APPENDIX L. EVAPORATION POND NEAR-FIELD AIR QUALITY TECHNICAL SUPPORT DOCUMENT

Supplemental Air Quality Impact Analysis
Alternative F

Gasco Energy Inc.
Uinta Basin Natural Development Project
Environmental Impact Analysis

Water Evaporation Facility
Evaporation Pond Complex and Generator

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1. INTRODUCTION

Gasco Energy (Gasco), as part of the proposed Uinta Basin Natural Gas Development Project is planning to develop a Water Evaporation Facility (WEF) consisting of an evaporation pond complex and on-site electrical generation to support proposed well development project in the project area. The proposed facility is located approximately 7 miles southwest of Myton, Utah, in Section 13, Township 4S, Range 3W, Duchesne County. Approximate universal transverse mercator (UTM) coordinates for the center of the facility are 594,120 m Easting, 4,429,500 m Northing, Zone 12.

This analysis evaluates emissions from the WEF under the development scenario proposed under Alternative F of the environmental impact statement (EIS). Under Alternative F of the EIS, the proposed WEF will have one generator engine operating at approximately 1,320 horsepower (hp). The generator will be located in a generator/maintenance building. When constructed, the evaporation pond complex will consist of a series of evaporation ponds, to be built as needed, to handle the produced water as the wells proposed under Alternative F are developed. For modeling purposes, the evaporation pit was modeled at full build out and the produced water disposal rate based on the number of wells to be developed in the first 5 years of proposed development under Alternative F. The model analysis also included the nearest 8 wellsites, and the equipment at each of those well sites consisting of two stock tanks and one separator heater.

This analysis is being completed for 1-hour nitrogen dioxide (NO_2) impacts from the generator engine and well site sources, and impacts from the evaporation pond complex and generator for the following hazardous air pollutants (HAPs), benzene, toluene, ethylbenzene, xylene and methanol.

Figure 1 presents the evaporation pit site diagram information input into AERMOD for modeling, which includes the Gasco emission points at the evaporation pond facility, including the generator and the evaporation pond, the sites fenceline and the nearby receptors. Figure 2 presents all modeled Gasco sources and the full receptor grid.

