Exhibit C Trinity Consultants Report

Trinity Consultants

MEMORANDUM

TO: David Braslau
FROM: Jared Morrison
DATE: December 30, 2004
RE: University of Minnesota Steam Plant Modeling

Trinity Consultants, Inc. (Trinity) has completed an air dispersion modeling analysis to determine the impacts of the University of Minnesota Southeast Steam Plant on four alternatives of a proposed complex of buildings located to the northwest of the existing plant. The methodology used to perform this analysis and the results derived are detailed in the following sections.

MODELING METHODOLOGY

DISPERSION MODEL

Trinity has conducted the criteria pollutant dispersion modeling analysis according to dispersion modeling guidance provided by the Minnesota Pollution Control Agency (MPCA). MPCA guidance states the agency's preference for the Industrial Source Short Term model utilizing the PRIME algorithm (ISC-PRIME). Accordingly, Trinity utilized version 01228 of the ISC-PRIME model to estimate the maximum elevated concentrations along the side of the buildings. Appropriate averaging periods based on the National Ambient Air Quality Standards (NAAQS) and Minnesota state standards were considered in the analysis.

According the MPCA guidance, the regulatory default ISC-PRIME options are used in this analysis.

Building Downwash

The purpose of this evaluation is to determine if the plume discharged from the stack will become caught in the turbulent wake of a building (or other structure), resulting in downwash of the plume. The downwash of the plume can result in elevated concentrations.

The EPA provides guidance for determining whether building downwash will occur in *Guideline for Determination of Good Engineering Practice Stack Height.*[1] The minimum stack height not subject to the effects of downwash (called the Good Engineering Practice or GEP stack height) is defined by the following formula:

[1] EPA, Office of Air Quality Planning and Standards. *Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) (Revised).* Research Triangle Park, North Carolina. EPA 450/4-80-023R. June, 1985.

$$GEP = H + 1.5L$$

Where: GEP = the minimum GEP stack height
H = the height of the structure
L = the lesser dimension of the structure (height or projected width)

Stacks located more than 5L from any building are not subject to the effects of building downwash.

The Building Profile Input Program (BPIP) with Plume Rise Model Enhancements (PRIME) was used to determine the building downwash characteristics for each stack in 10-degree directional intervals. The PRIME version of BPIP features enhanced plume dispersion coefficients due to turbulent wake and reduced plume rise caused by a combination of the descending streamlines in the lee of the building and the increase entrainment in the wake. For PRIME downwash analyses, the building downwash data include the following parameters for the dominant building: building height, building width, building length, x-dimension building adjustment, and y-dimension building adjustment.

Meteorological Data

Meteorological data for use in ISC was preprocessed by the MPCA for the years 1987 through 1991[2]. The raw meteorological data includes surface meteorological data from the Minneapolis/St. Paul surface station and upper air meteorological data from the St. Cloud upper air station. The anemometer height for the Minneapolis/St. Paul surface station is 33 feet (10 meters).

Receptor Configuration

The dispersion model used a series of elevated discrete receptors to determine the impacts along the sides of the buildings in question. Each of the receptors was spaced at an increment of 10 ft starting at the base of the buildings and extending to the top. Receptors were placed on the front corners of each building nearest to the University of Minnesota's stacks.

Source and Building Elevations and Heights

The height of all sources and buildings were based on a ground-level elevation of 812 ft above sea level. Table 1 displays the building heights used in the four alternatives of this modeling study while Figure 1 identifies the building numbers utilized in this analysis.

[2] Meteorological data obtained from MPCA website: http://www.pca.state.mn.us/air/modeling.html

TABLE 1. BUILDING AND STACK HEIGHTS RELATIVE TO MAIN STREET ELEVATION

	Alternative 1 Height above Main Street (ft)	Alternative 2 Height above Main Street (ft)	Alternative 3 Height above Main Street (ft)	Alternative 4 Height above Main Street (ft)
Univ. of Minnesota Stacks*	225	225	225	225
Building 2† (Steam Plant Bldg.)	40	40	40	40
Building G‡	220	185	220	165
Building F/G‡	110	155	20	20
Building F‡	264	185	265	175
Building E2‡	264	185	297	180
Building E1‡	297	185	297	180
Building D/E‡	110	145	20	20
Building D‡	165	185	165	150
Building C‡	115	175	127	62
Building B‡	127	175	108	62

*Provided by Sunde Engineering Inc., modified by David Braslau December 8, 2004.
†Provided by David Braslau December 8, 2004.
‡ Provided by David Braslau December 27, 2004.

