2.0 EMISSION INVENTORY - DESOLATION FLATS PROJECT RELATED SOURCES

The emission inventory for sources directly associated with the Desolation Flats project was developed based upon emissions inventories for similar studies in Wyoming. The inventory includes five criteria pollutants; oxides of nitrogen (NO_X), sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter less than 10 microns and 2.5 microns (PM_{10} and $PM_{2.5}$), and volatile organic compounds (VOCs). Hazardous air pollutants (HAPs) including benzene, toluene, ethylbenzene, xylene (BTEX), n-hexane, and formaldehyde were also estimated in the inventory.
Project related activities evaluated in the inventory include:

- construction emissions, including well pad and resource road construction;
- well drilling, completion and testing;
- wind erosion of disturbed areas;
- well production emissions, and
- gas compression and processing.

The types of new sources proposed for Desolation Flats are similar to the sources affiliated with other similar projects throughout southwest Wyoming. The inventory presented herein is developed for both individual wells and the entire well field. The maximum required compression for gas transportation is calculated at 30,000 horsepower based upon a production rate of up to 385 million standard cubic feet per day (MMscf/day). On average, approximately two barrels of condensate will be produced for every million cubic feet of gas, resulting in a total condensate production rate of 770 barrels (bbls) per day. Full field development is expected to consist of 385 active wells producing 1.0 MMscf/day each. This inventory represents the project "potential to emit," which assumes continuous operation of wells and compressors (i.e., 8,760 hours per year).

2.1 Short-Term Project Development Emissions

Air emissions will result from three sequential short term development activities: well pad and resource road construction, well drilling, and well completion. These development activities consist of different sources of air emissions and are discussed separately in the following sections. Emissions of both criteria pollutants and HAPs are estimated for each activity, when applicable. The emission calculations for each of the activities described below, along with any pertinent assumptions, are provided in Appendix A.

2.1.1 Well Pad and Resource Road Construction

Well pad and resource road construction consists of the clearing, grading, and construction of the resource road and well pad. The emission sources affiliated with this activity include fugitive dust emissions from travel on unpaved roads (haul trucks, pickup trucks, etc.) and heavy construction operations, plus tailpipe emissions from mobile sources (haul trucks and heavy equipment, including a dozer, a grader, and a backhoe) used in the construction process. Assumed controls for these activities include watering well pads and resource roads during construction to control the emission of fugitive particulate matter. The watering control efficiency was assumed to be 50 percent as recommended by the WDEQ-AQD.

2.1.2 Well Drilling

Well drilling activities consist of the mobilization of the drill rig, drilling of the well, and de-mobilization of the rig. The emission sources associated with well drilling include fugitive dust emissions from travel on unpaved roads (18-wheeler semi-trailer trucks, support trucks, and crew pickup trucks), plus tailpipe emissions from mobile sources (heavy duty diesel engine powered trucks and drill rigs) used in the drilling process. Particulate matter control was assumed to be watering on the unpaved roads, with a control efficiency of 50 percent.

2.1.3 Well Completion and Testing

The emission sources associated with well completion include fugitive dust emissions from travel on unpaved roads (18-wheeler semi-trailer trucks, support trucks, and pickup trucks), tailpipe emissions from mobile sources (heavy-duty diesel engine powered trucks), and the flaring of natural gas for well evaluation. Particulate matter control was assumed to be watering on the unpaved roads, with a control efficiency of 50 percent.

2.1.4 Short-Term Maximum (Hourly) Well Development Emissions

The short-term maximum (hourly) emissions were estimated on a per-well basis. For the calculation of short-term emissions, the consecutive nature of these activities was taken into account. During a one-hour period at a given well, only one of the three development activities; road construction, drilling, or completion, would be taking place. Also, it was conservatively assumed that wind erosion could potentially occur during any of the three development activities. Therefore, short-term emissions were calculated as the maximum hourly emission rate from the three development activities plus wind erosion emissions. Table 2.1 presents a summary of the short-term emissions resulting from construction.

2.1.5 Long-Term (Annual) Well Development Emissions

Long-term well development emissions were estimated on an annual basis assuming a development rate of 45 wells per year. Typically, each constructed well would undergo all three development activities; construction, drilling, and completion, over the course of a year. Therefore, long-term emissions were calculated as the sum of the emissions from the three development activities plus wind erosion emissions, as presented in Table 2.2.

2.1.6 Distribution of Emissions for Modeling

The emissions from development activities are diffuse by nature and the exact location of the sources cannot be accurately predicted. Therefore, the emissions from development activities are treated as area sources in the dispersion modeling. For the long-term averaging period, emissions resulting from well development (assuming 45 wells are constructed per year) are distributed evenly over the Desolation Flats Project Area.

