 hour sample then were sent to Total Air Analysis in Carson California. Samples were analyzed for 14 sulfide compounds using a GC-PFPD (pulsed flame photometric detector) equipped with a cryogenic trap for condensing the air samples. The results demonstrate that nearly all the reduced sulfur compounds recorded at the ambient stations are Hydrogen sulfide only (Table A1).

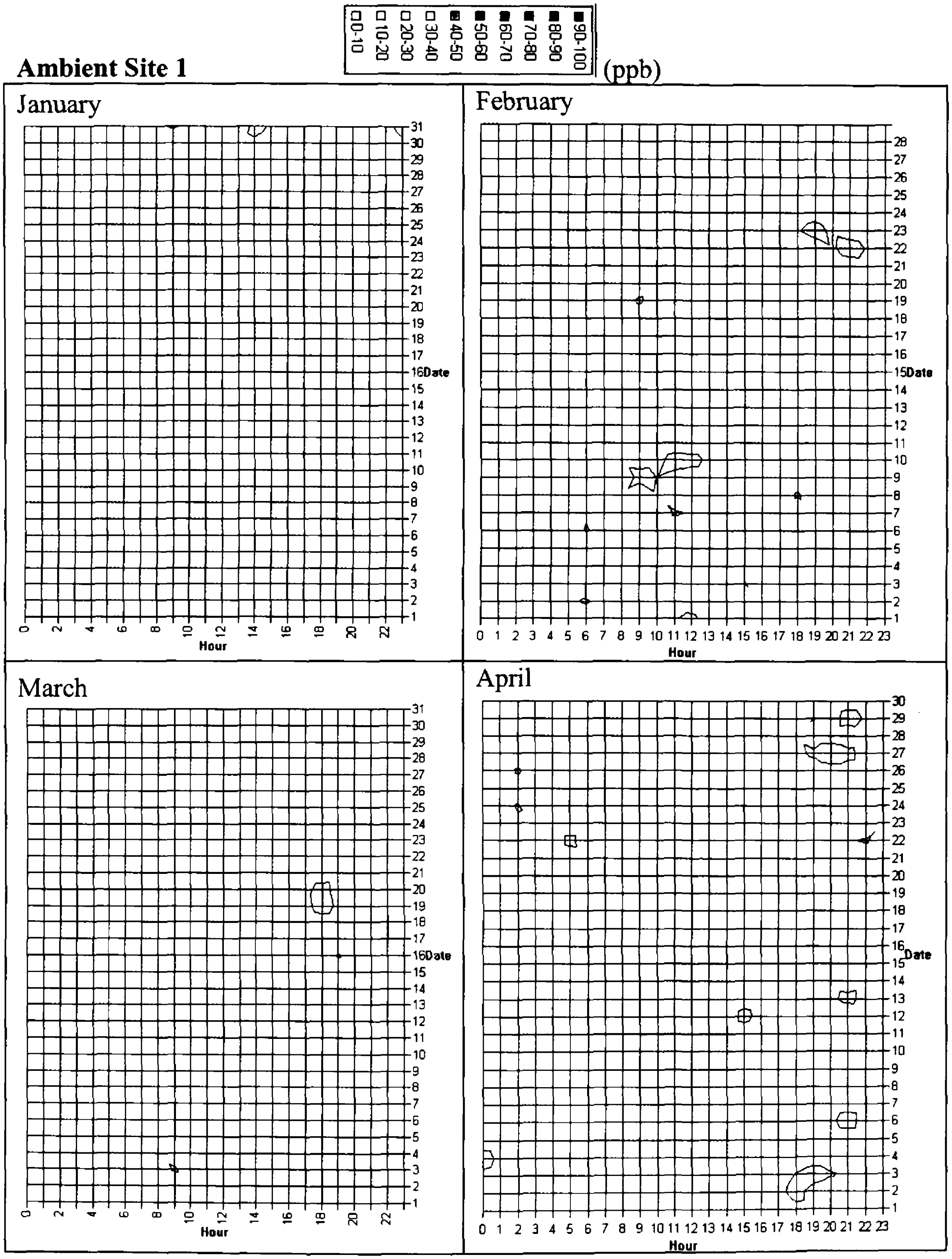
Table A-1 Suma Canister Analysis for Speciation of Reduced Sulfur Compounds

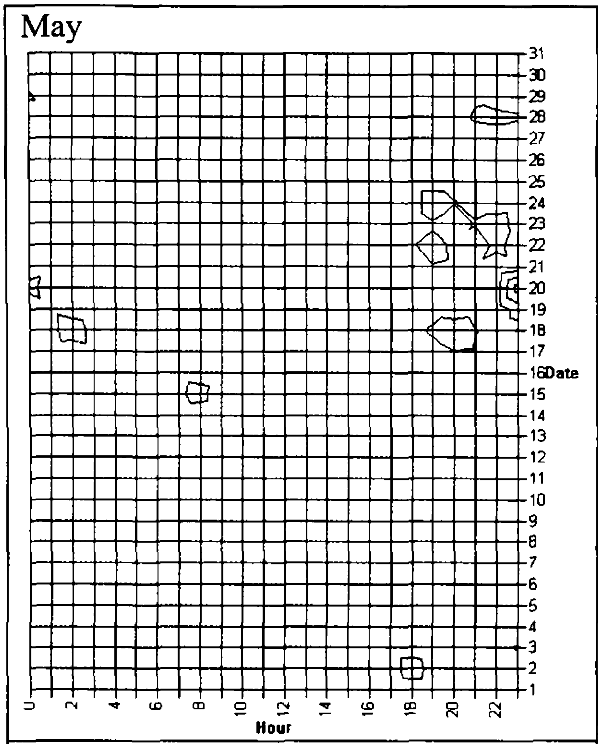
			Date		Time		Analytes													
	Canister	Location	Begin	End	Begin	End	Hydrogen Sulfide	Carbonyl Sulfide	Methyl Mercaptan	Ethyl Mercaptan	Propyl Mercaptan	Carbon Disulfide	Methyl Sulfide	Meth.Ethyl Sulfide	Methyl Disulfide	Allyl Sulfide	Propyl Sulfide	Allyl Disulfide	Butyl Sulfide	Thiophene
Session 1	51	Pond 17	9/12/00	9/13/00	15:08	15:08	[redacted]	<5	[redacted]	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	52	NPP	9/12/00	9/13/00	15:25	15:25	[redacted]	<5	[redacted]	[redacted]	<5	<5	[redacted]	<5	<5	<5	<5	<5	<5	<5
	55	Pond 8	9/12/00	9/13/00	15:16	15:16	[redacted]	<5	[redacted]	[redacted]	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	53	Amb 1A	9/12/00	9/13/00	15:39	15:45	[redacted]	<5	[redacted]	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	54	Amb 2A	9/12/00	9/13/00	14:57	14:57	[redacted]	<5	[redacted]	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

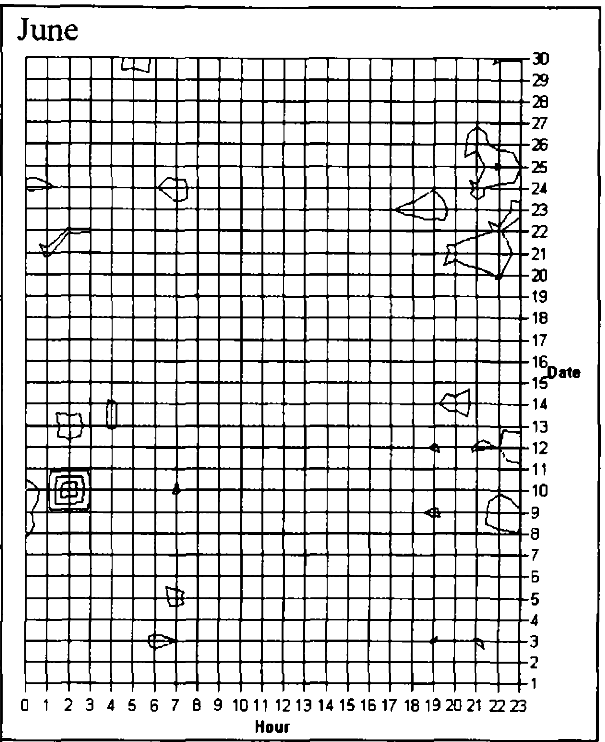
Appendix B

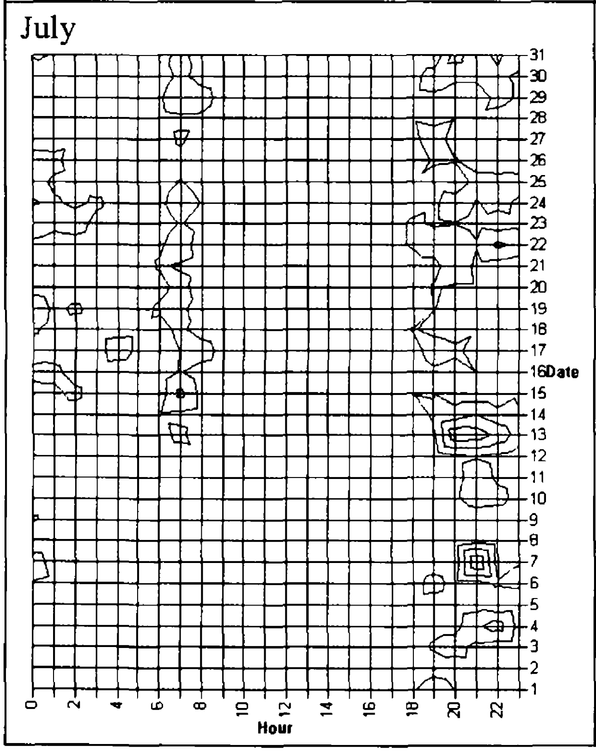
Ten Year Average (1990-1999) Ambient H_2S Contour Charts

Ambient Site 1




May


June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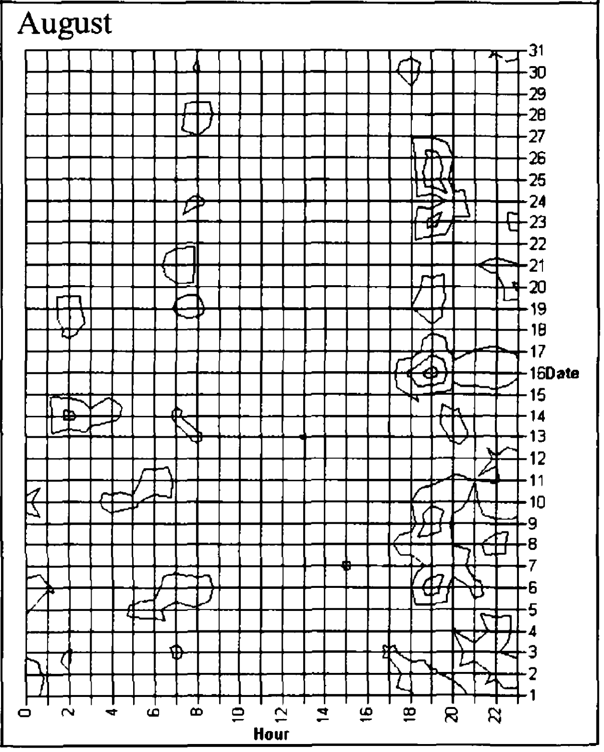
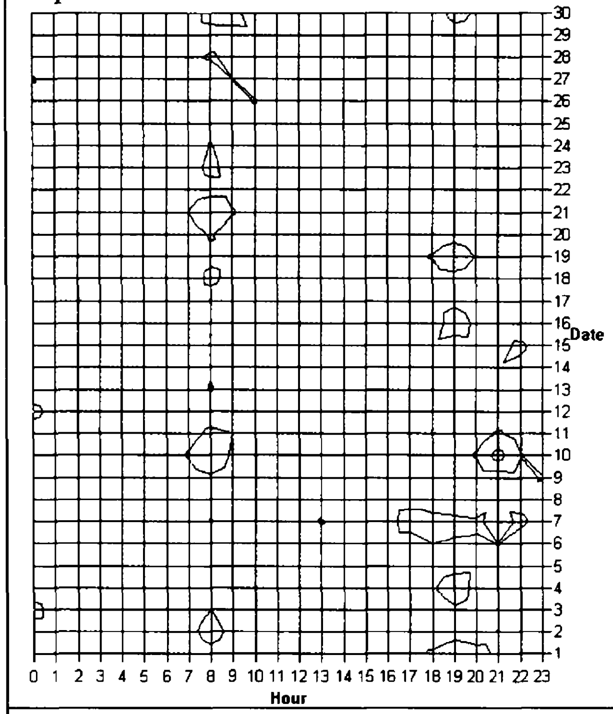
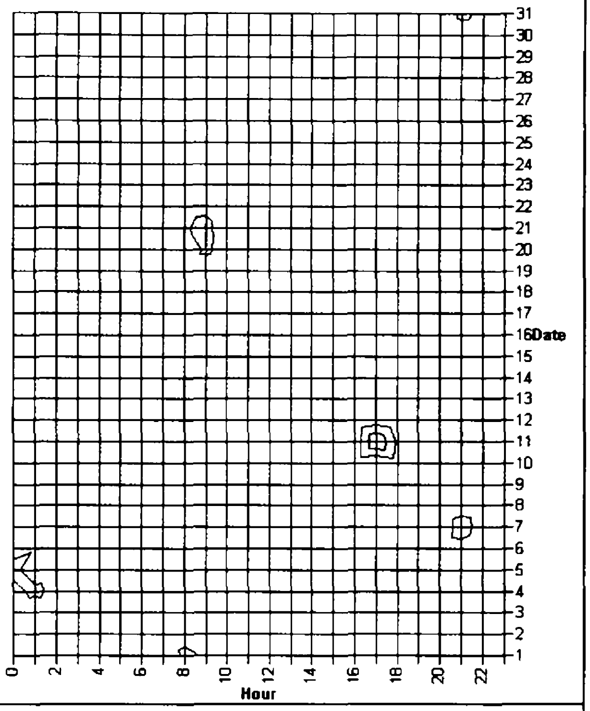

