The AERMOD model has been used to conduct the modeling analysis, which employs PRIME downwash and calculates all pollutant concentrations occurring within the cavity region associated with a given stack/building configuration. Therefore, all pollutant concentrations occurring within any potential cavity regions have been addressed within the modeling analysis.

Modeling Analysis Receptor Grid

The southwest corner of the existing Ripley Heating Plant building **(refer to the Plot Plan of Appendix A)** has been designated as the internal Cartesian grid ordinate (0,0). As elevated terrain has been incorporated into the modeling analysis through the use of the AERMAP pre-processing program, and all coordinates were translated from an internal site coordinate system (based on the designated site ordinate) to NAD27 based Universal Transverse Meridian (UTM) coordinates to facilitate the incorporation of DEM terrain data.

The designated site ordinate has a UTM coordinate of Zone 16, Easting = 468,874.0 meters, and Northing = 5,156,608.0 meters.

As was indicated in the Modeling Protocol for this permit application (dated August 16, 2006), which has been reviewed and approved by the AQD, the following receptor grid configuration has been utilized for the dispersion modeling analysis:

- Fence Line Receptors: No fence line
- Near-field Cartesian Receptor Grid: Receptors were placed at 50 meter spacing outward to 1,500 m from the center of the facility sources (468,860.85 Easting; 5,156,653.92 Northing).
- Mid-field Cartesian Receptor Grid: Receptors were placed at 100 meter spacing from the boundary of the Near-field grid out to 3 km from the center point.
- Far-field Cartesian Receptor Grid: Receptors were placed at 250 meter spacing from the boundary of the Mid-field grid outward to 5 km. As a result, the overall grid occupies a 10.0 km by 10.0 km area. The southwest corner of the far-field grid in UTMs is (463,860.85 Easting, 5,151,653.92 Northing).

The combination of these receptor grids provides a more dense (50 m) grid close to the facility, while expanding the grid out 5 km in each direction from the facility center with wider receptor spacing (up to 250-m spacing). The use of this receptor grid configuration contains a total of 7,537 receptors. A graphical representation of the facility layout and the receptor grid used in the modeling analysis are contained in Appendix C.

Modeling Options

The modeling options employed during the CO, SO_2, PM_{10}, and NO_x, and TAC modeling analyses were elevated terrain, rural dispersion coefficients, and the AERMOD model's regulatory default options. The regulatory default options include the following model settings:

- Use stack-tip downwash (except for Schulman-Scire downwash)
- Incorporate the effects of elevated terrain
- Use the calms processing routine
- Use missing data processing routine
- Use upper-bound concentration estimates for sources influenced by building downwash from super-squat buildings
- Use a 4-hour half life for exponential decay of SO_2 for urban sources

6.3 NMU EMISSION RATES AND EXHAUST PARAMETERS

The following sections will present the modeled emission rates for the equipment associated with the new powerhouse and the existing Ripley Heating Plant, and present the source parameters for each NMU modeled emission source.

New Powerhouse Sources

Section 3 summarizes the CO, SO_2, PM_{10}, NO_x, and TAC emission rates from the proposed new powerhouse emission sources. CO, SO_2, NO_x and TACs will only be discharged from the new baghouse stack associated with this modification. PM_{10} will be emitted from the new CFB, along with some minor material handling and storage silos. Fugitive emissions resulting from coaling handling operations will be contained and controlled by limiting the on-hand supply of coal and through the use of a three-walled containment structure, and as such, fugitive PM_{10} is expected to be less than 1 tpy. Therefore, as the new CFB boiler baghouse stack is the only significant source of hourly PM_{10} emissions, it is the only new source of PM_{10} considered in the PM_{10} modeling analysis.

Table 6-4 presents the new CFB boiler baghouse stack modeled emission rates for each criteria pollutant in terms of the maximum pound per hour and the corresponding gram per second emission rates. The maximum emission rates have been determined on a worse case basis considering each type of fuel source (i.e., highest lb/hour rate from wood, coal, natural gas). The following calculation procedure was used to convert lb/hour emission rate to gram/second emission rates.

$$Emission\ Rate(g/sec) = \frac{Emission\ Rate,\ lb}{hour} \times \frac{hour}{3{,}600\ seconds} \times \frac{453.59\ grams}{lb}$$

For each pollutant with standards that have an annual averaging period, it was conservatively assumed that the maximum hourly emission rate would occur continuously (i.e. 24 hours per day and 365 days per year).

