3.0 NEAR-FIELD MODELING ANALYSES

3.1 MODELING METHODOLOGY

A near-field ambient air quality impact analysis was performed to quantify the maximum criteria pollutants (PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2, and ozone [O_3]) and HAPs (BTEX, n-hexane, and formaldehyde) impacts that could occur within and near the JIDPA. These impacts would result from emissions associated with Project construction and production activities, and are compared to applicable ambient air quality standards, and significance thresholds. All modeling analyses were generally performed in accordance with the Protocol presented in Appendix A with input from the BLM and members of the air quality stake holders' group, including the EPA, USDA Forest Service, and WDEQ-AQD.

The EPA's proposed guideline dispersion model, AERMOD (version 02222), was used to assess near-field impacts of criteria pollutants PM_{10}, $PM_{2.5}$, CO, NO_2 and SO_2, and to estimate short-term and long-term HAP impacts. This version of AERMOD utilizes the PRIME building downwash algorithms which are the most recent "state of science" algorithms for modeling applications where aerodynamic building downwash is a concern. One year of JIDPA meteorology data was used with the AERMOD dispersion model to estimate these pollutant impacts. O_3 impacts were estimated from a screening methodology developed by Scheffe (1988) that utilizes NO_x and VOC emissions ratios to calculate O_3 concentrations. Various construction and production activities were modeled to provide for a complete range of alternatives and activities. For each pollutant, the magnitude and duration of emissions from each Project phase (i.e., construction or production) emissions activity were examined to determine the maximum emissions scenario for modeling.

3.2 METEOROLOGY DATA

One year of surface meteorological data, collected in the JIDPA from January 1999 through January 2000, was used in the analysis. A wind rose for these data is presented in Figure 3.1.