TABLE 2.1 - SHORT-TERM WELL DEVELOPMENT EMISSIONS

Pollutant	Individual Well Emissions (lb/hour/well)				Wind Erosion	Maximum Total (lb/hr/well)
	Construction	Drilling	Completion	Development		
NO_X	2.69	24.05	2.65	0.11	-	24.05
CO	0.90	5.81	14.32	0.40	-	14.32
VOCs	0.15	0.73	2.47	0.07	-	2.47
SO_2	0.08	0.41	0.01	0.00	-	0.41
PM_{10}	5.62	4.90	18.89	8.37	0.06	18.95
$PM_{2.5}$	1.28	1.11	2.99	1.22	0.02	3.01
Benzene	-	-	-	-	-	negligible
Toluene	-	-	-	-	-	negligible
Xylenes	-	-	-	-	-	negligible
Ethylbenzene	-	-	-	-	-	negligible
n-Hexane	-	-	0.06	0.06	-	0.06
Formaldehyde	0.06	-	-	0.06	-	0.06

TABLE 2.2 - LONG-TERM WELL DEVELOPMENT EMISSIONS

Pollutant	Annual Well Development Emissions (tons/year)				Wind Erosion	Total Emissions (tons/year)
	Construction	Drilling	Completion	Development		
NO_X	2.42	714.16	4.68	0.08	-	721.35
CO	0.81	172.45	25.19	0.29	-	198.73
VOCs	0.14	21.76	4.23	0.05	-	26.17
SO_2	0.07	12.09	0.04	-	-	12.20
PM_{10}	5.06	145.47	67.47	6.03	12.20	236.21
$PM_{2.5}$	1.15	33.00	10.23	0.88	4.88	50.14
Benzene	-	-	-	-	-	negligible
Toluene	-	-	-	-	-	negligible
Xylenes	-	-	-	-	-	negligible
Ethylbenzene	-	-	-	-	-	negligible
n-Hexane	-	-	0.10	-	-	0.10
Formaldehyde	0.06	-	-	-	-	0.06

2.2 Well Production Emissions

Emissions to the atmosphere result from several aspects of gas production: three-phase separation, triethylene glycol (TEG) dehydration, and condensate storage. Each of these processes are discussed separately in this section. The emissions of both criteria pollutants and HAPs are estimated for each process as applicable.

The emission calculations for each of the production sources described below, along with any pertinent assumptions, are provided in Appendix A.

2.2.1 Three-Phase Separator and Glycol Regeneration Heaters

A natural gas-fired three-phase separator heater, rated at 750,000 BTU per hour, will operate an average of 15 minutes per hour throughout the year. In addition, a glycol regeneration heater, rated at 250,000 BTU per hour, is assumed to operate 15 minutes per hour on average throughout the year. To account for seasonal variation in heater operations, the heater emissions were weighted for the impact analysis. During the winter months of November through April, the heater emissions were weighted at 172% of the average rate, while the remaining summer months were weighted at 28% of the average emission rate.

Note that the three-phase separator and TEG dehydrator also emit VOCs and HAPs. The separator emissions result from the flashing of condensate when it is transferred to the storage tank. The dehydrator still vent emits hydrocarbons that were stripped from the produced gas during the dehydration process. These emissions are discussed separately below.

2.2.2 Glycol Dehydration System - VOC/HAPs Emissions

VOC and HAPs emissions from the glycol dehydration system were estimated using the Gas Research Institute's (GRI's) GLYCALC emissions estimation program. Dehydrator still vent emissions are dependent upon the produced gas composition and throughput. For this study, predicted emissions from a typical well were calculated assuming an average production rate of 1.0 MMscf/day. The inlet gas composition was estimated by averaging the gas analyses from three existing wells in the study area. HAPs concentrations were conservatively estimated at the maximum concentration observed in the three existing wells. Dehydrator emissions were calculated on an individual well and a total project basis. It was assumed that no controls will be required for dehydrator still vent emissions.

2.2.3 Flashing

Flashing emissions occur as a result of pressure differentials between the separator and the storage tank. For this study, the flashing of VOCs and HAPs from a condensate storage tank were estimated utilizing a HYSYM process simulation conducted for a well located near the study area. Individual well flashing emissions were based upon an average condensate production rate of two barrels per day. Since the average rate of condensate production is relatively low, it was assumed that no controls would be required for flashing emissions.

2.2.4 Storage Tank Working and Breathing Emissions

Storage tank working and breathing losses occur as a result of the filling and emptying of the storage tanks in addition to the daily heating and cooling of the condensate which results in thermal expansion. An emission estimation program, EPA Tanks 4.0, was utilized to calculate the storage tank emissions. For this analysis, the condensate was assumed to have an average Reid vapor pressure of 8.0. Again, an average condensate production rate of two barrels per day was assumed.