In addition to criteria pollutants, maximum hourly TAC emission rates were determined for each of the types of fuel that may be used in the new CFB boiler. The maximum hourly emission rates are presented in Table B-2 of Appendix B, and have been converted to gram per second emission rates for use in the TAC modeling analysis.

Table 6-4. New CFB Boiler Criteria Pollutant Emission Rates [1]

Pollutant	Maximum Hourly Emission Rate (lb/hour)	Modeled Emission Rate (gram/sec)
CO	34.85	4.39
SO_2	87.80	11.06
PM_{10}	6.15	7.75E-01
NO_X	20.50	2.58

[1] Based on worst-case emissions per fuel type.

Existing Ripley Heating Plant Sources

In order to conduct the PSD and NAAQS modeling analysis for the various criteria pollutants, emissions from existing sources at the NMU facility need to be quantified and accounted for as appropriate. The existing sources for the NMU facility consists solely of the equipment (3 fuel oil/natural gas fired boilers) installed at the Ripley Heating Plant.

In order to determine the past actual emissions (for use in determining PSD Increment modeling rates), reported emissions of the existing boilers were utilized and assumed to occur evenly over 8,760 hours per year. However, a PSD emission rate (in other words, a "net" emission rate calculated as future potential minus past actual) was only determined and modeled for PM_{10} emissions. For all other criteria pollutants, the future potential emission rates were used because they were either very similar to the "net" hourly emission rates or the pollutant impact from NMU was fairly low and modeling the future potential is conservative.

In order to determine maximum hourly emissions for NAAQS modeling purposes, a determination of maximum hourly emission rates was made by analyzing the expected operation of the existing boilers on either fuel oil or natural gas. For NAAQS modeling purposes, it was assumed that only 2 boilers would operate at any given time (at maximum capacity) and that the third boiler would only operate when the new CFB boiler was not in operation. Therefore, for NAAQS purposes, the existing boiler emission rates are based on only 2 boilers operating simultaneously with the new CFB boiler.

Table 6-5 presents the modeled emission rates for the existing Ripley Heating Plant boilers, which all exhaust from a common stack.

Table 6-5. Existing Ripley Heating Plant Criteria Pollutant Emission Rates [1]

Pollutant	Maximum Hourly Emission Rate (lb/hour)	Modeled Emission Rate (gram/sec)
CO	24.90	3.14
SO_2	86.18	10.86
PM_{10} – PSD Increment Rate	4.44	0.56
PM_{10} – NAAQS Rate	4.79	0.60
NO_x [2]	10.24	1.29

[1] All boilers exhaust from a single common stack. Except for PM_{10}, the emission rates presented represent the future potential maximum hourly emissions based on two of the three existing boilers operating simultaneously.

[2] The NOx emission rate has been determined based on the annual average emissions assuming that the existing equipment would be limited to 99.9 tpy of SO_2. At this limit, the boilers would have limited operation on fuel oil, with the balance of operation on natural gas. Therefore, annual NOx emissions would also be limited to approximately 44.9 tpy, which results in an annual average NOx emission rate of 10.2 lb/hr.

Stack Parameters – NMU Emission Sources

Table 6-6 presents the baghouse exhaust stack characteristics for both the new CFB boiler stack and for the existing Ripley Heating Plant stack, and includes: stack locations (based upon UTM coordinates) and parameters such as flow rate, temperature, and stack height and diameter. Both of these exhaust stacks will discharge unobstructed vertically to the ambient air.

Note that the exhaust stack diameter and height for the stack that exhausts the 3 boilers at the Ripley Heating Plant will be modified from the stack requirements in PTI No. 126-05.

