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APPENDIX A

Modeling Assessment

EXECUTIVE SUMMARY

A human health risk assessment (HHRA) was conducted on behalf of Mahoning Renewable Energy (MRE) to evaluate potential health risks associated with hypothetical worst-case emissions from the proposed Ohio advanced energy facility. The primary objective of the HHRA was to understand whether emissions from the proposed facility would result in non-cancer hazards and cancer risks that fall within the acceptable United States Environmental Protection Agency (USEPA) and Ohio Environmental Protection Agency (OEPA) risk limits.

The HHRA was conducted in accordance with USEPA and OEPA risk assessment guidance and included; an evaluation of the compounds of potential concern (COPCs) for which risks were calculated, an assessment of the types of human receptors exposed, identification of toxicity values for the COPCs and a characterization of non-cancer hazards and cancer risks.

For this evaluation, the HHRA estimated cumulative non-cancer hazards and/or cancer risks associated with inhalation of ambient (outdoor) air for two distinct exposure scenarios:

1) an acute (short-term) residential scenario, in which a resident is assumed to have a one-time exposure to the maximum one-hour ambient air concentration of each COPC; and

2) a chronic (long-term) residential scenario, in which a resident is assumed to be continuously exposed at the maximum annual concentration in ambient air over 70 years of exposure.

Ambient air concentrations were modeled for various compounds (generally, heavy metals, dioxins, and acids) using a USEPA air dispersion model (AERMOD) and conservative input parameters to estimate worst-case maximum one-hour and annual ambient air concentrations.

Results of the HHRA indicate that non-cancer hazards for both the short-term and long-term residential scenarios are below the USEPA and OEPA non-cancer hazard limit. The risk analysis also demonstrates that the incremental lifetime cancer risk for long-term residents is below the OEPA cancer risk threshold and within the USEPA acceptable risk range.

1. INTRODUCTION

On behalf of Mahoning Renewable Energy, LLC (MRE), Woodard and Curran, Inc. (W&C) conducted a focused human health risk evaluation for the proposed Mahoning, Ohio facility located at 12003 Oyster Road, Smith Township, Mahoning County, Ohio. A human health risk assessment (HHRA) is a tool used by regulators to assess the relative risk using conservative exposure scenarios for a proposed activity, which in this case, includes emissions from the thermal conversion of solid waste to energy. The results of the HHRA should not be considered to be absolute, but instead as an additional means to evaluate the operational characteristics of the proposed facility against established risk management criteria. This HHRA uses highly conservative assumptions that likely overstate actual risk. The results of the HHRA indicate that estimated emissions concentrations for the proposed MRE facility are below both OEPA and USEPA established risk management criteria and will not result in unacceptable risk.

This HHRA was conducted at the request of the OEPA to assist with their evaluation of the proposed MRE energy facility. The objective of the HHRA was to estimate potential risks based on worst case emissions and dispersion of emissions from the proposed facility. The focused risk evaluation, which is based on USEPA and OEPA risk assessment guidance (USEPA 1989, 1997a, 2003a, 2003b, 2004, 2005; OEPA 2004a, 2004b), consists of a quantitative analysis of modeled emissions data from the proposed stack and is organized in the following manner:

- Hazard Identification
- Exposure Assessment
- Dose-Response Assessment; and
- Risk Characterization

Results of this evaluation demonstrate that, using conservative data and exposure assumptions, calculated risks are within the range of acceptable risk established by OEPA and USEPA.

1.1 HAZARD IDENTIFICATION

The objective of the Hazard Identification is to present the relevant environmental data and select the Compounds of Potential Concern (COPCs). COPCs are those constituents that are carried through the risk assessment process. For this evaluation, stack emissions from combustion of solid waste and construction and demolition debris (processed into refuse-derived fuel, or RDF) were modeled using the AERMOD air dispersion model (Version 07026). Modeling parameters, assumptions and methods are described in detail in Appendix A to this document and in the MRE Air Permit–to-Install (PTI) Application (October 10, 2008) and are only briefly summarized here.

The receptor grid for the air dispersion modeling analysis consisted of receptors at 25 meter spacing out to a distance of 1 kilometer (km), 100 meter spacing from 1 km to 4 km, 500 meter spacing from 4 km to 10 km, and 1 km spacing from 10 km to 25 km in every direction. Land use within 3 km of the Facility is rural. Therefore, models with the rural dispersion coefficients were used in the modeling analysis. The model assumed a stack height of 241 feet, which is the height proposed in the permit application.

Modeling results used to complete the PTI application were also utilized to determine the maximum one-hour and annual modeled concentrations used in this risk analysis. Several conservative assumptions were made when performing the modeling for the PTI application. These assumptions are as follows:

- The facility operates 8760 hours per year (8784 hours per leap year)[1];
- The facility operates at flow rates (low flow conditions) that would minimize dispersion, thereby, maximizing concentrations[2]; and
- The facility operates at emission rates (high load conditions) that would maximize ambient air concentrations.[3]

These conservative assumptions resulted in a maximum one-hour concentration based on 43,824 hours of data and a maximum annual concentration based on five years (43,824 hours) of data. The one-hour concentration was then used to assess the acute risk and annual average concentration was used to assess a chronic, seventy (70) year risk exposure. Evaluation of a 70 year exposure duration is highly conservative, particularly since it is virtually impossible for an individual to continuously remain at a single location where the maximum air concentration occurs for 70 years. In addition, the MRE facility is designed to have an operating lifespan of approximately 30-40 years. It is likely that during the 30 to 40 year facility operating life that upgrades to the air quality system will be made and that end of operating life upgrades will result in reduced emissions as technological advances are developed.

Compounds considered by the USEPA to be "Air toxic contaminants" (i.e., the COPCs for this evaluation) were chosen to be analyzed based on data in the EPA WebFire Database, the OAC 3745-114 Air Toxic Contaminant List, and actual stack testing conducted at facilities employing similar technologies.

For the purposes of the Air PTI Application, only those air toxics with annual emissions exceeding one ton are required to be modeled for comparison to OEPA Maximum Allowable Ground Level Concentrations (MAGLC). However, at OEPA's request, dioxins/furans, lead and mercury (whose emissions were less than 1-ton per year) were included in the MAGLC assessment which was part of the Air PTI Application. This HHRA evaluated the potential risk from all of the compounds identified, regardless of the annual emission rate.

As noted above, ambient air concentrations were estimated for these COPCs for both a one-hour (short-term/acute) and annual (long-term) averaging period. To be conservative, maximum 1-hr and annual concentrations were used in the HHRA without regard to the location where maximum concentrations were predicted to occur.

Table 1 presents emission rates along with a summary of estimated one-hour maximum and maximum annual ambient air concentrations for the COPCs. Appendix A discusses the method used to develop the air contaminant emissions and emission rates used in both the permit-to-install air quality assessment and the HHRA. However, the dioxin emission rate used in the HHRA, unlike the permit-to-install air quality

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[1] It is not expected that the facility will operate continuously during the entire year. Units will be shut down, either individually or together, to conduct preventative or emergency maintenance. Therefore, this assumption of continuous operation is conservative.

[2] Modeling the lower flow rate resulted in concentrations approximately 15% higher than modeling at the highest flow rate encountered during maximum production (on which emission rates were based).

[3] Emissions represent 100% load rates, which overestimate long term facility emissions.

assessment, was based on the average emission rate for similar facilities using the Turbosorp air quality control system, which is the system proposed to be used at the MRE facility. Data for active facilities using the Turbosorp system show that a much lower emission rate is achievable, relative to the applicable USEPA standard for the MRE facility (40 CFR Part 60, subpart Eb).

1.2 EXPOSURE ASSESSMENT

The objective of the Exposure Assessment is to estimate the type and magnitude of potential exposure to emission of airborne COPCs. For this evaluation, two residential scenarios were evaluated, reflecting acute and chronic exposures, respectively: 1) a resident located downwind of the facility exposed one time to the 1-hour maximum concentration, and 2) a long-term resident, exposed to the maximum annual emissions.

To evaluate the acute/short-term exposure, residents were assumed to be exposed to the one hour maximum ambient concentration as a one-time event. For evaluation of long-term exposures, residents were assumed to be exposed 365 days per year, 24 hours each day, over the course of 70 years, which is the EPA-recommended lifetime (USEPA 1989).

The assumptions used for the long-term scenario reflect a maximum exposed individual (MEI) scenario, consistent with USEPA inhalation risk assessment guidance (2004). Use of a 70 year exposure duration is highly conservative, since the American population is generally mobile and residential tenure is typically much lower than 70 years. U.S Bureau of the Census data and other population mobility studies suggest a median residential tenure of approximately 9 years, with most of the population moving within approximately 30 years (USEPA 1997a). Thus, use of a 70 year exposure duration, coupled with the assumption that residents are exposed to the maximum annual emissions 24 hours per day, 365 days per year, is a highly conservative assumption that is intended to overestimate health risks.

For both the short-term and long-term exposure scenarios, the estimated ambient air concentrations (Table 1) are equivalent to the average daily exposure and are not time-adjusted. The exposure estimates are combined with dose-response (toxicity) information to characterize the potential risk to human receptors.

1.3 DOSE-RESPONSE ASSESSMENT

The dose-response assessment describes the relationship between the level of exposure and the likelihood and/or severity of an adverse effect. In other words, the dose-response assessment quantifies the toxicity of each COPC using information obtained from published literature describing epidemiologic or toxicological studies.

Inhalation hazards associated with noncarcinogenic (non-cancer) effects (e.g., liver or kidney toxicity, decreased birth weight, etc.) are derived assuming that an exposure concentration will not exceed a threshold concentration ("reference concentration", or RfC), above which toxicity will occur.

Inhalation cancer risks are based on the inhalation unit risk (UR), which is the 95% Upper Confidence Limit of the mean incremental lifetime cancer risk estimated to result from lifetime exposure to an agent if it is in the air at a concentration of 1 microgram per cubic meter ($\mu g/m^3$).

Table 2 provides a summary of the inhalation toxicity values used in this assessment. Chronic toxicity information was primarily obtained from the USEPA Integrated Risk Information System (IRIS) (USEPA 2008), which generally provides chronic toxicity values. Where IRIS values were not available for a COPC, values were obtained from the Agency for Toxic Substances and Disease Registry (ATSDR)

Minimal Risk Levels (MRLs; ATSDR 2008), California Environmental Protection Agency (CalEPA) chronic Reference Exposure Levels (RELs; CalEPA 2005), or USEPA Health Effects Assessment Summary Tables (HEAST; USEPA 1997b), in accordance with the hierarchy suggested in USEPA and OEPA guidance (USEPA 2003b; OEPA 2004a). Because acute RfCs are generally not available from IRIS for the COPCs evaluated, ATSDR MRLs for acute or intermediate exposures, or CalEPA acute RELs were used where available. If an acute MRL or REL was not available, then chronic or subchronic RfCs were conservatively used as available to evaluate the short-term exposure scenario. Note that chronic and/or acute inhalation toxicity values were not available for several of the COPCs, including copper, lead, molybdenum and tin. Therefore, hazards/risks for these constituents were not estimated.

1.4 RISK CHARACTERIZATION

Characterization of the risk of harm to human health is the estimation of the incidence and severity of the adverse effects likely to occur in a human population due to chemical exposures, expressed as risk estimates. Risk estimates are based upon the comparison of the results of the exposure assessment and the dose-response assessment to EPA established risk management criteria and are indicative of the likelihood that adverse effects will occur.

The potential for non-carcinogenic health effects is characterized by the Hazard Quotient (HQ), which is the ratio of the estimated average daily exposure (ADE) of a chemical (the amount estimated to be the airborne exposure level which is inhaled.) to a threshold concentration at or below which adverse health effects would not be observed (e.g., the RfC), or:

$$HQ = ADE / RfC$$

Toxicity of non-carcinogens is assumed to be additive in nature; therefore, the HQ of each COPC is added to estimate a cumulative non-cancer hazard index (HI), or:

$$\text{Cumulative } HI_{\text{route-specific}} = \sum HQ_{\text{compound-specific}}$$

The cumulative HI may be calculated as the sum of individual route-specific HIs across all COPCs, assuming that toxicity of all COPCs is additive in nature, or may be calculated as the sum of route-specific HIs within a group of COPCs that share a common endpoint (e.g., liver toxicity or reproductive effects). In other words, HIs may be segregated by target organ or effect:

$$\text{Cumulative } HI_{\text{endpoint a}} = \sum HI_{\text{route-specific, endpoint a}}$$

The cumulative HI is then compared with the USEPA and OEPA acceptable noncancer hazard limit of 1 (USEPA 1989; OEPA 2004b). If the HI is less than or equal to 1, then concentrations of COPCs are not likely to cause adverse health effects. In other words, if the average daily exposure of a chemical is less than the reference concentration (resulting in a ratio of 1 or lower), then adverse effects are not likely to result from exposure to that chemical.