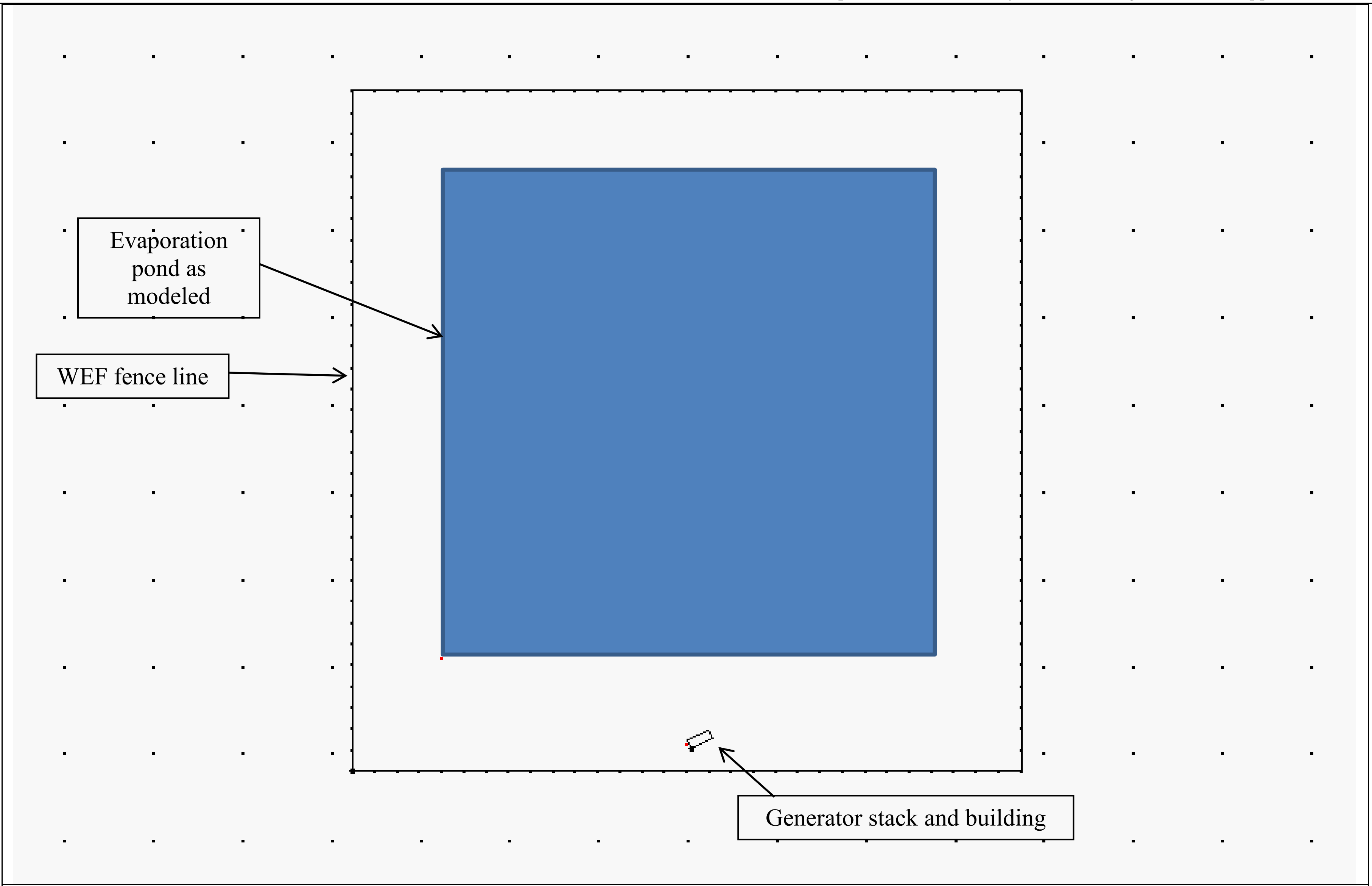


Figure 1. Site diagram – Gasco WEF and nearby receptors

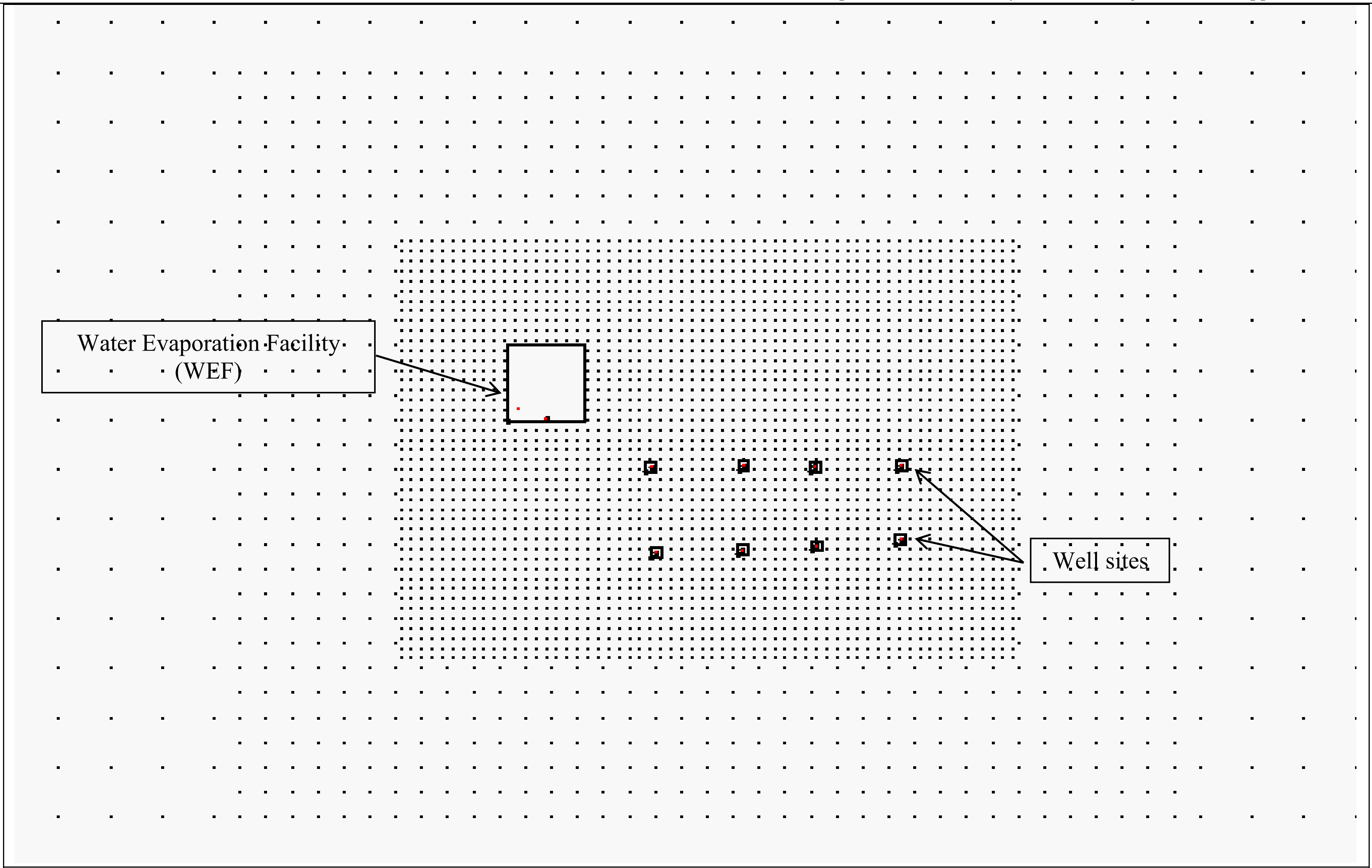


Figure 2. Site diagram – All modeled Gasco sources and full receptor grid

2. REGULATORY STANDARDS

2.1 Criteria Emissions

Utah and National Ambient Air Quality Standards (UAAQS and NAAQS) have been promulgated for the purpose of protecting human health and welfare with an adequate margin of safety. Pollutants for which standards have been determined include sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), particulate matter less than 10 microns in diameter (PM_{10}) and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$).