Table 6-6. New CFB Boiler and Existing Boiler Exhaust Stack Characteristics

Baghouse Exhaust Stack	UTM Easting [1] (meters)	UTM Northing [1] (meters)	Stack Height (feet)	Exhaust Temp (°F)	Flow Rate [2] (ACFM)	Exit Velocity (m/s)	Diam (inches)
New CFB Boiler	468,853.5	5,156,684.2	165	325	86,300	15.51	72
Existing Stack [2]	468,868.2	5,156,623.6	160	300	47,234	12.22	60

1 For reference, the southwest corner of the Ripley Heating Plant building was taken as the site ordinate, and is located at the following UTM coordinate: Easting = 468,874 m, Northing = 5,156,608 m.
2 The existing stack currently has a diameter of 108 inches and a height of 150 feet. Upon installation of the new boiler, the stack will be modified to a diameter of 60 inches and a height of 160 feet.

6.4 OFFSITE SOURCES AND BACKGROUND CONCENTRATIONS

The CO, SO_2, PM_{10}, and NO_x modeling analyses have been conducted to demonstrate compliance with the applicable PSD Increments and NAAQS. Therefore, the PSD modeling must include appropriate off-site PSD Increment consuming sources, and the NAAQS modeling analyses must include all sources that the MDEQ-AQD considers to have significant impact areas (SIAs) that interact with the SIAs produced by the NMU sources. However, since only the emissions of SO_2 from NMU boilers result in ambient impacts greater than the applicable significant impact levels (SILs), conducting a detailed modeling analysis that includes off-site sources was only necessary to demonstrate compliance with the SO_2 standards.

MDEQ-AQD modeling personnel were consulted to provide a list of appropriate off-site sources for use in the PSD Increment and NAAQS modeling analyses. The off-site inventories were e-mailed to NTH Consultants on August 18, 2006. The listing supplied by the AQD indicated that there were no off-site sources for purposes of PSD Increment modeling for any of the pollutants (i.e. there are no PSD Increment consuming sources in the area near NMU, other than NMU itself), and therefore only provided sources that needed to be included in the NAAQS modeling analyses. Table 6-7 presents the off-site sources included in the SO_2 NAAQS modeling analysis. The information in this table includes the source SRN and modeling ID, the company name and source description, the emission rates, and pertinent exhaust characteristics for the various NAAQS analyses.

Table 6-7. List of Off-Site Sources for the NMU SO_2 NAAQS Modeling Analysis

SRN	Source Name	UTM Easting (meters)	UTM Northing (meters)	Facility/Source Emission Rates		Source Distance from NMU (km)	Stack Information [2]				
				(pph)	(g/sec)		Height (ft)	Diam (inch)	Temp. (deg F)	Flow (ACFM)	Velocity (m/s)
SO_2 NAAQS Increment Modeling Sources/Parameters											
B1827	Empire Iron Mining Partner	453,954	5,143,680	1,211.4	152.64	19.9	133.80	122.2	289.23	401,171	24.96
B1833	Marquette Board of Light & Power	469,900	5,153,000	315.4	39.74	4.0	280.27	95.4	252.54	185,172	19.16
B4261	Wisconsin Electric Power Co	469,745	5,158,290	10,102.0	1,272.85	1.7	402.70	117.4	339.19	338,115	22.84
B4885	Tilden Mining Company L.C.	449,950	5,142,850	1,211.2	152.61	23.5	191.62	193.8	330.91	661,860	16.08

Background Concentrations

To analyze impacts relative to NAAQS, estimates of background pollutant concentrations are needed. Background concentrations are obtained from ambient air quality monitors and include contributions from other sources in the area and may include contributions from natural sources, anthropogenic sources too distant to be included in the modeling inventory, small area sources, and/or other unidentified sources.

For this study, background concentrations of CO, SO_2, PM_{10}, and NO_x were obtained from the MDEQ-AQD via email on August 21, 2006. However, as will be discussed in the results section, only SO2 requires a full dispersion modeling analysis to demonstrate compliance with the applicable NAAQS. Therefore, only the background concentration of SO2 is needed for the NMU modeling analysis. Table 6-8 summarizes the background concentrations that have been used in the NAAQS analysis for SO_2. Monitor selection and background concentrations are presented in Appendix C, along with the background concentrations of the other pollutants.

Table 6-8. Background Concentrations for NAAQS Modeling

Pollutant	Averaging Period	Concentration ($\mu g/m^3$)
SO2	Annual	2.7
	24-Hour	13.3
	3-Hour	45.2

The following sections will present the results of the criteria pollutant and TAC dispersion modeling analyses.