The potential for carcinogenic health effects is characterized as the Incremental Lifetime Cancer Risk (ILCR). The ILCR represents the incremental probability of an individual, above background, developing

cancer over a lifetime as a result of exposure to a potential carcinogen. For a given compound, the ILCR is the product of the quantified exposure and the measure of carcinogenic potency (i.e., UR):

$$ICLR = ADE \times UR$$

The ILCR, which represents the probability of developing cancer relative to the background incidence of cancer in the general population, is presented in scientific notation. For example, the ILCR of a specific chemical might be expressed as 1×10^{-6} or one in one million, which means that the probability of an individual developing cancer over a lifetime, as a result of exposure to the potential carcinogen, is one in one million. To account for exposures that a receptor may receive from multiple constituents, the ILCRs for all COPCs are added together to derive a cumulative route-specific ILCR. Route-specific ILCRs are then summed to estimate a cumulative ILCR for an exposure scenario, as demonstrated by the following equations:

$$ILCR_{route\text{-}specific} = \sum ILCR_{compound\text{-}specific}$$

$$\text{Cumulative ILCR} = \sum ILCR_{route\text{-}specific}$$

It is assumed that carcinogenic effects are additive across all COPCs, and therefore, ILCRs are not segregated by target organ as may be done for noncancer hazards. The cumulative ILCR is compared to USEPA's cumulative receptor cancer risk limits, which range from one-in-one million (1×10^{-6}) to one in ten thousand (1×10^{-4}), as well as the OEPA ILCR threshold of 1×10^{-5} (OEPA 2004b). If the cumulative cancer risk is below the OEPA risk limit and within the USEPA ILCR range, then it may be concluded that significant risks are unlikely.

Calculation of noncancer hazards is presented on Table 3 for the short-term exposure scenario (because this scenario evaluates a one-time, acute exposure, no cancer risks are estimated). Calculation of noncancer hazard and cancer risk is presented on Tables 4-5 for the long-term exposure scenario. Risk estimates for both short-term and long-term exposure scenarios are summarized below in the following table:

Exposure Scenario	**Cumulative Hazard Index (HI)**	**Incremental Lifetime Cancer Risk (ILCR)**
Child/Adult Residents: Short Term Exposure	0.4	Not applicable
Child/Adult Residents: Long Term Exposure	0.09	2×10^{-6}
USEPA Cumulative Risk Limit	**1**	**1×10^{-4} to 1×10^{-6}**
OEPA Cumulative Risk Limit	**1**	**1×10^{-5}**

As shown on the table above, estimated cumulative non-cancer hazards for both the acute, short-term and the chronic, long term exposure scenarios are below the USEPA and OEPA risk limit of one. The cumulative cancer risk for the long-term exposure scenario is within the USEPA target cancer risk range of 1×10^{-6} and 1×10^{-4} and below the OEPA cancer risk threshold of 1×10^{-5}. Ninety percent of the

cumulative cancer risk is attributable to dioxin; the individual ILCRs for all other COPCs were at or below 1×10^{-6}.

All estimates of hazard and risk include uncertainties and as such, the risk numbers are not intended to reflect an actual risk but instead are intended to be used to support risk management decisions. Because this HHRA is used to evaluate risk from a proposed facility, there is uncertainty in both emissions estimation and air dispersion modeling; however, to counter this uncertainty, conservative exposure assumptions were used in risk estimation, including:

- Use of maximum ambient air concentrations, which may not correlate with residential locations;
- Assumption that the proposed MRE facility would continuously operate at its maximum for 70 years;
- Assumption that a downwind resident would be exposed to maximum air concentrations for 24 hours/day, 365 days/year, over 70 years;
- Inclusion of uncertainty and modification factors, ranging from approximately 10 to 1000, that are incorporated into toxicity values; and
- Where acute toxicity values were not available, the use of chronic or subchronic toxicity values to evaluate acute exposures.

As discussed, chronic and/or acute inhalation toxicity information was not available for copper, lead[4], molybdenum and tin, and so cumulative risks may potentially be underestimated. However, since the risk estimates are based on highly conservative assumptions, and the cumulative risks estimates are below USEPA risk limits, it is not anticipated that exclusion of these constituents would underestimate risks to any appreciable degree such that the conclusions of this evaluation would not be valid.

[4] The estimated ambient air concentration of lead (0.02 µg/m^3 for the maximum estimated 1 hour averaging period) is below the National Ambient Air Quality Standard (NAAQS) of 1.5 µg/m^3. Estimated ambient air concentrations for other constituents not presented in this evaluation (e.g., carbon monoxide, particulate matter, sulfur dioxide, nitrogen oxides) are also below NAAQS, as described in the MRE Permit-to-Install Application dated October 10, 2008.

2. CONCLUSIONS

A human health risk assessment (HHRA) was conducted on behalf of Mahoning Renewable Energy (MRE) to evaluate potential health risks associated with hypothetical worst-case emissions from the proposed Ohio advanced energy facility. The primary objective of the HHRA was to understand whether emissions from the proposed facility would result in non-cancer hazards and cancer risks that fall within the acceptable United States Environmental Protection Agency (USEPA) and Ohio Environmental Protection Agency (OEPA) risk limits.

Based on the results of this analysis, it is concluded that, emissions from the proposed MRE Facility will fall within the range of acceptable risk criteria established by the OEPA and USEPA.

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TABLE 1
Emission Rate and Air Dispersion Modeled Concentrations
Mahoning Renewable Energy

Pollutant	Emission Rates		Model Predicted Concentrations	
	(lbs/hr)	(g/s)	1-Hour (µg/m^3)	Annual (µg/m^3)
Ammonia	7.34E+00	0.92502	1.15E+00	5.40E-02
Antimony	6.55E-03	0.000825	1.02E-03	4.82E-05
Arsenic	2.96E-03	0.000373	4.63E-04	2.18E-05
Barium	6.53E-02	0.00823	1.02E-02	4.81E-04
Beryllium	1.96E-05	2.47E-06	3.07E-06	1.44E-07
Cadmium	1.80E-02	0.00227	2.81E-03	1.32E-04
Chromium (III)	4.55E-02	0.00574	7.12E-03	3.35E-04
Chromium (VI)	1.14E-02	0.00143	1.78E-03	8.37E-05
Chromium total*	5.69E-02	0.00717	8.90E-03	4.19E-04
Cobalt	1.05E-02	0.00133	1.65E-03	7.76E-05
Copper	5.49E-02	0.00692	8.59E-03	4.04E-04
Dioxin (2,3,7,8-TCDD) long term **	2.76E-07	3.47E-08	4.31E-08	2.03E-09
Fluoride (sodium)	2.69E-01	0.0339	4.21E-02	1.98E-03
Sulfuric acid	5.58E+00	0.703	8.73E-01	4.10E-02
Hydrogen chloride	1.43E+01	1.803	2.24E+00	1.05E-01
Lead	1.40E-01	0.0176	2.19E-02	1.03E-03
Manganese	4.93E-02	0.00622	7.72E-03	3.63E-04
Mercury	2.22E-01	0.0280	3.47E-02	1.63E-03
Molybdenum	2.34E-03	0.000295	3.66E-04	1.72E-05
Nickel	1.32E-01	0.0166	2.07E-02	9.72E-04
Selenium	5.38E-03	0.000677	8.41E-04	3.95E-05
Tin	6.22E-02	0.00784	9.73E-03	4.58E-04

Notes:

Toxic concentration = Emission rate * Modeled concentration

Modeled Concentration (1-hr):	1.24115	µg/m^3 - g/s (1-Hour Averaging Period) at 1 g/s
Modeled Concentratin (Annual):	0.05837	µg/m^3 - g/s (Annual Averaging Period) at 1 g/s

1 hr =	3600	secs
1 yr =	8760	hrs
1 lb =	453.5924	grams
1 ton =	2000	lbs

*Assumed chromium (VI) comprised 20% of total chromium, based on information from Adirondack Resource Recover Facility in Hudson Falls, NY in April 1992. For this facility, chromium VI comprised 19.7% of total chromium emissions.

**Emission rate based on Spittelau Thermal Waste Treatment Plant with dioxin concentration of 0.4 $^{ng}/_{dscm}$ (0.004 $^{\mu g}/_{dscm}$) I-TEQ.

TABLE 3
CALCULATION OF CHEMICAL NON-CANCER HAZARDS
Inhalation of Ambient Air: Short-term Exposures
Child/Adult Resident
Mahoning Renewable Energy

RISK EQUATIONS:

Inhalation of Ambient Air:

$$HQ = \frac{ADE_{inhalation}}{RfC}$$

Parameter	Definition	Units
HI =	Hazard index (sum of all HQs)	Unitless
HQ =	Hazard quotient	Unitless
ADE =	Average daily exposure (1-hr concentration in air)	mg/m^3
RfC =	Inhalation reference concentration (Acute)	mg/m^3

Chemical of Potential Concern (COPC)	CAS Number	ADE	Acute RfC	COPC-Specific Hazard Quotient HQ
Ammonia	7664-41-7	1.1E-03	3.2E+00	3.59E-04
Antimony	7440-36-0	1.0E-06	2.0E-04	5.12E-03
Arsenic	7440-38-2	4.6E-07	1.9E-04	2.44E-03
Barium	7440-39-3	1.0E-05	5.0E-03	2.04E-03
Beryllium	7440-41-7	3.1E-09	2.0E-05	1.54E-04
Cadmium	7440-43-9	2.8E-06	3.0E-05	9.38E-02
Chromium (III)	16065-83-1	7.1E-06	1.0E-04	7.12E-02
Chromium (VI)	18540-29-9	1.8E-06	3.0E-04	5.94E-03
Cobalt	7440-48-4	1.6E-06	1.0E-04	1.65E-02
Copper	7440-50-8	8.6E-06	1.0E-01	8.59E-05
Dioxin (2,3,7,8-TCDD)	1746-01-6	4.3E-11	NA	NA
Fluoride (sodium)	7681-49-4	4.2E-05	2.4E-01	1.75E-04
Sulfuric acid	7664-93-9	8.7E-04	1.2E-01	7.27E-03
Hydrogen chloride	7647-01-0	2.2E-03	2.1E+00	1.07E-03
Lead	7439-92-1	2.2E-05	NA	NA
Manganese	7439-96-5	7.7E-06	5.0E-05	1.54E-01
Mercury	7439-97-6	3.5E-05	1.8E-03	1.93E-02
Molybdenum	7439-98-7	3.7E-07	NA	NA
Nickel	7440-02-0	2.1E-05	6.0E-03	3.44E-03
Selenium	7782-49-2	8.4E-07	2.0E-02	4.20E-05
Tin	7440-31-5	9.7E-06	NA	NA
CUMULATIVE NONCANCER HAZARD INDEX (HI)				**4E-01**

Notes:
NA: toxicity information not available; therefore, risk value not calculated.

TABLE 2
SUMMARY OF INHALATION TOXICITY INFORMATION
Mahoning Renewable Energy

Chemical of Potential Concern	CAS No.	Chronic Reference Concentration				Acute Reference Concentration			USEPA Weight of Evidence Cancer Classification	Inhalation Unit Risk	
		Value (mg/m^3)	Source	UF x MF	Target Organ(s)	Value (mg/m^3)	Source	Target Organ(s)		Value $(mg/m^3)^{-1}$	Source
Ammonia	7664-41-7	1.00E-01	IRIS	30 x 1	Respiratory system	3.20E+00	CalEPA	Respiratory system; eye	Not assessed		
Antimony	7440-36-0	2.00E-04	IRIS (Value for antimony trioxide)	300 x 1	Respiratory system	2.00E-04	IRIS (chronic)	Respiratory system	Not assessed		
Arsenic	7440-38-2	3.00E-05	CalEPA		Developmental; Cardiovascular system; Nervous system	1.90E-04	CalEPA	Reproductive system; developmental system	A	4.30E+00	IRIS
Barium	7440-39-3	5.00E-04	HEAST	1000	Developmental	5.00E-03	HEAST (subchronic)	Developmental	D		
Beryllium	7440-41-7	2.00E-05	IRIS	10 x 1	Respiratory system	2.00E-05	IRIS (chronic)	Respiratory system	B1	2.40E+00	IRIS
Cadmium	7440-43-9	1.00E-05	ATSDR MRL	3 x 3	Kidney	3.00E-05	ATSDR	Respiratory system	B1	1.80E+00	IRIS
Chromium (III)	16065-83-1	1.00E-04	IRIS (Value for Chromium VI applied)	300 x 1	Respiratory system	1.00E-04	IRIS (chronic)	Respiratory system	D		
Chromium (VI)	18540-29-9	1.00E-04	IRIS	300 x 1	Respiratory system	3.00E-04	ATSDR (intermediate)	Respiratory system	A	1.20E+01	IRIS
Cobalt	7440-48-4	1.00E-04	ATSDR MRL		Respiratory system	1.00E-04	ATSDR (chronic)	Respiratory system			
Copper	7440-50-8					1.00E-01	CalEPA	Respiratory system	D		
Dioxin (2,3,7,8-TCDD)	1746-01-6								B2	3.80E+04	CalEPA
Fluoride	7681-49-4	1.30E-02	CalEPA		Bone/teeth; respiratory system	2.40E-01	CalEPA	Respiratory system; eye			
Hydrogen chloride	7647-01-0	2.00E-02	IRIS	300 x 1	Respiratory system	2.10E+00	CalEPA	Respiratory system; eye	Not assessed		
Lead	7439-92-1								B2		
Manganese	7439-96-5	5.00E-05	IRIS	1000 x 1	Central nervous system	5.00E-05	IRIS (chronic)	Central nervous system	D		
Mercury	7439-97-6	3.00E-04	IRIS	30 x 1	Central nervous system	1.80E-03	CalEPA	Reproductive system; developmental system	C		
Molybdenum	7439-98-7								Not assessed		
Nickel	7440-02-0	9.00E-05	ATSDR MRL	30 x 10	Respiratory system	6.00E-03	CalEPA	Respiratory system; immune system	A	4.80E-01	IRIS (value for nickel subsulfide)
Selenium	7782-49-2	2.00E-02	CalEPA		Alimentary, cardiovascular, nervous systems	2.00E-02	CalEPA (chronic)	Alimentary, cardiovascular, nervous systems	D		
Sulfuric acid	7664-93-9	1.00E-03	CalEPA		Respiratory system	1.20E-01	CalEPA	Respiratory system			
Tin	7440-31-5										