August

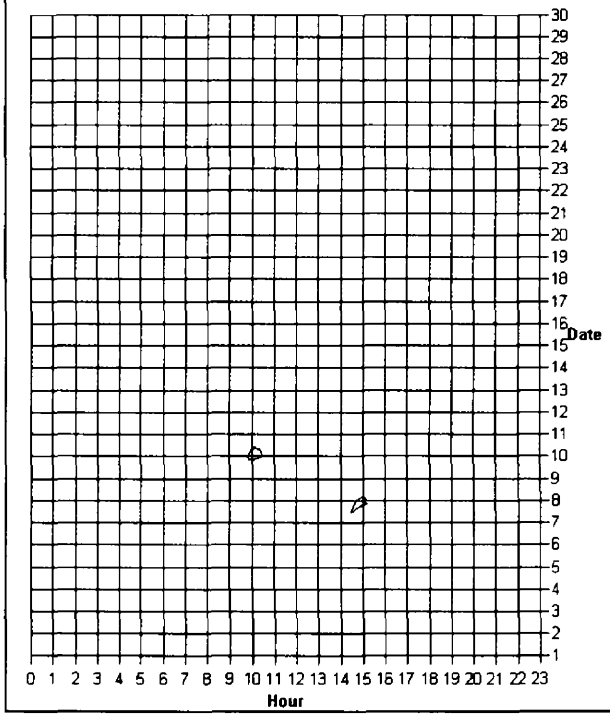
September



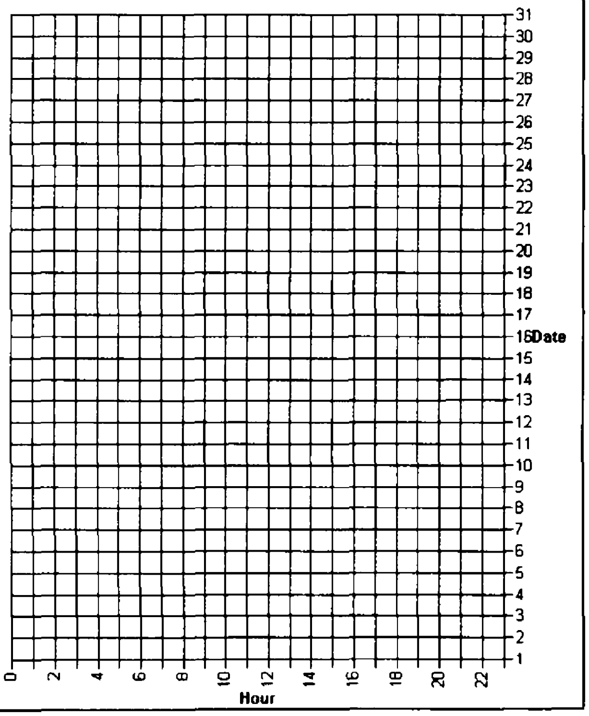
October



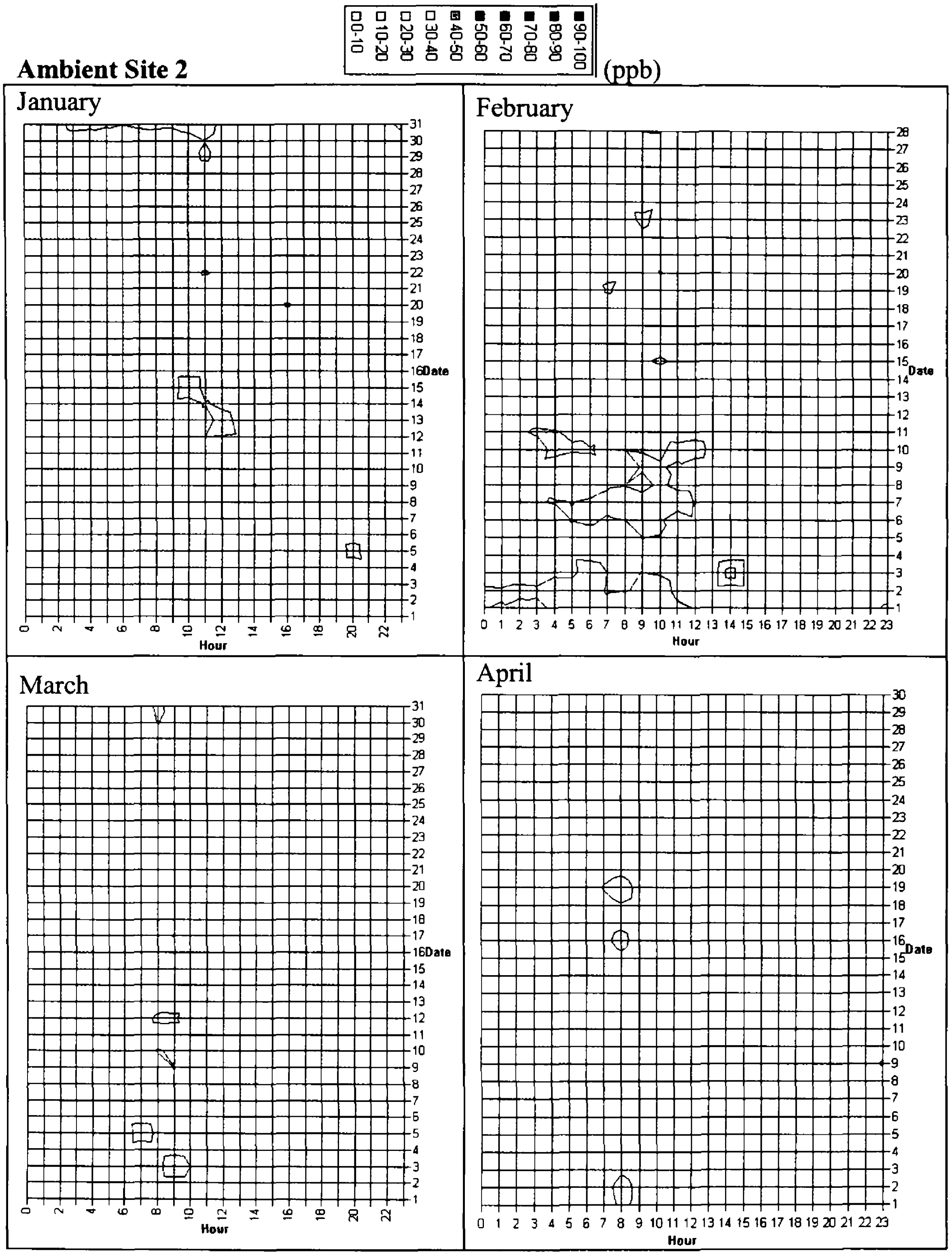
November



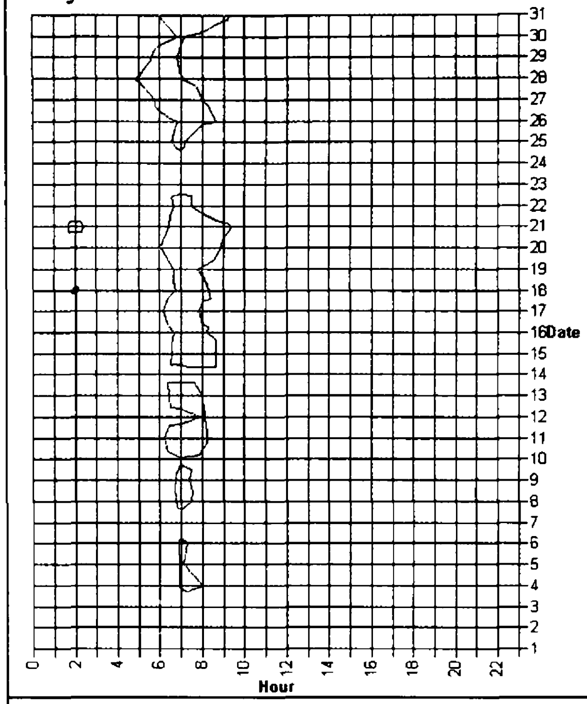
December



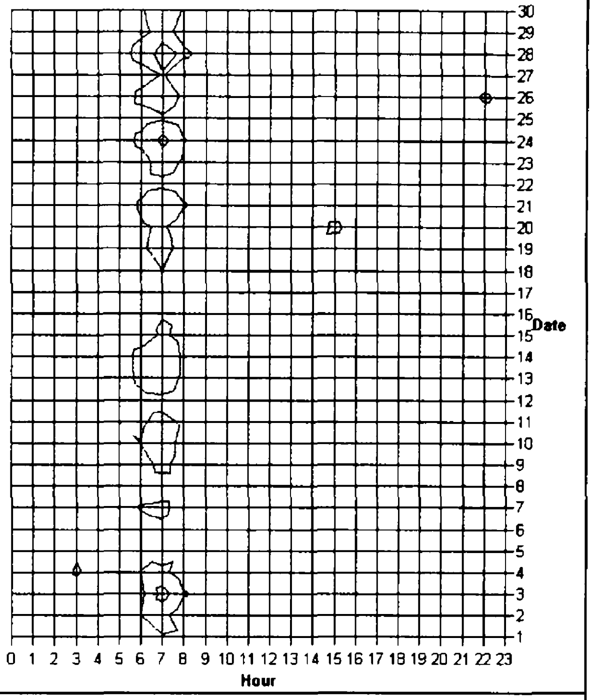
Ambient Site 2



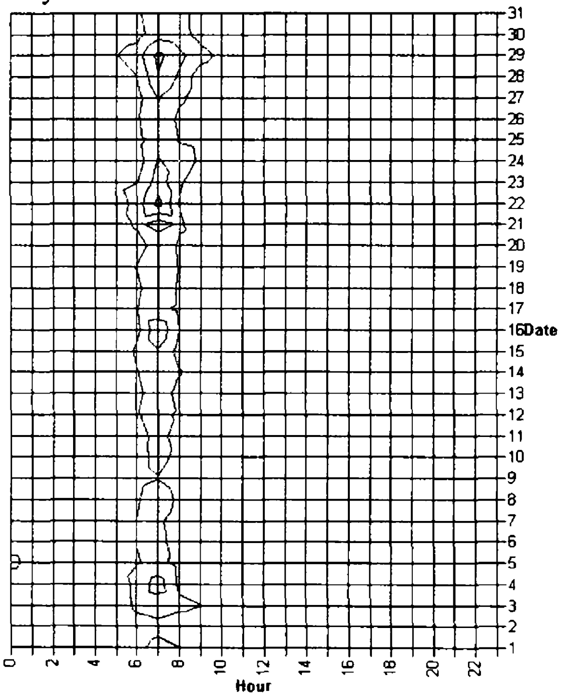
May



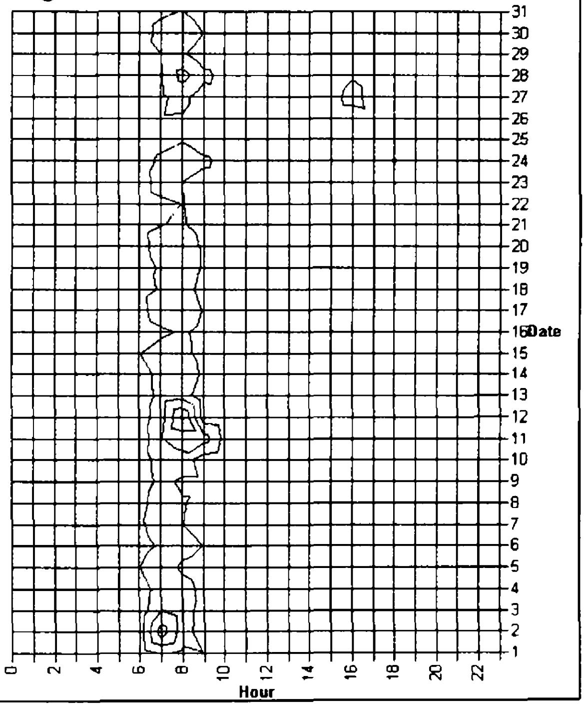
June



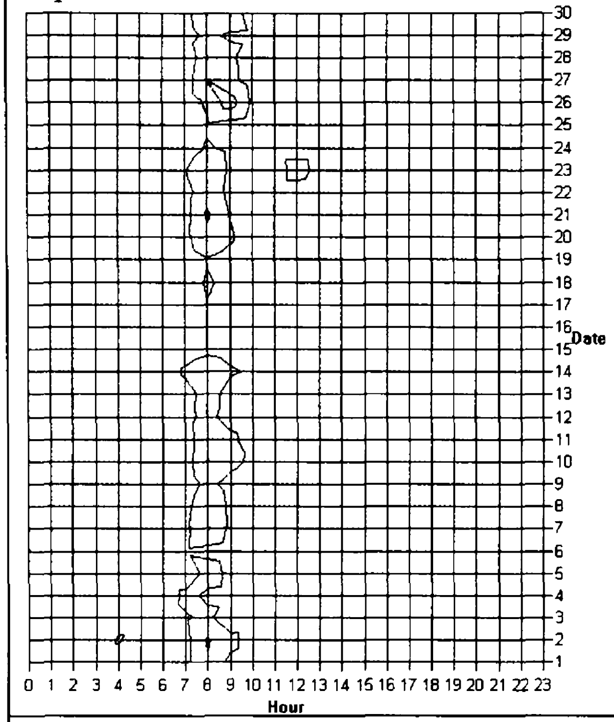
July



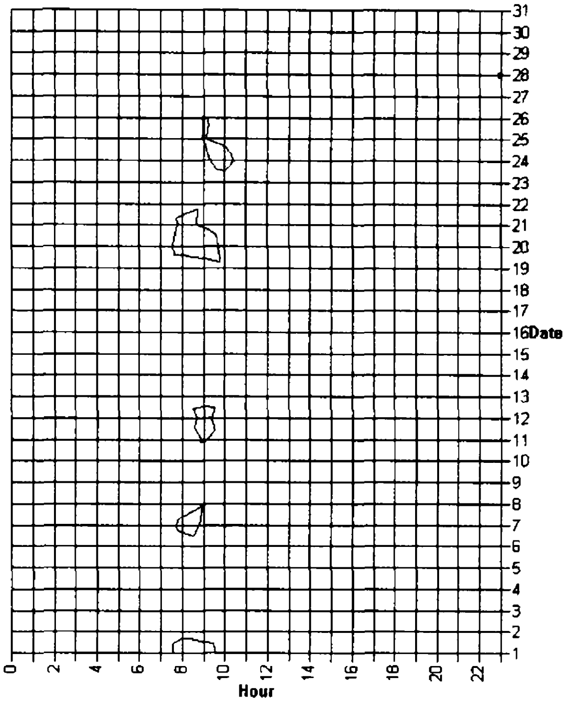
August



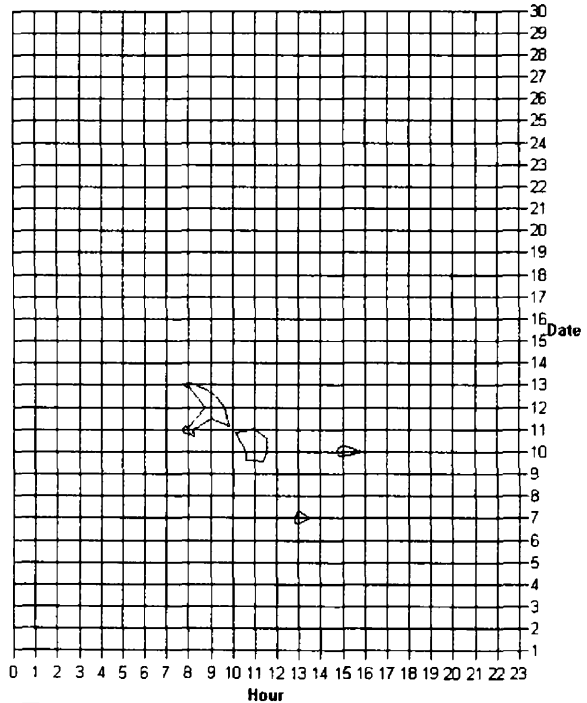
September



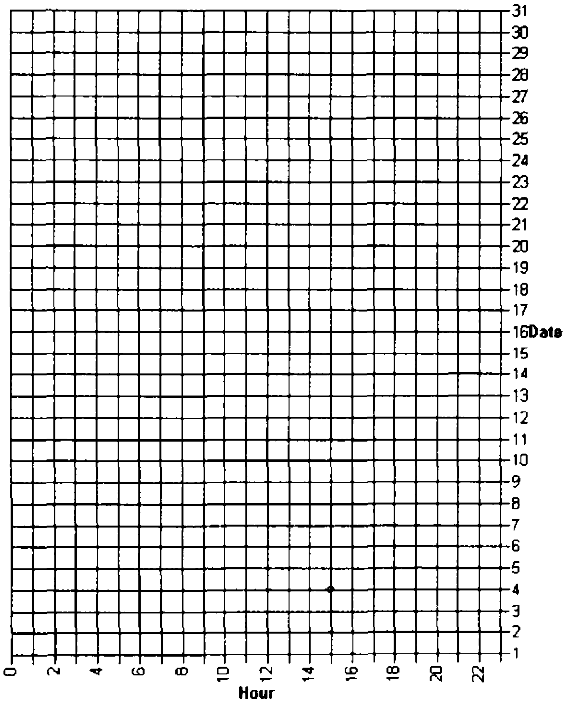
October



November



December



Appendix C

Jerome Study

A Jerome 631-X handheld H_2S analyzer was used to sample ambient air at 24 locations throughout the pond complex once per week beginning October 13, 2000 and ending June 20, 2001. The locations are identified by number in figure C-2. The resulting data is displayed in Table C-1. Figure C-1 displays a summary of results. Consistently higher readings were found near the sludge ponds (P3, P5, P17), at pond 8, and near the north and south polishing ponds (NPP, SPP). (Data for this study were generated by Eric Mannlein (2000), an environmental engineering intern at the Missoula Mill.)

Figure C-1 Summary of Jerome H_2S Analysis Results

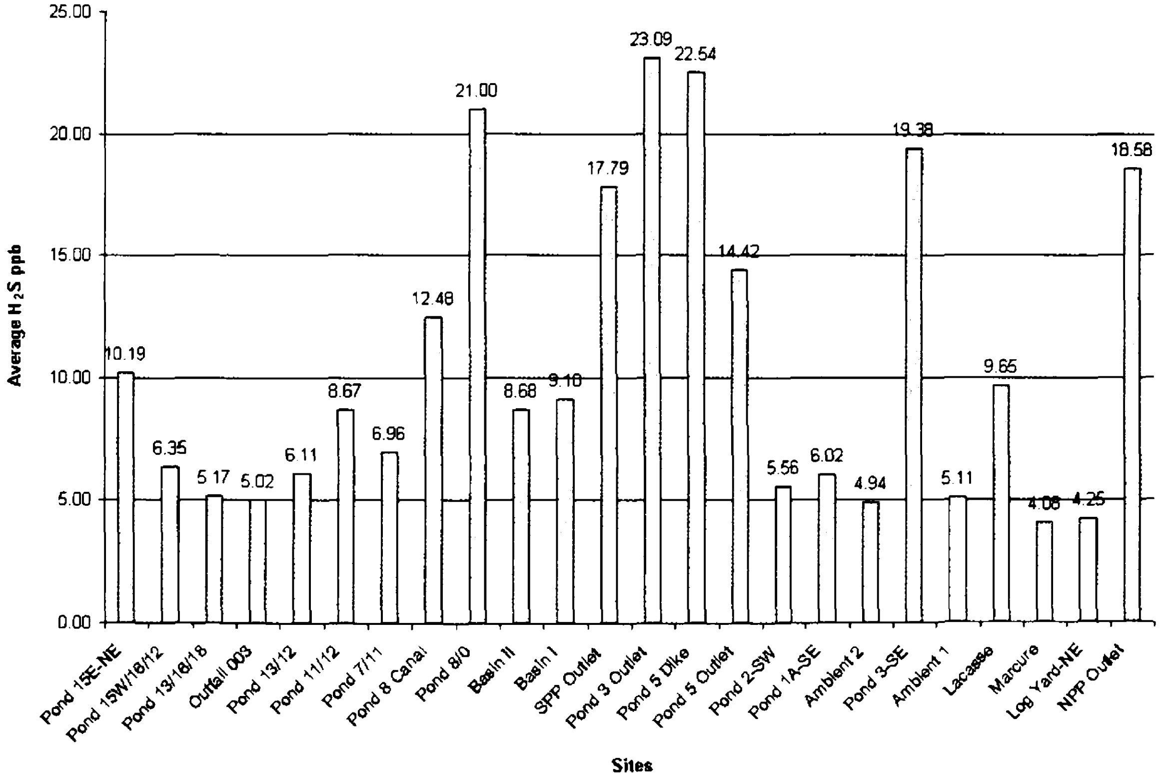


Figure C-2 Jerome Study Sampling Locations

#	Site
1	Pond 15-NE
2	Pond 15W/16/12 Intersection
3	Pond 13/16/18
4	Outfall 003
5	Pond 13/12 Intersection
6	Pond 11/12 Intersection
7	Pond 7/11 Intersection
8	Pond 8 Canal
9	Pond 8
10	Basin II Outlet
11	Basin I – II Midpoint
12	SPP Outlet
13	Pond 3 Outlet
14	Pond 5 Dike
15	Pond 5 Outlet
16	Pond 2-SW
17	Pond 1A-SE
18	Ambient 2
19	Pond 3-SE
20	Ambient 1
21	Lacasse Lane
22	Marcure Lane
23	Log Yard-NE
24	NPP Outlet

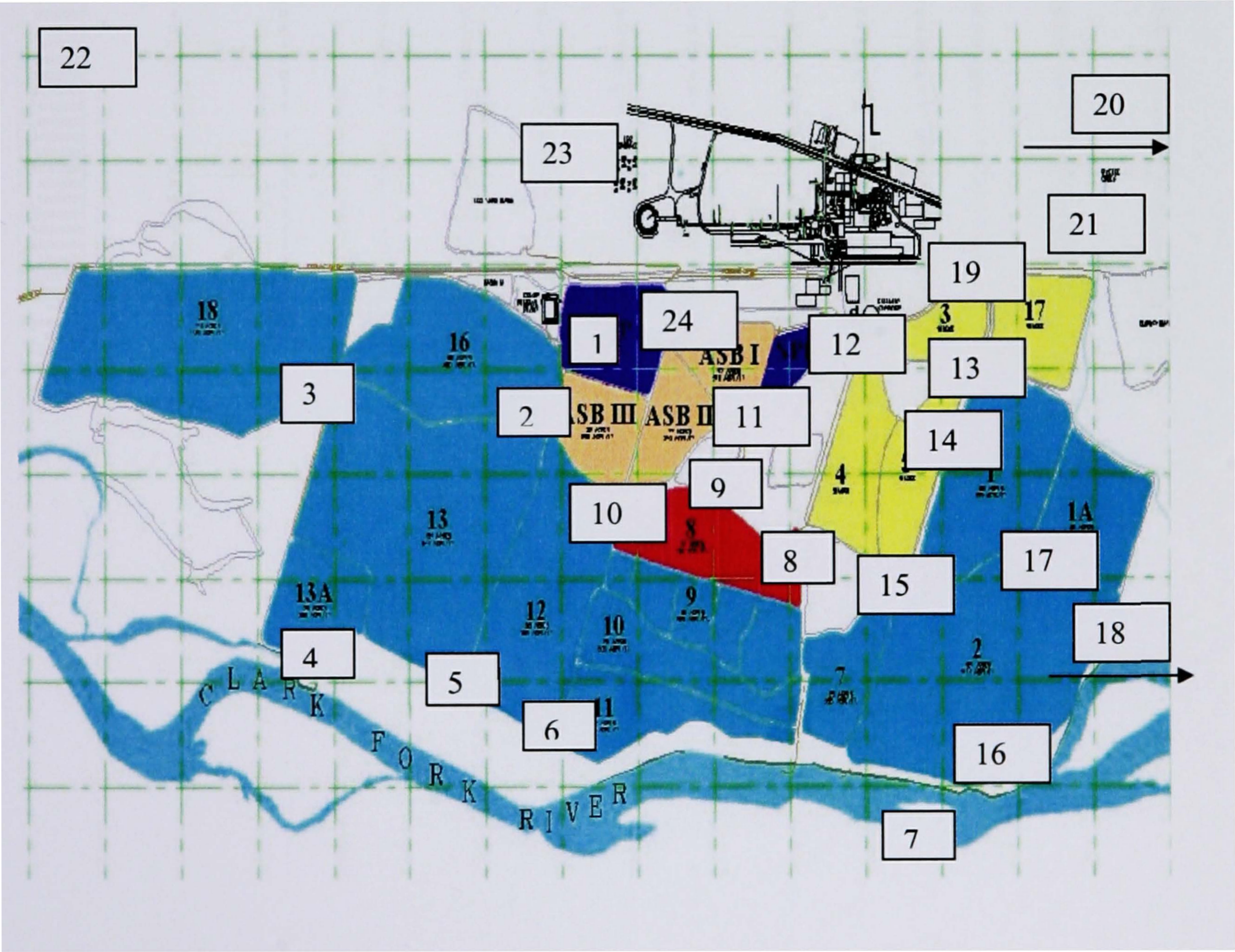


Table C-1 Jerome Study Data

Date	Pond 15E-NE	Pond 15W/16/12	Pond 13/16/18	Outfall 003	Pond 13/12	Pond 11/12	Pond 7/11	Pond 8 Canal	Pond 8/0	Basin II	Basin I	SPP Outlet	Pond 3 Outlet
10/13/2000	0	25	0	2	3	5	15	10	3	4	4	3	
10/17/2000	28	17	9	14	19	13	15	26	22	17	19	49	
10/19/2000	7	1	1	0	1	1	2	3	4	2	2	25	
10/23/2000	2	2	1	2	1	2	2	4	3	3	2	11	
10/25/2000	31	25	20	25	28	27	26	11	10	15	18	26	
10/31/2000	11	7	5	3	3	3	25	3	13	6	5	25	12
11/7/2000	5	2	3	4	3	5	5	19	10	3	6	43	10
11/10/2000	6	3	3	5	4	4	3	5	7	6	9	7	5
11/14/2000	4	4	5	5	4	4	4	5	6	5	6	7	10
11/16/2000	24	5	4	3	3	3	2	3	3	5	5	3	5
11/21/2000	3	3	2	1	1	1	3	4	3	5	3	9	6
11/27/2000	3	0	1	3	3	3	1	5	61	1	4	16	22
11/30/2000	5	4	3	1	2	2	4	4	12	4	4	25	33
12/4/2000	4	3	2	1	2	2	2	2	2	3	4	10	7
12/8/2000	10	4	5	4	5	6	3	5	6	5	7	7	7
12/12/2000	3	3	18	5		4		9			10	8	5
12/18/2000	10	10	6	7	6	6	7	36	31	18	16	26	12
12/20/2000	4	4	5	5	9	10	5	5	15	18	14	30	6
12/22/2000	4	3	4	4	4	4	0	15	5	5	4	9	24
12/28/2000	10	11	10	12	13	15	8	21	21	16	15	18	8
12/30/2000	14	7	5	7	7	6	6	24	15	7	20	17	13
1/3/2001	8	10	8	8	16	10	10	11	8	8	8	36	95
1/5/2001	0	0	0	0	0	1	0	14	3	0	5	32	5
1/9/2001	7	13	13	10	19	7	8	15	14	16	16	21	10
1/11/2001	5	6	5	4	4	3	5	6	5	5	5	6	5
1/15/2001	4	10	4	5	8	14	21	27	10	18	35	8	81
1/19/2001													
1/23/2001	2	3	2	3	3	3	4	17	9	3	3	4	9
1/30/2001	8	5	5	2	4	8	12	9	3	4	5	25	23
2/7/2001	9	4	4	4	5	5	5	5	7	12	5	12	15
2/14/2001	5	6	6	6	5	5	7	8	6	6	9	14	23
2/21/2001	8	13	7	8	10	16	12	19	31	12	15	121	28
3/1/2001	13	14	11	13	13	13	16	18	14	14	15	29	53
3/7/2001	27	4	8	8	4	6	4	27	70	6	16	13	3
3/13/2001	35	12	2	9	15	18	4	35	170	28	26	6	13
3/22/2001	17	12	11	10	8	7	9	19	33	14	20	8	7
3/27/2001	3	3	3	4	7	127	19	62	4	3	5	6	13
4/4/2001	3	4	4	3	5	5	6	15	29	4	7	12	6
4/11/2001													
4/12/2001	0	1	1	0	0	0	0	2	4	30	3	1	13
4/19/2001	3	2	3	2	3	4	5	7	77	3	5	10	5
4/26/2001	12	9	6	5	7	7	3	4	35	22	7	10	3
5/3/2001	15	9	14	10	10	5	6	8	5	3	2	2	150
5/9/2001	48	4	4	4	5	7	6	7	18	7	7	18	71
5/16/2001	2	3	2	2	3	3	4	3	23	7	4	4	24
5/23/2001	3	6	4	3	5	4	4	12	23	8	10	11	6
5/29/2001	2	2	3	2	3	3	13	5	90	5	10	62	63
6/6/2001	55	0	0	0	0	0	0	1	0	0	0	2	3
6/13/2001	6	4	3	1	0	1	1	1	2	17	9	3	3
6/20/2001	1	3	3	2	4	8	5	23	42	5	8	4	78
mean	10.19	6.35	5.17	5.02	6.11	8.67	6.96	12.48	21.00	8.68	9.10	17.79	23.09
std dev	12.00	5.66	4.37	4.56	5.75	18.21	6.36	11.61	30.20	7.14	7.03	20.09	30.76
Xrsd*	117.80	89.05	84.63	90.90	94.09	210.11	91.34	93.01	143.82	82.24	77.18	112.94	133.19

Table C-1 Continued....