6.5 CRITERIA POLLUTANT MODELING RESULTS

The U.S. EPA AERMOD (with PRIME) dispersion model was used for the refined modeling analyses for the facility, utilizing the most current 5-years of NWS meteorology (2001-2005) available from MDEQ. The results of the CO, SO_2, PM_{10}, and NO_x modeling analyses are contained in the following subsections.

6.5.1 CO Significant Impact Level (SIL) Modeling Results

The maximum CO emission rate from the proposed CFB boiler has been included in an air quality dispersion modeling analysis. In addition, for conservatism, the maximum hourly emission rate of CO from the existing boilers was also included in this analysis. The CO emission rates presented in Tables 6-4 and 6-5 for the two exhaust stacks were modeled to determine the maximum ground level concentration (GLC) for both stacks emitting simultaneously. Consistent with the ambient standards for CO, both the maximum 1-hour and 8-hour highest second high GLCs (over the five year set of meteorological data) have been determined.

Criteria pollutant modeling is typically conducted in discrete phases. The first phase consisting of determining the maximum GLCs for the sources that are being permitted based upon the most recent single year of meteorological data and first highest value or a five-year set of meteorological data and the highest of the second high values. The resulting GLCs are then compared to SILs that have been established for the various criteria pollutants and associated averaging periods. If the results of the first step in the analysis indicate that the GLCs are less than the applicable SILs, then further modeling is not required and the source(s) are assumed to be in compliance with the federal standards (NAAQS for CO). However, if the first step in the analysis indicates an exceedance of an applicable SIL, further modeling is conducted.

Per the preceding discussion, the CO combined impacts from the two stacks have been determined for comparison with the applicable SILs of 2,000 $\mu g/m^3$ on a 1-hour basis and 500 $\mu g/m^3$ on an 8-hour basis. The results of this analysis are presented in Table 6-9.

As shown in Table 6-9, the maximum CO emission rates for both the proposed new CFB boiler and the existing boiler stack result in maximum combined GLCs of 85.3 $\mu g/m^3$ on a 1-hour basis and 27.2 $\mu g/m^3$ on an 8-hour basis. These GLCs are approximately 4.3% and 5.4% of the 1-hour and 8-hour significant impact levels, respectively. Due to the fact that impacts from the proposed new boiler and existing boilers are less than the applicable SILs for CO, the impacts are considered insignificant and no further modeling is required to demonstrate compliance with the CO NAAQS for this project.

Table 6-9. Results of the NMU CO SIL Modeling Analysis (01-05 SAW MET)

Averaging Period	NMU Maximum Impact [1] (μg/m^3)	Year of Maximum Impact	Impact UTM Easting (meters)	Impact UTM Northing (meters)	Significant Impact Level (μg/m^3)	Impact As % Of SIL
1-hour	85.30	2002	466,860.8	5,151,904.0	2000	4.27%
8-hour	27.18	2003	469,210.8	5,156,254.0	500	5.44%

[1] Consistent with how the standards are applied, the maximum impacts are based upon the highest of the 2nd High impacts determined using five discrete years of meteorological data (2001 through 2005).

6.5.2 SO_2 PSD Increment Modeling Results

The SO_2 PSD Increment modeling analysis also considered all of the NMU sources, both existing and the new proposed CFB boiler as it was determined that the SO_2 impacts from the CFB boiler alone would be greater than the applicable SILs for SO_2. As the existing boilers were installed and/or modified after the SO_2 PSD baseline date of February 8, 1980 (AQCR 126), it has been assumed that all existing boilers are sources of SO_2 for PSD Increment consumption purposes.

The analysis has a tiered approach for compliance demonstration. The first tier is used to show that the proposed project, together with the existing facility sources, will not consume more than 80% of the allowed U.S. EPA PSD Increment for each averaging period (i.e., for SO_2 – annual, 24-hour, and 3-hour periods). The second tier is to show that the NMU PSD Increment consuming sources and all off-site Increment consuming sources, modeled simultaneously, will comply with 100% of the applicable PSD Increment for each averaging period. However, as discussed in Section 6.4, the AQD has indicated that there are no PSD Increment consuming sources to be considered in the PSD analysis, and therefore, the 100% PSD Increment analysis is based solely on the impacts from NMU.