SOURCE PARAMETERS

Table 2 presents the source parameters that were modeled for all averaging periods and all four building height alternatives..

TABLE 2. UNIT 12 SOURCE PARAMETERS FOR DISPERSION MODELING

Modeling Source ID	Elevation (ft)	CO Emissions (lb/hr)	NO_x Emissions (lb/hr)	PM_{10} Emissions (lb/hr)	SO_x Emissions (lb/hr)	Height (ft)	Temp (F)	Exit Vel. (ft/s)	Diameter (ft)
ST101	812	70.75	58.96	4.78	96.1	225	300	9.5	14.1
ST102	812	20.78	72.75	18.7	267.6	225	473	20.1	14.1
ST103	812	5.75	198.74	1.01	56.78	225	202	9.1	14.1
ST104	812	52.34	146.61	0.95	62.83	225	253	10.4	14.1

All source parameters, excluding emission rates and stack height, were obtained from the University of Minnesota's Environmental Impact Statement dated October 1994. As stated above, stack heights were provided by Sunde Engineering Inc. and updated by Mr. David Braslau on December 8, 2004. The modeled emission rates are the maximum potential emission rates as taken from the University of Minnesota's Air Emission Permit No. 00000093.

As indicated in Table 2, the source emissions include the maximum potential NO_x emissions. While NO_x is the pollutant limited in the facility's permit, the pollutant with an established NAAQS limit is NO_2, a subset of total NO_x. In 40 CFR 51 Appendix W, EPA published the Ambient Ratio Method (ARM) guideline for evaluating NO_2 impacts [3]. The process utilizes the equilibrium that exists between NO_2 and NO_x in ambient air. A standard assumption and one accepted by the MPCA is that 75 percent of all NO_x is NO_2. The results of this analysis make use of the ARM procedure when determining the maximum modeled impacts of NO_2.

MODELING RESULTS

This section summarizes the results of the modeling analysis in comparison to the NAAQS and Minnesota state air quality standards. If both a Minnesota and national standard exist for the same pollutant over identical averaging periods, the more stringent of the two standards is utilized for comparison to modeled results.

Tables 3 through 6 summarize the results of the modeling analysis for each building alternative. Note that the five most recent years of meteorological data provided by the MPCA are considered and the worst case year for each pollutant and averaging period is presented. Annual results shown are the maximum modeled impact while short-term averaging periods are represented by the high-2^{nd}-high modeled result.

[3] Christopher Nelson of the MPCA indicated via telephone on December 10, 2004 that the Ambient Ratio Method is accepted in Minneapolis and the default equilibrium NO_2/NO_x value is 0.75.

TABLE 3. BUILDING ALTERNATIVE 1 MODELED HIGHS

Pollutant	Averaging Period	Year	Maximum Modeled Concentration (µg/m^3)	Background Concentration (µg/m^3)	Total Concentration (µg/m^3)	Building ID	Height (ft)	NAAQS or Minnesota Standard (µg/m^3)	Maximum as a Fraction of Standard
PM_{10}	24-hour	1989	11.6	103	114.6	F	264	150	76.4%
	Annual	1990	1.4	31	32.4	E	297	50	64.8%
SO_2	1-hour	1988	995.6	181	1,176.6	E	297	1,300	90.5%
	3-hour	1990	567.9	128	695.9	E	297	1,300	53.5%
	24-hour	1988	303.4	60	363.4	F	264	365	99.6%
	Annual	1990	38.0	5	43.0	F	264	60	71.7%
CO	1-hour	1988	437.3	4.7	442.0	E	297	40,000	1.1%
	8-hour	1990	190.0	2.3	192.3	F	264	10,000	1.9%
NO_2	Annual	1990	50.8*	41	91.8	F	264	100	91.8%

* Modeled concentrations include a 75% ambient NO_2/NO_x ratio

TABLE 4. BUILDING ALTERNATIVE 2 MODELED HIGHS

Pollutant	Averaging Period	Year	Maximum Modeled Concentration (µg/m^3)	Background Concentration (µg/m^3)	Total Concentration (µg/m^3)	Building ID	Height (ft)	NAAQS or Minnesota Standard (µg/m^3)	Maximum as a Fraction of Standard
PM_{10}	24-hour	1990	6.0	103	109.0	G	185	150	72.7%
	Annual	1990	0.5	31	31.5	B	185	50	63.0%
SO_2	1-hour	1988	327.8	181	508.8	G	185	1,300	39.1%
	3-hour	1987	295.1	128	423.1	FG	185	1,300	32.6%
	24-hour	1991	172.0	60	232.0	G	185	365	63.6%
	Annual	1988	14.7	5	19.7	G	185	60	32.8%
CO	1-hour	1991	157.1	4.7	161.8	G	185	40,000	0.4%
	8-hour	1990	128.2	2.3	130.5	G	185	10,000	1.3%
NO_2	Annual	1988	21.5*	41	62.5	G	185	100	62.5%