The only criteria pollutant being modeled in this analysis is nitrogen oxides (NO_X) from the proposed generator engine for comparison to the 1-huor NO_2 NAAQS. NO_X is emitted from the proposed on-site 1,320 hp generator. The majority of NO_X is emitted as nitric oxide (NO) which will gradually convert to NO_2 depending on the amount of sunlight and the amount of ambient ozone.

The NAAQS has recently been revised to reflect changes to the NO_2 1-hr standard. The standard 1-hr standard NO_2 is set at 100 parts per billion (ppb) (or 188 $\mu g/m^3$) based on the 3-year average of the 98th percentile of the annual distribution of the daily maximum 1-hour concentrations. The new standard was published in the Federal Register on February 9, 2010, and became effective on April 12, 2010.

2.2 Hazardous Air Pollutant Standards

Hazardous Air Pollutants (HAPs) emissions analyzed from the WEF project include benzene, toluene, ethylbenzene, xylene and methanol. Since there are no applicable federal ambient air quality standards for the above pollutants, Reference Concentrations (RfC) for chronic inhalation exposure and Reference Exposure Levels (REL) for acute inhalation exposures are applied as significance criteria. The RfCs represent an estimate of the continuous (i.e. annual average) inhalation exposure rate to the human population (including sensitive subgroups such as children and the elderly) without an appreciable risk of harmful effects. The RELs represent the acute (i.e. one-hour average) concentration at or below which no adverse health effects are expected; set by California EPA. Both the RfC and REL guideline values are for non-cancer effects.

Concentrations and exposure levels for the RfCs and RELs are provided in Table 2-1.

Table 2.1 HAP Reference Exposure Levels and Reference Concentrations

Hazardous Air Pollutant	Reference Exposure Level [a] [REL 1-hr Average] (µg/m^3)	Reference Concentration [a] [RfC Annual Average] (µg/m^3)
Benzene [b, c]	1,300	30
Toluene	37,000	5,000
Ethylbenzene	350,000	1,000
Xylene	22,000	100
Methanol	28,000	4,000

[a] EPA Air Toxics Database, Table 1 http://www.epa.gov/ttn/atw/toxsource/summary.html.
[b] EPA Air Toxics Database, Table 2.
[c] REL for benzene is based on a 6-hr exposure; predicted concentration is a 6-hr average.

The State of Utah has adopted Toxic Screening Levels (TSLs) to assist in the evaluation of hazardous air pollutants released into the atmosphere (Utah Department of Environmental Quality- Division of Air Quality 2000). The TSLs are derived from Threshold Limit Values (TLVs) published in the American Conference of Governmental Industrial Hygienists (ACGIH) – "Threshold Limit Values for Chemical Substances and Physical Agents" (American Conference of Governmental Industrial Hygienists 2007). These levels are not standards that must be met, but screening thresholds which if exceeded, would suggest that additional information is needed to evaluate potential health and environmental impacts. The TSLs are compared against modeling concentrations for averaging periods of 1-hour (short-term) and 24-hour (chronic). All applicable HAP's for this analysis have chronic TSLs.

Table 2-2 lists the corresponding TSLs for each applicable HAP.

Table 2.2 Utah Toxic Screening Levels (24-hour TSLs)

Pollutant	Toxic Screening Levels [a] (µg/m^3)
Benzene	53
Toluene	2,512
Ethylbenzene	14,473
Xylene	14,473
Methanol	9,282

[a] Source: Utah Department of Environmental Quality - Air Quality Division.

3. MODELING INFORMATION

3.1 Model Selection

The most recent version of the AERMOD (version no. 11103) air dispersion model was selected to perform this modeling analysis. AERMOD is an EPA approved steady-state model capable of analyzing multiple sources over distances of up to 50 km. All technical options within the model were set according to regulatory defaults. The current EPA approved AERMOD model version 11103 was utilized using Bee-Line software (version 9.90a).

3.2 Meteorological Data

No onsite meteorological data are available for the project area. Correspondence with the Utah Department of Environmental Quality – Division of Air Quality (UDEQ-DAQ) indicated that suitable meteorological data for AERMOD for a four-year period (2005-2008) was available from a monitor located in Vernal, Utah. For the analysis, all four calendar years of meteorological data were utilized. The data consist of surface measurements collected in Vernal, Utah for the years 2005, 2006, 2007 and 2008 combined with upper air data recorded in Grand Junction, Colorado. Individual model runs for each calendar year of data were completed for NO_2, as required by the post-processing program. For operation of the meteorological data, a profile base elevation of 1470 meters was utilized.