Notes:
mg/m3 = Milligrams per cubic meter.
Blank cells indicate no information is available.
UF = Uncertainty factor
MF = Modifying factor
IRIS = United States Environmental Protection Agency (USEPA) Integrated Risk Information System (IRIS), searched online at http://cfpub.epa.gov/ncea/iris/index.cfm in October 2008.
ATSDR = Agency for Toxic Substances and Disease Registry. Toxicological Profiles, obtained online at http://www.atsdr.cdc.gov/toxpro2.html. Values are ATSDR Minimal Risk Levels (MRLs).
CalEPA = California Environmental Protection Agency chronic and acute Reference Exposure Level (REL),
February 2005. http://www.oehha.ca.gov/air/chronic_rels/pdf/allchrels.pdf; http://www.oehha.ca.gov/air/acute_rels/allAcRELs.html
HEAST = USEPA Health Effects Assessment Summary Tables: FY-1997 Update. Office of Research and Development. EPA 540/R-97-036.
US EPA Weight-of-Evidence Classification of Carcinogenicity:
A: Human carcinogen
B: Probable human carcinogen
B1: Limited evidence of carcinogenicity in humans from epidemiological studies
B2: Sufficient evidence of carcinogenicity in animals, inadequate evidence in humans
C: Limited evidence of carcinogenicity in animals
D: Inadequate evidence of carcinogenicity.

TABLE 5
CALCULATION OF CHEMICAL CANCER RISKS
Inhalation of Ambient Air: Long-term Exposures
Resident (Child/Adult)
Mahoning Renewable Energy

RISK EQUATIONS:

Inhalation of Ambient Air:

$$ILCR = LADE_{inhalation} * IUR$$

Parameter	Definition	Units
ILCR =	Incremental lifetime cancer risk	Unitless
LADE =	Lifetime average daily exposure (carcinogenic effects)	mg/m^3
IUR =	Inhalation unit risk	$(mg/m^3)^{-1}$

Chemical of Potential Concern (COPC)	CAS Number	LADE	*IUR*	COPC-Specific ILCR
Ammonia	7664-41-7	5.4E-05	NA	NA
Antimony	7440-36-0	4.8E-08	NA	NA
Arsenic	7440-38-2	2.2E-08	4.3E+00	9.4E-08
Barium	7440-39-3	4.8E-07	NA	NA
Beryllium	7440-41-7	1.4E-10	2.4E+00	3.5E-10
Cadmium	7440-43-9	1.3E-07	1.8E+00	2.4E-07
Chromium (III)	16065-83-1	3.3E-07	NA	NA
Chromium (VI)	18540-29-9	8.4E-08	1.2E+01	1.0E-06
Cobalt	7440-48-4	7.7E-08	NA	NA
Copper	7440-50-8	4.0E-07	NA	NA
Dioxin (2,3,7,8-TCDD)	1746-01-6	2.1E-12	3.8E+04	7.9E-08
Fluoride (sodium)	7681-49-4	2.0E-06	NA	NA
Sulfuric acid	7664-93-9	4.1E-05	NA	NA
Hydrogen chloride	7647-01-0	1.1E-04	NA	NA
Lead	7439-92-1	1.0E-06	NA	NA
Manganese	7439-96-5	3.6E-07	NA	NA
Mercury	7439-97-6	1.6E-06	NA	NA
Molybdenum	7439-98-7	1.7E-08	NA	NA
Nickel	7440-02-0	9.7E-07	4.8E-01	4.7E-07
Selenium	7782-49-2	3.9E-08	NA	NA
Tin	7440-31-5	4.6E-07	NA	NA
TOTAL RISK (based on dioxin long term)*				**2E-06**

Notes:
NA: toxicity information not available; therefore, risk value not calculated.

TABLE 4
CALCULATION OF CHEMICAL NON-CANCER HAZARDS
Inhalation of Ambient Air: Long-term Exposures
Resident (Child/Adult)
Mahoning Renewable Energy

RISK EQUATIONS:

Inhalation of Ambient Air:

$$HQ = \frac{ADE_{inhalation}}{RfC}$$

Parameter	Definition	Units
HI =	Hazard index (sum of all HQs)	Unitless
HQ =	Hazard quotient	Unitless
ADE =	Average daily exposure (noncarcinogenic effects)	mg/m^3
RfC =	Inhalation reference concentration (chronic)	mg/m^3

Chemical of Potential Concern (COPC)	CAS Number	ADE	Chronic RfC	COPC-Specific Hazard Quotient HQ
Ammonia	7664-41-7	5.4E-05	1.0E-01	5.39E-04
Antimony	7440-36-0	4.8E-08	2.0E-04	2.40E-04
Arsenic	7440-38-2	2.2E-08	3.0E-05	7.26E-04
Barium	7440-39-3	4.8E-07	5.0E-04	9.60E-04
Beryllium	7440-41-7	1.4E-10	2.0E-05	7.21E-06
Cadmium	7440-43-9	1.3E-07	1.0E-05	1.32E-02
Chromium (III)	16065-83-1	3.3E-07	1.0E-04	3.34E-03
Chromium (VI)	18540-29-9	8.4E-08	1.0E-04	8.36E-04
Cobalt	7440-48-4	7.7E-08	1.0E-04	7.74E-04
Copper	7440-50-8	4.0E-07	NA	NA
Dioxin (2,3,7,8-TCDD)	1746-01-6	2.1E-12	NA	NA
Fluoride (sodium)	7681-49-4	2.0E-06	1.3E-02	1.52E-04
Sulfuric acid	7664-93-9	4.1E-05	1.0E-03	4.10E-02
Hydrogen chloride	7647-01-0	1.1E-04	2.0E-02	5.25E-03
Lead	7439-92-1	1.0E-06	NA	NA
Manganese	7439-96-5	3.6E-07	5.0E-05	7.25E-03
Mercury	7439-97-6	1.6E-06	3.0E-04	5.43E-03
Molybdenum	7439-98-7	1.7E-08	NA	NA
Nickel	7440-02-0	9.7E-07	9.0E-05	1.08E-02
Selenium	7782-49-2	3.9E-08	2.0E-02	1.97E-06
Tin	7440-31-5	4.6E-07	NA	NA
CUMULATIVE NONCANCER HAZARD INDEX				**9E-02**

Notes:
NA: toxicity information not available; therefore, risk value not calculated.

APPENDIX A

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Figure A-9: Major Component Site Layout

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AIR QUALITY MODELING ASSESSMENT

This section describes air dispersion modeling techniques used to predict future air quality for use in the human health risk assessment (HHRA) prepared for the Mahoning Renewable Energy (MRE) Project. Air dispersion model predictions of air quality from the MRE Facility operation have been assessed for compliance with applicable air quality standards through the application of air quality dispersion models that are approved by the U.S. Environmental Protection Agency (USEPA) and the OEPA. Assessments documented in the MRE Air Permit Application to Install demonstrated that the MRE Facility will be in compliance with all applicable federal and OEPA ambient air quality and air toxic rule requirements.

The source considered in the air quality analysis was the single stack for the combined Babcock Power Advanced RDF Stoker Boilers. Figure A-1 is a site plan depicting the location of the proposed boilers and stack, along with other components of the MRE Facility.

A.1 EMISSION RATE DEVELOPMENT

The MRE Facility has the potential to emit hazardous air pollutants (HAPs), also referred to as toxic contaminants in OAC 3745-114 USEPA's Compilation of Emission Factors (Chapter 2 of AP-42, Fifth Edition, Volume 1) was used at the primary reference to determine the HAPs emitted as a result of waste combustion. As as a refinement, other similar projects where reviewed to determine which pollutants were included in permits following evaluation by state and federal regulatory agencies during the individual comparable facility review process.

A.1.1 Air Toxic Contaminant Selection

Trace amounts of a variety of compounds may be present in the exhaust of the advanced energy refuse-derived fuel (RDF) stoker boilers prior to treatment in the air emission control system. As such, a reasonable approach as outlined below was taken to identify those constituents to be included in the modeling and air quality assessment. The steps selecting the air toxic compounds are outlined below, along with the number of constituents affected:

- Determine the initial list of all compounds that may be present in the advanced energy RDF stoker boiler exhaust, using the EPA WebFire Database. [Approximately 26 different compounds from multiple types of mass burn and RDF facilities]
- Review other applications for renewable energy facilities similar to this project and add to the list those compounds investigated in these studies. [Added an additional 5 compounds]
- Remove from the list developed in steps 1 and 2, all compounds that are not regulated (i.e., that are not USEPA HAPs, criteria pollutants, VOCs, or OAC 3745-114 toxic air contaminants). [Excluded 9 compounds]
- If applicable, remove from the list compounds that were below detection in WebFire. [None removed]

A.1.2 Air Toxic Contaminant Emissions

The remaining 20 compounds were evaluated for inclusion in the air toxic analysis. Table A-1 summarized the estimated emissions of each air toxic contaminant at the MRE facility. All contaminants were modeled and the estimated concentrations were compared to the appropriate standards and the OAC 3745-114 maximum allowable ground level concentrations (MAGLC). The

analysis comparing potential MRE HAP emissions with OEPA MAGLCs was presented in the MRE Air PTI Application.

Table A-1: Estimated MRE Facility Air Toxic Contaminant Emissions

Pollutant	No. of Facilities	Facility Average Emission Concentration		Factored Emission Concentrations		Factored Emission Rate (g/s)
Ammonia[1]	0	15	ppm	15.0	ppm	0.925
Antimony	1	0.95	µg/m³	9.5	µg/m³	0.000825
Arsenic	4	0.43	µg/m³	4.3	µg/m³	0.000373
Barium	2	9.48	µg/m³	94.8	µg/m³	0.00823
Beryllium	2	2.85E-03	µg/m³	0.029	µg/m³	2.47E-6
Cadmium	3	2.61	µg/m³	26.1	µg/m³	0.00227
Chromium	3	8.26	µg/m³	82.6	µg/m³	0.00717
Cobalt	3	1.53	µg/m³	15.3	µg/m³	0.00133
Copper	2	7.97	µg/m³	79.7	µg/m³	0.00692
Dioxins[2]	9	4.00E-04	µg/m³	0.0004	µg/m³	3.47E-08
Fluorides	3	0.39	ppm	0.5	ppm	0.0339
H_2SO_4	2	1.65	ppm	2.0	ppm	0.703
HCl	10	11.38	ppm	13.7	ppm	1.803
Lead	3	19.18	µg/m³	191.8	µg/m³	0.0176
Manganese	2	7.16	µg/m³	71.6	µg/m³	0.00622
Mercury	3	32.2	µg/m³	322.0	µg/m³	0.0280
Molybdenum	2	0.34	µg/m³	3.4	µg/m³	0.000295
Nickel	4	19.17	µg/m³	191.7	µg/m³	0.0166
Selenium	2	0.78	µg/m³	7.8	µg/m³	0.000677
Tin	1	9.03	µg/m³	90.3	µg/m³	0.00784

[1] Ammonia slip from operation of the RSCR™
[2] Dioxin concentration of 0.4 $^{ng}/_{dscm}$ (0.0004 $^{\mu g}/_{dscm}$) I-TEQ achieved at the Spittelau Thermal Waste Treatment Plant

To predict the emission rates for air toxic contaminants, stack test data was reviewed from the RDF and mass burn facilities listed below. Table A-1 provides a list of air toxics and the number of facilities which have tested for each of the listed compounds. Based on the stack test data, an average concentration value was calculated for each pollutant. Using the average concentration and MRE's estimated stack exhaust air flow rate, an emissions rate was calculated for all compounds except for ammonia and dioxins. These two emissions rates are not based on the average concentration from other MWC facilities. Instead, the dioxin concentration of 0.4 ng/dscm, achieved at the Spittelau Thermal Waste Treatment Plant, was used to determine the estimated emissions rate. Ammonia emissions are the result of the ammonia slip from the regenerative selective catalytic reduction system (RSCR) used to control NO_x emissions. For compounds other than acid gases (HCl, H_2SO_4, and Hf), emission rates were multiplied by a factor of 10 to account for uncertainty in the data set and for the

limited number of data points. A lower scaling factor of 1.2 was used for the acid gases, due to the ability to control the lime injection rates as part of the air pollution control equipment.