Date	Pond 5 Dike	Pond 5 Outlet	Pond 2-SV	Pond 1A-SE	Ambient 2	Pond 3-SE	Ambient 1	Lacasse	Marcure	Log Yard-NE	NPP Outlet
10/13/2000	0	47	10	11	0	53	0	12	3	1	7
10/17/2000	0	39	5	5		17		0	3	18	40
10/19/2000	40	5	2	14	3	19	2	1	1	1	2
10/23/2000	17	3	2	10	6	11	10	5	1	2	24
10/25/2000	11	5	4	4	2	30	2	9	9	12	53
10/31/2000	15	4	2	3	2	22	4	10	2	3	36
11/7/2000	29	5	5	7	2	6	8	7	3	2	29
11/10/2000	4	5	4	4	4	4	4	3	3	3	4
11/14/2000	16	4	4	8	4	6	8	7	4	3	4
11/16/2000	3	4	2	2	2	8	3	4	4	3	9
11/21/2000	36	3	3	9	14	9	7	6	4	4	8
11/27/2000	110	5	3	3	2	38	2	5	2	4	97
11/30/2000	130	8	3	4	5	12	13	7	4	3	4
12/4/2000	11	3	4	5	7	10	3	9	3	3	12
12/8/2000	4	5	4	4	3	15	5	6	3	5	3
12/12/2000	10	5	5	4	5	6	4	3	3	4	5
12/18/2000	15	13	10	9	5	5	4	5	16	11	13
12/20/2000	5	5	8	5	5	9	6	6	9	8	7
12/22/2000	8	6	10	7	6	6	5	150	4	5	5
12/28/2000	7	7	7	7	6	21	7	8	6	9	8
12/30/2000	7	17	7	6	7	9	6	6	8	8	8
1/3/2001	28	25	41	20	30	8	34	27	17	8	70
1/5/2001	41	5	2	10	1	140	4	8	1	3	43
1/9/2001	10	22	7	9	8	10	8	9	9	9	15
1/11/2001	170	5	6	7	8	15	5	6	4	4	15
1/15/2001	4	29	4	6	6	6	7	7	3	7	4
1/19/2001											
1/23/2001	10	5	7	6	5	2	1	1	2	5	5
1/30/2001	25	104	7	4	5	7	1	2	6	3	4
2/7/2001	4	4	5	4	4	6	7	3	3	3	3
2/14/2001	14	18	12	8	5	6	4	3	4	4	19
2/21/2001	98	14	3	5	4	11	3	2	2	0	4
3/1/2001	50	33	14	21	17	13	9	7	8	8	26
3/7/2001	6	4	3	1	3	1	1	2	7	1	36
3/13/2001	3	115	3	3	1	8	3	3	3	2	8
3/22/2001	7	6	5	5	6	14	4	4	6	0	18
3/27/2001	22	12	14	7	5	14	13	7	5	4	7
4/4/2001	8	7	7	8	8	23	4	4	4	3	4
4/11/2001											
4/12/2001	4	36	0	0	0	14	1	4	1	3	2
4/19/2001	26	11	4	7	3	4	4	3	3	3	3
4/26/2001	6	6	1	1	3	6	2	1	1	5	7
5/3/2001	9	3	1	1	2	6	2	1	2	1	1
5/9/2001	7	6	6	6	6	230	8	37	4	4	105
5/16/2001	19	5	2	4	3	21	3	35	1	3	74
5/23/2001	5	4	1	3	2	11	2	2	0	5	6
5/29/2001	9	4	4	4	3	10	5	13	2	1	28
6/6/2001	0	0	1	0	0	2	0	0	0	0	3
6/13/2001	2	3	0	0	0	15	0	0	0	0	1
6/20/2001	17	8	3	8	4	11	2	3	3	3	3
mean	22.54	14.42	5.56	6.02	4.94	19.38	5.11	9.65	4.08	4.25	18.58
std dev	34.73	22.69	6.20	4.29	4.93	37.31	5.30	22.04	3.51	3.48	24.50
%rsd*	154.08	157.39	111.43	71.33	99.91	192.55	103.89	228.52	86.01	81.87	131.86

Appendix D

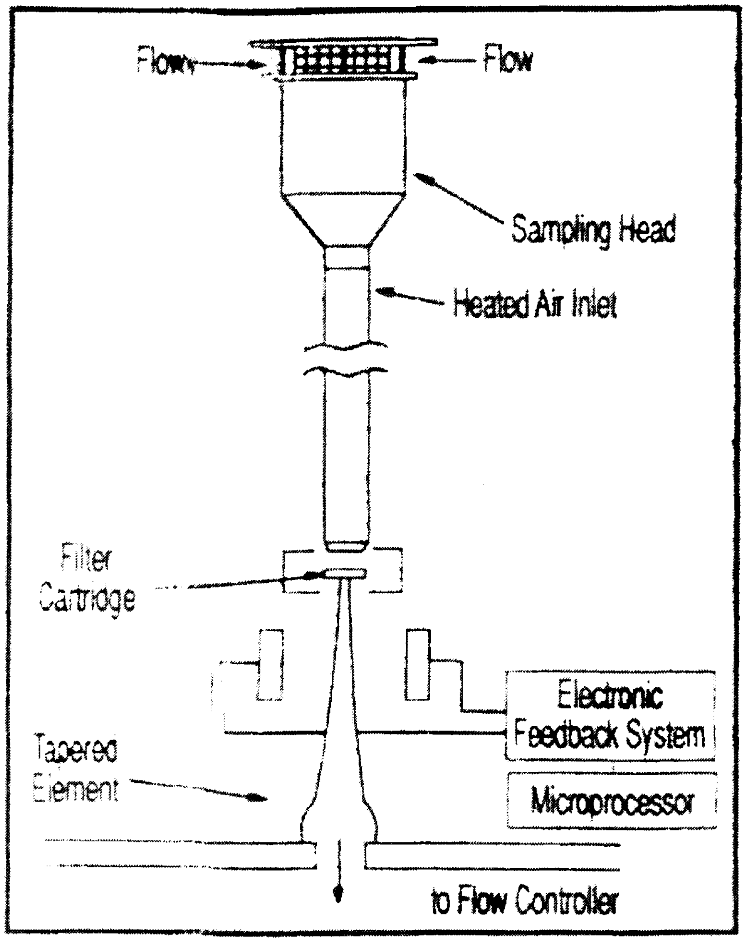
Tapered Element Oscillation Microbalance (TEOM)

A Tapered Element Oscillating Microbalance (TEOM®) was used in this study to provide hourly particulate data from Boyd Park in Missoula. This instrument provides continuous quantitative data for 10 um particulate, or PM10, which was used as a surrogate to characterize the amount of smoke in the valley during the fire season of 2000. While PM2.5 may have provided a better surrogate for smoke (Ward 2001), hourly data were not available. The following is an overview of the mechanics of this instrument. Detailed descriptions can be found in (Patashnick and Rupprecht 1991, and Maas 1992).

The TEOM® system for ambient air monitoring uses an exchangeable filter at the end of a tapered tube (figure E1). The wider end of the tube is fixed. Particulate deposits on the filter as ambient air is drawn through the tapered tube. Filtered air passes through the tapered tube to a flow controller. The tube and filter assembly is maintained in oscillation by applying a voltage, similar to a piezoelectric crystal in a microbalance. The frequency of the oscillation changes as particulate collects on the filter. Consequently, the voltage needed to maintain the oscillation changes. Voltage changes and flow rates are recorded on a microprocessor. When voltage change is combined with flow rate, an accurate measurement of particulate concentration can be made.

The TEOM® at Boyd Park is operated and maintained by Ben Schmit at the Missoula county department of health. Filters are changed every 30 days or sooner depending on air quality. During July and August 2000 the filters were changed every other week. Flow checks and bleed checks are run every two weeks. The TEOM® is capable of detecting PM10 at concentrations as low as 5 ug/m^3. Relative error for the range 5 ug/m^3 to 500 ug/m^3 is ± 20%.

Figure D-1 Schematic Diagram of the TEOM Ambient Particulate Monitor (Patashnick and Rupprecht 1991)



Appendix E: PreProcess Installation and Quick User Guide

Program Installation:

1. Download and install the most recent Java runtime environment from sun at http://java.sun.com/products/jdk/1.2/jre/download-windows.html (about 5MB). Or Install the 'jdk-1_2_2_008-win.exe' file included on this CD.
2. Unzip the 'Preprocess.zip' file, and extract onto your "C" drive.
3. **Execute** the '**run.bat**' file from a **Dos prompt**. *(In Dos, go to the folder where the run.bat file is located, type run.bat and press enter).*
4. A Java window should open, if it does not you may need to add a line to your autoexec.bat file
    a. In your start bar go to 'run', type 'msconfig'
    b. Click on the 'autoexec.bat' tab.
    c. On the bottom of the window click 'new'
    d. Type in this line PATH C:\JDK1.2.2\BIN
    e. Click 'Apply'
    f. Close the 'msconfig' file
    g. Try to execute the run.bat file at a Dos prompt again.
5. If the program still won't open, refer to http://java.sun.com/products/jdk/1.2/jre/download-windows.html for help. The path to your Java Runtime Environment is probably not properly installed.

Preprocess.exe Quick User Guide

Quick Notes:

1. Preprocess.exe is a Java for windows program which checks for missing dates and hours in AIRS data base files then prepares the data file in a comma delimited format so that it can be imported into a spreadsheet without gaps for dates and times.
2. The input data must be in **AIRS hourly format**.
3. The input data must include only **one parameter**. (ie: wind direction)
4. The input file must not exceed **1 year** of data.
5. You can divide the data into individual parameters and years by cutting and pasting into a text file prior to operating on it with the preprocess program.

Program Operation:

1. To use the program, do a File...Open on the input file you want to process.
2. The file will immediately be read, and the input and output is written to the screen.
3. An output file is automatically created by appending ".out" to the input filename. The new output file will be located in the same folder your input file was.
4. Use a text editor to view your output file.
5. You can import the output file directly into excel, or cut and paste it.
6. Using the text to columns operation in the 'Data' menu of your excel program, separate the data by checking the comma delimited radio box.
7. The data is now ready to be operated on by the macrobook excel macros included on this CD.

Appendix F: MacroBook Installation and Quick User Guide

MacroBook Installation:

1. Drag and Drop the "*MacroBook.xls*" file from the main index on the supplemental CD to any file in your hard drive.
2. Open the file "*MacroBook.xls*", an empty spreadsheet file should appear. A warning box may come up stating *you are opening a file containing macros*... click *enable macros.*
3. Click *Tools* then *Macro* then *Macros*..., highlight "*CreateToolbar*" with a single click, then click *run.*
4. A toolbar of macros should appear on your screen somewhere, you can drag it to any convenient place on you screen, including within the other toolbars.
5. If you wish not to view the toolbar any longer, click *view* then *toolbars*, then deselect the "*AIRS Data Toolbar*". This will remove it from your screen. You can replace it by reselecting the toolbar in the *view* menu.
6. The toolbar will remain even when the file "M*acroBook*" is closed. If you wish to execute a macro on the toolbar, the file "*MacroBook*" will first reopen then the macro will be executed.

MacroBook Quick User Guide:

The macros in the AIRS Data Toolbar provide a quick and easy way to organize hourly AIRS data into tables by month, day and hour using Microsoft excel. These time/date grids can be further organized into contour charts. The macros were designed to manipulate AIRS H_2S data but have also been used to organize meteorological data. These macros should operate on other hourly AIRS data, but only the two former parameters have been tested. The *preprocess.exe* program described in appendix 7 should be used to parse all data operated on by these macros. The preprocessed output files can be imported into an excel workbook then formatted using the text to columns option in the *Data* menu. The preprocessed output files are comma delimited.

The following is a brief description of each macro in the AIRS Data Toolbar including its utility and limitations.

Generate Monthly Data

This macro operates on 1 year of hourly data for a single parameter in AIRS format. Again, the data must be processed by the *preprocess.exe* program before it can be properly organized. The macro divides a year of data into 12 individual months. Each month appears on a separate worksheet within a workbook. Click the Generate Monthly Data control button and follow the instructions on the screen. This macro will not work if there are any worksheets named; Jan, Feb, Mar, April, May, June, July, Aug, Sept, Octo, Nov, or Dec, prior to starting the macro. All 12 worksheets will be generated even if the raw data is incomplete.

Format Monthly Data

This macro inserts a sequence of 24 hours in the first row (from 0 to 23) and calculates a mean and maximum value for each day and each hour. Additionally, this macro removes check codes inserted into the data to represent operations zero span checks and other equipment checks for a particular hour. The check codes are numerical and must be removed to properly calculate mean and maximum values.

Generate Charts

This macro prepares contour surface plots for the time/date data grids. With such plots daily and hourly trends within the month can be visualized. Individual worksheets are prepared for each contour chart and are named according to the month they represent by attaching a "C" to the month; ie: JanC, FebC, etc. This macro was designed to plot H_2S data and prepares a scale by 10's from 0 to 100ppb. Date is plotted on the ordinate and hour on the abscissa. The data maintains the same format as entered into the AIRS database (yymmdd) or (yyyymmdd).

Set Header

A custom head can be set with a uniform format for each of the Charts and Tables in the workbook. Click on the control button for "Set Header" and enter the proper information into the input boxes. Rerunning this macro will simply override previous headings.

Set Red Condition

This macro was written to aid researchers in finding those H_2S values, which were equal to or exceeded 50 ppb. The macro highlights these hours by filling the table cell with a red background.

Wind MapMaker

Monthly wind patterns can be easily recognized by using this macro to color code hourly wind directional coordinates. In a monthly day/hour table (as was used for the H_2S contour charts) directional data is divided into four quadrants by color (Table F-1). Colors are used to shade the corresponding hour in a wind velocity table. Such that the viewer can see direction (by color) and velocity (by the value in the cell. To operate the macro, in a new workbook, simply click the "WindMapMaker" button on the AIRS toolbar and follow the directions on the screen.

Table F-1 Wind Directional Quadrants and Their Associated Descriptive Colors and Integers

Quadrant	Degrees	Color	Integer
North	315-45	Purple	4
East	45-135	Blue	2
South	135-225	Red	1
West	225-315	Yellow	3

WDinteger

Monthly wind patterns can also be viewed when scatterplots are made similar to those shown in Figure 4-6 - 4-9. The macro *WDinteger* converts wind direction coordinates into one of four integers that represent the four directional quadrants North, South, East or West (Table F1). Operate the macro by clicking the "Wdinteger" button on the AIRS toolbar. Then follow the directions on the screen. Again, data must be in the same format as was described for H_2S data. This macro will operate on a full year of hourly data. Months can then be generated and formatted using first two buttons on the AIRS toolbar. Calculate a "mode" for each hour of the 24 hours of data and use this row to prepare the scatter plot. If you use the first two macros to generate and format the monthly data, a mode will be calculated for you.

Appendix G: Supplemental CD Index

Folder	Subfolder	Description of Contents
AirsData		
	H_2S Books	Excel workbooks for H_2S hourly data tables and contour charts at ambient sites 1 and 2, 1990 – 2001.
	PM10	Hourly PM10 data from Boyd park 1995 – 1997, and 2000.
	RawData	Hourly meteorological and H_2S data from ambient sites 1 and 2, 1990 – 2001 in AIRS format.
	Temperature	Daily maximum, minimum and average temperature from Missoula's municipal air port for 1996 – 2000 and part of 2001.
	Weather	Complete meteorological data from Missoula's municipal airport for June – November 2000.
	Wind	Hourly wind direction and velocity data from ambient station 1, for 1997 – 2001.
	MacroBook (file)	Contains the AIRS toolbar macro, which supplies shortcuts to various macros allowing the user to conveniently organize hourly meteorological and H_2S data in AIRS format.
Preprocess		
	Classes	Includes the executable preprocess program "run.bat" which is necessary to properly parse and correct unformatted AIRS data before it can be operated on with Macrobook macros.
	src	Supplemental preprocess files necessary for successful operation of the preprocess program.
	Preprocess.zip (file)	Complete program and supplemental files in a compressed .zip format.