3.3 Terrain Elevation

Terrain elevations for receptors within the modeling domain were determined by AERMAP processed with National Elevation Dataset (NED) prepared by the U.S. Geologic Survey (USGS). NED provides elevations based upon 10 meter grid spacing (1/3 arc-second). Elevations were converted from the NED grid spacing to the model receptor grid spacing by interpolating from the elevation values closest to the receptor grid point.

3.4 Receptor Selection

The model receptors consisted of a series of Cartesian grids. The receptor grid is extended out to a distance of what is considered to be the maximum distance any noticeable impact could occur (5 kilometers). Table 3-1 presents the spacing of the receptor grid. Figures 1 and 2 above, shows the site diagram with surrounding discrete Cartesian receptors, including fenceline receptors.

3.5 Downwash Effects

There is one proposed building onsite for maintenance purposes. There are also two (2) proposed onsite storage tanks for each of the eight (8) tanks wellsites included in the model. The building and tanks are incorporated into the model as a concern for downwash and considered through the application of the BPIP model. The dimensions for the building are specified in Table 3-2.

3.6 PVMRM

This analysis used the Plume Volume Molar Ratio Method (PVMRM) predict the NO_X to NO_2 conversion within the stack. Background ozone data were utilized to determine the ambient conditions for the NO_2 impact. The local hourly ozone data used in this analysis was obtained from the analysis of a similar project (Greater Natural Buttes Supplement to the Draft Environmental Impact Statement, May 2011). No hourly ozone data was available for 2008.

Values used in the PVMRM analysis included setting the NO_X to NO_2 ratio (NO2STACK) to the default value of 0.10, and the equilibrium ratio (NO2EQUIL) set to 0.90 in accordance with UDEQ guidance.

3.7 Assumptions

Assumptions used for this analysis include:

Produced Water Sample Analysis: A total of 4 samples were obtained from facilities similar to the proposed WEF. Samples were analyzed for TPH-GRO using Method 8015, BTEX components using Method 8260, and Methanol using Method 8015. The results for each constituent were averaged. The averages of the sample values are shown below

- Benzene 10,783 µg/l (Method 8260)
- Toulene 25,925 µg/l (Method 8260)
- e-Benzene 1,466 µg/l (Method 8260)
- Xylene 21,675 µg/l (Method 8260)
- Methanol 629 mg/l (Method 8015)
- TPH (VOC) 169 mg/l (Method 8015)

Note: VOC emissions were not modeled

Produced Water Volume: Based on the information for Alternative F, a maximum disposal rate of 10,500 bbls/day of produced water was used in the analysis to calculate annual emissions.

Emission Calculation Methodology: For this analysis, a mass balance approach was used to calculate annual emissions from the evaporation pond. This conservative methodology assumes that all the BTEX and methanol introduced into the evaporation ponds in the produced water will be emitted, and does not account for potential biological degradation or adsorption.

Evaporation Pond Emission Rate: The disposal rate and the corresponding emissions were assumed to be spread equally throughout the year

Evaporation Pit Size: The proposed evaporation pond complex was simplified and modeled as one large 1800 ft. by 1800 ft. volume source. The WEF was modeled with a fence line 100 meters from the edges of the modeled evaporation pond.

Uncontrolled Emissions Case: One model run was conducted assuming that no emission control was incorporated to control HAP emissions from the evaporation pond. Emissions are presented below in Tables 3-4 through 3-8.

Controlled Emission Case: For the controlled emissions scenario, a control efficiency of 60% for the BTEX components was applied to the HAPs (except methanol) emissions from the evaporation pond, based on the use of Dissolved Air Floatation (DAF) as a control measure. DAF involves pre-treatment of the produced water before disposal in the evaporation ponds. Emissions are presented below in Tables 3-4 through 3-8.

Methanol concentrations are unaffected by the use of DAF, and therefore were not adjusted by the 60% control factor.

Generator Engine: The analysis was run using the emission and stack exhaust parameters from a typical Caterpillar 3516LE generator set that uses natural gas as a fuel. The engine emissions were based on the emissions at 100% load, and assumed full time operation (i.e. 8,760 hours/yr).

The exact engine type and emissions are unknown at this time as the generator equipment cannot be explicitly identified due to uncertainties in equipment availability and other factors (i.e. required load, equipment suitability). Generally, the generator engine at the WEF will have to meet the Vernal BLM RMP specified emission factor of 1 g/hp-hr for field engines rated greater than 300 hp. Additional analysis can be performed when the actual equipment to be installed is identified to determine compliance with the 1-hour NO_2 NAAQS, and to comply with any requirement under the Tribal NSR regulation.

3.8 Model Inputs

Inputs used in this analysis are presented in Tables 3-1 through Table 3-10.