2.2.5 Fugitive VOC Emissions

Fugitive VOC emissions from gas well production facilities typically account for less than one percent of the VOC emission inventory. Therefore, fugitive VOC emissions were assumed to be negligible for the Desolation Flats Project.

2.2.6 Wind Erosion Emissions During Production

Wind erosion emissions were calculated for disturbed areas including well pads and access roads. The erosion estimates were based upon meteorological data measured at Baggs, Wyoming in 1995.

2.2.7 Long-Term (Annual) Production Emissions

Long-term production emissions were summarized for an individual well and the entire project. Tables 2.3 and 2.4 present the annual production emissions. These emission rates were based upon maximum project production rates of 385 MMscf/day of natural gas and 770 bbls/day of condensate.

TABLE 2.3 - INDIVIDUAL WELL PRODUCTION EMISSIONS

Pollutant	Individual Well Production Emissions (tons/year)						
	Separator Heater	Dehydrator Heater	Dehydration Still Vent	Storage Tank Flash	Tank Working and Storage	Wind Erosion	Well Production Emissions
NO_X	0.082	0.026	-	-	-	-	0.11
CO	0.017	0.011	-	-	-	-	0.03
VOC	-	-	11.32	26.06	0.95	-	38.32
SO_2	-	-	-	-	-	-	negligible
PM_{10}	0.006	0.002	-	-	-	0.27	0.28
$PM_{2.5}$	0.006	0.002	-	-	-	0.11	0.12
Benzene	-	-	0.87	0.07	-	-	0.94
Toluene	-	-	2.26	0.08	-	-	2.34
Ethylbenzene	-	-	1.23	-	-	-	1.23
Xylenes	-	-	1.60	0.02	-	-	1.62
n-Hexane	0.001	-	0.08	-	-	-	0.08
Formaldehyde	-	-	-	-	-	-	negligible

TABLE 2.4 - PROJECT PRODUCTION EMISSIONS

Pollutant	Project Production Emissions (tons/year)						
	Separator Heater	Dehydrator Heater	Dehy Still Vent	Storage Tank Flash	Tank Working and Storage	Wind Erosion	Project Production Emissions
NO_X	31.618	9.907	-	-	-	-	41.53
CO	6.640	4.216	-	-	-	-	10.86
VOC	0.175	0.080	4,358	10,031	365.52	-	14,755
SO_2	-	-	-	-	-	-	negligible
PM_{10}	2.403	0.801	-	-	-	48.25	51.45
$PM_{2.5}$	2.403	0.801	-	-	-	19.30	22.50
Benzene	0.001	-	334.95	25.32	-	-	360.27
Toluene	0.001	-	870.10	32.56	-	-	902.66
Ethylbenzene	-	-	473.55	0.91	-	-	474.46
Xylenes	-	-	616.00	8.77	-	-	624.77
n-Hexane	0.569	0.190	30.80	-	-	-	31.56
Formaldehyde	0.024	0.008	-	-	-	-	0.03