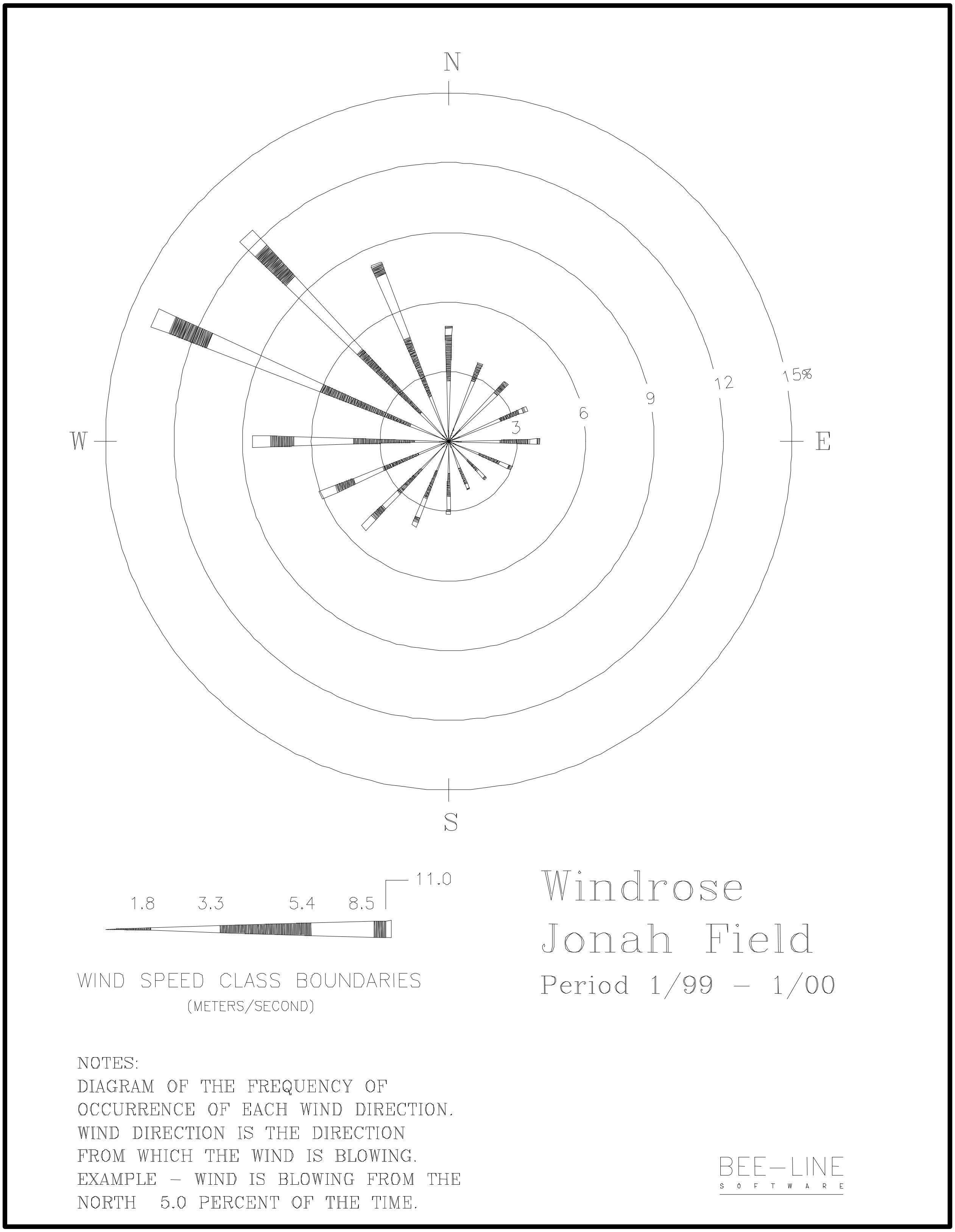

Figure 3.1 Wind Rose, Jonah Field, 1999.

The JIDPA meteorology data included hourly surface measurements of wind speed, wind direction, standard deviation of wind direction [sigma theta], and temperature. These data were processed using the AERMET preprocessor to produce a dataset compatible with the AERMOD dispersion model. AERMET was used to combine the JIDPA surface measurements with twice daily sounding data from Riverton, Wyoming, cloud cover data collected at Big Piney, Wyoming, and solar radiation measurements collected at Pinedale, Wyoming.

3.3 BACKGROUND POLLUTANT CONCENTRATIONS

Background concentration data collected for criteria pollutants at regional monitoring sites were added to concentrations modeled in the near-field analysis to establish total pollutant concentrations for comparison to ambient air quality standards. The most representative monitored regional background concentrations available for criteria pollutants are shown in Table 3.1.

Table 3.1 Near-Field Analysis Background Ambient Air Quality Concentrations (Micrograms per Cubic Meter [$\mu g/m^3$]).

Pollutant	Averaging Period	Measured Background Concentration
CO[1]	1-hour	3,336
	8-hour	1,381
NO_2[2]	Annual	3.4
O_3[3]	1-hour	169
	8-hour	147
PM_{10}[4]	24-hour	33
	Annual	16
$PM_{2.5}$[4]	24-hour	13
	Annual	5
SO_2[5]	3-hour	132
	24-hour	43
	Annual	9

1 Data collected by Amoco at Ryckman Creek for an 8-month period during 1978-1979, summarized in the Riley Ridge EIS (BLM 1983).

2 Data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period January-December 2001 (Air Resource Specialists [ARS] 2002).

3 Data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period June 10, 1998, through December 31, 2001 (ARS 2002).

4 Data collected by WDEQ-AQD at Emerson Building, Cheyenne, Wyoming, Year 2001, second highest 24-hour concentrations. These data were determined by WDEQ-AQD to be the most representative co-located PM_{10} and $PM_{2.5}$ data available.

5 Data collected at LaBarge Study Area, Northwest Pipeline Craven Creek Site 1982-1983.

3.4 CRITERIA POLLUTANT IMPACT ASSESSMENT

The near-field criteria pollutant impact assessment was performed to estimate maximum potential impacts of PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO, and O_3 from project emissions sources including well site and compressor station emissions. Maximum predicted concentrations in the vicinity of project emissions sources were compared with the Wyoming Ambient Air Quality Standards (WAAQS), National Ambient Air Quality Standards (NAAQS), and applicable Prevention of Significant Deterioration (PSD) Class II increments shown in Table 3.2. This NEPA analysis compared potential air quality impacts from Project alternatives to applicable ambient air quality standards and PSD increments. The comparisons to the PSD Class I and II increments are intended to evaluate a threshold of concern for potential impacts, and does not represent a regulatory PSD increment comparison. Such a regulatory analysis is the responsibility of the state air quality agency (under EPA oversight) and would be conducted during the permitting process.