Table 3-1 - Receptor Grid Summary

Receptor Interval	Receptor Spacing
Facility Fenceline	25 meters
Fenceline to 1000 meters	100 meters
1000 meters to 2500 meters	250 meters
2500 meters to 5000 meters	500 meters

Table 3-2 – Building Parameters

Maintenance Building (roof ht. 3.66 m)	
Easting	Northing
594,203	4,429,506
594,198	4,429,516
594,222	4,429,526
594,227	4,429,518

The calculated facility emission rates, assuming constant operation, are summarized in Table 3.3 through Table 3.8. Exhaust stack parameters are summarized in Table 3.9.

Table 3.3 – NO_X Emission Rates (100% Load)

Source	Emission Factor (g/hp-hr)	Emission Rate (lb/hr)	Emission Rate (tons/year)
Generator Engine	1.0	2.95	12.75
Separators (each)	-	0.038	0.167

Table 3.4 – Benzene Emission Rates

Source	Uncontrolled Emission Rate (lb/hr)	Uncontrolled Emission Rate (tons/year)	Controlled Emission Rate (lb/hr)	Controlled Emission Rate (tons/year)
Generator Engine	0.005	0.021	0.005	0.021
Evaporation Pond	1.65	7.23	0.66	2.89

Assumed 60% control efficiency

Table 3.5 – Toluene Emission Rates

Source	Uncontrolled Emission Rate (lb/hr)	Uncontrolled Emission Rate (tons/year)	Controlled Emission Rate (lb/hr)	Controlled Emission Rate (tons/year)
Generator Engine	0.004	0.019	0.004	0.019
Evaporation Pond	3.97	17.37	1.59	6.95

Assumed 60% control efficiency

Table 3.6 – Ethylbenzene Emission Rates

Source	Uncontrolled Emission Rate (lb/hr)	Uncontrolled Emission Rate (tons/year)	Controlled Emission Rate (lb/hr)	Controlled Emission Rate (tons/year)
Generator Engine	0.000	0.002	0.000	0.002
Evaporation Pond	0.224	0.983	0.09	0.39

Assumed 60% control efficiency

Table 3.7 – Xylene Emission Rates

Source	Uncontrolled Emission Rate (lb/hr)	Uncontrolled Emission Rate (tons/year)	Controlled Emission Rate (lb/hr)	Controlled Emission Rate (tons/year)
Generator Engine	0.002	0.009	0.002	0.009
Evaporation Pond	3.32	14.52	1.33	5.81

Assumed 60% control efficiency

Table 3.8 – Methanol Emission Rates (Assumed to be equal for both the Uncontrolled and Controlled cases)

Source	Emission Rate (lb/hr)	Emission Rate (tons/year)
Generator Engine	0.033	0.146
Evaporation Pond	96.21	421

Table 3.9– Point Source Stack Parameters

Source	Stack Height (ft)	Temperature (°F)	Exit Velocity (ft/s)	Stack Diameter (ft)
Generator Engine	20.0	855	163	1.0
Separators	15.1	800	9.32	0.75

Table 3.10 – Volume Source Release Parameters

Source	Release Height (m)	Horizontal Dimension [a] (m)	Vertical Dimension [b] (m)
Evaporation Pond	0.00	127.7	1.395

[a] Horizontal dimension calculated by dividing the horizontal length of the source by 4.30 in accordance with EPA ISC User's Guide 1.2.2 of Volume II, Table 3.1 (549 meters \ 4.30 = 127.7)
[b] Vertical dimension calculated by dividing vertical height of the source by 2.15 in accordance with EPA ISC User's Guide 1.2.2 of Volume II, Table 3.1 (3 meters \ 2.15 = 1.395)