2.3 Compression Emissions

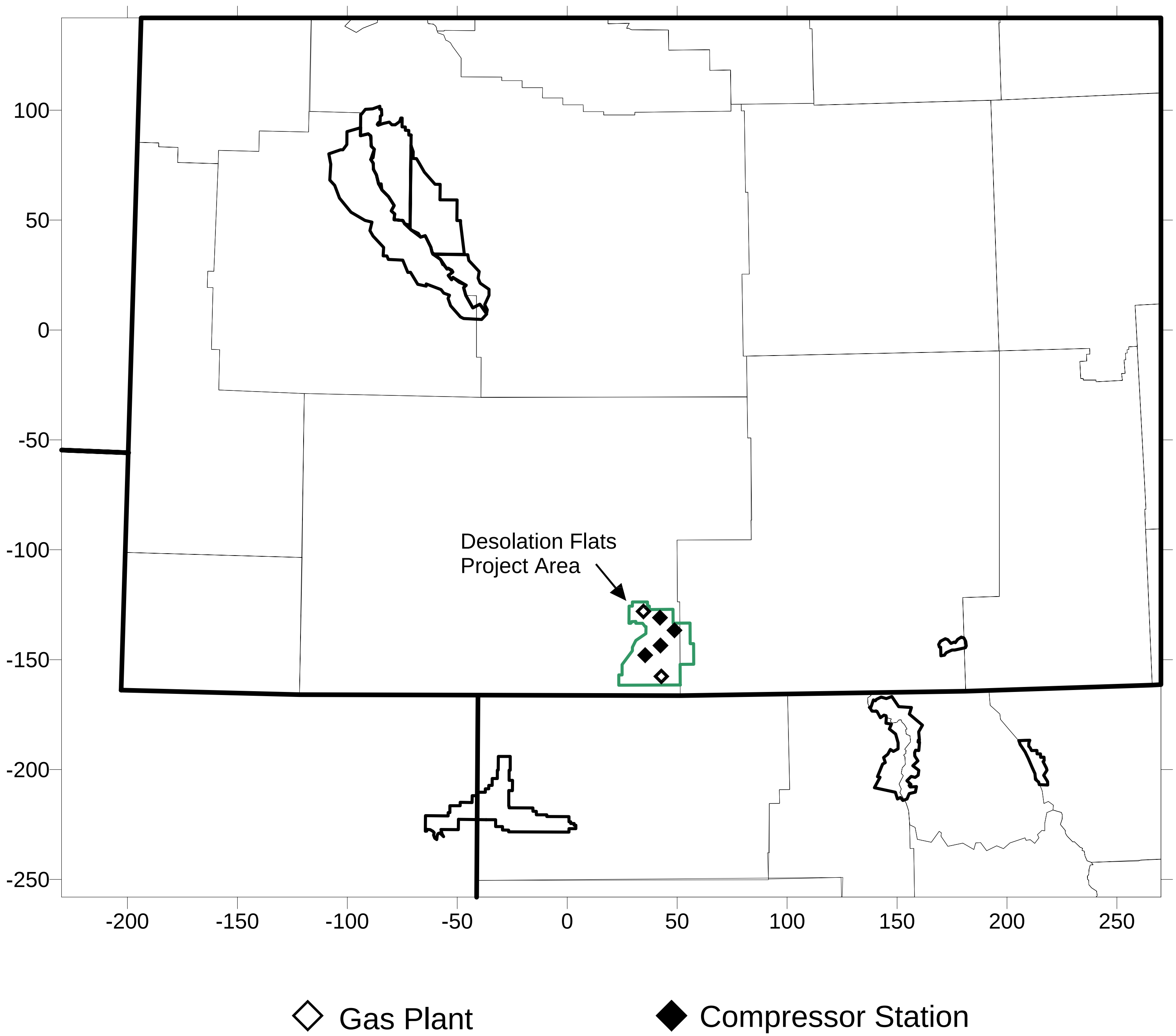
The emissions from compression were calculated for a total of 32,000 horsepower, based upon estimated project requirements of 30,000 horsepower for gas transportation and 2,000 horsepower for gas plant processing. Application of state-regulated Best Available Control Technology (BACT) was considered in estimating the compression emissions. Current control technology can reduce NO_X emissions to between 0.7 and 1.5 grams per horsepower-hour (g/hp-hr). NO_X emissions were quantified at the most typical rate of 1.0 g/hp-hr, while CO and VOC emissions were quantified at 3.0 g/hp-hr and 0.5 g/hr-hr respectively. Hazardous air pollutant emission rates were estimated based on AP-42 emission factors. Compression and processing emissions are summarized in Table 2.5.

Compressor sources are treated as point sources in the CALPUFF modeling. The potential distribution of the compressor stations and gas plants was assumed, considering the location of the existing pipelines. Figure 2.1 presents the compressor station and gas plant locations utilized for the analysis. For the modeling, it was assumed that each compressor exhaust stack was located along the north side of a 20-foot tall (to roof peak) compressor building, measuring 36 feet in length and 30 feet in width.

TABLE 2.5 - GAS COMPRESSION AND PROCESSING EMISSIONS

Pollutant	Emissions (lb/hr)	Emissions (tons/yr)
NO_X	70.55	309.0
CO	211.64	927.0
VOCs	35.27	154.5
SO_2	-	negligible
PM_{10}	1.55	6.8
$PM_{2.5}$	1.55	6.8
Benzene	0.13	0.6
Toluene	0.05	0.2
Ethylbenzene	-	negligible
Xylenes	0.02	0.1
Formaldehyde	10.58	46.3

Figure 2-1
Desolation Flats Compressor and Gas Plant Locations



2.4 Total Project Emissions Summary

The total annual emissions for the project, including well development, production and compression are summarized in Table 2.6

TABLE 2.6 - TOTAL PROJECT EMISSIONS

Pollutant	Total Project Emissions (tons/year)			
	Well Construction and Development	Well Production	Gas Compression and Processing	Total Project Emissions
NO_X	721.3	41.5	309.0	1,072
CO	198.7	10.9	927.0	1,137
VOCs	26.2	14,755	154.5	14,936
SO_2	12.2	-	-	12.2
PM_{10}	236.2	51.4	6.8	294.5
$PM_{2.5}$	50.1	22.5	6.8	79.4
Benzene	-	360.3	0.6	360.8
Toluene	-	902.7	0.2	902.9
Ethylbenzene	-	474.5	-	474.5
Xylenes	-	624.8	0.1	624.8
n-Hexane	0.1	31.6	-	31.7
Formaldehyde	0.1	0.03	46.3	46.4