RDF Facilities

Maine Energy Recovery, ME
Mid-Connecticut Resource Recovery, CT
Penobscot Energy Recovery, ME
SEMASS, MA
Southeastern Public Service Authority, VA

Mass Burn Facilities

Bristol Resource Recovery, CT
Charleston Resource Recovery, SC
Camden Resource Recovery, NJ
Greater Portland Resource Recovery, ME
Hudson Falls Resource Recovery, NY
Lee County Resource Recovery, FL
Montgomery County Resource Recovery, MD
Southeast Connecticut Resource Recovery, CT
Wallingford Resource Recovery, CT

A.2 CLIMATE IN THE PROJECT AREA

The MRE Facility will be located on approximately 30 acres and is located to the northeast of the Central Landfill (approximately 1,200 acres) bordered by Middletown Road to the north and Bandy Road to the east. The region has warm summers and cold winters, which are typical of a continental-type climate. The mean monthly temperature ranges from the mid 20°s (Fahrenheit) in January to the upper 70°s in July and August. Normal daytime high temperatures range from freezing (32°F) during the winter to the low 80°s during the summer months of July and August. Normal nighttime low temperatures range from upper 10°s during the winter, to the low 60°s during the summer months of July and August. The average annual temperature is approximately 50°F.

Annual precipitation in the region averages approximately 38 inches (rain equivalent) per year and is somewhat evenly distributed throughout the year. January and February are the driest months, with normal precipitation of approximately 2.3 inches, while May, June and July are the wettest months, receiving greater than 3.5 inches.

Annual average wind patterns are predominantly from the southwest to the west (from 195° – 270^{0}), as measured by the National Weather Service (NWS) Pittsburg International Airport station. Mean annual wind speed is approximately 6.5 miles per hour (mph) with higher monthly average wind speeds occurring during from December through April. Figures A-2 through A-6 present wind roses for the 2001 through 2005 calendar years depicting the annual average wind patterns in the Project area that was used for air dispersion modeling. Figure A-7 presents a wind rose depicting the average wind patterns in the project area during the full 5 years used as weather data for air dispersion modeling.

A.3 TOPOGRAPHY IN THE PROJECT AREA

The proposed MRE Facility will be located in the northwest corner of the TLA-Alliance Central Landfill, bordered by Middletown Road to the north and near Bandy Road to the east. The modeled stack base elevation is 1074 feet above mean sea level (MSL) and the actual stack elevation will be 241 feet. The area surrounding the MRE Facility is relatively flat. The nearest terrain elevations in the study area to exceed the stack top elevation (1074 + 241 = 1315 feet MSL) is approximately 7.25 miles (11.7 km) to the southeast of the proposed stack . Figures A-8 and A-9 provide a topographic map and an aerial view of the proposed location. The area is rural in character and the general land uses in the immediate area include the TLA-Alliance Central Landfill to the west and southwest of the proposed MRE Facility, farming (along with associated housing and buildings), and wetlands.

A.4 SOURCE DATA

A Turbosorp® circulating fluidized bed semi-dry scrubbing system utilizing lime injection, a baghouse, and an RSCR™ (regenerative selective catalytic reduction system) are proposed to control emissions from the facility. The stack will be located at 494916.95 m E and 4533963.3 m N (40.957 ^{o}N Latitude/81.060 ^{o}W Longitude). The MRE Facility property fence line is the origins of the receptor grid. There was a row of receptors spaced 25 meters along the property/fence line. The receptor grid for the modeling analysis consisted of receptors at 25 meter spacing out to a distance of 1 kilometer (km), 100 meter spacing from 1 km to 4 km, 500 meter spacing from 4 km to 10 km, and 1 km spacing from 10 km to 25 km in every direction. Property located within the property/fence line, areas that the public does not have reasonable access; was excluded from the modeling analysis. All source and receptor locations were specified using the UTM coordinate system (NAD27 datum). The receptor grid is depicted in Figure A-10 and Figure A-11 (near grid receptors and far grid receptors).

A.4 MODEL SELECTION FACTORS

A.4.1 Dispersion Environment

Land-use within a 3 km radius of the MRE Facility was classified using the recommended method outlined in "The Guideline on Air Quality Models" (Appendix W of 40 CFR Part 51) which uses the meteorological land use typing scheme proposed by Auer in 1978. This classification is necessary to determine whether rural or urban dispersion coefficients should be used in the dispersion modeling analysis. If more than 50 percent of the area is classified as urban, urban dispersion parameters should be used in the modeling, otherwise, rural dispersion coefficients should be used.

Information contained on the USGS topographic maps of the area was sufficient to make the urban/rural determination. Land use within 3 km of the Facility is predominantly rural. Therefore, models with the rural dispersion coefficients were used in the modeling analysis.

A.4.2 Good Engineering Practice (GEP) Stack Height Determination

OAC 3754-16 and USEPA stack height regulations limit the stack height used in performing dispersion modeling to calculate air quality impact of a source for regulatory purposes. Sources must be modeled at their actual physical height unless that height exceeds their calculated GEP stack height, in which case the GEP stack height is modeled. If the physical stack height is less than the GEP formula, the actual stack height is again modeled and the potential for the plume to be affected by aerodynamic wakes created by nearby buildings must be evaluated in the dispersion modeling analysis.

A GEP stack height analysis was performed in accordance with OAC 3745-16 and the "Guidelines for Determination of Good Engineering Practice Stack Height" (USEPA, 1985). A GEP stack height is defined as the greater of:

- 65 meters (213.25 feet), measured from the ground-level at the base of the stack,
  or
- the formula height (Hg), as determined from the following equation:

  $$Hg = H + 1.5L$$

  Where:

  Hg = good engineering stack height, measured from the ground-level at the base of the stack,

  H = height of the nearby structure which maximizes Hg,

  L = lesser dimension (height or projected width) of the building,

The GEP formula height is based on the "nearby" buildings that result in the greatest justifiable height. For the purposes of determining the maximum GEP formula height, "nearby" is limited to five building heights or widths ("5L"), whichever is less, from the trailing edge (edge closest to the source) of the building. The structures nearby the stack include the tipping floor/RDF processing building, the RDF storage building, and the boiler/turbine building. Table A-2 is a list of the buildings at the MRE Facility and their dimensions and Figure A-1 depicts the location of each of the buildings.

Table A-2: MRE Facility Structures

Building	Length (ft)	Width (ft)	Height (ft)
Tipping Floor	400	300	35
RDF Process Building	425	300	35
Fuel Storage Building	350	175	35
Maintenance Building	150	50	25
Office Area	80	50	25
Turbine Hall	175	110	75
Boiler Enclosure	175	110	110
Cooling Tower	175	52	35*
Water Tank		62 (diameter)	32

To Fan Deck, Fan Shroud 10 feet high. Structure modeled with a 45 foot height

Only the buildings listed above are within the distance of 5L of the stack. The largest structure will be the boiler enclosure, and it will be the controlling building with respect to formula GEP. The boiler enclosure will be approximately 175 feet by 110 feet with a height of 110 feet. As a squat structure, the formula GEP stack height for this building is approximately 2.5 x 110 feet, or 275 feet (83.82 meters) which is GEP stack height.

The Building Profile Input Program (BPIP) was run to confirm that the stack was at GEP formula height. Using the structures listed in Table A-2 and a stack of 241 feet, the BPIP model was run. The GEP formula height calculated by BPIP is 274.2 feet or 83.59 meters. A stack of 241 feet was modeled during the air quality assessment. Because the stack is below the GEP stack height, building downwash was assessed in the modeling analysis.

A.4.3 Cavity Region

The cavity region created by a building can extend out to three times the lesser of the building height or projected width. Effects of building induced cavity on pollutant concentrations need to be analyzed for these lesser downwind distances when the stack height is less than GEP height. (RIDEM, 2002) Since the actual stack height will be below the GEP height, a cavity analysis is required. The BPIP was run to confirm and analyze the GEP stack height. The output from the BPIP program was used as an input file for the AERMOD program so that the wake effects by the nearby structures would be considered when determining impacts.

A.4.4 Local Topography

Local topography plays a role in the selection of dispersion model. Dispersion models can be divided into two categories: (1) those applicable to areas where terrain is less than height of the top of the stack (simple terrain), and (2) those applicable to areas where the terrain is greater than the final height

of the plume (complex terrain). The closest complex terrain for the formula GEP stack is found approximately 7.25 miles southeast of the proposed stack.

A.4.5 Models Selected for Use

The dispersion environment, potential of aerodynamic building downwash effects on ground-level concentrations, and the local topography help to determine the appropriate models for use in dispersion modeling analysis. Simple terrain models are used to calculate concentrations in simple terrain (below stack-top elevation) and up to final plume height in complex terrain Complex terrain models are used to calculate concentrations in complex terrain (above stack-top elevation). For complex terrain, the higher of the simple terrain or complex terrain model predicted concentrations is used for comparing to the air quality standards.

The AERMOD Modeling System (Version 07026) was used for the refined modeling analysis. AERMOD is the USEPA and OEPA preferred/recommended modeling system which models air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. In addition, AERMOD also allows building downwash to be considered.

A.4.6 Averaging Periods

AERMOD has the capability of modeling annual and various short-term averaging periods (1-hour, 3-hour, 8-hour, and 24-hour). Since HHRA risk analysis was developed from 1-hour and annual average ambient concentrations, these averaging times were selected as output options.

A.4.7 Operating and Stack Parameters

Modeled stack and exhaust parameters for the proposed MRE Facility are presented in Table A-3. Facility operating conditions representing 75% and 100% RDF loading were evaluated to determine minimum and maximum stack conditions. Once established, each condition was modeled separately.

A.4.8 Cavity Region Assessment

As discussed in Paragraph A.4.3, the stack will be 241 feet high, which required cavity affects to be included in the modeling assessment. Therefore, the potential for building wake effect on the advanced RDF Stoker Boiler emissions was needed and a cavity assessment was completed and the results of this assessment were used as inputs in the air dispersion modeling.

Table A-3: Modeled Stack Exhaust Parameters

Stack Parameter	75% RDF Loading		100% RDF Loading	
	English Units	Metric Units	English Units	Metric Units
Modeled Base Elevation	1074 feet MSL	327.36 meters MSL	1074 feet MSL	327.36 meters MSL
Stack Height Above Ground	241 feet	73.5 meters	241 feet	73.5 meters
Stack Interior Exhaust Diameter	8.5 feet	2.6 meters	8.5 feet	2.6 meters
Stack Orientation	vertical	vertical	vertical	Vertical
Exhaust Flow Rate	243373.5 acfm	114.9 acm/s	324498 acfm	153.1 acm/s
Exhaust Velocity	71.5 ft/sec	21.8 meters/sec	95.31 ft/sec	29.1 meters/sec
Exhaust Temperature	280 ^{o}F	410.9 ^{o}K	280 ^{o}F	410.9 ^{o}K
Throughput Basis for Modeled Exhaust Parameters	68.8 tons/hr	62.4 metric tons/hr	91.7 tons/hr	83.2 metric tons/hr

A.4.9 Screening and Refined Modeling Assessment

Two load scenarios at two different fuel mixes were initially proposed to be modeled. Table A-4 describes the stack parameters for each of the load scenarios. The emission factors noted in Table A-1 were used for each of the four modeled scenarios.

Initial screen modeling was completed which illustrates that the maximum ambient air concentrations would result from the 75% loads as a result of the decreased exhaust flow exiting the stack. Therefore, conservatively, the worst emission rates from the 60 C&D/40% MSW and the 50% C&D/50% MSW of all operating scenarios at the 75% load flowrate (243373.5 acfm) were utilized in the refined modeling.