Table 6-10 presents the results of the modeling analysis conducted to demonstrate compliance with 80% and 100% of the SO_2 PSD Increments (as NMU is the only source included in the 100% analysis). The NMU SO_2 emission sources modeled for the PSD Increment analysis include all sources of SO_2 emissions – both existing boilers and the new CFB boiler. The NMU SO_2

emission rates were previously listed in Table 6-4 for the new CFB boiler and in Table 6-5 for the existing NMU boilers.

Table 6-10. Results of NMU SO_2 80% and 100% Increment Modeling (01-05 SAW MET)

Averaging Period	NMU & PSD Maximum Impact [1] (µg/m³)	Impact UTM Easting (meters)	Impact UTM Northing (meters)	100% of PSD Class II Increment (µg/m³)	80% of PSD Class II Increment (µg/m³)	Maximum NMU & PSD Impact As % of PSD Class II Increment
Annual	6.06	468,660.8	5,156,254.0	20	16	30.28%
24-hour	60.86	469,110.8	5,156,354.0	91	72.8	66.87%
3-hour	119.08	469,110.8	5,156,404.0	512	409.6	23.26%

[1] Consistent with how the standards are applied, the maximum annual impact is based upon the highest of the 1st high impacts determined using five discrete years of meteorological data (2001 through 2005), while the 24-hour and 3-hour maximum impacts are based upon the highest of the 2nd high impacts from the same five year set of meteorological data.

As shown in Table 6-10, the PSD Increment consuming SO_2 emission rates for NMU sources, including those associated with the proposed project and currently existing, do not result in impacts that are greater than 80% (and consequently, 100%) of the applicable SO_2 PSD Increments. The annual impact is predicted to be approximately 30% of the PSD Increment, while the 24-hour and 3-hour impacts are about 67% and 23% of their applicable PSD Increment, respectively.

6.5.3 SO_2 NAAQS Modeling Results

After having demonstrated compliance with the PSD Class II Increments, the last step in the SO_2 modeling analysis is a demonstration of compliance with the annual, 24-hour, and 3-hour SO_2 NAAQS.

Unlike PSD Increments, which are designed to prevent the air quality in a given region from significantly deteriorating beyond the conditions that existed at a stipulated baseline date, the NAAQS are designed to ensure the protection of human health and the environment. Therefore, the NAAQS modeling analysis includes **all** pertinent sources of emissions near the source of interest (at their maximum allowable emission rates), regardless of their installation date. In addition, NAAQS modeling analyses also include a background concentration, which represents the natural background concentrations from local sources in the area of interest (anthropogenic sources) and biogenic sources (concentrations presented in Table 6-9).

The SO_2 NAAQS consist of primary and secondary standards. The primary standards have been developed to protect public health, including the health of sensitive portions of the general population (i.e., asthmatics, children, elderly, etc.). The secondary standards are designed to protect public welfare, including decreased visibility in a region and damage to animals, crops, vegetation, and buildings. In the case of SO_2, the primary standards are for the annual and 24-hour averaging periods, while the 3-hour averaging period is a secondary standard.

Similar to the PSD Increments, the SO_2 NAAQS are applicable over the annual, 24-hour, and 3-hour averaging periods. The NAAQS modeling analysis includes all SO_2 emission sources – all NMU SO_2 emission sources and all off-site SO_2 emission sources (sources listed for SO_2 emissions in Table 6-8) – at their allowable (or proposed allowable) emission rates. The background concentrations were then added to the concentrations predicted by the dispersion model in order to determine the overall maximum concentrations. The results of the SO_2 NAAQS modeling analysis are presented in Table 6-11.

Table 6-11. Results of the NMU SO_2 NAAQS Modeling Analysis (01-05 SAW MET)

Averaging Period	Maximum Impact [1] (μg/m³)	Impact UTM Easting (meters)	Impact UTM Northing (meters)	Primary NAAQS (μg/m³)	Background Concentration (μg/m³)	Total NAAQS Impact (μg/m³)	Total Impact As % Of NAAQS
Annual	30.56	469,260.8	5,157,204.0	80	2.7	33.26	41.57%
24-Hour	217.39	469,410.8	5,157,104.0	365	13.3	230.69	63.20%
3-Hour	520.24	465,360.8	5,151,654.0	1300	45.2	565.44	43.50%

[1] Consistent with how the standards are applied, the maximum annual impact is based upon the highest of the 1st high impacts determined using five discrete years of meteorological data (2001 through 2005), while the 24-hour and 3-hour maximum impacts are based upon the highest of the 2nd high impacts from the same five year set of meteorological data.