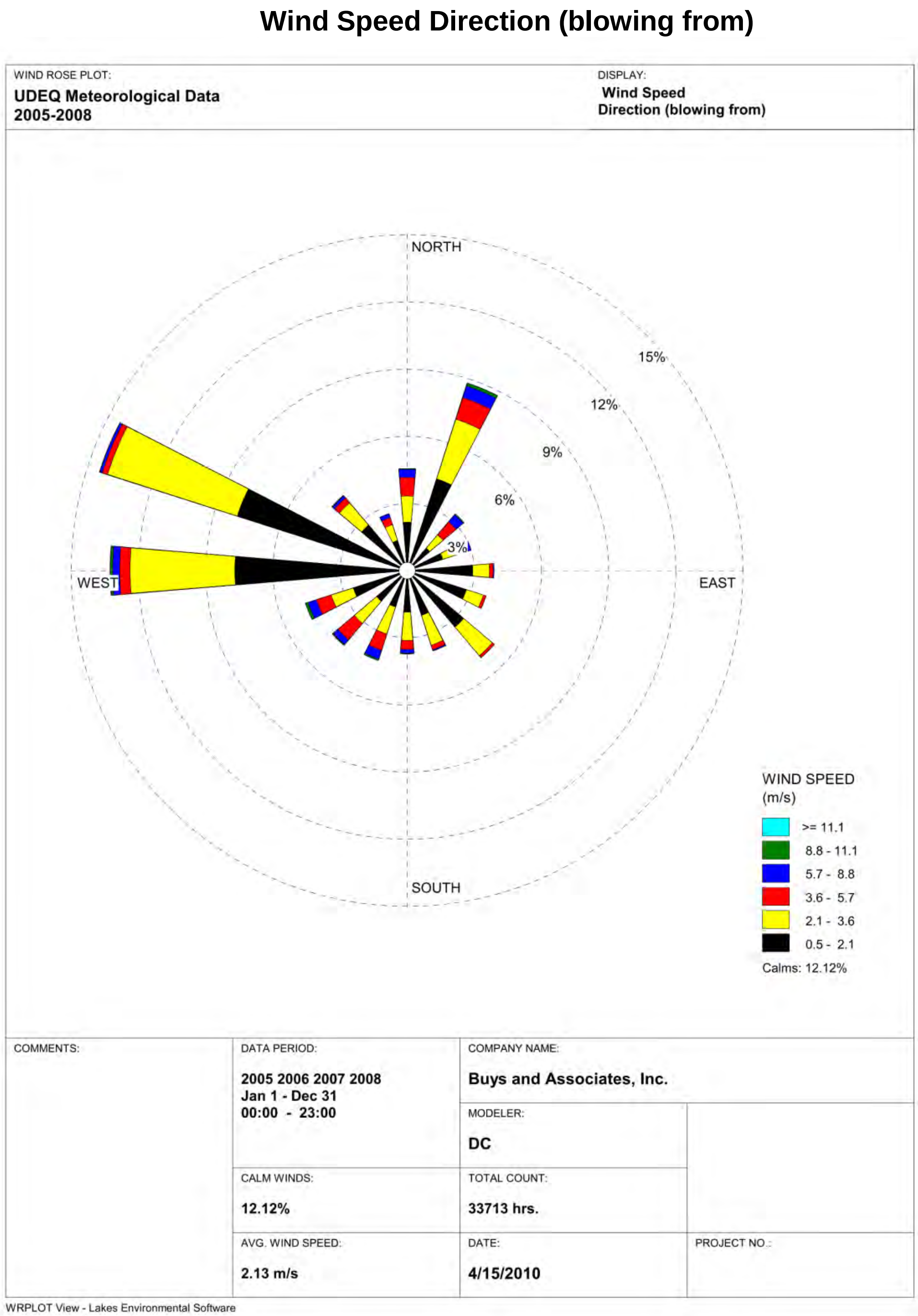


Figure 3 Wind rose from AERMET Vernal, UT data years 2005-2008

4. IMPACT ANALYSES

4.2 NO_2 Analysis

4.2.1 1-Hour NO_2 Analysis

NO_X will be emitted from the proposed generator (emission rate presented in Table 1).

The background concentration of 69 µg/m^3 is based on monitored values from the Uinta Basin (GNB SEIS May 2011).