Table A-4: MRE Facility Advanced RDF Boiler, Stack Parameters

Parameter	Units	Biomass Advanced Stoker Boiler			
		60% C&D/40% MSW		50% C&D/50% MSW	
Load Case		100 %	75 %	100 %	75 %
Ambient Temperature	^{o}F	80	80	80	80
Exit Temperature	^{o}F	280	280	280	280
Flow Rate	acfm	324498	243373.5	324498	243373.5
Heat Input	MMBtu/hr	1066	799	1042	781

Source: Babcock Power Environmental

A.5 MODELING RESULTS

Refined modeling was completed utilizing the stack parameter for the advanced RDF boiler operating at 75% load and the emission factors from Table A-1. Table A-5 lists the one hour average modeling results for each of the five years modeled along with the maximum one-hour concentration used in the HHRA. Table A-6 lists the annual average modeling results for each of the five years modeled along with the maximum annual concentration used in the HHRA.

Table A-5: One-Hour Maximum Modeling Results for Each of the 5-Years Modeled

Compound	2001 (ug/m^3)	2002 (ug/m^3)	2003 (ug/m^3)	2004 (ug/m^3)	2005 (ug/m^3)	Max Concentration (ug/m^3)
Ammonia	1.15E+00	1.11E+00	1.11E+00	1.11E+00	1.09E+00	1.15E+00
Antimony	1.02E-03	9.89E-04	9.94E-04	9.93E-04	9.76E-04	1.02E-03
Arsenic	4.63E-04	4.48E-04	4.50E-04	4.49E-04	4.42E-04	4.63E-04
Barium	1.02E-02	9.87E-03	9.91E-03	9.91E-03	9.74E-03	1.02E-02
Beryllium	3.07E-06	2.97E-06	2.98E-06	2.98E-06	2.93E-06	3.07E-06
Cadmium	2.81E-03	2.72E-03	2.73E-03	2.73E-03	2.68E-03	2.81E-03
Chromium	8.90E-03	8.60E-03	8.64E-03	8.63E-03	8.48E-03	8.90E-03
Cobalt	1.65E-03	1.59E-03	1.60E-03	1.60E-03	1.57E-03	1.65E-03
Copper	8.59E-03	8.30E-03	8.34E-03	8.33E-03	8.19E-03	8.59E-03
Dioxins	4.31E-08	4.17E-08	4.18E-08	4.18E-08	4.11E-08	4.31E-08
Fluorides	4.21E-02	4.06E-02	4.08E-02	4.08E-02	4.01E-02	4.21E-02
H_2SO_4	8.73E-01	8.43E-01	8.47E-01	8.46E-01	8.32E-01	8.73E-01
HCl	2.24E+00	2.16E+00	2.17E+00	2.17E+00	2.13E+00	2.24E+00
Lead	2.19E-02	2.12E-02	2.12E-02	2.12E-02	2.09E-02	2.19E-02
Manganese	7.72E-03	7.46E-03	7.49E-03	7.48E-03	7.35E-03	7.72E-03
Mercury	3.47E-02	3.35E-02	3.37E-02	3.36E-02	3.31E-02	3.47E-02
Molybdenum	3.66E-04	3.54E-04	3.56E-04	3.55E-04	3.49E-04	3.66E-04
Nickel	2.07E-02	2.00E-02	2.00E-02	2.00E-02	1.97E-02	2.07E-02
Selenium	8.41E-04	8.12E-04	8.16E-04	8.15E-04	8.01E-04	8.41E-04
Tin	9.73E-03	9.40E-03	9.44E-03	9.43E-03	9.28E-03	9.73E-03

Table A-6: Annual Modeling Results for Each of the 5-Years Modeled

Compound	2001 (ug/m^3)	2002 (ug/m^3)	2003 (ug/m^3)	2004 (ug/m^3)	2005 (ug/m^3)	Max Concentration (ug/m^3)
Ammonia	4.87E-02	5.40E-01	4.85E-02	4.96E-02	4.41E-02	5.40E-01
Antimony	4.35E-05	4.82E-04	4.33E-05	4.42E-05	3.93E-05	4.82E-04
Arsenic	1.97E-05	2.18E-04	1.96E-05	2.00E-05	1.78E-05	2.18E-04
Barium	4.34E-04	4.81E-03	4.32E-04	4.41E-04	3.93E-04	4.81E-03
Beryllium	1.30E-07	1.44E-06	1.30E-07	1.33E-07	1.18E-07	1.44E-06
Cadmium	1.19E-04	1.32E-03	1.19E-04	1.22E-04	1.08E-04	1.32E-03
Chromium	3.78E-04	4.19E-03	3.76E-04	3.85E-04	3.42E-04	4.19E-03
Cobalt	7.00E-05	7.76E-04	6.97E-05	7.12E-05	6.33E-05	7.76E-04
Copper	3.65E-04	4.04E-03	3.63E-04	3.71E-04	3.30E-04	4.04E-03
Dioxins	1.83E-09	2.03E-08	1.82E-09	1.86E-09	1.66E-09	2.03E-08
Fluorides	1.79E-03	1.98E-02	1.78E-03	1.82E-03	1.62E-03	1.98E-02
H_2SO_4	3.70E-02	4.10E-01	3.69E-02	3.77E-02	3.35E-02	4.10E-01
HCl	9.50E-02	1.05E+00	9.45E-02	9.67E-02	8.60E-02	1.05E+00
Lead	9.29E-04	1.03E-02	9.25E-04	9.46E-04	8.41E-04	1.03E-02
Manganese	3.28E-04	3.63E-03	3.26E-04	3.33E-04	2.96E-04	3.63E-03
Mercury	1.47E-03	1.63E-02	1.47E-03	1.50E-03	1.33E-03	1.63E-02
Molybdenum	1.56E-05	1.72E-04	1.55E-05	1.58E-05	1.41E-05	1.72E-04
Nickel	8.77E-04	9.72E-03	8.73E-04	8.93E-04	7.94E-04	9.72E-03
Selenium	3.57E-05	3.95E-04	3.55E-05	3.63E-05	3.23E-05	3.95E-04
Tin	4.13E-04	4.58E-03	4.11E-04	4.20E-04	3.74E-04	4.58E-03

MIDDLETOWN RD.

GAS MAIN

TO UTILITY TIE

PROPERTY LINE

REF: D-138-04-CSK05

REF: D-138-04-CSK05

REF: D-138-04-CSK07

REF: D-138-04-CSK06

100'

100'

100'

NON-JURISDICTIONAL DRAINAGE SWALE

6" GAS LINE

FUEL STORAGE

DETENTION BASIN

OUTFALL

0 60 120 180 240

SCALE: 1"=60'

PRELIMINARY

LEGEND

1. TIPPING FLOOR
2. RDF PROCESSING
3. C&D PROCESSING
4. BOILER #1
5. BOILER #2
6. ADMIN. BLDG.
7. STEAM TURBINE
8. TRANSFORMER
9. ELECTRICAL SUBSTATION
10. WATER TANK
11. AIR COOLED CONDENSER
12. FUEL STORAGE
13. MAINTENANCE BLDG.
14. CHIMNEY
15. DUST COLLECTORS
16. RECYCLE STORAGE
17. GAS METER
18. RECYCLE WATER TANK
19. DETENTION BASIN
20. RELOCATED DRAINAGE SWALE
21. ASH SILO
22. TURBOSORP SCRUBBERS
23. FABRIC FILTERS
24. RSCR EQUIPMENT
25. FUEL CONVEYOR

No.	Description	By	Date	Appd
D	GEN. REVISION	JJN	8/06/08	GJC
C	REV. DRAINAGE SWALE	JJN	07/18/08	GJC
B	ADD TK, DET. BASIN	JJN	07/14/08	GJC
A	FOR REVIEW	JRH	06/27/08	JRH

REVISIONS

TRI-MONT Engineering Company
Braintree, MA.

CLIENT: JEFFERSON RENEWABLE ENERGY

PROJECT: MAHONING RENEWABLE ENERGY

Title: SITE PLAN
Figure A - 1

TRI-MONT	By	Date	Client	By	Date
Drawn	NAME	00/00/00	Approved		
Checked	NAME	00/00/00	Approved		
Approved	NAME	00/00/00	Approved		

Scale:	Job No.	Drawing No.	Rev. No.
1"=60'		D-138-04-CSK04	D

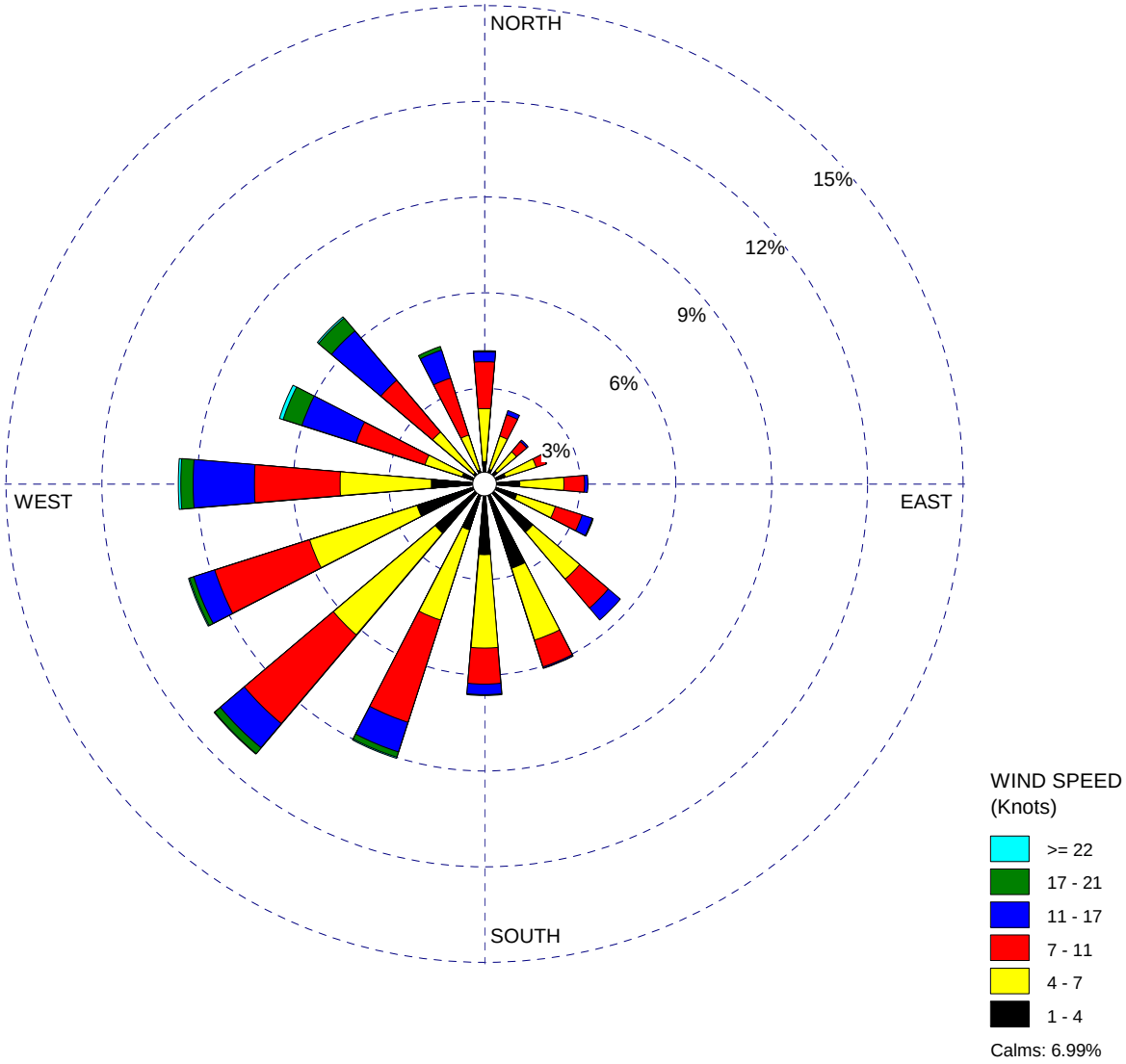
13804CSK04(D).dwg 08/07/08

WIND ROSE PLOT:

Mahoning Renewable Energy

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
Figure A-2 2001 Wind Rose	**2001** **Jan 1 - Dec 31** **00:00 - 23:00**	**Woodard and Curran**	
		MODELER: **Tomas Ennis**	
	CALM WINDS: **6.99%**	TOTAL COUNT: **8148 hrs.**	
	AVG. WIND SPEED: **7.12 Knots**	DATE: **5/21/2008**	PROJECT NO.: **219641**