Appendix H

AIRS Database Macro's; Visual Basic for Applications Code

Create Toolbar

```
Sub CreateToolbar()
'Created by: David Tooke
'Fall 1999

Dim cbar As CommandBar, cbctl As CommandBarControl

'Remove any old AIRS Data Toolbars and replace with new.
For Each cbar In Application.CommandBars
  If cbar.Name = "AIRS Data Toolbar" Then cbar.Delete
  Next

  Set cbar = Application.CommandBars.Add(Name:="AIRS Data Toolbar", Position:=msoBarFloating)
  cbar.Visible = True

  'Add a control button
  Set cbctl = cbar.Controls.Add(Type:=msoControlButton)
  cbctl.Visible = True
  cbctl.Style = msoButtonCaption
  cbctl.Caption = "Generate Monthly Data"
  cbctl.TooltipText = "Divides the data into 12 months"
  cbctl.OnAction = "generatemonths"

  'Add a control button
  Set cbctl = cbar.Controls.Add(Type:=msoControlButton)
  cbctl.Visible = True
  cbctl.Style = msoButtonCaption
  cbctl.Caption = "Format Monthly Data"
  cbctl.TooltipText = "Calculates averages and maximums for both hourly and daily data"
  cbctl.OnAction = "Formatdata"

  'Add a control button
  Set cbctl = cbar.Controls.Add(Type:=msoControlButton)
  cbctl.Visible = True
  cbctl.Style = msoButtonCaption
  cbctl.Caption = "Generate Charts"
  cbctl.TooltipText = "Generates a contour chart for each month"
  cbctl.OnAction = "MacroGraph"

  'Add a control button
  Set cbctl = cbar.Controls.Add(Type:=msoControlButton)
  cbctl.Visible = True
  cbctl.Style = msoButtonCaption
  cbctl.Caption = "Set Header"
  cbctl.TooltipText = "Customizes the header"
  cbctl.OnAction = "SetHeader"

  'Add a control button
  Set cbctl = cbar.Controls.Add(Type:=msoControlButton)
  cbctl.Visible = True
  cbctl.Style = msoButtonCaption
  cbctl.Caption = "Set Red Condition"
  cbctl.TooltipText = "Places red background in cells with exceedances"
  cbctl.OnAction = "MacroSetredCondition"

  'Add a control button
  Set cbctl = cbar.Controls.Add(Type:=msoControlButton)
  cbctl.Visible = True
  cbctl.Style = msoButtonCaption
  cbctl.Caption = "WindMapMaker"
```

```
    cbctl.TooltipText = "Builds Wind Maps From Hourly Wind Velocity/Direction Data"
    cbctl.OnAction = "windMapMaker"

    'Add a control button
    Set cbctl = cbar.Controls.Add(Type:=msoControlButton)
    cbctl.Visible = True
    cbctl.Style = msoButtonCaption
    cbctl.Caption = "WDinteger"
    cbctl.TooltipText = "Replaces directional coordinates with descriptive quadrant integers"
    cbctl.OnAction = "WDinteger"
    End Sub
```

Format Data

```
Sub Formatdata()
On Error Resume Next
Worksheets("Jan").Activate
Call Format31

Worksheets("Feb").Activate
Call Format29

Worksheets("Mar").Activate
Call Format31

Worksheets("April").Activate
Call Format30

Worksheets("May").Activate
Call Format31

Worksheets("June").Activate
Call Format30

Worksheets("July").Activate
Call Format31

Worksheets("Aug").Activate
Call Format31

Worksheets("Sept").Activate
Call Format30

Worksheets("Octo").Activate
Call Format31

Worksheets("Nov").Activate
Call Format30

Worksheets("Dec").Activate
Call Format31

MsgBox "Proceed to 'Generate Charts' Macro if you wish to prepare monthly contour charts of this data.", vbOKOnly, "Next Macro"

End Sub


Sub Format31()
'
' Formatmonth Macro
' Macro by David Tooke
'Format monthly data sheets

'
Cells(1, 1).Select
Selection.EntireRow.Insert
    Range("B1").Select
    ActiveCell.FormulaR1C1 = "0"
```

```
    Range("C1").Select
    ActiveCell.FormulaR1C1 = "1"
    Range("B1:C1").Select
    Selection.AutoFill Destination:=Range("B1:Y1"), Type:=xlFillDefault

    Range("A33").Formula = "Mean"
    Range("A34").Formula = "Max"
    Range("A35").Formula = "Median"
    Range("A36").Formula = "Mode"
    Range("Z1").Formula = "Mean"
    Range("AA1").Formula = "Max"
    Range("Z1:AA1").Select
    With Selection
       .HorizontalAlignment = xlRight
    End With


    Range("B33").Formula = "=Average(B2:B32)"
    Range("B33").Select
    Selection.AutoFill Destination:=Range("B33:Y33"), Type:=xlFillDefault

    Range("B34").Formula = "=Max(B2:B32)"
    Range("B34").Select
    Selection.AutoFill Destination:=Range("B34:Y34"), Type:=xlFillDefault

    Range("B35").Formula = "=Median(B2:B32)"
    Range("B35").Select
    Selection.AutoFill Destination:=Range("B35:Y35"), Type:=xlFillDefault

    Range("B36").Formula = "=Mode(B2:B32)"
    Range("B36").Select
    Selection.AutoFill Destination:=Range("B36:Y36"), Type:=xlFillDefault

    Range("Z2").Formula = "=Average(B2:Y2)"
    Range("Z2").Select
    Selection.AutoFill Destination:=Range("Z2:Z32"), Type:=xlFillDefault

    Range("AA2").Formula = "=Max(B2:Y2)"
    Range("AA2").Select
    Selection.AutoFill Destination:=Range("AA2:AA32"), Type:=xlFillDefault

    Range("A33:Y33").Activate
       With Selection.Font
        .ColorIndex = 3
    End With
    Range("A34:Y34").Activate
       With Selection.Font
       .ColorIndex = 5
    End With

    Range("Z1:Z32").Activate
       With Selection.Font
        .ColorIndex = 3
    End With
    Range("AA1:AA32").Activate
       With Selection.Font
       .ColorIndex = 5
    End With

Range("A1:AA34").Select
Selection.NumberFormat = "0"

Call removecodes
End Sub

Sub removecodes()
'David Tooke
Dim c As Range
For Each c In [b2:y366]
If c.Value > 999 Then
```

```
c.Select
Selection.Clear
End If
If c.Value < 0 Then
c.Select
Selection.Clear
End If
Next
End Sub

Sub Format30()
" Formatmonth Macro
' Macro by David Tooke
'Format monthly data sheets

'
Cells(1, 1).Select
Selection.EntireRow.Insert
    Range("B1").Select
    ActiveCell.FormulaR1C1 = "0"
    Range("C1").Select
    ActiveCell.FormulaR1C1 = "1"
    Range("B1:C1").Select
    Selection.AutoFill Destination:=Range("B1:Y1"), Type:=xlFillDefault

    Range("A32").Formula = "Mean"
    Range("A33").Formula = "Max"
    Range("A34").Formula = "Median"
    Range("A35").Formula = "Mode"
    Range("Z1").Formula = "Mean"
    Range("AA1").Formula = "Max"
    Range("Z1:AA1").Select
    With Selection
        .HorizontalAlignment = xlRight
    End With

    Range("B32").Formula = "=Average(B2:B31)"
    Range("B32").Select
    Selection.AutoFill Destination:=Range("B32:Y32"), Type:=xlFillDefault

    Range("B33").Formula = "=Max(B2:B31)"
    Range("B33").Select
    Selection.AutoFill Destination:=Range("B33:Y33"), Type:=xlFillDefault

    Range("B34").Formula = "=Median(B2:B31)"
    Range("B34").Select
    Selection.AutoFill Destination:=Range("B34:Y34"), Type:=xlFillDefault

    Range("B35").Formula = "=Mode(B2:B31)"
    Range("B35").Select
    Selection.AutoFill Destination:=Range("B35:Y35"), Type:=xlFillDefault

    Range("Z2").Formula = "=Average(B2:Y2)"
    Range("Z2").Select
    Selection.AutoFill Destination:=Range("Z2:Z31"), Type:=xlFillDefault

    Range("AA2").Formula = "=Max(B2:Y2)"
    Range("AA2").Select
    Selection.AutoFill Destination:=Range("AA2:AA31"), Type:=xlFillDefault

    Range("A32:Y32").Activate
        With Selection.Font
         .ColorIndex = 3
    End With
    Range("A33:Y33").Activate
        With Selection.Font
        .ColorIndex = 5
    End With

    Range("Z1:Z32").Activate
```

```
      With Selection.Font
       .ColorIndex = 3
   End With
   Range("AA1:AA32").Activate
      With Selection.Font
       .ColorIndex = 5
   End With

Range("A1:AA33").Select
Selection.NumberFormat = "0"

Call removecodes
End Sub

Sub Format29()
'
' Formatmonth Macro
' Macro by David Tooke
'Format monthly data sheets

Cells(1, 1).Select
Selection.EntireRow.Insert
   Range("B1").Select
   ActiveCell.FormulaR1C1 = "0"
   Range("C1").Select
   ActiveCell.FormulaR1C1 = "1"
   Range("B1:C1").Select
   Selection.AutoFill Destination:=Range("B1:Y1"), Type:=xlFillDefault

   Range("A31").Formula = "Mean"
   Range("A32").Formula = "Max"
   Range("A33").Formula = "Median"
   Range("A34").Formula = "Mode"
   Range("Z1").Formula = "Mean"
   Range("AA1").Formula = "Max"
   Range("Z1:AA1").Select
   With Selection
      .HorizontalAlignment = xlRight
   End With

   Range("B31").Formula = "=Average(B2:B30)"
   Range("B31").Select
   Selection.AutoFill Destination:=Range("B31:Y31"), Type:=xlFillDefault

   Range("B32").Formula = "=Max(B2:B30)"
   Range("B32").Select
   Selection.AutoFill Destination:=Range("B32:Y32"), Type:=xlFillDefault

   Range("B33").Formula = "=Median(B2:B30)"
   Range("B33").Select
   Selection.AutoFill Destination:=Range("B33:Y33"), Type:=xlFillDefault

   Range("B34").Formula = "=Mode(B2:B30)"
   Range("B34").Select
   Selection.AutoFill Destination:=Range("B34:Y34"), Type:=xlFillDefault

   Range("Z2").Formula = "=Average(B2:Y2)"
   Range("Z2").Select
   Selection.AutoFill Destination:=Range("Z2:Z30"), Type:=xlFillDefault

   Range("AA2").Formula = "=Max(B2:Y2)"
   Range("AA2").Select
   Selection.AutoFill Destination:=Range("AA2:AA30"), Type:=xlFillDefault

   Range("A31:Y31").Activate
      With Selection.Font
       .ColorIndex = 3
   End With
   Range("A32:Y32").Activate
      With Selection.Font
```

```
    .ColorIndex = 5
  End With

  Range("Z1:Z32").Activate
    With Selection.Font
     .ColorIndex = 3
  End With
  Range("AA1:AA32").Activate
    With Selection.Font
    .ColorIndex = 5
  End With

Range("A1:AA32").Select
Selection.NumberFormat = "0"
Call removecodes
End Sub
```

Generate Months

```
Sub generatemonths()
'created by David Tooke

'add worksheets for each month

Sheets.Add
  ActiveSheet.Name = "Jan"
Sheets.Add
  ActiveSheet.Name = "Feb"
Sheets.Add
  ActiveSheet.Name = "Mar"
Sheets.Add
  ActiveSheet.Name = "April"
Sheets.Add
  ActiveSheet.Name = "May"
Sheets.Add
  ActiveSheet.Name = "June"
Sheets.Add
  ActiveSheet.Name = "July"
Sheets.Add
  ActiveSheet.Name = "Aug"
Sheets.Add
  ActiveSheet.Name = "Sept"
Sheets.Add
  ActiveSheet.Name = "Octo"
Sheets.Add
  ActiveSheet.Name = "Nov"
Sheets.Add
  ActiveSheet.Name = "Dec"

'format column size
Sheets(Array("Jan", "Feb", "Mar", "April", "May", "June", "July", "Aug", "Sept", "Octo", "Nov", "Dec")).Select
dataout = InputBox("Enter the name of the worksheet containing the data you will be dividing.", "Data Output", "")
Sheets("Jan").Activate
Columns("B:Y").Select
Selection.ColumnWidth = 3
Worksheets(dataout).Activate
'set counters (i) for sheet1 and (i,j,k,l,m,n,o,p,q,r,s,t) for monthly sheets
i = 1
j = 1
k = 1
l = 1
m = 1
N = 1
o = 1
p = 1
q = 1
r = 1
s = 1
```

```
t = 1

'loop through data and copy into appropriate monthly worksheets

If Cells(1, 1).Value Like "##01##" Then
GoTo Line2
End If
If Cells(1, 1).Value Like "####01##" Then
GoTo Line3
End If

Line3:

Do While Cells(i, 1).Value Like "####01##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Jan").Select
   Cells(i, 1).Select
   ActiveSheet.Paste
   Worksheets(dataout).Activate
   i = i + 1
Loop

Do While Cells(i, 1).Value Like "####02##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Feb").Select
   Cells(j, 1).Select
   ActiveSheet.Paste
   j = j + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "####03##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Mar").Select
   Cells(k, 1).Select
   ActiveSheet.Paste
   k = k + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "####04##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("April").Select
   Cells(l, 1).Select
   ActiveSheet.Paste
   l = l + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "####05##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("May").Select
   Cells(m, 1).Select
   ActiveSheet.Paste
   m = m + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "####06##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
```

```
Sheets("June").Select
   Cells(N, 1).Select
   ActiveSheet.Paste
   N = N + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "####07##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("July").Select
   Cells(o, 1).Select
   ActiveSheet.Paste
   o = o + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "####08##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Aug").Select
   Cells(p, 1).Select
   ActiveSheet.Paste
   p = p + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "####09##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Sept").Select
   Cells(q, 1).Select
   ActiveSheet.Paste
   q = q + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "####10##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Octo").Select
   Cells(r, 1).Select
   ActiveSheet.Paste
   r = r + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "####11##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Nov").Select
   Cells(s, 1).Select
   ActiveSheet.Paste
   s = s + 1
Worksheets(dataout).Activate
i = i + 1
Loop
Do While Cells(i, 1).Value Like "####12##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Dec").Select
   Cells(t, 1).Select
   ActiveSheet.Paste
   t = t + 1
Worksheets(dataout).Activate
```

```
i = i + 1
Loop
Cells(1, 1).Select
Application.CutCopyMode = False

MsgBox "Proceed to 'Format Monthly Data' Macro.", vbOKOnly, "Next Macro"


Line2:

Do While Cells(i, 1).Value Like "##01##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Jan").Select
   Cells(i, 1).Select
   ActiveSheet.Paste
   Worksheets(dataout).Activate
   i = i + 1
Loop

Do While Cells(i, 1).Value Like "##02##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Feb").Select
   Cells(j, 1).Select
   ActiveSheet.Paste
   j = j + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "##03##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Mar").Select
   Cells(k, 1).Select
   ActiveSheet.Paste
   k = k + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "##04##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("April").Select
   Cells(l, 1).Select
   ActiveSheet.Paste
   l = l + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "##05##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("May").Select
   Cells(m, 1).Select
   ActiveSheet.Paste
   m = m + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "##06##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("June").Select
   Cells(N, 1).Select
   ActiveSheet.Paste
```

```
   N = N + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "##07##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("July").Select
   Cells(o, 1).Select
   ActiveSheet.Paste
   o = o + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "##08##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Aug").Select
   Cells(p, 1).Select
   ActiveSheet.Paste
   p = p + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "##09##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Sept").Select
   Cells(q, 1).Select
   ActiveSheet.Paste
   q = q + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "##10##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Octo").Select
   Cells(r, 1).Select
   ActiveSheet.Paste
   r = r + 1
Worksheets(dataout).Activate
i = i + 1
Loop

Do While Cells(i, 1).Value Like "##11##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Nov").Select
   Cells(s, 1).Select
   ActiveSheet.Paste
   s = s + 1
Worksheets(dataout).Activate
i = i + 1
Loop
Do While Cells(i, 1).Value Like "##12##"
Range(Cells(i, 1), Cells(i, 25)).Select
Selection.Copy
Sheets("Dec").Select
   Cells(t, 1).Select
   ActiveSheet.Paste
   t = t + 1
Worksheets(dataout).Activate
i = i + 1
Loop
Cells(1, 1).Select
```

```
Application.CutCopyMode = False

MsgBox "Proceed to 'Format Monthly Data' Macro.", vbOKOnly, "Next Macro"
End Sub
```

MacroGraph

```
Sub MacroGraph()
'David Tooke
'Make a surface area chart for each month in the workbook
On Error Resume Next
Worksheets("Jan").Activate
Call Macro31Chart

Worksheets("Feb").Activate
Call Macro29Chart

Worksheets("Mar").Activate
Call Macro31Chart

Worksheets("April").Activate
Call Macro30Chart

Worksheets("May").Activate
Call Macro31Chart

Worksheets("June").Activate
Call Macro30Chart

Worksheets("July").Activate
Call Macro31Chart

Worksheets("Aug").Activate
Call Macro31Chart

Worksheets("Sept").Activate
Call Macro30Chart

Worksheets("Octo").Activate
Call Macro31Chart

Worksheets("Nov").Activate
Call Macro30Chart

Worksheets("Dec").Activate
Call Macro31Chart

MsgBox "If you would like to set a custom header, proceed to 'Set Header' Macro.", vbOKOnly, "Next Macro"

End Sub
Sub Macro31Chart()
'Make a chart for months with 31 days
shtname = ActiveSheet.Name
Charts.Add
ActiveChart.SetSourceData Source:=Sheets(shtname).Range("A1:Y32"), PlotBy:=xlRows
 ActiveChart.Location Where:=xlLocationAsNewSheet
   ActiveChart.Name = (shtname) & "C"
   ActiveChart.ChartType = xlSurfaceTopView
   With ActiveChart
      .HasTitle = True
      .ChartTitle.Characters.Text = shname
      .Axes(xlCategory).HasTitle = True
      .Axes(xlCategory).AxisTitle.Characters.Text = "Hour"
      .Axes(xlSeries).HasTitle = True
      .Axes(xlSeries).AxisTitle.Characters.Text = "Date"
      .Axes(xlValue).HasTitle = False
   End With
   ActiveChart.Legend.Select
 With ActiveChart.Axes(xlValue)
      .MinimumScaleIsAuto = True
```

```
        .MaximumScale = 100
        .MinorUnitIsAuto = True
        .MajorUnit = 10
        .Crosses = xlAutomatic
        .ReversePlotOrder = False
        .ScaleType = xlLinear
    End With
    ActiveChart.Legend.LegendEntries(1).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 2
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(2).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 35
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(3).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 36
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(4).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 40
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(5).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 45
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(6).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 46
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(7).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 3
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(8).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 53
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(9).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 55
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(10).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 1
        .Pattern = xlSolid
    End With
End Sub
Sub Macro30Chart()
'Make a chart for months with 30 days
shtname = ActiveSheet.Name
Charts.Add
ActiveChart.SetSourceData Source:=Sheets(shtname).Range("A1:Y31"), PlotBy:=xlRows
 ActiveChart.Location Where:=xlLocationAsNewSheet
    ActiveChart.Name = (shtname) & "C"
    ActiveChart.ChartType = xlSurfaceTopView
    With ActiveChart
        .HasTitle = True
        .ChartTitle.Characters.Text = shname
        .Axes(xlCategory).HasTitle = True
```

```
        .Axes(xlCategory).AxisTitle.Characters.Text = "Hour"
        .Axes(xlSeries).HasTitle = True
        .Axes(xlSeries).AxisTitle.Characters.Text = "Date"
        .Axes(xlValue).HasTitle = False
    End With
    ActiveChart.Legend.Select
With ActiveChart.Axes(xlValue)
        .MinimumScaleIsAuto = True
        .MaximumScale = 100
        .MinorUnitIsAuto = True
        .MajorUnit = 10
        .Crosses = xlAutomatic
        .ReversePlotOrder = False
        .ScaleType = xlLinear
    End With
    ActiveChart.Legend.LegendEntries(1).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 2
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(2).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 35
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(3).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 36
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(4).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 40
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(5).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 45
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(6).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 46
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(7).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 3
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(8).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 53
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(9).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 55
        .Pattern = xlSolid
    End With
    ActiveChart.Legend.LegendEntries(10).LegendKey.Select
    With Selection.Interior
        .ColorIndex = 1
        .Pattern = xlSolid
    End With
End Sub
Sub Macro29Chart()
'Make a chart for months with 28 or 29 days
shtname = ActiveSheet.Name
Charts.Add
```

```
ActiveChart.SetSourceData Source:=Sheets(shtname).Range("A1:Y30"), PlotBy:=xlRows
 ActiveChart.Location Where:=xlLocationAsNewSheet
   ActiveChart.Name = (shtname) & "C"
   ActiveChart.ChartType = xlSurfaceTopView
   With ActiveChart
      .HasTitle = True
      .ChartTitle.Characters.Text = shname
      .Axes(xlCategory).HasTitle = True
      .Axes(xlCategory).AxisTitle.Characters.Text = "Hour"
      .Axes(xlSeries).HasTitle = True
      .Axes(xlSeries).AxisTitle.Characters.Text = "Date"
      .Axes(xlValue).HasTitle = False
   End With
   ActiveChart.Legend.Select
With ActiveChart.Axes(xlValue)
      .MinimumScaleIsAuto = True
      .MaximumScale = 100
      .MinorUnitIsAuto = True
      .MajorUnit = 10
      .Crosses = xlAutomatic
      .ReversePlotOrder = False
      .ScaleType = xlLinear
   End With
   ActiveChart.Legend.LegendEntries(1).LegendKey.Select
   With Selection.Interior
      .ColorIndex = 2
      .Pattern = xlSolid
   End With
   ActiveChart.Legend.LegendEntries(2).LegendKey.Select
   With Selection.Interior
      .ColorIndex = 35
      .Pattern = xlSolid
   End With
   ActiveChart.Legend.LegendEntries(3).LegendKey.Select
   With Selection.Interior
      .ColorIndex = 36
      .Pattern = xlSolid
   End With
   ActiveChart.Legend.LegendEntries(4).LegendKey.Select
   With Selection.Interior
      .ColorIndex = 40
      .Pattern = xlSolid
   End With
   ActiveChart.Legend.LegendEntries(5).LegendKey.Select
   With Selection.Interior
      .ColorIndex = 45
      .Pattern = xlSolid
   End With
   ActiveChart.Legend.LegendEntries(6).LegendKey.Select
   With Selection.Interior
      .ColorIndex = 46
      .Pattern = xlSolid
   End With
   ActiveChart.Legend.LegendEntries(7).LegendKey.Select
   With Selection.Interior
      .ColorIndex = 3
      .Pattern = xlSolid
   End With
   ActiveChart.Legend.LegendEntries(8).LegendKey.Select
   With Selection.Interior
      .ColorIndex = 53
      .Pattern = xlSolid
   End With
   ActiveChart.Legend.LegendEntries(9).LegendKey.Select
   With Selection.Interior
      .ColorIndex = 55
      .Pattern = xlSolid
   End With
   ActiveChart.Legend.LegendEntries(10).LegendKey.Select
   With Selection.Interior
```

```
        .ColorIndex = 1
        .Pattern = xlSolid
    End With
End Sub
```