As shown in Table 6-11, the SO_2 NAAQS modeling analysis shows that the proposed project will not cause a violation of the SO_2 3-hour, 24-hour, or annual NAAQS when the model predicted maximum impacts are added to the background concentrations.

6.5.4 PM_{10} Significant Impact Level (SIL) Modeling Results

The PM_{10} PSD Increment modeling analysis considered all NMU boilers, both existing and the newly proposed boiler. Similar to CO, the PM_{10} impacts were initially determined for the newly proposed boiler and the existing boilers in order to compare the results to SILs that have been established for the various PM_{10} standards and averaging periods. If the results of this initial analysis indicate that the ambient impacts are less than the applicable SILs, then further modeling is not required to demonstrate compliance with the federal standards (PSD Increment and NAAQS for PM_{10}).

Per the preceding discussion, the PM_{10} combined impacts from the two stacks have been determined for comparison with the applicable SILs of 5 $\mu g/m^3$ on a 24-hour basis and 1 $\mu g/m^3$ on an annual basis. The full 5-year meteorological data set was utilized, and the results of this analysis are presented in Table 6-12.

As shown in Table 6-12, the maximum PM_{10} emission rates for both the proposed new CFB boiler and the existing boiler stack result in maximum combined ambient impacts of 3.23 $\mu g/m^3$ on a 24-hour basis and 0.35 $\mu g/m^3$ on an annual basis. These impacts are approximately 65% and 35% of the 24-hour and annual significant impact levels, respectively. Due to the fact that impacts from the proposed new boiler and existing boilers are less than the applicable SILs for PM_{10}, the impacts are considered insignificant and no further modeling is required to demonstrate compliance with the PM_{10} PSD Increment standards and NAAQS for this project.

Table 6-12. Results of the NMU PM_{10} SIL Modeling Analysis (01-05 SAW MET)

Averaging Period	NMU Maximum Impact [1] ($\mu g/m^3$)	Year of Maximum Impact	Impact UTM Easting (meters)	Impact UTM Northing (meters)	Significant Impact Level ($\mu g/m^3$)	NMU Impact As % Of SIL
Annual	0.35	2003	468,660.8	5,156,254.0	1	35.20%
24-hour	3.23	2004	469,160.8	5,156,304.0	5	64.60%

[1] Consistent with how the standards are applied, the maximum annual impact is based upon the highest of the 1st high impacts determined using five discrete years of meteorological data (2001 through 2005), while the 24-hour maximum impacts are based upon the highest of the 2nd high impacts from the same five year set of meteorological data.

6.5.5 NO_x Significant Impact Level (SIL) Modeling Results

The NO_x significant impact level modeling analysis considered all NMU boilers, both existing and the newly proposed boiler. Similar to CO and PM_{10}, the NO_x impacts were initially determined for the newly proposed boiler and the existing boilers in order to compare the results to SIL that has been established for the NO_x annual standard. Had the results of this initial analysis indicated that the ambient impacts were greater than the applicable SILs, then further modeling would have been required to demonstrate compliance with the federal standards (PSD Increment and NAAQS for NO_x). However, the results predicted that the NO_x impacts would be below the applicable SIL.

Per the preceding discussion, the NO_x combined impacts from the two stacks have been determined for comparison with the applicable SIL of 1 $\mu g/m^3$ on an annual basis. The full 5-year meteorological data set was utilized, and the results of this analysis are presented in Table 6-13.

As shown in Table 6-13, the maximum NO_x emission rates for both the proposed new CFB boiler and the existing boiler stack result in a maximum combined ambient impact of 0.97 $\mu g/m^3$ on an annual basis. This maximum impact is below the annual significant impact level, and therefore, the NOx impact from the NMU boilers is considered insignificant and no further modeling is required to demonstrate compliance with the NO_x PSD Increment standard and NAAQS.