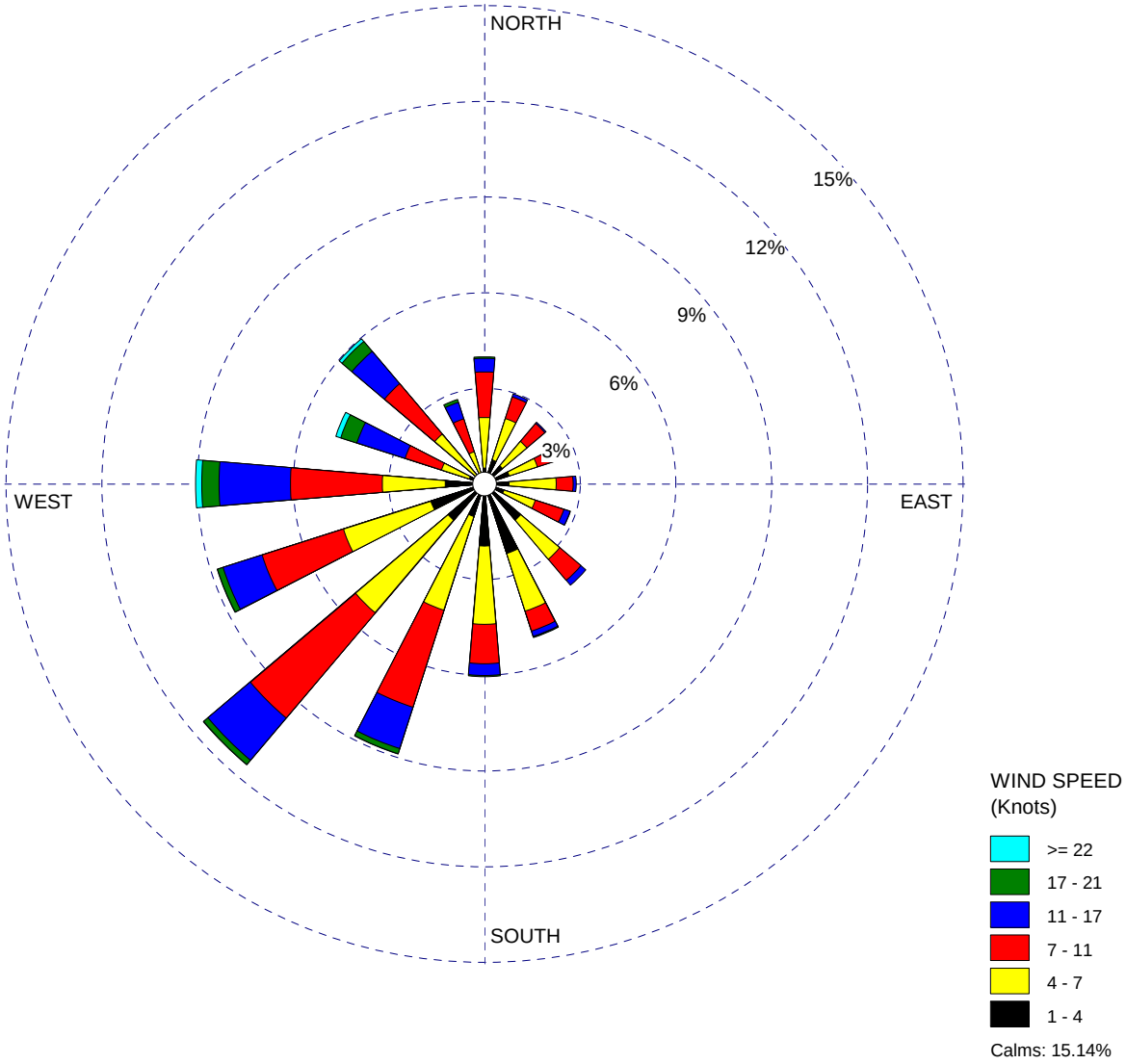
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Mahoning Renewable Energy

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
Figure A-3 2002 Wind Rose	**2002** **Jan 1 - Dec 31** **00:00 - 23:00**	**Woodard and Curran**	
		MODELER: **Tomas Ennis**	
	CALM WINDS: **15.14%**	TOTAL COUNT: **7434 hrs.**	
	AVG. WIND SPEED: **6.76 Knots**	DATE: **5/21/2008**	PROJECT NO.: **219641**

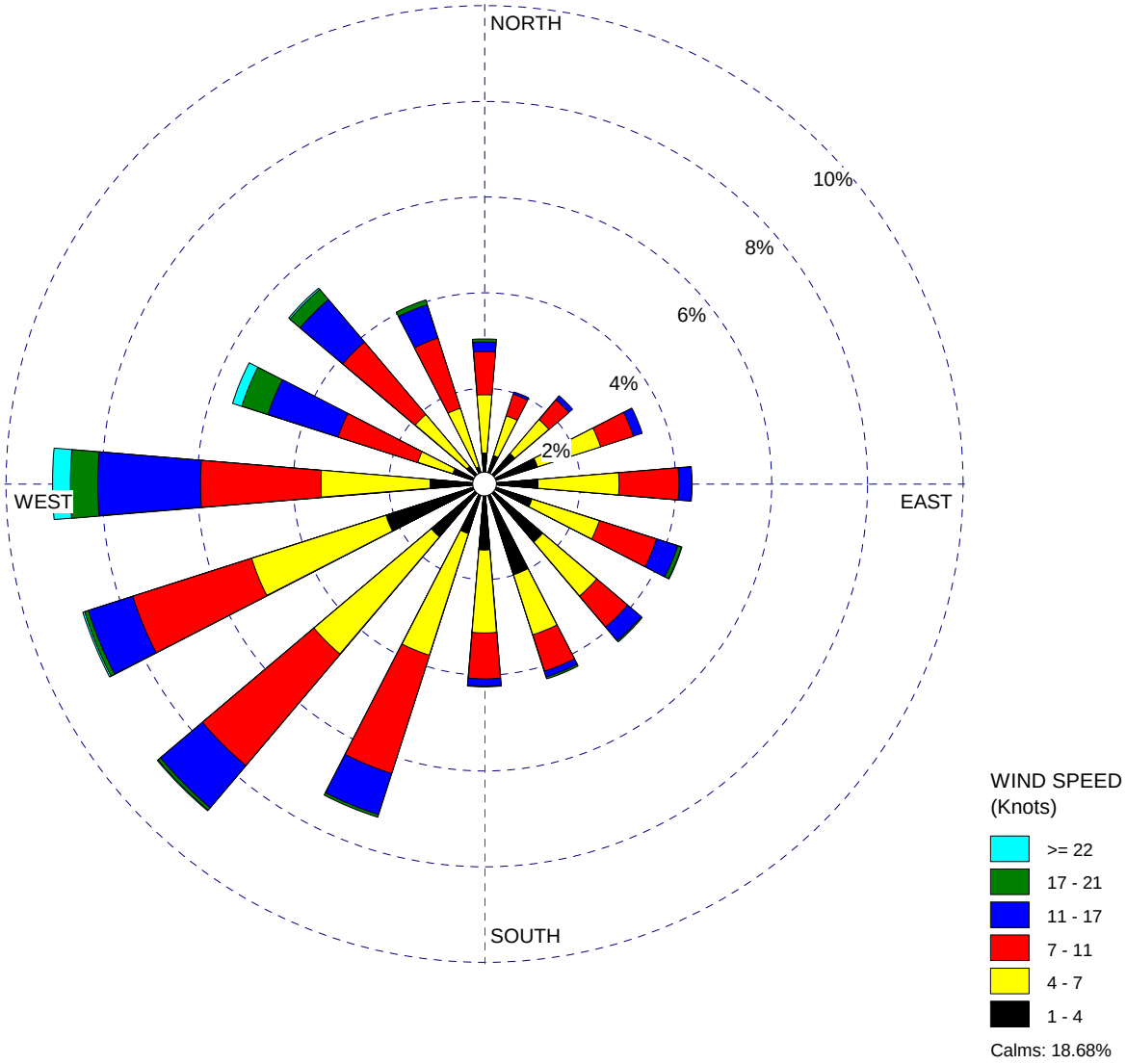
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Mahoning Renewable Energy

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
Figure A-4 2003 Wind Rose	**2003** **Jan 1 - Dec 31** **00:00 - 23:00**	**Woodard and Curran**	
		MODELER: **Tomas Ennis**	
	CALM WINDS: **18.68%**	TOTAL COUNT: **7124 hrs.**	
	AVG. WIND SPEED: **6.38 Knots**	DATE: **5/21/2008**	PROJECT NO.: **219641**

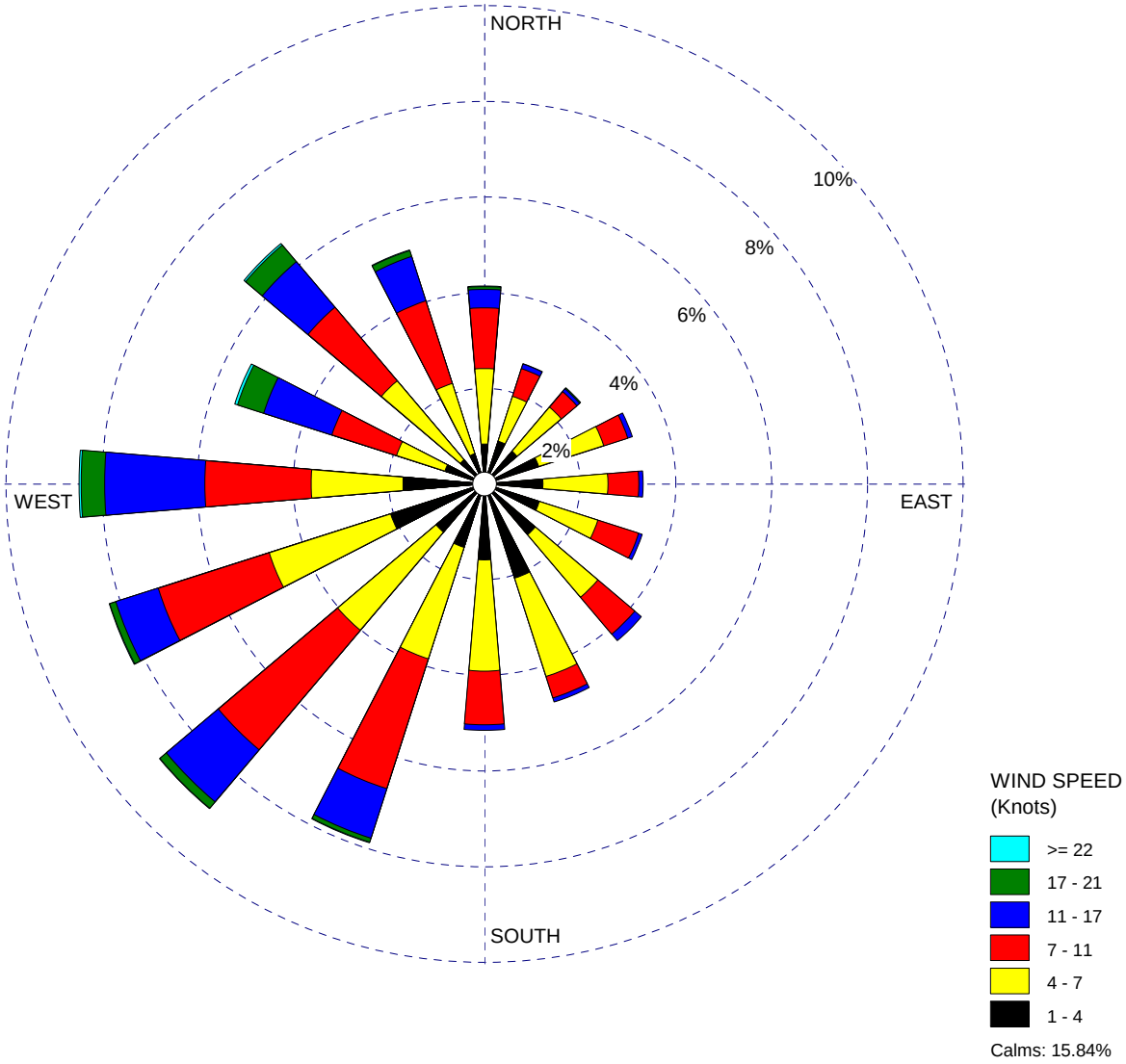
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Mahoning Renewable Energy

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
Figure A-5 2004 Wind Rose	**2004** **Jan 1 - Dec 31** **00:00 - 23:00**	**Woodard and Curran**	
		MODELER: **Tomas Ennis**	
	CALM WINDS: **15.84%**	TOTAL COUNT: **7393 hrs.**	
	AVG. WIND SPEED: **6.38 Knots**	DATE: **5/21/2008**	PROJECT NO.: **219641**