Macro Set Red Condition

```
Sub MacroSetredCondition()
'Created by David Tooke
On Error Resume Next
Worksheets("Jan").Activate
Call Macro31

Worksheets("Feb").Activate
Call Macro29

Worksheets("Mar").Activate
Call Macro31

Worksheets("April").Activate
Call Macro30

Worksheets("May").Activate
Call Macro31

Worksheets("June").Activate
Call Macro30

Worksheets("July").Activate
Call Macro31

Worksheets("Aug").Activate
Call Macro31

Worksheets("Sept").Activate
Call Macro30

Worksheets("Octo").Activate
Call Macro31

Worksheets("Nov").Activate
Call Macro30

Worksheets("Dec").Activate
Call Macro31
End Sub

Sub Macro31()
' Macro31 Macro
' select cells that exceed 50 and color them red
    Range("B2:Y32").Select
    Selection.FormatConditions.Delete
    Selection.FormatConditions.Add Type:=xlCellValue, Operator:=xlGreaterEqual _
        , Formula1:="50"
    Selection.FormatConditions(1).Interior.ColorIndex = 3
    Range("B2").Select
End Sub

Sub Macro30()
' select cells that exceed 50 and color them red
Range("B2:Y31").Select
    Selection.FormatConditions.Delete
    Selection.FormatConditions.Add Type:=xlCellValue, Operator:=xlGreaterEqual _
        , Formula1:="50"
    Selection.FormatConditions(1).Interior.ColorIndex = 3
    Range("B2").Select
End Sub

Sub Macro29()
' select cells that exceed 50 and color them red
Range("B2:Y30").Select
```

```
    Selection.FormatConditions.Delete
    Selection.FormatConditions.Add Type:=xlCellValue, Operator:=xlGreaterEqual _
        , Formula1:="50"
    Selection.FormatConditions(1).Interior.ColorIndex = 3
    Range("B2").Select
End Sub
```

Set Header

```
Sub SetHeader()
'macro by David Tooke
'writes headers for Workbooks containing 12 months
On Error Resume Next
sheetyr = InputBox("What Year?", "Year", "")
sitename = InputBox("Monitoring Site Name?", "Site", "")

shtname = "January"
Worksheets("Jan").Activate
Call Macrosheetheader
Charts("JanC").Activate
Call Macrochartheader

shtname = "Febuary"
Worksheets("Feb").Activate
Call Macrosheetheader
Charts("FebC").Activate
Call Macrochartheader

shtname = "March"
Worksheets("Mar").Activate
Call Macrosheetheader
Charts("MarC").Activate
Call Macrochartheader

shtname = "April"
Worksheets("April").Activate
Call Macrosheetheader
Charts("AprilC").Activate
Call Macrochartheader

shtname = "May"
Worksheets("May").Activate
Call Macrosheetheader
Charts("MayC").Activate
Call Macrochartheader

shtname = "June"

Worksheets("June").Activate
Call Macrosheetheader
Charts("JuneC").Activate
Call Macrochartheader

shtname = "July"
Worksheets("July").Activate
Call Macrosheetheader
Charts("JulyC").Activate
Call Macrochartheader

shtname = "August"
Worksheets("Aug").Activate
Call Macrosheetheader
Charts("AugC").Activate
Call Macrochartheader

Line9:
shtname = "September"
Worksheets("Sept").Activate
```

```
Call Macrosheetheader
Charts("SeptC").Activate
Call Macrochartheader

shtname = "October"
Worksheets("Octo").Activate
Call Macrosheetheader
Charts("OctoC").Activate
Call Macrochartheader

shtname = "November"

Worksheets("Nov").Activate
Call Macrosheetheader
Charts("NovC").Activate
Call Macrochartheader

shtname = "December"

Worksheets("Dec").Activate
Call Macrosheetheader
Charts("DecC").Activate
Call Macrochartheader

Call macrolandscape

MsgBox "Proceed to 'Set Red Condition' Macro if you would like to highlight all H2S exceedance data.", vbOKOnly, "Next Macro"

End Sub

Sub Macrosheetheader()
'Created by David Tooke
' MacrosheetHeader Macro
'
'Writes headers for worksheets

    ActiveSheet.PageSetup.PrintArea = ""
    With ActiveSheet.PageSetup
        .CenterHeader = "TRS Data" & Chr(10) & (sitename) & Chr(10) & (shtname) & Space(1) & (sheetyr)
        .LeftHeader = "Stone Container, Missoula Mill"
    End With
End Sub

Sub Macrochartheader()
'Created by David Tooke
' Macroheader2 Macro
'
'Writes headers for charts

    With ActiveChart.PageSetup
        .CenterHeader = "TRS Chart" & Chr(10) & (sitename) & Chr(10) & (shtname) & Space(1) & (sheetyr)
        .LeftHeader = "Stone Container, Missoula Mill"
    End With
End Sub



Sub Macrosetlandscape()
'
' Macrosetlandscape Macro
' Macro created 8/21/00 by David Tooke
'

'
    With ActiveSheet.PageSetup
        .PrintTitleRows = ""
        .PrintTitleColumns = ""
        .TopMargin = Application.InchesToPoints(1.35)
        .BottomMargin = Application.InchesToPoints(0.5)
    End With
```

```
    ActiveSheet.PageSetup.PrintArea = ""
    With ActiveSheet.PageSetup
        .Orientation = xlLandscape
    End With
End Sub

Sub macrolandscape()
On Error Resume Next
Worksheets("Jan").Activate
Call Macrosetlandscape

Worksheets("Feb").Activate
Call Macrosetlandscape

Worksheets("Mar").Activate
Call Macrosetlandscape

Worksheets("April").Activate
Call Macrosetlandscape

Worksheets("May").Activate
Call Macrosetlandscape

Worksheets("June").Activate
Call Macrosetlandscape

Worksheets("July").Activate
Call Macrosetlandscape

Worksheets("Aug").Activate
Call Macrosetlandscape

Worksheets("Sept").Activate
Call Macrosetlandscape

Worksheets("Octo").Activate
Call Macrosetlandscape

Worksheets("Nov").Activate
Call Macrosetlandscape

Worksheets("Dec").Activate
Call Macrosetlandscape
End Sub
```

WDInteger

```
Sub WDinteger()
'Created by David Tooke
'Convert a wind direction value into 1 of 4 interger values
'write these values to another worksheet.

Dim c As Range      'the cell being worked on
Dim dest As Object 'dest = variable "sname"

Dim wdinput As String 'sheetname of the WD input file
Dim sname As String 'Output sheet containing the new table

Dim adrs As String
Dim w As Integer
Dim x As Integer
Dim y As Integer
Dim z As Integer

'MsgBox "Paste the H2S, wind velocity, and wind direction data into worksheets in this workbook.", vbOKOnly, "Table Maker"
wdinput = InputBox("Enter the name of the wind direction worksheet you will be reading data from", "Input", "")
sname = InputBox("Enter the name of the worksheet you will be writing data to", "Output", "")
'Insert output sheet and copy dates across
```

```
Sheets.Add
ActiveSheet.Name = sname
Worksheets(wdinput).Activate
Range("A1:A370").Copy
Worksheets(sname).Activate
Range("A1").Select
ActiveSheet.Paste
Application.CutCopyMode = False
'
Worksheets(wdinput).Activate
'
'Assign values 1-4 according to the wind direction
w = 45
x = 135
y = 225
z = 315
For Each c In [b1:y366]
adrs = c.Address(RowAbsolute:=False, ColumnAbsolute:=False, ReferenceStyle:=xlA1)
Set dest = Worksheets(sname).Range(adrs)
'NORTH
If c.Value < w Or c.Value > z Then
dest.Value = 4
End If
'EAST
If c.Value >= w And c.Value <= x Then
dest.Value = 2
End If
'SOUTH
If c.Value > x And c.Value < y Then
dest.Value = 1
End If
'WEST
If c.Value >= y And c.Value <= z Then
dest.Value = 3
End If
If c.Value Like "" Then
dest.Value = ""
End If
Next
'
End Sub
```

Wind Map Maker

```
Sub windMapMaker()
'David Tooke
'Color the wind velocity table with the directional cell colors

MsgBox "Paste the wind velocity and wind direction data into separate worksheets in this workbook.  Each of these worksheets must
be in the same format as the H2S data.", vbOKOnly, "Table Maker"

windvinput = InputBox("Enter the name of the wind velocity input worksheet", "Wind Input", "")
winddoutput = InputBox("Enter the name of the wind direction output worksheet", "Wind Ouput", "")
Call windmap
Worksheets(winddoutput).Activate
Range("B2:Y32").Select
   Selection.Copy
   Worksheets(windvinput).Select
   Range("B2").Select
   Selection.PasteSpecial Paste:=xlFormats, Operation:=xlNone, SkipBlanks:= _
      False, Transpose:=False
   Application.CutCopyMode = False

End Sub


Sub windmap()
```

```
w = 45
x = 135
y = 225
z = 315
Dim c As Range
For Each c In [b2:y32]
'NORTH
If c.Value < w Or c.Value > z Then
c.Select
Selection.Interior.ColorIndex = 13
End If
'EAST
If c.Value >= w And c.Value <= x Then
c.Select
Selection.Interior.ColorIndex = 41
End If
'SOUTH
If c.Value > x And c.Value < y Then
c.Select
Selection.Interior.ColorIndex = 3
End If
'WEST
If c.Value >= y And c.Value <= z Then
c.Select
Selection.Interior.ColorIndex = 6
End If
Next

End Sub
```

Wind Table Maker

```
Sub wtablemaker()
'Created by David Tooke
'builds tables that include only h2s exceedance data and the associated met data
'Each of the tables must have cells that correspond to each other.
'to expand the table size searched, change the range for each c loops.

Dim c As Range      'the cell being checked for and exceedance
Dim dest As Object 'dest = variable "sname"
Dim dt As Object  'dt = date
Dim tm As Object  'tm = time
Dim h2sinput As String 'sheetname of the H2S input file
Dim sname As String 'Output sheet containing the new table
Dim windv As Object 'wind velocity cell coresponding to the exceedance cell
Dim windd As Object 'wind direction cell corresponding to the exceedance cell
Dim adrs As String
MsgBox "Paste the H2S, wind velocity, and wind direction data into worksheets in this workbook.", vbOKOnly, "Table Maker"
h2sinput = InputBox("Enter the name of the H2S input worksheet", "Input", "")
sname = InputBox("Enter the output worksheet name", "Output", "")
windvinput = InputBox("Enter the name of the wind velocity input worksheet", "Wind Input", "")
winddinput = InputBox("Enter the name of the wind direction input worksheet", "Wind Input", "")
Sheets.Add
ActiveSheet.Name = sname
Cells(1, 1).Value = "Date"
Cells(1, 2).Value = "Time"
Cells(1, 3).Value = "Conc."
Cells(1, 4).Value = "Velocity"
Cells(1, 5).Value = "Direction"
'Sheets.Add
'ActiveSheet.Name = sname
'Set ssheet = sname
Worksheets(h2sinput).Activate
For Each c In [b2:y366]
If c.Value Like "" Then
c.Value = "0"
End If
Next
```

```
i = 2

For Each c In [b2:y366]
Set dest = Worksheets(sname).Cells(i, 3)
Set dt = Worksheets(sname).Cells(i, 1)
Set tm = Worksheets(sname).Cells(i, 2)
Set windv = Worksheets(sname).Cells(i, 4)
Set windd = Worksheets(sname).Cells(i, 5)
'copy the exceedances, date and time into sheet4
If c.Value >= 50 Then
adrs = c.Address(RowAbsolute:=False, ColumnAbsolute:=False, ReferenceStyle:=xlA1)
windv.Value = Worksheets(windvinput).Range(adrs)
windd.Value = Worksheets(winddinput).Range(adrs)
c.Copy dest
c.End(xlToLeft).Copy dt
c.End(xlUp).Copy tm

i = i + 1
End If
Next
End Sub

Sub addrows()
'add every other row
'for making wind rose tables
'David Tooke 01-14-02
Dim a As Integer
Cells(2, 1).EntireRow.Insert
For i = 4 To 3000 Step 2
Cells(i, 1).Select
Selection.EntireRow.Insert
Next
End Sub
```

Appendix I Acronyms and Terms

CF - Collection Factor (Pounds of Methanol per day)

DCS - Distributive Control System

DFO - Direct Fired Oxidizer

EPA - Environmental Protection Agency

GPM - Gallons Per Minute

HAP - Hazardous Air Pollutant

HVLC - High Volume Low Concentration vent gas

LVHC - Low Volume High Concentration vent gas

M&D Digester - Messing and Durkee (Sawdust Digester)

MACT - Maximum Achievable Control Technology

MTDEQ - Montana Department of Environmental Quality

NCASI - National Council for Air and Stream Improvement

NCG - Non Condensable Gas

OCC - Old Corrugated Cardboard (Recycled Cardboard)

ODTP - Oven Dried Tons of Pulp = (wet pulp tons x 0.93)

RMC - Representative Methanol Concentration

SAP - Sampling and Analysis Plan

SARA 313 - **S**uperfund **A**mendments and **R**eauthorization **A**ct of 1986, section 313 (SARA 313). Under SARA 313, about 23,000 facilities annually report the amount of certain toxic chemicals they release to the environment.

SOG - Stripper – off - gas

SSC - Smurfit Stone Container

Black Liquor - Used cooking liquor containing 70 – 75% solids.

Dregs - Large clusters of inorganic material found in green liquor

Green Liquor - Forms when smelt (mostly Na_2CO_3) is dissolved in weak black liquor (white liquor with about 15% other solids) and converted into NaOH

Hog Fuel - Bark, sawdust, and reject chips burned in the multifuel boiler

White Liquor - Pulp cooking chemical containing 25 – 35% Na_2S and 65 – 75% NaOH in water.

Appendix J:

Modified NCASI Method DI/MeOH-94.03 Methanol Analysis by GC/FID Stone Container Corporation - Missoula Mill MACT I Project

1.0 Scope and Applicaton

1.1 NCASI Method DI/MeOH-94.03 will be used for the analysis of methanol in process liquid samples from the MACT I project at Stone Container's Missoula Mill. This laboratory plan has been written using NCASI Method DI/MeOH-94.03 taking into account the specific capabilities of a Varian CP 3800 Gas Chromatograph, which has been purchased for the MACT I project at the Missoula Mill. Methanol analysis will be performed at the University of Montana under the supervision of Dr. Garon Smith and the Missoula Mill.

1.2 This laboratory plan includes the necessary valid QA/QC data to assure sample results are valid for use in the MACT I project.

1.3 NCASI Method DI/MeOH-94.03 using the Varian CP 3800 Gas Chromatograph is capable of detecting methanol at the part per million (ppm) level. The practical quantifiable limit (PQL) has been determined to be 1 ppm.

2.0 Summary of Method

2.1 Field samples will be collected by mill employees. The mill's testing protocols will list the necessary requirements for sample collection, chain-of-custody, sample handling, and sample transport to the University of Montana for methanol analysis.

2.2 As discussed in Section 2.1 above, field samples will be collected by mill employees. Daily grab samples (3 to 4 samples) will be collected from each condensate source and transported to the laboratory at the University of Montana for sample compositing and analysis. The daily grab samples (3 to 4 samples) from each source will be composited into a single sample (for each source). The composite procedure will consist of combining equal aliquots (approximately 10 mL) from each grab sample into a single 40 mL VOA vial.

2.3 An aliquot of each sample (composite) will be transferred to autosampler vials and an internal standard will be added to each vial. Dilutions will be performed as needed. Samples will be analyzed on a Varian CP3800 GC equipped with a flame ionization detector. Methanol will be qualified by its retention time as compared to that of a known standard.

2.4 Reports will be issued to Stone Container following each set of samples analyzed. Hard copies will be filed at the University of Montana, Chemistry Department.

3.0 Interferences

3.1 Method interferences, if any, may be caused by contaminants in solvents, glassware, and analysis hardware. Interferences will be identified by analyzing system and method blanks.

3.2 Butanol will be used as an internal standard.

4.0 Safety

4.1 All laboratory samples and chemical reagents will be considered as potential health hazards in accordance with good laboratory procedure. MSDS's will be available to laboratory analysts.

4.2 Methanol is flammable and potentially harmful when inhaled or ingested. Fume hoods, gloves, eye protection, and other protective clothing will be used when handling samples and other chemicals.

5.0 Equipment and Supplies

5.1 Sampling Equipment

5.1.1 40 mL VOA vials
5.1.2 Foam VOA holders
5.1.3 Ice, Coolers

5.2 Laboratory glassware and supplies

5.2.1 Volumetric Flasks
5.2.2 Syringes
5.2.3 Autosampler Vials
5.2.4 Pipets

5.3 Analytical equipment

5.3.1 Gas Chromatograph. Methanol analyses will be performed using a Varian CP 3800 Gas Chromatograph with a cryogenic kit for increased analyte resolution.

5.3.2 Restek 30m x 0.53mm x 3 df RTX624 fused silica column

5.3.3 Flame Ionization Detector

6.0 Reagents and Standards

6.1 Deionized Water

6.2 Internal standard primary spiking solution - 50,000 ppm of 1- butanol

6.3 Calibration primary stock solution - 100,000 ppm of methanol

6.4 Calibration and matrix spike solutions - Calibration range is from 10 - 1000 ppm

6.5 Certified reference material - A certified reference standard will be analyzed periodically to verify the accuracy of the calibration curve.

7.0 Sample Collection, Preservation, Transport and Storage

7.1 **Collection** – Field sampling is discussed in the field sampling protocols.

7.2 **Preservation** – There is no laboratory preservative required for condensate samples. Samples are planned to be cooled in a laboratory refrigerator until methanol analysis is performed, as discussed below.

7.3 **Transport** – Samples will be packaged in foam packaging and kept on ice in coolers. Each set of samples will be accompanied by a chain of custody which will be signed by the sampler, delivery personnel, and the receiver.

Upon delivery to the laboratory, the samples will be placed in a designated refrigerator and the chain of custody will be left inside the log book. If a person is not available to sign the chain of custody for sample receipt, then the delivery personnel may do so.

7.4 **Sample Log Book –** Lab personnel will log samples into the log book. Each sample will be assigned a lab number. Samples will be logged in with the same order they are listed on the chain of custody. All samples will be referenced by their lab number for analysis purposes. The initial Sample ID will be referenced in the final report.

7.5 **Storage** - All samples must be kept refrigerated until analysis. Samples may be stored for 30 days. However, all attempts will be made to adhere to the EPA's suggested holding time of 14 days for volatile samples

8.0 Quality Control

8.1 A calibration check standard will be verified, preceding each set of samples analyzed. The 250 or 500 ppm standards will be analyzed in the calibration check. The concentration of the analyte must be within ± 30% of the initial calibration. If the check standard fails to fall within this range, routine instrument maintenance or recalibration may be required.

8.2 **Frequency** - One sample per analytical batch of about 15 samples will be allocated for quality control. Laboratory replicates and matrix spikes will be performed on each quality control sample.

8.3 **Method blanks** - A method blank consisting of DI water and the internal standard will be run before each analytical batch to verify that the internal standard and DI water are free of interferences.

8.4 **System blanks** - A system blank will be run once a week to assure the instrument is clean and free of carryover contamination.