* Modeled concentrations include a 75% ambient NO_2/NO_x ratio

TABLE 5. BUILDING ALTERNATIVE 3 MODELED HIGHS

Pollutant	Averaging Period	Year	Maximum Modeled Concentration ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)	Building ID	Height (ft)	NAAQS or Minnesota Standard ($\mu g/m^3$)	Maximum as a Fraction of Standard
PM_{10}	24-hour	1987	12.7	103	115.7	E	297	150	77.1%
	Annual	1990	1.5	31	32.5	E	297	50	65.1%
SO_2	1-hour	1988	1,033.6	181	1,214.7	E	297	1,300	93.4%
	3-hour	1990	694.2	128	822.2	E	297	1,300	63.2%
	24-hour	1988	304.9	60	364.9	F	265	365	99.98%
	Annual	1990	38.8	5	43.8	E	297	60	73.1%
CO	1-hour	1988	451.9	4.7	456.6	E	297	40,000	1.1%
	8-hour	1988	213.4	2.3	215.7	E	297	10,000	2.2%
NO_2	Annual	1990	51.2*	41	92.2	F	265	100	92.2%

* Modeled concentrations include a 75% ambient NO_2/NO_X ratio

TABLE 6. BUILDING ALTERNATIVE 4 MODELED HIGHS

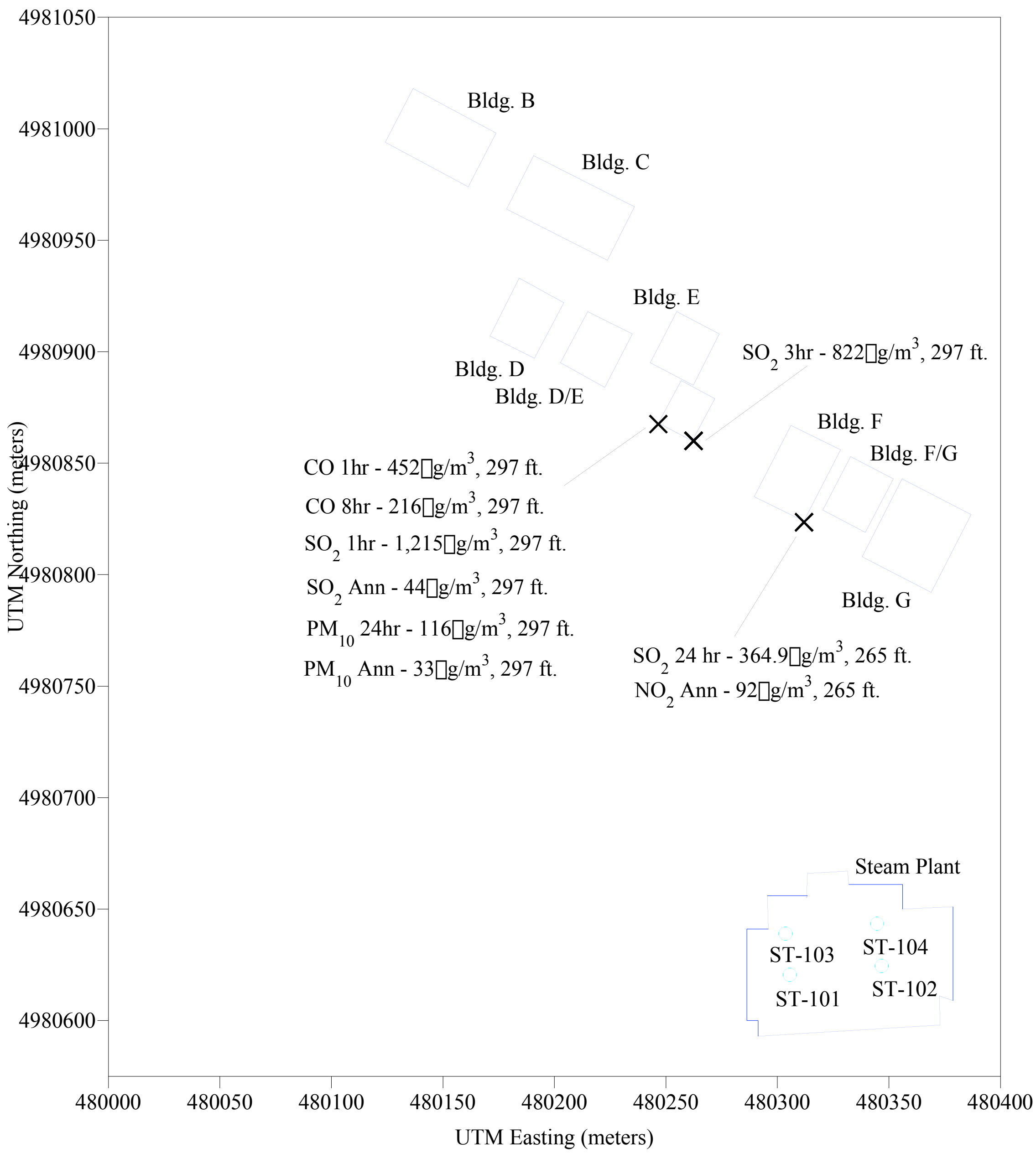
Pollutant	Averaging Period	Year	Maximum Modeled Concentration ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)	Building ID	Height (ft)	NAAQS or Minnesota Standard ($\mu g/m^3$)	Maximum as a Fraction of Standard
PM_{10}	24-hour	1991	4.4	103	107.4	E	180	150	71.6%
	Annual	1990	0.5	31	31.5	E	180	50	62.9%
SO_2	1-hour	1988	261.9	181	442.9	F	175	1,300	34.1%
	3-hour	1988	236.3	128	364.3	F	175	1,300	28.0%
	24-hour	1988	124.2	60	184.2	F	175	365	50.5%
	Annual	1990	12.2	5	17.2	E	180	60	28.7%
CO	1-hour	1988	120.4	4.7	125.1	G	165	40,000	0.3%
	8-hour	1990	99.1	2.3	101.4	F	175	10,000	1.0%
NO_2	Annual	1990	17.4	41	58.4	F	175	100	58.4%