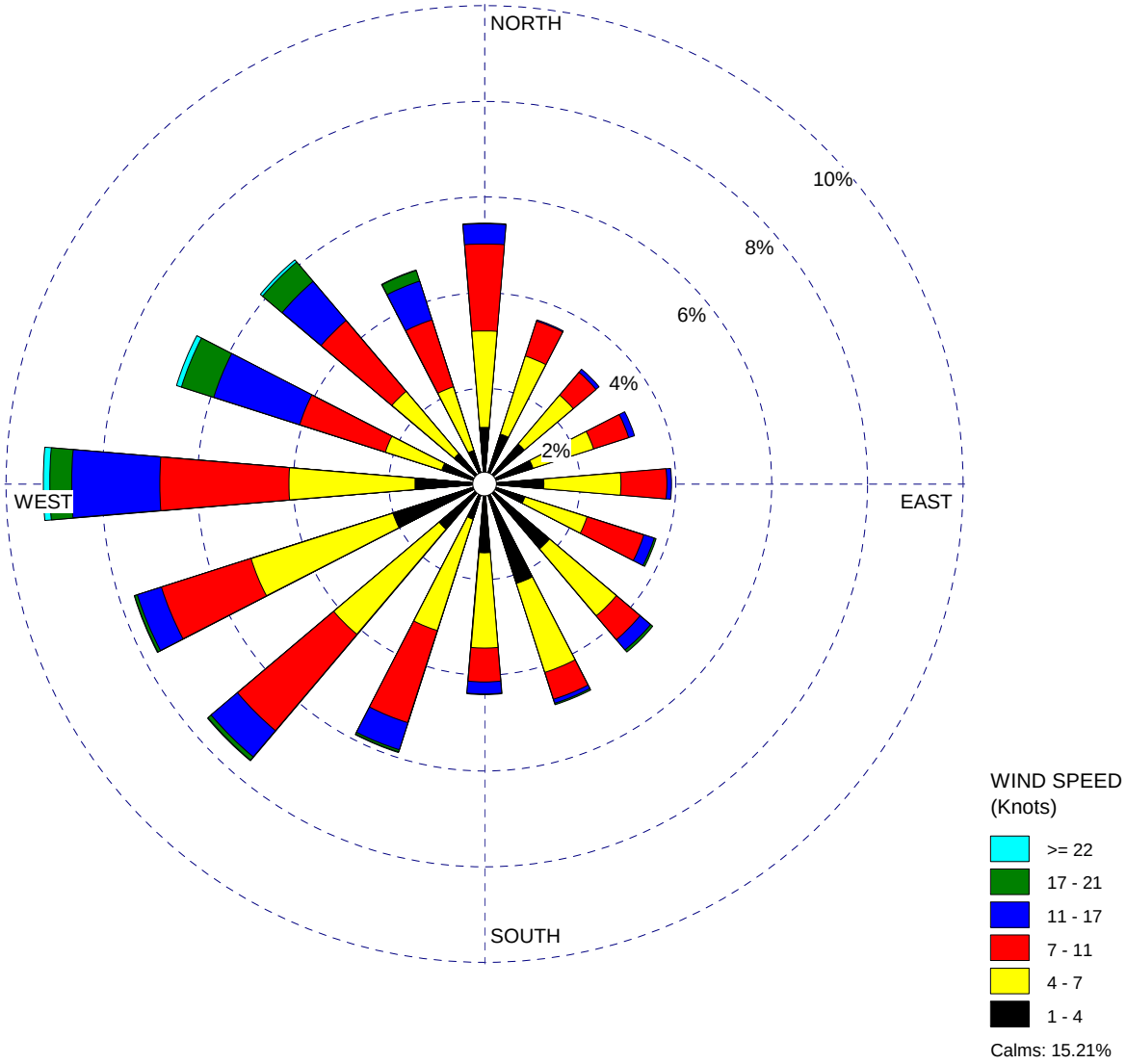
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Mahoning Renewable Energy

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
Figure A-6 2005 Wind Rose	**2005** **Jan 1 - Dec 31** **00:00 - 23:00**	**Woodard and Curran**	
		MODELER: **Tomas Ennis**	
	CALM WINDS: **15.21%**	TOTAL COUNT: **7428 hrs.**	
	AVG. WIND SPEED: **6.35 Knots**	DATE: **5/21/2008**	PROJECT NO.: **219641**

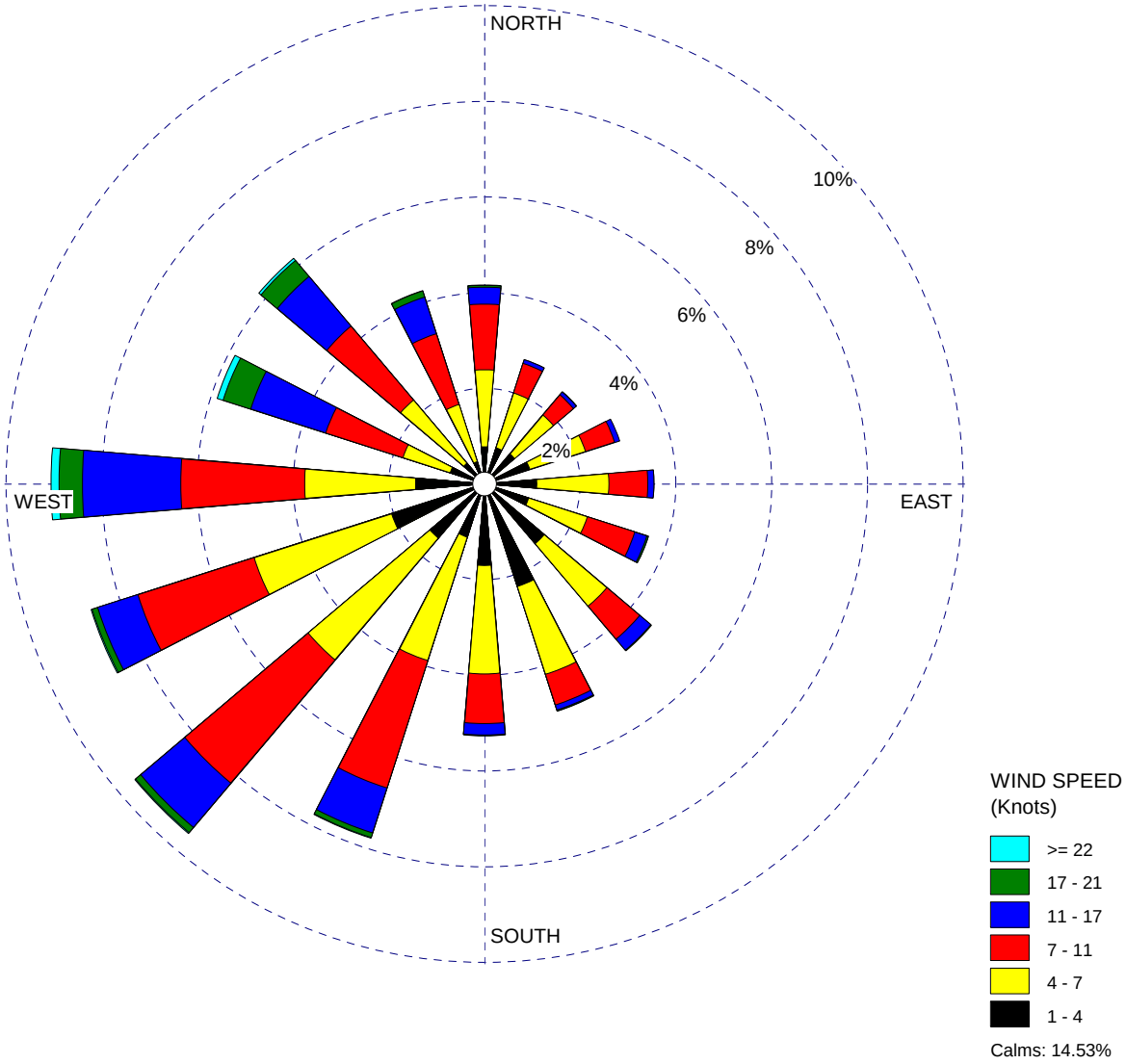
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Mahoning Renewable Energy

DISPLAY:

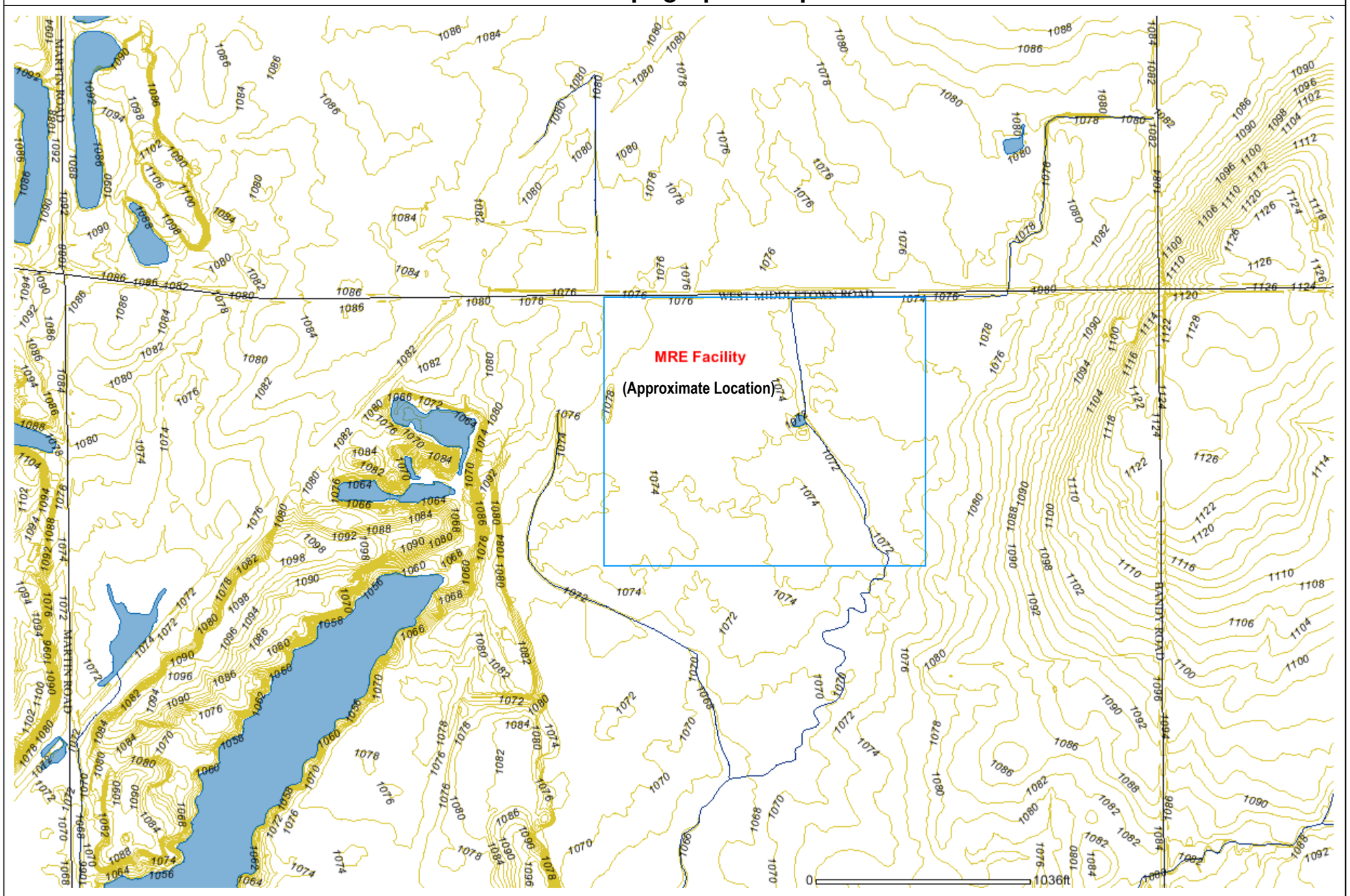
Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
Figure A-7 2001-2005 Wind Rose	**2001-2005** **Jan 1 - Dec 31** **00:00 - 23:00**	**Woodard and Curran**	
		MODELER: **Tomas Ennis**	
	CALM WINDS: **14.53%**	TOTAL COUNT: **37456 hrs.**	
	AVG. WIND SPEED: **6.58 Knots**	DATE: **5/21/2008**	PROJECT NO.: **219641**