8.5 **Duplicate Samples** - One duplicate sample will be included in each analytical batch. The duplicate will be a separate aliquot of sample. Samples will not be continually duplicated from the same origin.

8.6 **Matrix spike recovery** – One matrix spike per analytical batch will be analyzed. The matrix spike will be performed on the duplicate sample, see Section 8.6 above.. The sample will be spiked with a concentration equal to or up to four times greater than the analyte concentration. The matrix spike will also be duplicated. The percent recovery must be within the control limits (mean ± 3s). Matrix spikes will be reported as a percent recovery, using the following formula.

$$\text{Percent Recovery} = \frac{C_{MS} - C_{VS}}{C_{TH}} \times 100$$

Where:

C_{MS} – *concentration of matrix spike sample (ppm)*
C_{VS} – *concentration of unspiked sample (ppm)*
C_{TH} – *theoretical concentration of spike (ppm)*

9.0 Calibration and Standardization

9.1 FID Operating Conditions

Method Parameters

Split injection @ 20:1
Column type = .53mm x 30m x 3 df RTX624 Fused Silica
Column flow = 1.5 mL/min (constant)
Oven parameters
  Initial temperature = 0° C, hold for 2 min
  1st ramp rate = 5° C/min to 50° C, hold for 0 min
  2nd ramp rate = 25° C/min to 220° C, hold for 5 min
  Total run time = 23.80 min
Injector temperature = 170° C
Detector temperature = 275° C

Gas flows
  Helium (make-up gas) = 30 ml/min
  Hydrogen = 30 ml/min
  Air = 300 ml/min

9.2 GC/FID analysis of calibration standards

9.2.1 A five point calibration curve will be prepared (10, 100, 250, 500, 1000 ppm) from a 100,000 ppm certified stock solution.

9.2.2 The stock solution will be renewed monthly. New standards will be made every two weeks.

9.2.3 1 uL of calibration solution will be injected to determine the retention time of methanol relative to the internal standard.

9.2.4 A relative response factor (RRF_M) for methanol will be calculated in order to establish the validity of the calibration standards.

Using the equation:

$$RRF_M = \frac{A_M \times C_{IS}}{A_{IS} \times C_M}$$

Where:
A_M = *area of methanol peak*
A_{IS} = *area of internal standard peak*
C_M = *concentration of methanol injected*
C_{IS} = *concentration of internal standard injected*

If the average RRF_M exhibits a coefficient of variation of less than 20%, then the calibration will be acceptable. Else, the calibration solutions will be reanalyzed and reevaluated.

The RRF_M will be analyzed and calculated daily for a mid range standard. If the coefficient is not within range, instrument maintenance or recalibration may be required.

10.0 Data Analysis and Calculations

10.1 GC/FID Data Analysis

10.1.1 Methanol will be identified by comparing the relative retention time established in the calibration to that determined during sample analysis.

10.1.2 Methanol concentration in each sample will be calculated using the following formula:

$$C_A = \frac{A_A \text{ x } C_{IS} \text{ x } DF}{A_{IS} \text{ x } RRF_A}$$

Where:

C_A = conc. of compound A in sample (mg/L)
A_A = area of the compound A peak in the sample
C_{IS} = conc. of the internal standard (mg/L)
A_{IS} = area of the internal standard peak
RRF_M = relative response factor of compound A
DF = dilution factor

10.2 Data Review

10.2.1 All data will be reviewed for accuracy of analyte identification, determinate/indeterminate error, interferences and bias.

10.2.2 All chromatograms will be manually reviewed to confirm internal standard peak area consistency, analyte identification, and area integrations. The analyst will also check for baseline noise and any possible problems do to matrix inconsistencies.

10.2.3 Internal standard area counts must not exceed ± 20% of the mean.

10.2.4 Inconsistencies between replicate samples and replicate spikes must also be resolved.

10.3 Data Reporting

10.3.1 A report will be generated that includes: quality control data (for duplicates and spikes), sample concentration, and dilution factors.

10.3.2 Each report will be assigned a Batch number and a Report number. The Batch # corresponds with the Calibration file used to calculate the results. eg. Batch#: 001 corresponds with Calibration Method file 'MeOH001.mth'. The report number is simply, sequential within a batch. So each new batch begins with Report # 01 and so on.

10.3.3 Each report will contain QA/QC data specific to the group of samples analyzed.

1. Data will be presented for a method blank (solvent + internal standard). This data will include a result indicating the presence or absence of methanol.
2. There will be data for one duplicate and one spike per 10 samples analyzed. The data will include a mean concentration, a relative percent difference =
   ([sample] – [duplicate])/[mean]
   and a range = [sample] – [duplicate]. A percent recovery will also be reported for the spiked sample = (measured conc of spiked sample)/(sample conc + spike conc). The spiked sample concentration must not differ from the theoretical value by more than $\pm$ 3s. The sample chosen to be spiked will always be the same as that chosen for duplicate analysis. Therefore sufficient data will be present to determine the theoretical value for the spiked sample.
3. Data will be presented for a mid range calibration check standard. This data will include concentration and relative percent difference. The mid range standard used will always be the 500ppm standard.
4. Each report will contain data indicating the concentration of methanol found in individual samples. This data will also include any dilutions required for analysis

11.0 Waste Management

11.1 The laboratory will dispose of laboratory waste in accordance with campus policy.

12.0 QA/QC Control Charts for Methanol and Butanol

Seven injections of two certified standards were analyzed to develop QA/QC control charts. The low level standard chosen was 1 mg per liter methanol in water. The mid range standard chosen was 500 mg/L methanol in water. These standards were analyzed on a Varian CP3800 GC using a Restek 0.53mm x 30m 3 df RTX624 Fused Silica capillary column.

For each group of seven injections a mean, relative standard deviation, and confidence interval were calculated. A method detection limit (MDL) was also calculated for the low level standard using the formula MDL = S $t_{(n-1 \text{ degrees freedom, } 99\% \text{ confidence level})}$. Where S is the standard deviation, n is the number of injections (7) and t is the students t, corresponding to 6 degrees of freedom and the 99% confidence interval. The MDL was calculated at 0.44 mg/L. The practical quantifiable limit will be set at 1 mg/L.

13.0 Standard Report Example

A sample report sheet is attached to this laboratory plan.

Batch 007
Report 14
C of C # 256,257,258

Stone Container
MACT 1 Methanol Analysis

Sampling Date: 5/23/2001
Analysis Date: 5/31/2001
Report Date: 6/1/2001
Analyst Tooke

Lab#	Sample	ID	Date	Methanol (ppm)	Dilution
1F640	#1,2 Evaps AC Hotwell	1EK,EL,EM,EN,EO,EP	23-May	68	
1F646	#4 Evaps 2nd Eff Stnd Pipe	5M, N, O,P,Q,R	23-May	2419	10
1F647	#4 Evaps Hotwell	6IK,IL, IM, IN, IO,IP	23-May	5912	10
1F648	Foul cond to Steam Stripper	7AT	23-May	2683	10
1F649	Foul cond to Steam Stripper	7AU	23-May	3400	10
1F650	Foul cond to Steam Stripper	7AV	23-May	2340	10
1F651	Foul cond to Steam Stripper	7AW	23-May	2492	10
1F652	Foul cond to Steam Stripper	7AX	23-May	3073	10
1F653	Foul cond to Steam Stripper	7AY	23-May	3073	10
1F654	#1 Conc Hotwell	11DT,DU,DV,DW,DX,DY	23-May	270	
1F655	Stripped cond / Stm Stripper	12BU	23-May	59	
1F656	Stripped cond / Stm Stripper	12BV	23-May	63	
1F657	Stripped cond / Stm Stripper	12BW	23-May	46	
1F658	Stripped cond / Stm Stripper	12BX	23-May	58	
1F659	Stripped cond / Stm Stripper	12BY	23-May	62	
1F660	Stripped cond / Stm Stripper	12BZ	23-May	54	

Sample

Quality Control Data

Lab#	Sample ID		Date	Methanol (ppm)	Mean	% Dif.	% Recovery	SD	Acceptable Range
MB	Method Blank		31-May	< 1					
1F647	#4 Evaps Hotwell	6IK,IL, IM, IN, IO,IP	23-May	5912	5915.0	0.10			
1F647dup	#4 Evaps Hotwell	6IK,IL, IM, IN, IO,IP	23-May	5918					
1F647spike	#4 Evaps Hotwell	6IK,IL, IM, IN, IO,IP	23-May	6003	6397.5	12.33	103.8	349.0	5240 - 7090
1F647spike dup	#4 Evaps Hotwell	6IK,IL, IM, IN, IO,IP	23-May	6792					
	Spike Concentration			250	6165.0				
	Calib. Check Concentration			250					
CC	Calibraton Check		31-May	268		6.72			213 - 288

Appendix K

Compliance Testing Period Methanol Concentrations (ppm)

Date	1,2EAH	4E2ESP	4EH	1CH
5/22/2001	131.00	3310.00	7459.00	316.00
5/23/2001	68.00	2419.00	5915.00	270.00
5/24/2001	49.00	2883.00	6426.00	328.00
5/25/2001	43.00	2947.00	6070.00	207.00
5/26/2001	468.00	2915.00	8389.00	202.00
5/27/2001	394.00	2425.00	6833.00	313.00
5/28/2001	305.00	2774.00	7409.00	156.00
5/29/2001	25.00	2758.00	7591.00	365.00
5/30/2001	101.00	3418.00	7167.00	330.00
5/31/2001	8.00	3315.00	7825.00	305.00
6/1/2001	268.00	3304.00	7072.00	370.00
6/2/2001	48.00	3253.00	8707.00	466.00
6/3/2001	45.00	3135.00	6699.00	260.00
6/4/2001	7.00	2177.00	6490.00	391.00
6/5/2001				
6/6/2001	83.00		5024.00	80.00
6/7/2001	171.00	2508.00	5898.00	628.00
6/8/2001	195.00	3057.00	7244.00	345.00
6/9/2001	145.00	2577.00	7097.00	448.00
6/10/2001	42.00	2715.00	6613.00	431.00
6/11/2001	86.00	3427.00	8575.00	423.00
6/12/2001	145.00	2728.00	6335.00	413.00
6/13/2001	387.00	2514.00	7891.00	484.00
6/14/2001	99.00	2962.00	6482.00	336.00
6/15/2001	530.00	2566.00	5601.00	368.00
6/16/2001	292.00	2540.00	4971.00	243.00
6/17/2001	86.00	2431.00	6615.00	232.00
6/18/2001	194.00	2393.00	5752.00	194.00
6/19/2001	153.00	2852.00	5896.00	323.00
6/20/2001	79.00	2807.00	5647.00	243.00
6/21/2001	62.00	3029.00	6244.00	266.00
6/22/2001	275.00	3190.00	6368.00	233.00
6/23/2001	262.00	3160.00	6620.00	282.00
6/24/2001	264.00	2868.00	6870.00	100.00
6/25/2001	298.00	2655.00	6593.00	198.00
6/26/2001	204.00	2316.00	6044.00	172.00
6/27/2001				
6/28/2001	167.00	2966.00	5681.00	243.00
6/29/2001	33.00	3054.00	6321.00	345.00
6/30/2001	10.00	2652.00	5077.00	236.00
7/1/2001	85.00	2682.00	5757.00	173.00
7/2/2001	73.00	2465.00	6064.00	183.00
7/3/2001	151.00	2911.00	5548.00	219.00
7/4/2001	90.00	2939.00	6349.00	96.00
7/5/2001	181.00	3048.00	7554.00	346.00
7/6/2001	208.00	2646.00	7057.00	367.00
7/7/2001	192.00	2905.00	6845.00	445.00
7/8/2001	78.00	3001.00	7620.00	214.00
7/9/2001	41.00	3113.00	6746.00	397.00
7/10/2001	38.00	3124.00	7206.00	368.00
7/11/2001	100.00	3012.00		443.00
7/12/2001	248.00	3063.00	7274.00	418.00
7/13/2001	141.00	3075.00	7237.00	360.00
7/14/2001	71.00	2815.00	6712.00	169.00
7/15/2001	137.00	2115.00		325.00

Appendix K

Compliance Testing Period Flow Rates (gpm)

Date	Time	1,2EAH	4E2EAH	4EH	1CH	FC to SS	SC from SS
5/22/2001	8:00	7			3		250
5/22/2001	10:30	11			3		248
5/22/2001	13:30	6			4		250
5/22/2001	16:00	8			4		
5/22/2001	19:00	7			4		
5/22/2001	22:00	7			4		
5/22/2001	5:00		106	55		250	
5/23/2001	5:00		102	54		250	
5/23/2001	8:00	7			3		251
5/23/2001	10:30	6			3		250
5/23/2001	13:30	6			3		252
5/23/2001	0:00	4			3		250
5/23/2001	2:30	4			4		249
5/24/2001	5:00		83	55		229	
5/24/2001	5:30	4			4		251
5/24/2001	8:30	6			3		252
5/24/2001	2:30	4			4		3
5/25/2001	5:00	4			4		250
5/25/2001	5:00		76	53		249	
5/25/2001	8:30	5			3		249
5/25/2001	10:30	5			3		251
5/25/2001	16:00	6			4		
5/25/2001	19:00	5			3		
5/25/2001	22:00	6			3		
5/25/2001	0:00	5			3		251
5/25/2001	2:30	4			4		250
5/26/2001	5:00		100	49		250	
5/26/2001	5:00	4			4		249
5/26/2001	15:30	6			4		
5/26/2001	18:30	5			3		
5/26/2001	21:30	21			3		
5/26/2001	0:00	27					250
5/26/2001	2:30	5			4		248
5/27/2001	5:00		86	57		250	
5/27/2001	5:00	5			4		251
5/27/2001	16:00	5			4		
5/27/2001	18:30	5			3		
5/27/2001	21:30	12			3		
5/27/2001	0:00	21			3		249
5/27/2001	2:30	5			0		252
5/27/2001	5:00	14			4		251
5/28/2001	5:00		91	56		250	
5/28/2001	8:00	18			4		
5/28/2001	10:30	5			4		
5/28/2001	13:30	6			4		
5/28/2001	16:00	5			3		251
5/28/2001	18:30	5			4		251
5/28/2001	21:00	18			4		248
5/29/2001	5:00		91	58		249	
5/29/2001	16:00	5			3		249
5/29/2001	18:30	5			3		250
5/29/2001	21:00	6			4		251
5/30/2001	8:00	6			4		
5/30/2001	10:30	8			4		
5/30/2001	13:30	6			4		
5/30/2001	23:30	4			3		247
5/30/2001	2:30	4			3		249
5/30/2001	5:00	4			3		249
5/30/2001	5:00		98	58		250	
5/31/2001	8:00	5			3		
5/31/2001	5:00		108	55		250	
5/31/2001	10:30	6			4		
5/31/2001	13:30	6			4		

Appendix K

Compliance Testing Period Flow Rates (gpm)

Date	Time	1,2EAH	4E2EAH	4EH	1CH	FC to SS	SC from SS
5/31/2001	23:30	6			3		250
5/31/2001	3:00	8			3		250
6/1/2001	5:00		105	57		250	
6/1/2001	5:00	12			3		248
6/1/2001	8:00	7			4		
6/1/2001	10:30	5			3		
6/1/2001	13:30	6			3		
6/2/2001	5:00		106	56		251	
6/2/2001	16:00	6			4		251
6/2/2001	18:30	5			4		247
6/2/2001	21:00	4			4		250
6/3/2001	5:00		104	53		258	
6/3/2001	16:00	5			3		250
6/3/2001	18:30	5			4		250
6/3/2001	21:00	5			4		250
6/3/2001	23:30	4			3		306
6/3/2001	2:30	5			4		251
6/4/2001	5:30	4			3		246
6/4/2001	5:00		86	55		247	
6/4/2001	8:00	4			3		250
6/4/2001	10:30	5			3		248
6/4/2001	13:30	1			2		249
6/4/2001	15:30	0			4		250
6/4/2001	18:30	0			3		248
6/4/2001	21:30	3			3		251
6/5/2001	5:00		10	6		61	
6/6/2001	5:00		26	136		4	
6/7/2001	8:00	4			4		250
6/7/2001	5:00		105	54		246	
6/7/2001	10:30	5			4		250
6/7/2001	13:30	5			5		250
6/7/2001	23:30	5			4		
6/7/2001	2:30	5			4		
6/8/2001	5:30	6			4		
6/8/2001	5:00		104	54		248	
6/8/2001	8:00	6			4		250
6/8/2001	10:30	5			4		252
6/8/2001	13:30	4			4		251
6/8/2001	15:30	4			4		252
6/8/2001	18:30	4			4		250
6/8/2001	21:30	3			3		251
6/8/2001	23:30	5			4		
6/9/2001	5:00		89	54		238	
6/9/2001	15:30	4			3		250
6/9/2001	18:30	3			3		251
6/9/2001	21:30	4			3		251
6/9/2001	23:30	4			4		
6/9/2001	2:30	4			4		
6/10/2001	5:00		91	53		236	
6/10/2001	5:30	5			4		
6/10/2001	15:30	3			4		250
6/10/2001	18:30	3			4		251
6/10/2001	21:30	4			3		250
6/10/2001	23:30	4			3		
6/10/2001	2:30	5			4		
6/11/2001	5:30	5			4		
6/11/2001	5:00		96	56		250	
6/11/2001	8:30	4			3		
6/11/2001	11:00	3			4		251
6/11/2001	13:30	3			3		251
6/11/2001	18:30	4			3		
6/11/2001	21:00	4			4		
6/11/2001	0:30	4			4		

Appendix K

Compliance Testing Period Flow Rates (gpm)

Date	Time	1,2EAH	4E2EAH	4EH	1CH	FC to SS	SC from SS
6/11/2001	11:00	4			3		249
6/12/2001	5:00		97	56		276	
6/12/2001	8:30	3			4		248
6/12/2001	13:30	3			4		249
6/12/2001	16:00	4			4		
6/12/2001	19:00	4			4		
6/12/2001	22:00	4			4		
6/13/2001	5:00		78	46		202	
6/13/2001	8:00	10			4		253
6/13/2001	11:00	1			2		252
6/13/2001	0:00	7			4		250
6/13/2001	2:30	5			4		249
6/14/2001	5:30	6			4		251
6/14/2001	5:00		88	50		224	
6/14/2001	8:00	3			3		251
6/14/2001	11:00	3			3		246
6/14/2001	13:30	4			3		249
6/14/2001	0:00	0			4		
6/14/2001	2:30	0			4		
6/15/2001	5:00		100	53		185	
6/15/2001	5:30	4			4		
6/15/2001	8:30	4			3		234
6/15/2001	11:00	4			3		5
6/15/2001	13:30	4			3		250
6/15/2001	16:00	4			4		
6/15/2001	19:00	4			4		
6/15/2001	22:00	4			4		
6/15/2001	0:00	4			4		249
6/15/2001	2:30	4			4		252
6/16/2001	5:00		109	53		234	
6/16/2001	5:30	4			4		525
6/16/2001	16:00	5			4		
6/16/2001	19:00	5			4		
6/16/2001	22:00	5			4		
6/17/2001	5:00		105	53		211	
6/17/2001	5:00						
6/17/2001	16:00	4			4		
6/17/2001	19:00	4			4		
6/17/2001	22:00	4			4		
6/17/2001	0:00	4			4		
6/17/2001	2:30	4			4		251
6/18/2001	5:30	0			0		
6/18/2001	5:00		97	54		270	
6/18/2001	8:00	0			4		
6/18/2001	11:00	0			4		
6/18/2001	14:00	0			4		
6/18/2001	16:00	4			3		270
6/18/2001	18:30	4			4		351
6/18/2001	21:00	4			4		365
6/19/2001	5:00		107	53		252	
6/19/2001	8:00	0			3		
6/19/2001	11:00	0			4		
6/19/2001	13:30	0			4		
6/19/2001	16:00	4			4		250
6/19/2001	18:30	4			4		252
6/19/2001	21:00	4			4		252
6/20/2001	5:00		103	54		250	
6/20/2001	8:00	3			4		0
6/20/2001	2:30	4			3		251
6/20/2001	23:30	5			3		245
6/20/2001	13:30	4			4		
6/20/2001	11:00	6			4		
6/21/2001	5:30	4			3		254

Appendix K

Compliance Testing Period Flow Rates (gpm)