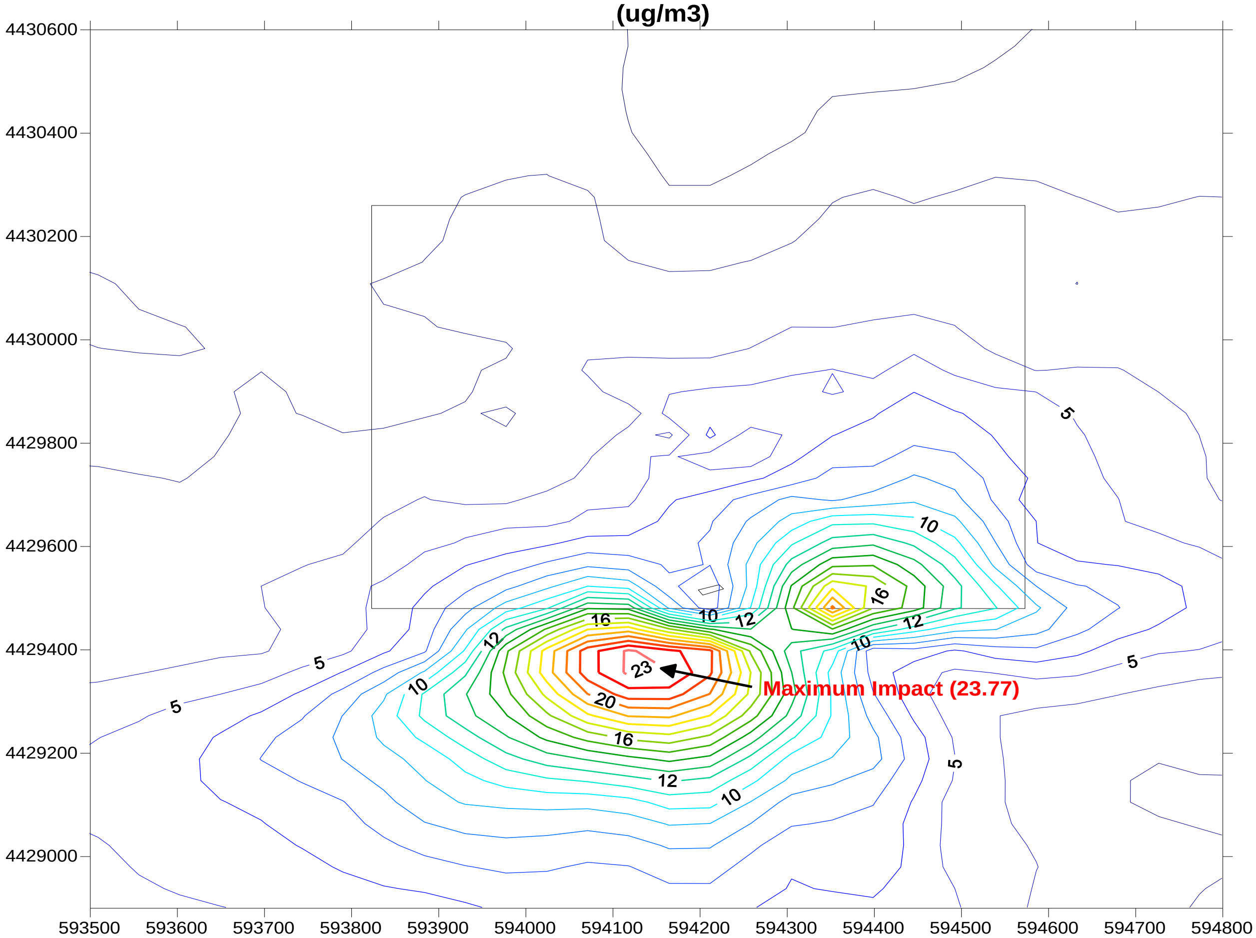
The NO_2 1-hour NAAQS is based on the 3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum concentrations. Table 4.1 illustrates that the maximum predicted NO_2 impact in addition to the background NO_2 concentration for the local area, is below the applicable NO_2 1-hour NAAQS.

Figure 4 presents the graphical output of the maximum NO_2 1-hour impact.

Table 4.1 Predicted 1-Hour 98th Percentile NO_2 Impact Comparisons to NAAQS (100% Load)

Source	Year	98th Percentile Predicted 1-hour NO_2 Impact (µg/m^3)	Local Area Background (µg/m^3)	Maximum Predicted 1-Hour NO_2 Combined Background (µg/m^3)	NAAQS (µg/m^3)	Cumulative Impact (% of NAAQS)
Gasco	2008	23.77	69	92.77	188	49.4%

Figure 4
NO2 1-hour Maximum Impact
(ug/m3)



4.2 HAPs Analyses

Modeled results for hazardous air pollutants (HAPs) were compared to the Utah screening levels, and the acute and chronic thresholds listed in Section 2 of this appendix. HAPs emissions associated with the WEF include benzene, toluene, ethylbenzene, xylene and methanol. The HAP emissions from the evaporation pond complex were modeled under two different scenarios.

- The uncontrolled scenario assumed that the HAPs are emitted with no emissions controls considered.
- The controlled scenario assumed a control efficiency of 60% for HAP emissions. The method of control was assumed to be dissolved air floatation (DAF). Methanol emissions were not adjusted due to the fact that DAF does not affect methanol concentrations.

Short-term impacts from HAP exposure were assessed by comparing one-hour average impacts to the HAP-specific acute REL (reference exposure level) and annual average impacts to the HAP-specific RfC (reference concentration for continuous inhalation exposure). The REL is the acute concentration at or below which no adverse health effects are expected. The RfC is the average concentration, i.e., an annual average, at or below which no long-term adverse health effects are expected. Both of these guideline values are for non-cancer effects.

Modeled results were also compared to the UDEQ TSL chronic values and discussed and presented in Section 2 of this appendix.

For the uncontrolled scenario, all modeled impacts were below the REL and RfC values. Modeled impacts for the uncontrolled scenario for toluene, e-benzene, xylene, and methanol were also below the TSL threshold, and only the modeled benzene impact was above the TSL standard.

For the controlled scenario, all modeled impacts were below the REL, RfC and TSL values.

Table 4.2 presents the predicted results of uncontrolled emission impacts and Table 4.3 presents the controlled emission impacts under the proposed action in comparison to the State of Utah TSLs. Table 4.2 and 4.3 also present the uncontrolled and controlled impacts compared to the acute RELs and RfCs for non-cancer effects for the Proposed Action. The controlled table shows that all HAPs are below all standards presented for the controlled scenario.