Table 3.2 Ambient Air Quality Standards and Class II PSD Increments for Comparison to Near-Field Analysis Results (μg/m^3).

Pollutant/Averaging Time	NAAQS	WAAQS	PSD Class II Increment
CO			
1-hour[1]	40,000	40,000	--[2]
8-hour[1]	10,000	10,000	--
NO_2			
Annual[3]	100	100	25
O_3			
1-hour[1]	235	235	--
8-hour[4]	157	157	--
PM_{10}			
24-hour[1]	150	150	30
Annual[3]	50	50	17
$PM_{2.5}$			
24-hour[1]	65	65[5]	--
Annual[3]	15	15[5]	--
SO_2			
3-hour[1]	1,300	1,300	512
24-hour[1]	365	260	91
Annual[3]	80	60	20

1 No more than one exceedance per year.
2 -- = No PSD Class II Increment has been established for this pollutant.
3 Annual arithmetic mean.
4 Average of annual fourth-highest daily maximum 8-hour average.
5 Standard not yet enforced in Wyoming.

The EPA's proposed guideline dispersion model, AERMOD, was used to model the near-field concentrations of PM_{10}, $PM_{2.5}$, CO, NO_2, and SO_2. AERMOD was run using one year of AERMET preprocessed JIDPA meteorology data following all regulatory default switch settings. Since $PM_{10}/PM_{2.5}$ emissions would be greatest during the resource road/well pad construction phase of field development, construction emissions sources were modeled to determine compliance with the $PM_{10}/PM_{2.5}$ WAAQS and NAAQS. Similarly, SO_2 emissions would be greatest from well drilling operations during construction. CO and NO_x emissions primarily from compressor stations would be greatest during well production.

O_3 impacts were estimated using the screening methodology developed by Scheffe (1988) which utilizes NO_x and VOC emissions ratios to calculate O_3 concentrations. NO_x and VOC emissions would be greatest during production activities, and these emissions were used to estimate O_3 impacts.

3.4.1 $PM_{10}/PM_{2.5}$

Maximum localized $PM_{10}/PM_{2.5}$ impacts would result from well pad and road construction activities and from wind erosion. Three different approximate well pad sizes are proposed within the range of Project alternatives; 3.8 acres, 7.0 acres, and 10.0 acres. Modeling scenarios were developed for each of these well pad sizes, with each scenario consisting of a well pad and a 2.5-mi resource road using the emissions estimates provided in Section 2.1. Model receptors were placed at 100-m intervals beginning 200 m from the edge of the well pad and road. Flat terrain was assumed for each modeling scenario. Figure 3.2 presents the configurations used to model each well pad and resource road scenario. Volume sources were used to represent emissions from well pads and roads. Hourly emission rate adjustment factors were applied to limit construction emissions to daytime hours. AERMOD was used to model each scenario 36 times, once at each of 36 10º rotations, to ensure that impacts from all directional layout configurations and meteorological conditions were assessed. Wind erosion emissions were modeled for all hours where the wind speed exceeded a threshold velocity defined by emissions calculations performed using AP-42 Section 13.2.5, Industrial Wind Erosion (EPA 2004).