Date	Time	1,2EAH	4E2EAH	4EH	1CH	FC to SS	SC from SS
6/21/2001	5:00		102	56		250	
6/21/2001	8:00	5			3		
6/21/2001	11:00	4			4		
6/21/2001	14:00	4			4		
6/21/2001	23:30	13			3		248
6/22/2001	2:30	3			4		250
6/22/2001	5:30	2			3		251
6/22/2001	5:00		109	55		250	
6/22/2001	8:00	5			3		
6/22/2001	13:30	14			4		
6/22/2001	16:00	13			4		250
6/22/2001	18:30	9			0		251
6/22/2001	21:00	12			0		
6/22/2001	2:30	10			3		250
6/23/2001	5:00		112	54		250	
6/23/2001	5:30	9			3		251
6/23/2001	23:30	8			4		250
6/24/2001	5:00		103	55		250	
6/24/2001	2:30	8			3		251
6/24/2001	5:30	9			3		254
6/24/2001	16:00	10			0		251
6/24/2001	18:30	10			0		249
6/24/2001	21:00	9			0		250
6/24/2001	23:30	8			4		252
6/25/2001	5:00		102	55		250	
6/25/2001	2:30	8			3		251
6/25/2001	5:30	7			3		249
6/25/2001	8:00	8			0		249
6/25/2001	10:30	9			0		250
6/25/2001	21:30	8			3		251
6/25/2001	15:30	9			4		253
6/25/2001	18:30	8			3		251
6/25/2001	13:00	9			3		252
6/26/2001	5:00		109	54		246	
6/26/2001	9:00	9			4		253
6/26/2001	11:30	8			0		250
6/26/2001	13:00	7			4		250
6/26/2001	21:30	7			3		251
6/26/2001	18:30	8			3		249
6/26/2001	15:30	7			3		248
6/27/2001	5:00		11	5		31	
6/27/2001	9:00	0			0		
6/28/2001	5:00		80	47		143	
6/28/2001	8:00	0			0		
6/28/2001	10:30	8			4		
6/28/2001	13:00	50			0		
6/28/2001	0:00	6			4		0
6/28/2001	3:00	6			4		
6/29/2001	6:00	6			4		
6/29/2001	5:00		116	51		230	
6/29/2001	8:00	7			3		251
6/29/2001	10:30	6			0		249
6/29/2001	13:00	6			0		
6/29/2001	23:59	6			4		
6/29/2001	3:00	6			4		
6/30/2001	5:00		119	51		249	
6/30/2001	6:00	6			4		0
6/30/2001	15:30	5			3		248
6/30/2001	18:30	4			3		250
6/30/2001	21:30	5			3		249
6/30/2001	23:59	5			3		
6/30/2001	3:00	6			3		
7/1/2001	5:00		112	50		250	

Appendix K

Compliance Testing Period Flow Rates (gpm)

Date	Time	1,2EAH	4E2EAH	4EH	1CH	FC to SS	SC from SS
7/1/2001	6:00	5			4		
7/1/2001	15:30	5			4		251
7/1/2001	18:30	5			4		249
7/1/2001	21:30	25			3		245
7/1/2001	23:55	5			4		
7/1/2001	3:00	6			4		
7/2/2001	5:00		110	51		259	
7/2/2001	5:30	6			4		
7/2/2001	8:30	4			3		246
7/2/2001	10:30	8			3		246
7/2/2001	13:30	4			3		250
7/2/2001	18:30	3			4		
7/2/2001	16:00	3			4		
7/2/2001	21:00	4			3		
7/3/2001	10:30	14			3		251
7/3/2001	8:30	14			3		251
7/3/2001	5:00		117	51		271	
7/3/2001	10:30	14			3		251
7/3/2001	13:30	14			2		251
7/3/2001	16:00	14			4		
7/3/2001	18:30	14			4		
7/3/2001	12:30	18			3		
7/4/2001	5:00		112	51		253	
7/4/2001	8:30	13			3		250
7/4/2001	10:30	12			3		250
7/4/2001	13:30	12			4		307
7/4/2001	5:30	13			2		152
7/4/2001	3:00	12			2		114
7/5/2001	5:00		95	55		257	
7/5/2001	0:30	13			0		248
7/5/2001	13:30	12			3		244
7/5/2001	10:30	12			3		249
7/5/2001	0:00	11			3		254
7/5/2001	3:30	13			1		249
7/6/2001	5:00		101	54		250	
7/6/2001	5:30	13			1		251
7/6/2001	12:56	0			248		
7/6/2001	10:30	13			3		246
7/6/2001	13:30	6			2		256
7/6/2001	16:00	12			3		
7/6/2001	18:30	13			3		
7/6/2001	21:00	12			4		
7/6/2001	0:30	13			4		247
7/6/2001	3:30	14			2		253
7/7/2001	5:00		99	55		250	
7/7/2001	5:30	13			2		249
7/7/2001	16:00	14			3		
7/7/2001	18:30	15			3		
7/7/2001	21:00	15			3		
7/7/2001	3:30	5			4		285
7/7/2001	0:30	8			2		249
7/8/2001	5:00		97	56		250	
7/8/2001	5:30	6			2		251
7/8/2001	18:30	6			3		
7/8/2001	21:00	5			3		
7/8/2001	0:30	6			3		252
7/8/2001	3:00	7			3		252
7/9/2001	5:30	7			4		250
7/9/2001	5:00		98	56		250	
7/9/2001	8:30	6			4		146
7/9/2001	12:00	6			0		108
7/9/2001	13:30	6			3		114
7/9/2001	16:00	6			3		250

Appendix K

Compliance Testing Period Flow Rates (gpm)

Date	Time	1,2EAH	4E2EAH	4EH	1CH	FC to SS	SC from SS
7/9/2001	18:30	6			4		250
7/9/2001	21:00	6			4		249
7/10/2001	5:00		99	54		251	
7/10/2001	8:30	5			4		3
7/10/2001	12:00	6			4		104
7/10/2001	13:00	5			2		104
7/10/2001	16:00	5			4		248
7/10/2001	18:30	6			4		250
7/10/2001	21:00	6			4		250
7/11/2001	5:00		94	52		250	
7/11/2001	8:30	6			3		95
7/11/2001	12:00	5			3		103
7/11/2001	13:30	5			3		100
7/11/2001	0:01	5			3		249
7/11/2001	2:30	5			3		249
7/12/2001	5:30	29			3		250
7/12/2001	5:00		92	53		247	
7/12/2001	8:30	6			3		3
7/12/2001	12:00	5			3		152
7/12/2001	13:00	5			3		147
7/12/2001	23:30	5			3		248
7/12/2001	2:30	5			3		248
7/13/2001	5:30	5			3		250
7/13/2001	5:00		92	55		250	
7/13/2001	8:30	5			3		115
7/13/2001	11:30	5			4		140
7/13/2001	13:30	5			3		127
7/13/2001	16:00	6			4		510
7/13/2001	21:00	7			4		250
7/13/2001	18:30	6			4		250
7/13/2001	23:30	5			4		250
7/13/2001	2:30	39			3		249
7/14/2001	5:00		91	54		250	
7/14/2001	5:30	5			3		253
7/14/2001	8:30	4			2		250
7/14/2001	10:30	5			3		
7/14/2001	13:00	16			3		
7/14/2001	23:30	5			3		248
7/14/2001	2:30	4			3		251
7/15/2001	5:00		87	53		250	
7/15/2001	5:30	4			3		253
7/15/2001	16:00	4			4		252
7/15/2001	18:30	5			4		251
7/15/2001	21:00	5			4		251
7/15/2001	23:30	5			3		252
7/15/2001	2:30	4			2		252

Appendix K
Compliance Testing Period Oven Dried Tons of Pulp (ODTP)

Date	Pulp Tons	ODTP (tons)
5/22/2001	807	751
5/23/2001	800	744
5/24/2001	853	793
5/25/2001	938	872
5/26/2001	809	752
5/27/2001	783	728
5/28/2001	783	728
5/29/2001	870	809
5/30/2001	925	860
5/31/2001	949	883
6/1/2001	955	888
6/2/2001	913	849
6/3/2001	741	689
6/4/2001	676	629
6/5/2001	13	12
6/6/2001	236	219
6/7/2001	806	750
6/8/2001	320	298
6/9/2001	817	760
6/10/2001	733	682
6/11/2001	1006	936
6/12/2001	1022	950
6/13/2001	785	730
6/14/2001	785	730
6/15/2001	805	749
6/16/2001	803	747
6/17/2001	850	791
6/18/2001	876	815
6/19/2001	874	813
6/20/2001	859	799
6/21/2001	925	860
6/22/2001	1012	941
6/23/2001	1022	950
6/24/2001	1055	981
6/25/2001	1056	982
6/26/2001	1047	974
6/27/2001	79	73
6/28/2001	631	587
6/29/2001	820	763
6/30/2001	800	744
7/1/2001	810	753
7/2/2001	810	753
7/3/2001	802	746
7/4/2001	861	801
7/5/2001	912	848
7/6/2001	886	824
7/7/2001	908	844
7/8/2001	997	927
7/9/2001	985	916
7/10/2001	932	867
7/11/2001	828	770
7/12/2001	876	815
7/13/2001	856	796
7/14/2001	840	781
7/15/2001	829	771

Appendix K

Compliance Testing Period Collection Factors (#MeOH/day)

Sample Date	1,2EAH	4E2ESP	4EH	1CH	Total
22-May-01	12	4191	4897	141	9241
23-May-01	4	2968	3802	11	6785
24-May-01	3	2885	4277	144	7310
25-May-01	3	2703	3871	8	6586
26-May-01	63	3482	4914	9	8468
27-May-01	45	2506	4705	12	7267
28-May-01	35	3031	4982	7	8055
29-May-01	2	6336	5336	16	11689
30-May-01	6	4008	5019	14	9047
31-May-01	1	4296	1203	13	5513
1-Jun-01	24	4159	4804	16	9003
2-Jun-01	3	4126	5862	22	10013
3-Jun-01	3	3913	4283	12	8210
4-Jun-01	0	2240	4286	15	6541
5-Jun-01					0
6-Jun-01			8224		8224
7-Jun-01	10	3146	3840	31	7027
8-Jun-01	11	3826	4709	15	8561
9-Jun-01	7	2767	4578	18	7370
10-Jun-01	2	2957	4202	18	7179
11-Jun-01	4	3937	5738	17	9696
12-Jun-01	7	3186	4239	19	7450
13-Jun-01	27	2368	4398	21	6815
14-Jun-01	3	3125	3884	14	7026
15-Jun-01	26	3073	3542	16	6657
16-Jun-01	16	3310	3150	11	6486
17-Jun-01	4	3055	4223	11	7293
18-Jun-01	4	2800	3725	8	6537
19-Jun-01	4	3673	3774	15	7465
20-Jun-01	4	3471	3682	11	7167
21-Jun-01	5	3698	4204	11	7918
22-Jun-01	28	4157	4240	8	
23-Jun-01	27	4255	4306	12	8600
24-Jun-01	29	3556	4512	2	8099
25-Jun-01	30	3263	4313	6	7611
26-Jun-01	19	3034	3924	6	6982
27-Jun-01					0
28-Jun-01	28	2851	3210	6	6096
29-Jun-01	2	4246	3898	10	8157
30-Jun-01	1	3786	3080	9	6876
1-Jul-01	9	3619	3456	8	7092
2-Jul-01	4	3257	3734	8	7002
3-Jul-01	26	4103	3402	8	7540
4-Jul-01	13	3939	3887	3	7843
5-Jul-01	27	3485	4958	8	8478
6-Jul-01	26	3202	4591	133	7952
7-Jul-01	27	3464	4500	17	8007
8-Jul-01	6	3509	5142	8	8664
9-Jul-01	3	3659	4540	15	8216
10-Jul-01	3	3729	4698	16	8445
11-Jul-01	7	3404		17	3428
12-Jul-01	27	3379	4659	16	8081
13-Jul-01	15	3380	4771	15	8182
14-Jul-01	6	3058	4342	6	7412
15-Jul-01	7	2196		13	2216

Appendix K

Compliance Testing Period Stripper Efficiency (MeOH ppm)

Sample Date	Sample Time	Inlet (ppm)	Outlet (ppm)	Steam Stripper Efficiency (%)
22-May-01	8:00	2744	45	98
22-May-01	10:30	3097	47	98
22-May-01	13:30	3754	56	99
22-May-01	16:00	3194	48	98
22-May-01	19:00	2778	52	98
22-May-01	22:00	2739	59	98
23-May-01	0:00	2492	58	98
23-May-01	2:30	3073	62	98
23-May-01	5:30	3073	54	98
23-May-01	8:00	2683	59	98
23-May-01	10:30	3400	63	98
23-May-01	13:30	2340	46	98
24-May-01	0:00	2699	66	98
24-May-01	2:30	2522	56	98
24-May-01	5:00	2895	61	98
24-May-01	8:30	2670	60	98
24-May-01	10:30	2637	49	98
24-May-01	13:30	3184	85	97
25-May-01	0:00	1122	60	95
25-May-01	2:30	1090	29	97
25-May-01	8:30	2937	56	98
25-May-01	10:30	2856	59	98
25-May-01	13:30	3331	234	93
25-May-01	16:00	2729	62	98
25-May-01	19:00	2720	61	98
25-May-01	22:00	2631	52	98
26-May-01	0:00	2837	59	98
26-May-01	2:30	2682	56	98
26-May-01	5:00	2776	56	98
26-May-01	5:00	997	54	95
26-May-01	15:30	1909	65	97
26-May-01	18:30	3663	71	98
26-May-01	21:30	2894	62	98
27-May-01	0:00	2395	56	98
27-May-01	2:30	3295	50	98
27-May-01	5:00	2543	52	98
27-May-01	16:00	2743	55	98
27-May-01	18:30	2865	57	98
27-May-01	21:30	3011	58	98
28-May-01	8:00	2823	56	98
28-May-01	10:30	3003	60	98
28-May-01	13:30	3229	74	98
28-May-01	16:00	3188	64	98
28-May-01	18:30	3074	60	98
28-May-01	21:00	2802	56	98
29-May-01	16:00	2958	57	98
29-May-01	18:30	3337	72	98
29-May-01	21:00	3107	64	98
30-May-01	2:30	3991	65	98
30-May-01	5:00	3203	66	98
30-May-01	8:00	3055	64	98
30-May-01	10:30	3285	67	98
30-May-01	13:30	3507	70	98
30-May-01	23:30	2900	60	98
31-May-01	3:00	2737	57	98
31-May-01	5:00	2977	60	98
31-May-01	8:00	2974	68	98
31-May-01	10:30	3387	70	98
31-May-01	13:03	3280	69	98
31-May-01	23:30	2888	57	98
1-Jun-01	8:00	3026	61	98
1-Jun-01	10:30	2917	64	98
1-Jun-01	13:30	3611	73	98

Appendix K

Compliance Testing Period Stripper Efficiency (MeOH ppm)

Sample Date	Sample Time	Inlet (ppm)	Outlet (ppm)	Steam Stripper Efficiency (%)
2-Jun-01	16:00	2797	73	97
2-Jun-01	18:30	2776	71	97
2-Jun-01	21:00	2742	59	98
3-Jun-01	2:30	3134	55	98
3-Jun-01	5:30	4189	268	94
3-Jun-01	16:00	2348	55	98
3-Jun-01	18:30	2392	53	98
3-Jun-01	21:00	2515	56	98
3-Jun-01	23:30	2948	47	98
4-Jun-01	8:00	4624	47	99
4-Jun-01	10:30	2230	51	98
4-Jun-01	13:30	2367	48	98
4-Jun-01	15:30	1684	49	97
4-Jun-01	18:30	2212	50	98
4-Jun-01	21:30	2410	52	98
7-Jun-01	2:30	2309	53	98
7-Jun-01	5:30	2442	53	98
7-Jun-01	8:00	815	38	95
7-Jun-01	10:30	2618	37	99
7-Jun-01	13:30	3088	58	98
7-Jun-01	23:30	3738	55	99
8-Jun-01	8:00	2895	53	98
8-Jun-01	10:30	3134	67	98
8-Jun-01	13:30	3138	72	98
8-Jun-01	15:30	3440	76	98
8-Jun-01	18:30	3211	73	98
8-Jun-01	21:30	2941	74	97
8-Jun-01	23:30	3057	66	98
9-Jun-01	2:30	2779	37	99
9-Jun-01	5:30	2870	73	97
9-Jun-01	15:30	4859	77	98
9-Jun-01	18:30	3424	73	98
9-Jun-01	21:30	2910	48	98
9-Jun-01	23:30	2402	69	97
10-Jun-01	2:30	2204	84	96
10-Jun-01	5:30	2187	82	96
10-Jun-01	15:30	3768	87	98
10-Jun-01	18:30	2495	65	97
10-Jun-01	21:30	2139	62	97
10-Jun-01	23:30	2030	68	97
11-Jun-01	3:00	2974	76	97
11-Jun-01	8:30	3472	83	98
11-Jun-01	11:00	3391	87	97
11-Jun-01	13:30	2817	80	97
11-Jun-01	18:30	3155	77	98
11-Jun-01	21:00	3129	75	98
12-Jun-01	8:30	3325	68	98
12-Jun-01	11:00	2479	55	98
12-Jun-01	13:30	2434	52	98
12-Jun-01	16:00	2116	59	97
12-Jun-01	19:00	1987	53	97
12-Jun-01	22:00	2295	49	98
13-Jun-01	0:00	2577	2280	12
13-Jun-01	2:30	2620	61	98
13-Jun-01	5:30	2554	58	98
13-Jun-01	8:00	3047	83	97
13-Jun-01	11:00	3045	2340	23
14-Jun-01	5:30	3342	75	98
14-Jun-01	8:00	3054	71	98
14-Jun-01	11:00	3042	73	98
14-Jun-01	13:30	3565	65	98
15-Jun-01	0:00	3031	53	98
15-Jun-01	2:30	2258	62	97

Appendix K

Compliance Testing Period Stripper Efficiency (MeOH ppm)

Sample Date	Sample Time	Inlet (ppm)	Outlet (ppm)	Steam Stripper Efficiency (%)
15-Jun-01	8:30	1542	836	46
15-Jun-01	13:30	2715	394	85
15-Jun-01	16:00	2694	391	85
15-Jun-01	19:00	2581	170	93
15-Jun-01	22:00	2807	84	97
16-Jun-01	16:00	2444	50	98
16-Jun-01	19:00	2591	44	98
16-Jun-01	22:00	2275	46	98
17-Jun-01	0:00	3440	60	98
17-Jun-01	2:30	1842	60	97
17-Jun-01	16:00	2394	51	98
17-Jun-01	19:00	3731	56	98
17-Jun-01	22:00	3410	84	98
18-Jun-01	8:00	2355	63	97
18-Jun-01	11:00	2309	59	97
18-Jun-01	14:00	2135	57	97
18-Jun-01	16:00	2301	61	97
18-Jun-01	18:30	2012	49	98
18-Jun-01	21:00	3102	52	98
19-Jun-01	8:00	2217	45	98
19-Jun-01	11:00	2142	52	98
19-Jun-01	13:30	2077	46	98
19-Jun-01	16:00	2362	41	98
19-Jun-01	18:30	2641	47	98
19-Jun-01	21:00	2577	52	98
20-Jun-01	2:30	1880	46	98
20-Jun-01	8:00	2353	38	98
20-Jun-01	11:00	1731	38	98
20-Jun-01	13:30	1876	41	98
20-Jun-01	23:30	2070	45	98
21-Jun-01	2:30	2251	38	98
21-Jun-01	5:30	2413	43	98
21-Jun-01	8:00	1593	44	97
21-Jun-01	11:00	1526	43	97
21-Jun-01	14:00	2488	44	98
21-Jun-01	23:00	2531	42	98
22-Jun-01	2:30	2752	39	99
22-Jun-01	5:30	2362	42	98
22-Jun-01	8:00	1765	46	97
22-Jun-01	11:00	2804	46	98
22-Jun-01	13:30	2546	46	98
22-Jun-01	16:00	2830	48	98
22-Jun-01	21:00	2287	47	98
22-Jun-01	23:30	2745	43	98
23-Jun-01	2:30	3067	52	98
23-Jun-01	5:30	2725	41	98
23-Jun-01	23:30	2883	49	98
24-Jun-01	2:30	2653	43	98
24-Jun-01	5:30	2883	41	99
24-Jun-01	16:00	3383	43	99
24-Jun-01	18:30	2920	45	98
24-Jun-01	21:00	3433	52	98
24-Jun-01	23:03	3138	57	98
25-Jun-01	5:30	3154	46	99
25-Jun-01	8:00	2550	42	98
25-Jun-01	10:30	2684	44	98
25-Jun-01	13:00	2634	46	98
25-Jun-01	15:03	2495	47	98
25-Jun-01	18:03	3002	51	98
25-Jun-01	21:30	3083	57	98
26-Jun-01	9:00	2124	39	98
26-Jun-01	11:30	2448	38	98
26-Jun-01	13:00	2349	37	98