WRPLOT View - Lakes Environmental Software

MRE Topographic Map



REF#:08-11121549

Legend

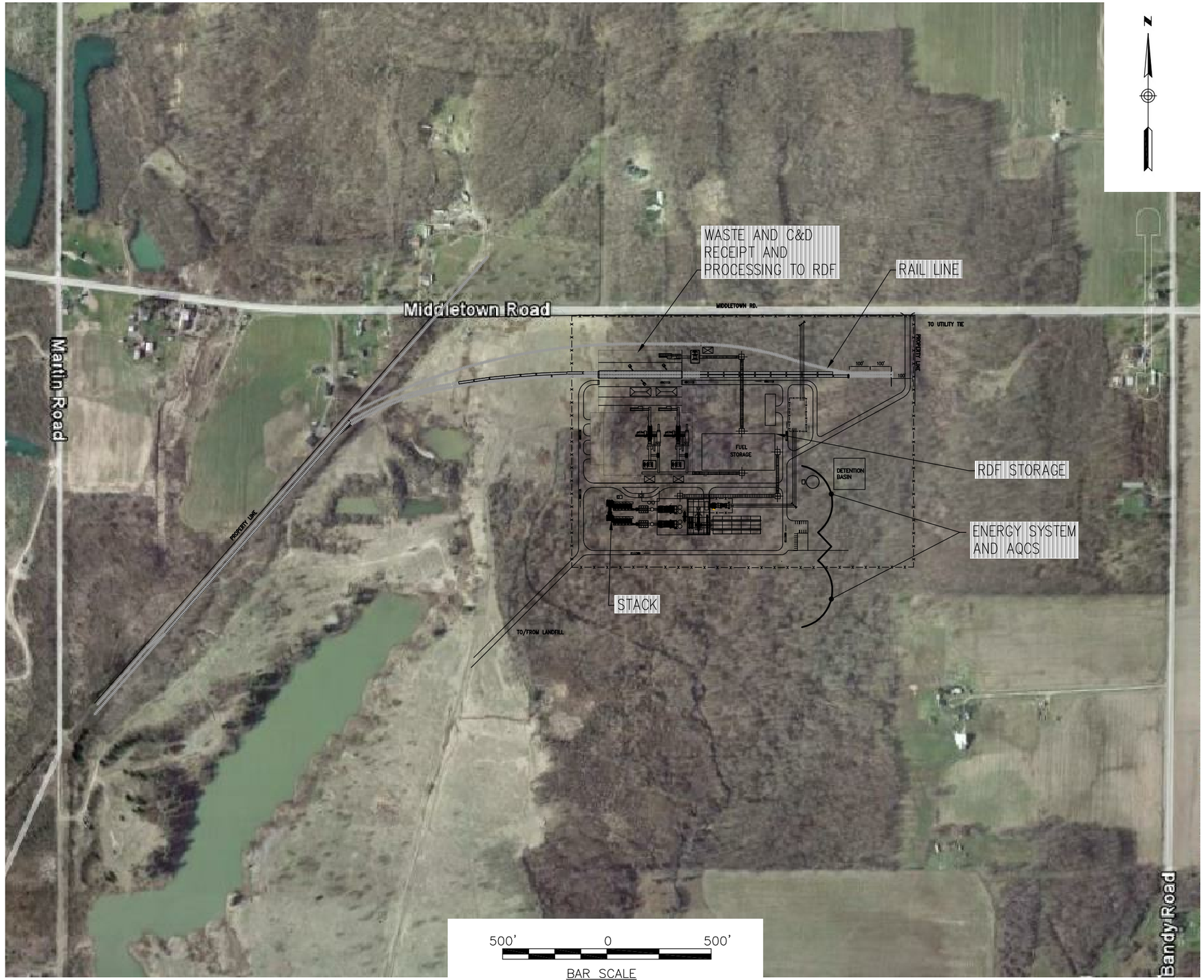
- County Boundary
- District Lines
- City Boundary
- County Boundary
- School Boundary
- Township Boundary
- Village Boundary
- Parks
- Park
- MVSD
- County Fairgrounds
- Railroad
- Road Name
- Lakes and Ponds
- Lake
- River
- Waterway
- Contour 2004

N

Figure A-8

DISCLAIMER: The digital data contained herein was compiled from recorded deeds, survey plats, orthophotography and other public records. Mahoning County does not warrant the accuracy, reliability or timeliness of any of said information and assumes no legal responsibility; persons relying on the information contained herein do so at their own risk. Users should consult public information sources for verification of the information referenced and should notify the Mahoning County GIS Department of any discrepancies.

Print Date:11/12/2008



REFERENCE:
AERIAL PHOTOGRAPH IMAGE OBTAINED FROM GOOGLE EARTH INC.

95 CEDAR STREET
PROVIDENCE, RHODE ISLAND 02903
800.985.7897 | www.woodardcurran.com

COMMITMENT & INTEGRITY DRIVE RESULTS

WOODARD & CURRAN

MAJOR COMPONENT SITE LAYOUT

DESIGNED BY: GTA, TE
DRAWN BY: GA
CHECKED BY: GTA, TE
219641-Aerial_W_Site-10-10-08.dwg

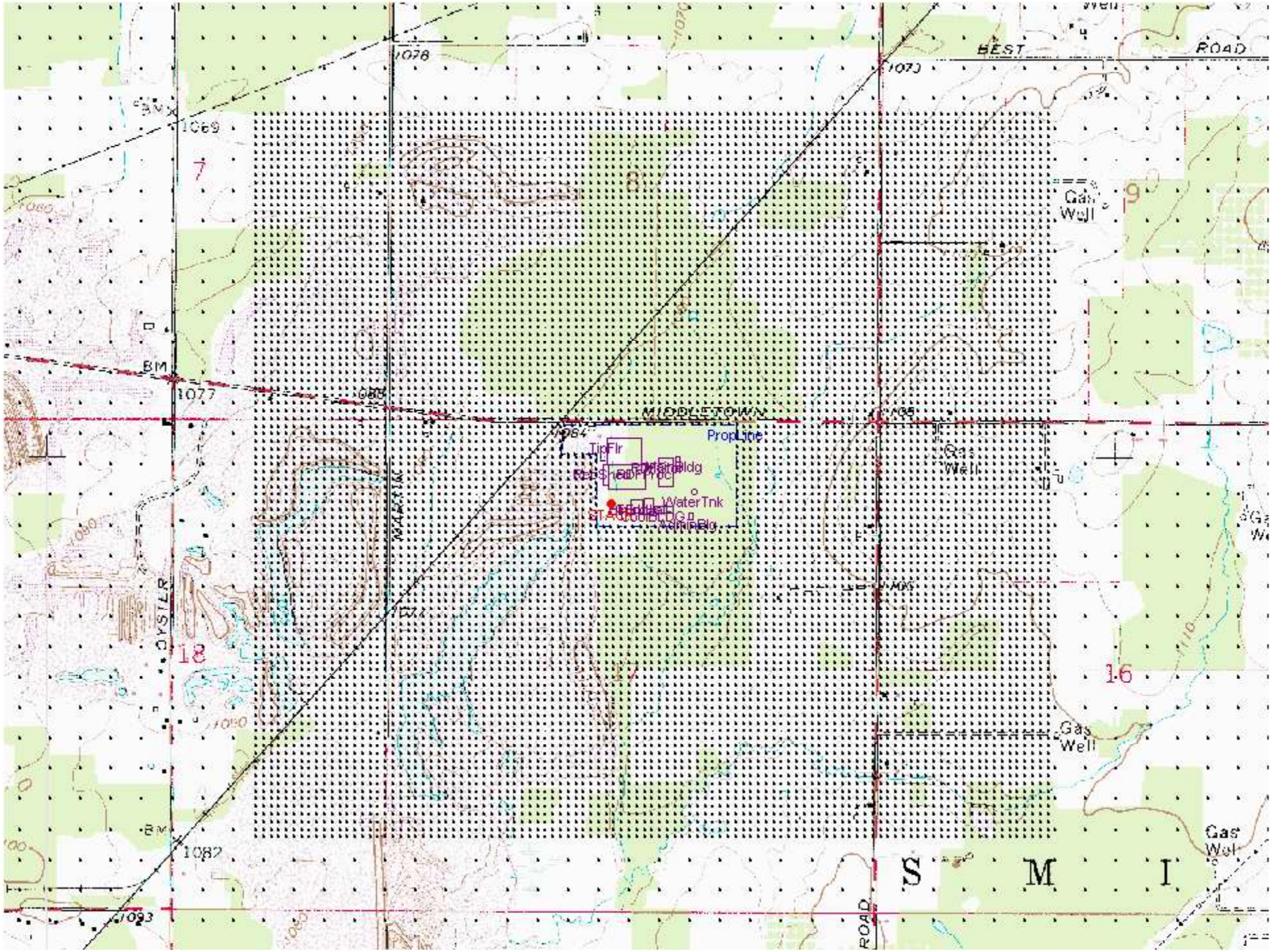
JEFFERSON RENEWABLE ENERGY

MAHONING RENEWABLE ENERGY FACILITY

JOB NO: 219641
DATE: OCTOBER 10, 2008
SCALE: 1"=500'

Figure A - 9

Mahoning Renewable Energy Near-Grid Receptors

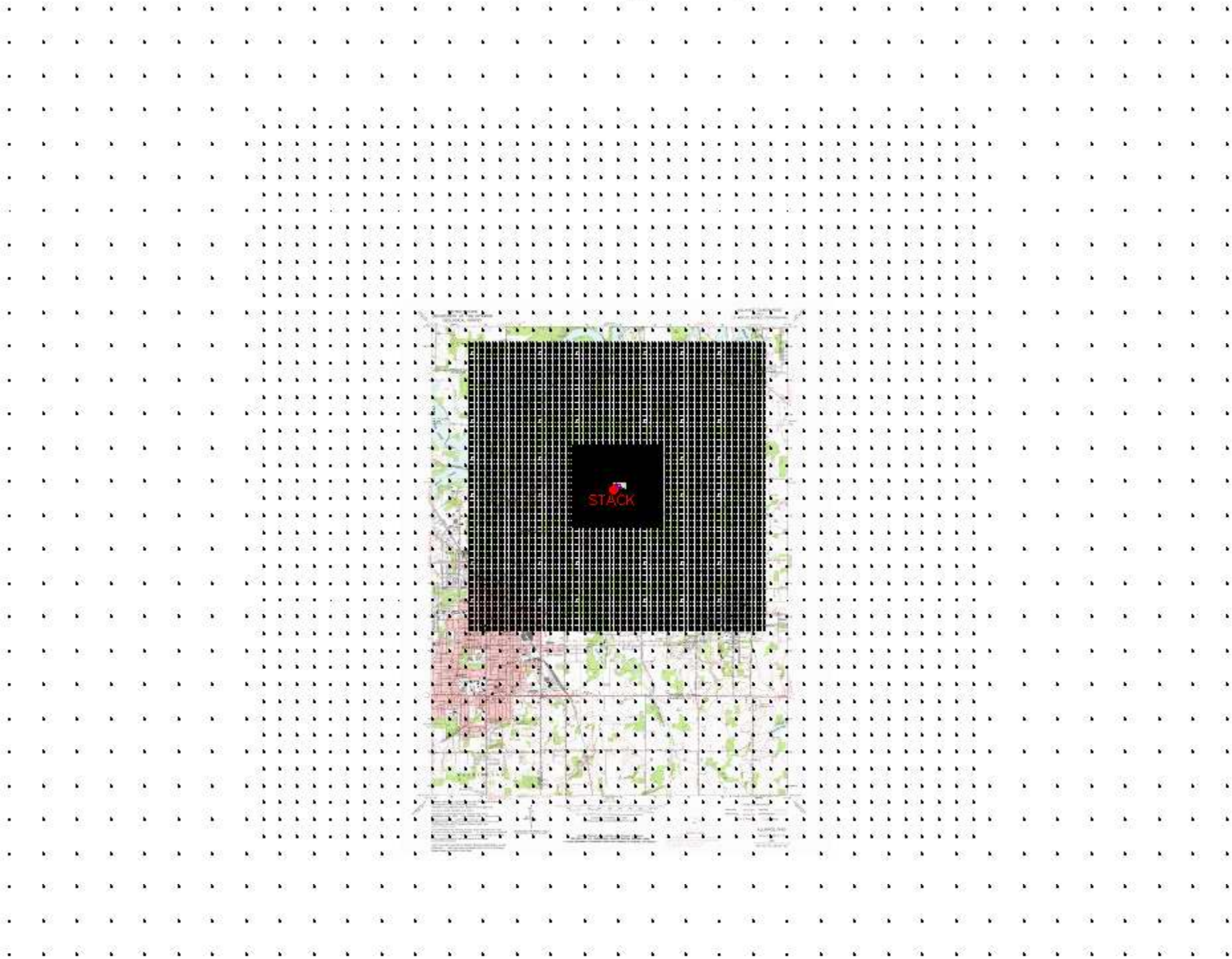


MRE Air Quality Analysis - Revised Plant Layout and Revised NOx Emis

Scale: 1" = 415.7 Meters

Figure A-10 Near-Grid Receptor Locations

Mahoning Renewable Energy Far-Grid Receptors



MRE Air Quality Analysis - Revised Plant Layout and Revised NOx Emis

Scale: 1" = 3767.9 Meters

Figure A-11 Far-Grid Receptor Locations