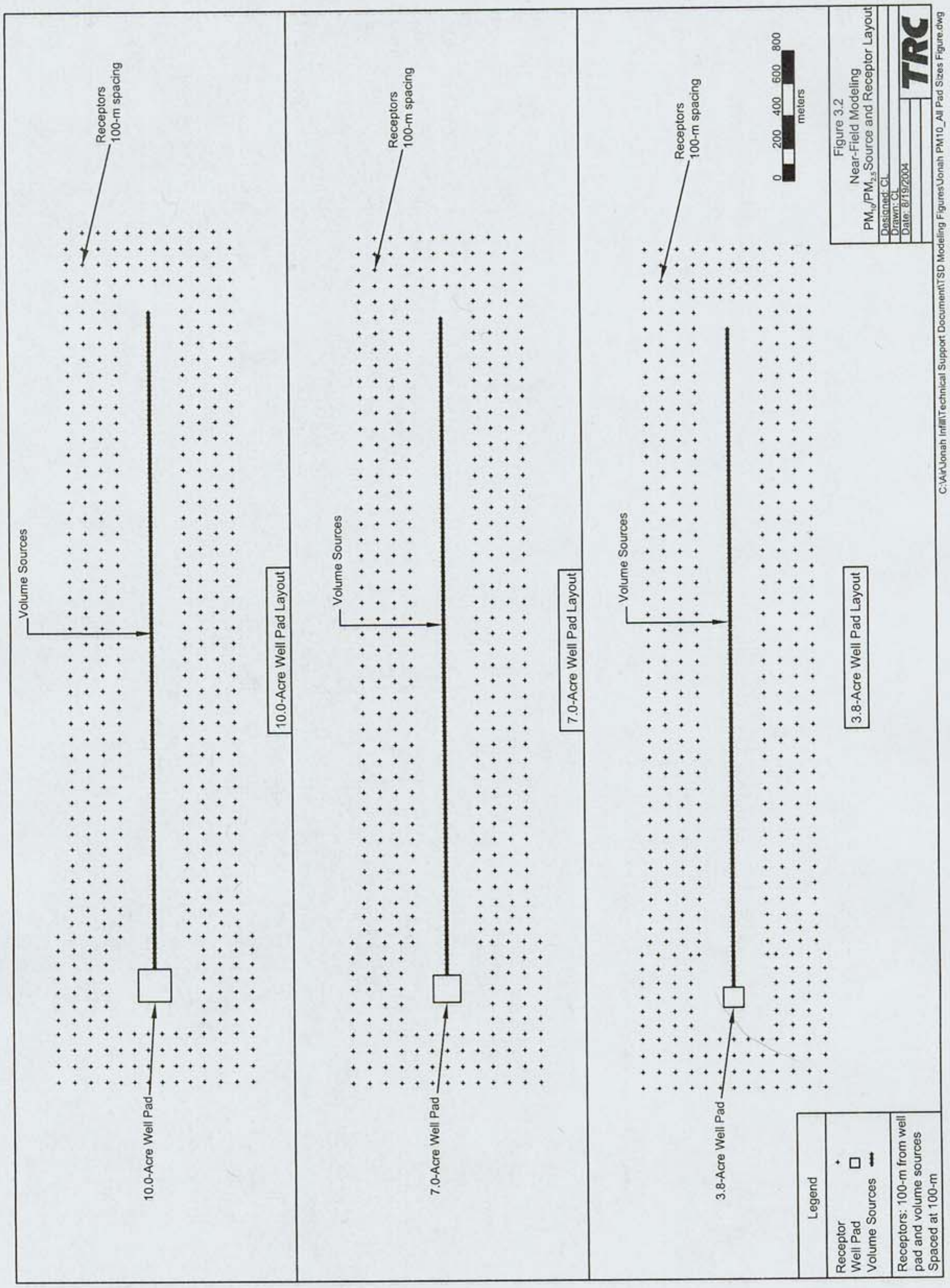

Figure 3.2 Near-field Modeling $PM_{10}/PM_{2.5}$ Source and Receptor Layout.

Table 3.3 presents the maximum modeled PM_{10}/$PM_{2.5}$ concentrations, for each well pad scenario. When the maximum modeled concentration was added to representative background concentrations, it was demonstrated that PM_{10} and $PM_{2.5}$ concentrations for all scenarios comply with the WAAQS and NAAQS for PM_{10} and proposed standards for $PM_{2.5}$.

Emissions associated with temporary construction activities do not consume PSD Increment; therefore, temporary PM_{10} emissions from well pad and road construction are excluded from increment consumption analyses.

Table 3.3 Maximum Modeled PM_{10}/$PM_{2.5}$ Concentrations, Jonah Infill Drilling Project.