Appendix K

Compliance Testing Period Stripper Efficiency (MeOH ppm)

Sample Date	Sample Time	Inlet (ppm)	Outlet (ppm)	Steam Stripper Efficiency (%)
26-Jun-01	15:30	2404	39	98
26-Jun-01	18:30	2826	49	98
26-Jun-01	21:30	3132	58	98
28-Jun-01	0:00	1891	50	97
28-Jun-01	3:00	3312	50	98
29-Jun-01	0:00	3350	59	98
29-Jun-01	3:00	3692	55	99
29-Jun-01	6:00	3243	48	99
29-Jun-01	8:00	3546	51	99
29-Jun-01	10:30	3919	56	99
29-Jun-01	13:00	3375	330	90
30-Jun-01	0:00	2442	47	98
30-Jun-01	3:00	2809	44	98
30-Jun-01	6:00	3642	55	98
30-Jun-01	15:30	1992	44	98
30-Jun-01	18:30	2082	43	98
30-Jun-01	21:30	2470	42	98
1-Jul-01	0:00	2292	48	98
1-Jul-01	3:00	2043	54	97
1-Jul-01	6:00	3202	45	99
1-Jul-01	15:30	2482	51	98
1-Jul-01	18:30	2527	47	98
1-Jul-01	21:30	2445	53	98
2-Jul-01	5:30	2791	54	98
2-Jul-01	8:30	2716	47	98
2-Jul-01	10:30	2328	43	98
2-Jul-01	13:30	2257	37	98
2-Jul-01	16:00	1882	43	98
2-Jul-01	18:30	1886	43	98
2-Jul-01	21:00	2149	34	98
3-Jul-01	8:30	2479	40	98
3-Jul-01	10:30	2459	47	98
3-Jul-01	13:30	2225	44	98
3-Jul-01	16:00	2161	46	98
3-Jul-01	18:30	2308	36	98
3-Jul-01	21:00	2259	37	98
4-Jul-01	0:00	1967	32	98
4-Jul-01	3:00	1858	45	98
4-Jul-01	6:00	1976	39	98
4-Jul-01	15:30	3243	52	98
4-Jul-01	18:30	2719	54	98
4-Jul-01	21:30	2561	53	98
5-Jul-01	8:30	2839	53	98
5-Jul-01	10:30	2635	56	98
5-Jul-01	13:30	5249	59	99
5-Jul-01	16:00	3897	58	99
5-Jul-01	18:30	3533	65	98
5-Jul-01	21:00	3333	59	98
6-Jul-01	0:00	3344	57	98
6-Jul-01	3:00	2693	47	98
6-Jul-01	6:00	2574	48	98
6-Jul-01	9:00	2555	43	98
6-Jul-01	12:00	2651	46	98
6-Jul-01	14:00	2442	46	98
6-Jul-01	16:00	2877	46	98
6-Jul-01	19:00	3058	51	98
6-Jul-01	21:30	3400	54	98
7-Jul-01	8:30	2582	63	98
7-Jul-01	10:30	2454	48	98
7-Jul-01	13:30	3547	70	98
7-Jul-01	16:00	3329	78	98
7-Jul-01	18:30	3768	67	98
7-Jul-01	21:00	3535	71	98

Appendix K

Compliance Testing Period Stripper Efficiency (MeOH ppm)

Sample Date	Sample Time	Inlet (ppm)	Outlet (ppm)	Steam Stripper Efficiency (%)
8-Jul-01	8:30	2894	52	98
8-Jul-01	10:30	2382	52	98
8-Jul-01	13:30	2866	53	98
8-Jul-01	16:00	2771	51	98
8-Jul-01	18:30	2853	49	98
8-Jul-01	21:00	4569	53	99
9-Jul-01	0:00	2649	55	98
9-Jul-01	3:00	2912	59	98
9-Jul-01	6:00	2925	53	98
9-Jul-01	15:30	3842	58	98
9-Jul-01	18:30	1887	57	97
9-Jul-01	21:30	1984	59	97
10-Jul-01	0:00	2482	49	98
10-Jul-01	3:00	2721	52	98
10-Jul-01	6:00	2747	54	98
10-Jul-01	15:30	2570	54	98
10-Jul-01	18:30	1809	47	97
10-Jul-01	21:30	2750	54	98
11-Jul-01	8:30	2889	52	98
11-Jul-01	10:30	2318	48	98
11-Jul-01	13:30	2317	42	98
11-Jul-01	16:00	2403	47	98
11-Jul-01	18:30	2365	47	98
11-Jul-01	21:00	2375	44	98
12-Jul-01	8:30	2192	44	98
12-Jul-01	10:30	2292	45	98
12-Jul-01	13:30	2321	45	98
12-Jul-01	16:00	2784	56	98
12-Jul-01	18:30	2339	56	98
12-Jul-01	21:00	2609	54	98
13-Jul-01	0:00	3017	50	98
13-Jul-01	3:00	2792	49	98
13-Jul-01	6:00	3133	42	99
13-Jul-01	9:00	2810	48	98
13-Jul-01	12:00	3165	49	98
13-Jul-01	14:00	3400	42	99
13-Jul-01	16:00	3128	55	98
13-Jul-01	19:00	3235	52	98
13-Jul-01	21:30	3027	54	98
14-Jul-01	8:30	2780	48	98
14-Jul-01	10:30	2881	58	98
14-Jul-01	13:30	2890	45	98
14-Jul-01	16:00	2748	49	98
14-Jul-01	18:30	2929	43	99
14-Jul-01	21:00	2410	46	98
15-Jul-01	8:30	2612	55	98
15-Jul-01	10:30	1989	48	98
15-Jul-01	13:30	2532	53	98
15-Jul-01	16:00	2632	48	98
15-Jul-01	18:30	2434	42	98
15-Jul-01	21:00	2711	55	98

Appendix L:
Compliance Data

This appendix contains only the first page of each worksheet in the compliance data set. For the complete data set, refer to the excel workbook labeled "Appendix L.xls" in the supplemental CD.

Appendix L

MACT 1 Compliance Data #1,2 Evaps A/C Hotwell

	Average		
[MeOH]	152 *		*Values Held Constant
Flow	6.47 *		
#MeOH/Day	882.19		
#/ODTP	0.02		

Date	#MeOH/day	ODTP/day	#/MeOH/ODTP	Min. sewering	#meoh sewered
4/16/2001	11.82	774	0.02		
4/17/2001	11.82	835	0.01		
4/18/2001	11.82	926	0.01		
4/19/2001	11.82	897	0.01		
4/20/2001	11.82	825	0.01		
4/21/2001	11.82	792	0.01		
4/22/2001	11.82	702	0.02		
4/23/2001	11.82	849	0.01		
4/24/2001	11.82	857	0.01		
4/25/2001	11.82	902	0.01		
4/26/2001	11.82	679	0.02		
4/27/2001	11.82	859	0.01		
4/28/2001	11.82	898	0.01		
4/29/2001	11.82	785	0.02		
4/30/2001	11.82	737	0.02		
5/1/2001	11.82	961	0.01		
5/2/2001	11.82	924	0.01		
5/3/2001	11.82	936	0.01		
5/4/2001	11.82	846	0.01		
5/5/2001	11.82	758	0.02		
5/6/2001	11.82	911	0.01		
5/7/2001	11.82	992	0.01		
5/8/2001	11.82	721	0.02		
5/9/2001	11.82	645	0.02		
5/10/2001	11.82	689	0.02		
5/11/2001	11.82	771	0.02		
5/12/2001	11.82	936	0.01		
5/13/2001	11.82	821	0.01		
5/14/2001	11.82	764	0.02	3	0.02
5/15/2001	11.82	861	0.01		
5/16/2001	11.82	1	12.71		
5/17/2001	11.82	902	0.01		
5/18/2001	11.82	888	0.01		
5/19/2001	11.82	917	0.01		
5/20/2001	11.82	919	0.01		
5/21/2001	11.82	924	0.01		
5/22/2001	11.82	751	0.02		
5/23/2001	11.82	744	0.02		
5/24/2001	11.82	793	0.01		
5/25/2001	11.82	872	0.01		
5/26/2001	11.82	752	0.02	2	0.02
5/27/2001	11.82	728	0.02		
5/28/2001	11.82	728	0.02		
5/29/2001	11.82	809	0.01		
5/30/2001	11.82	860	0.01		
5/31/2001	11.82	883	0.01		
6/1/2001	11.82	888	0.01		
6/2/2001	11.82	849	0.01		
6/3/2001	11.82	689	0.02		
6/4/2001	11.82	629	0.02		
6/5/2001	11.82	12	0.98		
6/6/2001	11.82	219	0.05		
6/7/2001	11.82	750	0.02		
6/8/2001	11.82	725	0.02		
6/9/2001	11.82	760	0.02		

[MeOH] based on mean value for 5-22-01 to 7-15-01.
Flows based on mean value for 5-22-01 to 7-15-01.
ODTP based on daily values.

#4 Evaporator 2nd Effect Stand Pipe

		Average		
May22 - October 7	**[MeOH]**	2851	*	*Values Held Constant
October 7th-current	**[MeOH]**	3345	*	
	Flow	120		
	#MeOH/Day	4641		
	#/ODTP	5		

Date	**Flow (gpm)**	**#MeOH/day**	**ODTP/day**	**#MeOH/ODTP**
4/16/2001	87.36	2994	774	4
4/17/2001	94.58	3241	835	4
4/18/2001	104.84	3593	926	4
4/19/2001	104.84	3593	897	4
4/20/2001	104.00	3564	825	4
4/21/2001		0	792	
4/22/2001	106.90	3663	702	5
4/23/2001	100.49	3443	849	4
4/24/2001	101.23	3469	857	4
4/25/2001	108.57	3720	902	4
4/26/2001	107.25	3675	679	5
4/27/2001	107.27	3676	859	4
4/28/2001	111.89	3834	898	4
4/29/2001	109.86	3765	785	5
4/30/2001	109.89	3766	737	5
5/1/2001	110.83	3798	961	4
5/2/2001	107.40	3680	924	4
5/3/2001	102.08	3498	936	4
5/4/2001	99.20	3399	846	4
5/5/2001	97.42	3338	758	4
5/6/2001	100.84	3455	911	4
5/7/2001	102.99	3529	992	4
5/8/2001		0	721	0
5/9/2001	102.72	3520	645	5
5/10/2001	104.85	3593	689	5
5/11/2001	109.72	3760	771	5
5/12/2001	103.36	3542	936	4
5/13/2001	106.73	3657	821	4
5/14/2001	11.68	400	764	1
5/15/2001	104.07	3566	861	4
5/16/2001	58.91	2019	1	2171
5/17/2001	73.72	2526	902	3
5/18/2001	108.93	3733	888	4
5/19/2001	115.62	3962	917	4
5/20/2001		0	919	
5/21/2001	116.01	3975	924	4
5/22/2001	105.52	3616	751	5
5/23/2001	102.26	3504	744	5
5/24/2001	83.40	2858	793	4
5/25/2001	76.44	2619	872	3
5/26/2001	99.55	3411	752	5
5/27/2001	86.10	2950	728	4
5/28/2001	91.04	3120	728	4
5/29/2001	90.55	3103	809	4
5/30/2001	97.71	3348	860	4
5/31/2001	107.99	3700	883	4
6/1/2001	104.90	3595	888	4
6/2/2001	105.70	3622	849	4
6/3/2001	104.01	3564	689	5
6/4/2001	85.75	2938	629	5
6/5/2001	10.43	357	12	30
6/6/2001	25.82	885	219	4
6/7/2001	104.53	3582	750	5
6/8/2001	104.29	3574	725	5

[MeOH] based on mean value for 5-22-01 to 7-15-01.
Flows based on mean value for 5-22-01 to 7-15-01.
ODTP based on daily values.

#4 Evaporator Hotwell

		Average	
5/22 - 10/7	[MeOH]	6664 *	*Values Held Constant
10/7 - current	[MeOH]	9777 *	
	Flow	41	
	#MeOH/Day	4163	
	#/ODTP	5	

Date	Flow (gpm)	#MeOH/day	ODTP/day	#MeOH/ODTP	min. sewer	#meoh sewered
4/16/2001	54.13	4336	774	6		
4/17/2001	50.79	4068	835	5		
4/18/2001	47.75	3825	926	4		
4/19/2001	47.75	3825	897	4		
4/20/2001	50.00	4005	825	5		
4/21/2001			792	0		
4/22/2001	49.95	4001	702	6		
4/23/2001	52.40	4197	849	5		
4/24/2001	50.98	4083	857	5		
4/25/2001	50.66	4058	902	4		
4/26/2001	50.84	4072	679	6		
4/27/2001	52.53	4207	859	5		
4/28/2001	52.58	4211	898	5		
4/29/2001	51.68	4139	785	5		
4/30/2001	52.83	4231	737	6		
5/1/2001	51.38	4115	961	4		
5/2/2001	51.51	4126	924	4		
5/3/2001	53.72	4303	936	5		
5/4/2001	53.20	4261	846	5		
5/5/2001	52.42	4199	758	6		
5/6/2001	53.80	4309	911	5		
5/7/2001	52.79	4228	992	4	6.00	18
5/8/2001	45.53	3647	721	5	67.00	170
5/9/2001	49.02	3926	645	6	1.00	3
5/10/2001	50.53	4047	689	6		
5/11/2001	50.37	4034	771	5		
5/12/2001	51.59	4132	936	4		
5/13/2001	51.65	4137	821	5		
5/14/2001	51.21	4102	764	5		
5/15/2001	50.65	4057	861	5		
5/16/2001	0.64	51	1	55		
5/17/2001	43.42	3478	902	4		
5/18/2001	50.12	4014	888	5		
5/19/2001	51.35	4113	917	4		
5/20/2001	45.53	3647	919	4		
5/21/2001	52.40	4197	924	5		
5/22/2001	54.71	4382	751	6	16.00	49
5/23/2001	53.56	4290	744	6		
5/24/2001	55.47	4443	793	6		
5/25/2001	53.15	4257	872	5	28.00	83
5/26/2001	48.81	3909	752	5		
5/27/2001	57.38	4596	728	6		
5/28/2001	56.04	4489	728	6		
5/29/2001	58.32	4671	809	6		
5/30/2001	58.35	4674	860	5		
5/31/2001	54.93	4400	883	5		
6/1/2001	56.61	4534	888	5		
6/2/2001	56.10	4493	849	5		
6/3/2001	53.28	4267	689	6	2.00	6
6/4/2001	55.03	4408	629	7		
6/5/2001	6.33	507	12	42	4.00	1
6/6/2001	136.41	10926	219	50		
6/7/2001	54.25	4345	750	6		
6/8/2001	54.17	4339	725	6		

[MeOH] based on mean value for 5-22-01 to 7-15-01.
Flows based on mean value for 5-22-01 to 7-15-01.
ODTP based on daily values.

#1 Concentrator Hotwell

	Average	
[MeOH]	299 *	*Values Held Constant
Flow	3.41 *	
#MeOH/Day	12.24	
#/ODTP	0.02	

Date	#MeOH/day	ODTP/day	#MeOH/ODTP	min. sewer	#meoh sewered
4/16/2001	12.25	774	0.02		
4/17/2001	12.25	835	0.01		
4/18/2001	12.25	926	0.01		
4/19/2001	12.25	897	0.01		
4/20/2001	12.25	825	0.01		
4/21/2001	12.25	792	0.02		
4/22/2001	12.25	702	0.02		
4/23/2001	12.25	849	0.01		
4/24/2001	12.25	857	0.01		
4/25/2001	12.25	902	0.01		
4/26/2001	12.25	679	0.02		
4/27/2001	12.25	859	0.01		
4/28/2001	12.25	898	0.01		
4/29/2001	12.25	785	0.02		
4/30/2001	12.25	737	0.02		
5/1/2001	12.25	961	0.01		
5/2/2001	12.25	924	0.01		
5/3/2001	12.25	936	0.01		
5/4/2001	12.25	846	0.01		
5/5/2001	12.25	758	0.02		
5/6/2001	12.25	911	0.01		
5/7/2001	12.25	992	0.01		
5/8/2001	12.25	721	0.02		
5/9/2001	12.25	645	0.02		
5/10/2001	12.25	689	0.02		
5/11/2001	12.25	771	0.02		
5/12/2001	12.25	936	0.01		
5/13/2001	12.25	821	0.01		
5/14/2001	12.25	764	0.02		
5/15/2001	12.25	861	0.01		
5/16/2001	12.25	1	13.18		
5/17/2001	12.25	902	0.01		
5/18/2001	12.25	888	0.01		
5/19/2001	12.25	917	0.01		
5/20/2001	12.25	919	0.01		
5/21/2001	12.25	924	0.01		
5/22/2001	12.25	751	0.02		
5/23/2001	12.25	744	0.02		
5/24/2001	12.25	793	0.02		
5/25/2001	12.25	872	0.01		
5/26/2001	12.25	752	0.02		
5/27/2001	12.25	728	0.02		
5/28/2001	12.25	728	0.02		
5/29/2001	12.25	809	0.02		
5/30/2001	12.25	860	0.01		
5/31/2001	12.25	883	0.01		
6/1/2001	12.25	888	0.01		
6/2/2001	12.25	849	0.01		
6/3/2001	12.25	689	0.02		
6/4/2001	12.25	629	0.02		
6/5/2001	12.25	12	1.01		
6/6/2001	12.25	219	0.06		
6/7/2001	12.25	750	0.02		
6/8/2001	12.25	725	0.02		
6/9/2001	12.25	760	0.02		

[MeOH] based on mean value for 5-22-01 to 7-15-01.
Flows based on mean value for 5-22-01 to 7-15-01.
ODTP based on daily values.

Totals

Average	8202	882	9.88	
SD	2459	238	2.46	
RSD (%)	30	27	25	

Date	**#MeOH/day**	**Collected ODTP/day**	**#MeOH/ODTP #MeOH/ODTP**	**60d rolling avg.**
4/16/2001	9608	774	12.40	
4/17/2001	4715	835	5.70	
4/18/2001	2934	926	3.10	
4/19/2001	8311	897	9.30	
4/20/2001	10212	825	12.40	
4/21/2001	40	792		
4/22/2001	9120	702	12.90	
4/23/2001	10244	849	12.00	
4/24/2001	10354	857	12.20	
4/25/2001	10847	902	12.00	
4/26/2001	7728	679	11.40	
4/27/2001	8013	859	9.30	
4/28/2001	9377	898	10.40	
4/29/2001	8826	785	11.30	
4/30/2001	7923	737	10.70	
5/1/2001	11121	961	11.60	
5/2/2001	10109	924	10.80	
5/3/2001	11404	936	12.20	
5/4/2001	8269	846	9.70	
5/5/2001	7962	758	10.50	
5/6/2001	7425	911	8.20	
5/7/2001	10308	992	10.50	
5/8/2001	16	721	0.00	
5/9/2001	4764	645	7.40	
5/10/2001	4760	689	6.90	
5/11/2001	8724	771	11.30	
5/12/2001	10314	936	11.10	
5/13/2001	7074	821	8.60	
5/14/2001	5844	764	7.70	
5/15/2001	8056	861	9.40	
5/16/2001	1283	1	1379.10	
5/17/2001	8448	902	9.30	
5/18/2001	8384	888	9.40	
5/19/2001	11158	917	12.00	
5/20/2001	24	919	0.00	
5/21/2001	10791	924	11.80	
5/22/2001	**9241**	**751**	**12.30**	
5/23/2001	6785	744	9.10	
5/24/2001	7310	793	9.20	
5/25/2001	6586	872	7.50	
5/26/2001	8468	752	11.20	
5/27/2001	7267	728	10.00	
5/28/2001	8055	728	11.00	
5/29/2001	11689	809	14.40	
5/30/2001	9047	860	10.50	
5/31/2001	5513	883	6.30	
6/1/2001	9003	888	10.10	
6/2/2001	10013	849	11.80	
6/3/2001	8210	689	11.90	
6/4/2001	6541	629	10.40	
6/5/2001	0	12	0.00	
6/6/2001	8224	219	37.50	
6/7/2001	7027	750	9.30	
6/8/2001	8561	298	28.80	
6/9/2001	7370	760	9.60	
6/10/2001	7179	682	10.50	

[MeOH] based on mean value for 5-22-01 to 7-15-01.
Flows based on mean value for 5-22-01 to 7-15-01.
ODTP based on daily values.