Table 4.2 Uncontrolled Scenario: HAP Impacts from the WEF

Pollutant	Maximum 1-hour Impact (μg/m^3)	REL 1-hour [a] (μg/m^3)	Maximum Annual Impact (μg/m^3)	RfC Annual [b] (μg/m^3)	Maximum 24-hour Impact (μg/m^3)	TSL 24-hour [c] (μg/m^3)
Benzene	164	1,300 [d]	22.7	30	***89.7***	***53***
Toluene	940	37,000	54.5	5,000	216	2,512
Ethylbenzene	53.2	350,000	3.09	1,000	12.2	14,473
Xylene	786	22,000	45.6	100	180	14,473
Methanol	22,806	28,000	1,322	4,000	5,232	9,282

[a] California EPA Reference Exposure Level (REL) for no adverse effects EPA Air Toxics Database, Table 2 (EPA 2007a).
[b] EPA Air Toxics Database, Table 1 (EPA 2007a).
[c] Source: Utah Department of Environmental Quality – Division of Air Quality (2008).
[d] Benzene REL based on a 6-hour average.

As can be seen from Table 4.2, uncontrolled scenario:

- The maximum 1-hour, 24-hour and annual impacts for Toluene are below the relevant REL, RfC and TSL values.

- The maximum 1-hour, 24-hour and annual impacts for Ethylbenzene are below the relevant REL, RfC and TSL values.

- The maximum 1-hour, 24-hour and annual impacts for Xylene are below the relevant REL, RfC and TSL values.

- The maximum 1-hour, 24-hour and annual impacts for Methanol are below the relevant REL, RfC and TSL values.

- The maximum 1-hour and maximum annual impacts for Benzene were below the REL and Rfc thresholds respectively. However, for the uncontrolled scenario, the 24-hour maximum impact for benzene is 89.7 μg/m^3, which is higher than the UDEQ TSL value of 53 μg/m^3.

Table 4.3 Controlled* Scenario: HAP Impacts from the WEF

Pollutant	Maximum 1-hour Impact (µg/m^3)	REL 1-hour [a] (µg/m^3)	Maximum Annual Impact (µg/m^3)	RfC Annual [b] (µg/m^3)	Maximum 24-hour Impact (µg/m^3)	TSL 24-hour [c] (µg/m^3)
Benzene	65.6	1,300 [d]	9.08	30	35.88	53
Toluene	376	37,000	21.8	5,000	86.4	2,512
Ethylbenzene	21.28	350,000	1.236	1,000	4.88	14,473
Xylene	314.4	22,000	18.24	100	72	14,473
Methanol	22,806	28,000	1,322	4,000	5,232	9,282

* Controlled emissions include a 60% reduction for the BTEX components, but no reduction of methanol.

[a] California EPA Reference Exposure Level (REL) for no adverse effects EPA Air Toxics Database, Table 2 (EPA 2007a).
[b] EPA Air Toxics Database, Table 1 (EPA 2007a).
[c] Source: Utah Department of Environmental Quality – Division of Air Quality (2008).
[d] Benzene REL based on a 6-hour average.

As can be seen from Table 4.3, controlled scenario:

- The maximum 1-hour, 24-hour and annual impacts for Benzene are below the relevant REL, RfC and TSL values.
- The maximum 1-hour, 24-hour and annual impacts for Toluene are below the relevant REL, RfC and TSL values.
- The maximum 1-hour, 24-hour and annual impacts for Ethylbenzene are below the relevant REL, RfC and TSL values.
- The maximum 1-hour, 24-hour and annual impacts for Xylene are below the relevant REL, RfC and TSL values.
- The maximum 1-hour, 24-hour and annual impacts for Methanol are below the relevant REL, RfC and TSL values.

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APPENDIX A

LIST OF MODEL FILES

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List of Model and Plot Files

BPIP Files	
***.PIP**	**Input files**
***.SO**	**Output files**
BPIP*.SUM	**Summary Output file**
***.TAB**	**Verbose Output file**
AERMOD Files	
*** _Poll.DTA**	**Input files for AERMOD; Poll. is Formaldehyde, Acrolein, (Annual) NO_X or (1-hr) NO_2**
***.LST**	**Model output list file**
***.SUM**	**Summary Output File**
***.GRF**	**Graphic Plot File**
Meteorological Data Files	
KVNL05_08.SFC or	**Processed meteorological input data; 05_08 indicates the modeling data year range (2005 – 2008).**
KVNLXX.SFC	**1-hour NO_2 modeling required individual years; XX indicates the modeling data year.**
Ozone Files	
Ouray_03 – Ouray_07.OUT	**Background ozone data from the Greater Natural Buttes analysis; 03-07 indicates the modeling data year range (2003 – 2007).**
KVNLXX.SFC	**1-hour NO_2 modeling required individual years; XX indicates the modeling data year.**
Topographic Data	
47361719.tif	**NED File**

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APPENDIX B

MODELING FILES

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The Appendix L Modeling Files document is included on the CD.

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