Scenario	Pollutant	Averaging Time	Direct Modeled (μg/m^3)	Background (μg/m^3)	Total Predicted (μg/m^3)	WAAQS (μg/m^3)	NAAQS (μg/m^3)
3.8-acre pad	PM_{10}	24-Hour	74.1	33	107.1	150	150
		Annual	3.4	16	19.4	50	50
	$PM_{2.5}$	24-Hour	27.0	13	40.0	65	65
		Annual	1.3	5	6.3	15	15
7-acre pad	PM_{10}	24-Hour	94.0	33	127.0	150	150
		Annual	4.7	16	20.7	50	50
	$PM_{2.5}$	24-Hour	31.0	13	44.0	65	65
		Annual	1.6	5	6.6	15	15
10-acre pad	PM_{10}	24-Hour	102.1	33	135.1	150	150
		Annual	5.6	16	21.6	50	50
	$PM_{2.5}$	24-Hour	32.2	13	45.2	65	65
		Annual	1.8	5	6.8	15	15

3.4.2 SO_2

Emissions from construction drilling operations would result in maximum SO_2 concentrations of all other project phases. Both straight well drilling and directional well drilling are proposed as part of the Project. Therefore, modeling scenarios were developed that included a drilling rig at the center of a pad, with model receptors placed along 100-m intervals, 100 m from the drilling engines, for both straight and directional drilling operations. Drilling rigs were modeled as point sources, with aerodynamic building downwash from the rig structure. Figure 3.3 illustrates the modeling configuration used for drilling rig SO_2 emissions.

AERMOD was used to model drilling rig SO_2 emissions for both straight and directional drilling operations. The maximum predicted concentrations are provided in Table 3.4. The modeled SO_2 impacts, when added to representative background concentrations, are below the applicable standards and, as with PM_{10} construction emissions, emissions from drilling rigs are temporary and do not consume SO_2 PSD Increment.

3.4.3 NO_2

Emissions from production activities (well site and compression) would result in the maximum near-field NO_2 concentrations. Analyses were performed to quantify the maximum NO_2 impacts that could occur within and nearby the JIDPA using the emissions from existing in-field compressor station and well emissions, anticipated future compression expansions, and proposed Project alternatives. Proposed well emissions include those from well site heaters, truck traffic, and from a water disposal well engine. Although no increases to compression are proposed as part of the Project, anticipated future compression expansions were obtained from the gas transmission companies that operate within the region and were considered in the modeling analyses. Anticipated future compression expansions were provided for the Bird Canyon, Falcon, Gobblers Knob, Jonah, Luman, and Paradise compressor stations. Bird Canyon, Falcon, Luman, and Jonah are primarily associated with the Jonah Field, whereas Gobblers Knob and Paradise are considered part of the Pinedale Anticline Project.