* Modeled concentrations include a 75% ambient NO_2/NO_X ratio

The results demonstrate that at the buildings in question for each alternative building scenario presented, the University of Minnesota steam plant, when considered with the appropriate background concentration, will cause ambient air concentrations within the NAAQS and Minnesota state standards for all modeled pollutants and applicable averaging periods.

The locations of maximum impacts for each pollutant and averaging period are presented in Figure 1 along with the receptor height experiencing the high concentration. All building alternatives are considered and the overall maximum impact is displayed.

FIGURE 1. OVERALL MAXIMUM MODELED IMPACTS



CONCLUSION

Based on the modeling results presented in this report, the proposed buildings in each alternative do not experience pollutant concentrations exceeding the NAAQS or Minnesota state standards for PM_{10}, SO_2, NO_2, or CO. The analysis includes the maximum potential emission rates from the University of Minnesota Steam Plant and the appropriate pollutant ambient air background concentrations. As a comparison to actual operating conditions, Table 12 details the steam plant's average actual emissions from 2002 and 2003 and the permitted potential emissions. The use of potential emissions for this analysis creates a conservative worst-case scenario. As evident in the emissions comparison, the steam plant emits only a fraction of its allowable permitted emission limits.

TABLE 12. COMPARISON OF STEAM PLANT POTENTIAL TO ACTUAL EMISSIONS

	Potential Emissions				Actual Emissions*			
Modeling Source ID	CO Emissions (lb/hr)	NO_x Emissions (lb/hr)	PM_{10} Emissions (lb/hr)	SO_x Emissions (lb/hr)	CO Emissions (lb/hr)	NO_x Emissions (lb/hr)	PM_{10} Emissions (lb/hr)	SO_x Emissions (lb/hr)
ST101	70.75	58.96	4.78	96.1	3.84	17.20	0.74	1.32
ST102	20.78	72.75	18.7	267.6	11.96	12.14	1.16	0.49
ST103	5.75	198.74	1.01	56.78	0.00	0.00	0.00	0.00
ST104	52.34	146.61	0.95	62.83	0.14	0.25	0.02	0.14

* 2002, 2003 average actual emissions per MPCA Air Emissions Summary