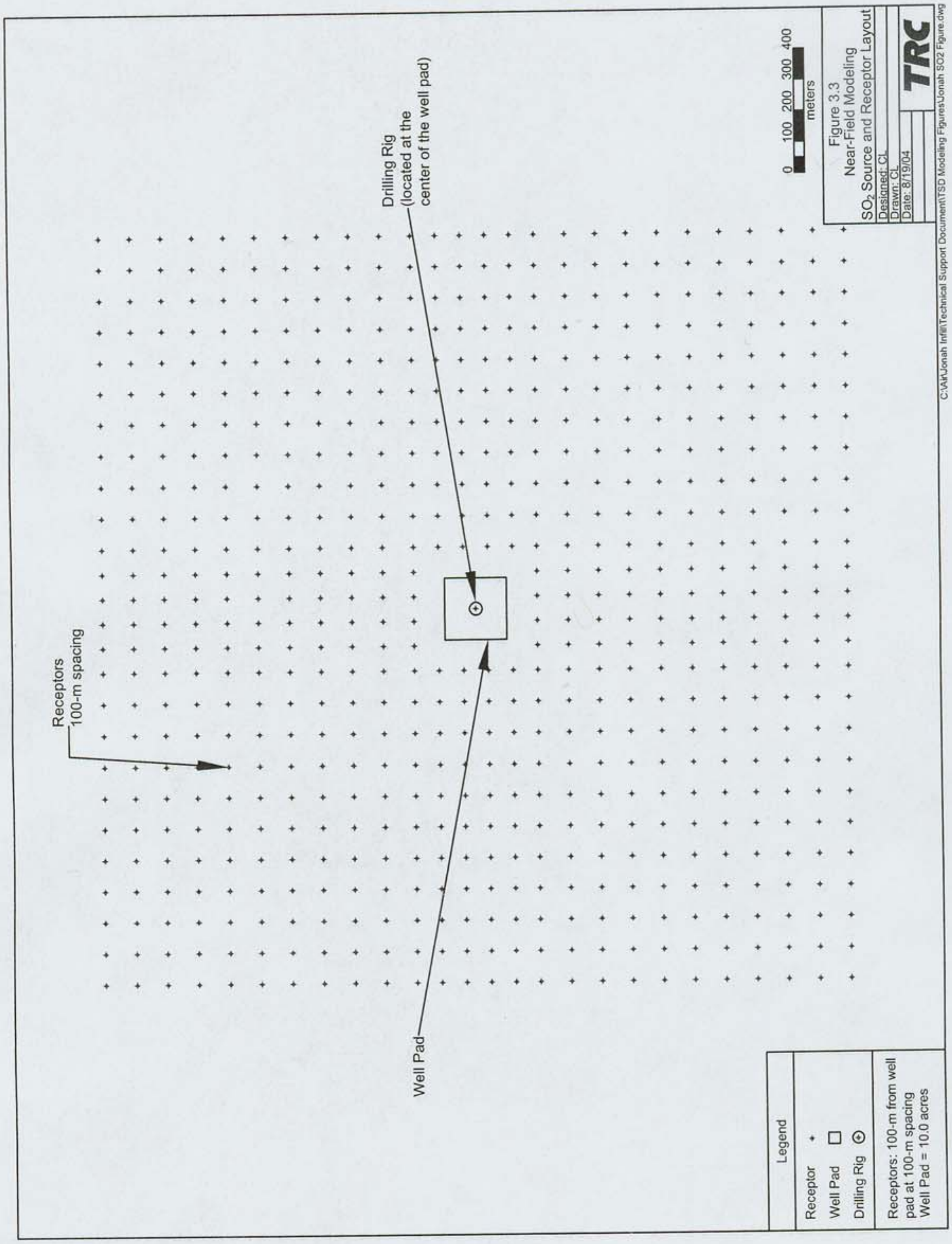

Figure 3.3 Near-field Modeling SO_2 Source and Receptor Layout.

Table 3.4 Maximum Modeled SO_2 Concentrations, Jonah Infill Drilling Project.

Scenario	Pollutant	Averaging Time	Direct Modeled ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total Predicted ($\mu g/m^3$)	WAAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
Straight Drilling	SO_2	3-Hour	103.8	132	235.8	1,300	1,300
		24-Hour	36.7	43	79.7	260	365
		Annual	5.2	9	14.2	60	80
Directional Drilling	SO_2	3-Hour	128.3	132	260.3	1,300	1,300
		24-Hour	45.3	43	88.3	260	365
		Annual	6.4	9	15.4	60	80

Two modeling analyses were performed to estimate near-field NO_2 concentrations. Scenario 1 utilized compressor emissions from the proposed compressor station expansions within the Jonah Field in combination with well emissions from the Proposed Action and alternative expansions of either 3,100 or 1,250 wells (the maximum range of well development for all Project alternatives). Scenario 2 utilized the projected compression expansions proposed within the Jonah and Pinedale Anticline fields, well site heater emissions from 198 wells developed in the JIDPA since January 2002, well site emissions from either 3,100 or 1,250 proposed wells and an inventory of existing regional compressor station emissions provided by the WDEQ-AQD. A WDEQ-AQD regional compressor station inventory has historically been required for use in ambient air quality compliance demonstrations performed under WDEQ-AQD guidance. The modeled impacts from the first analysis are reported as the maximum predicted direct impacts from the Proposed Action and alternatives, and results of the second analysis are representative of near-field cumulative impacts, since they include contributions from additional regional emissions. This near-field cumulative analysis is presented to further demonstrate regional compliance with ambient air quality standards and PSD increments.

Figure 3.4 illustrates all components of modeled Scenarios 1 and 2, above. NO_x emissions provided in Section 2.1.2 for well site heaters and truck tail pipe emissions were modeled

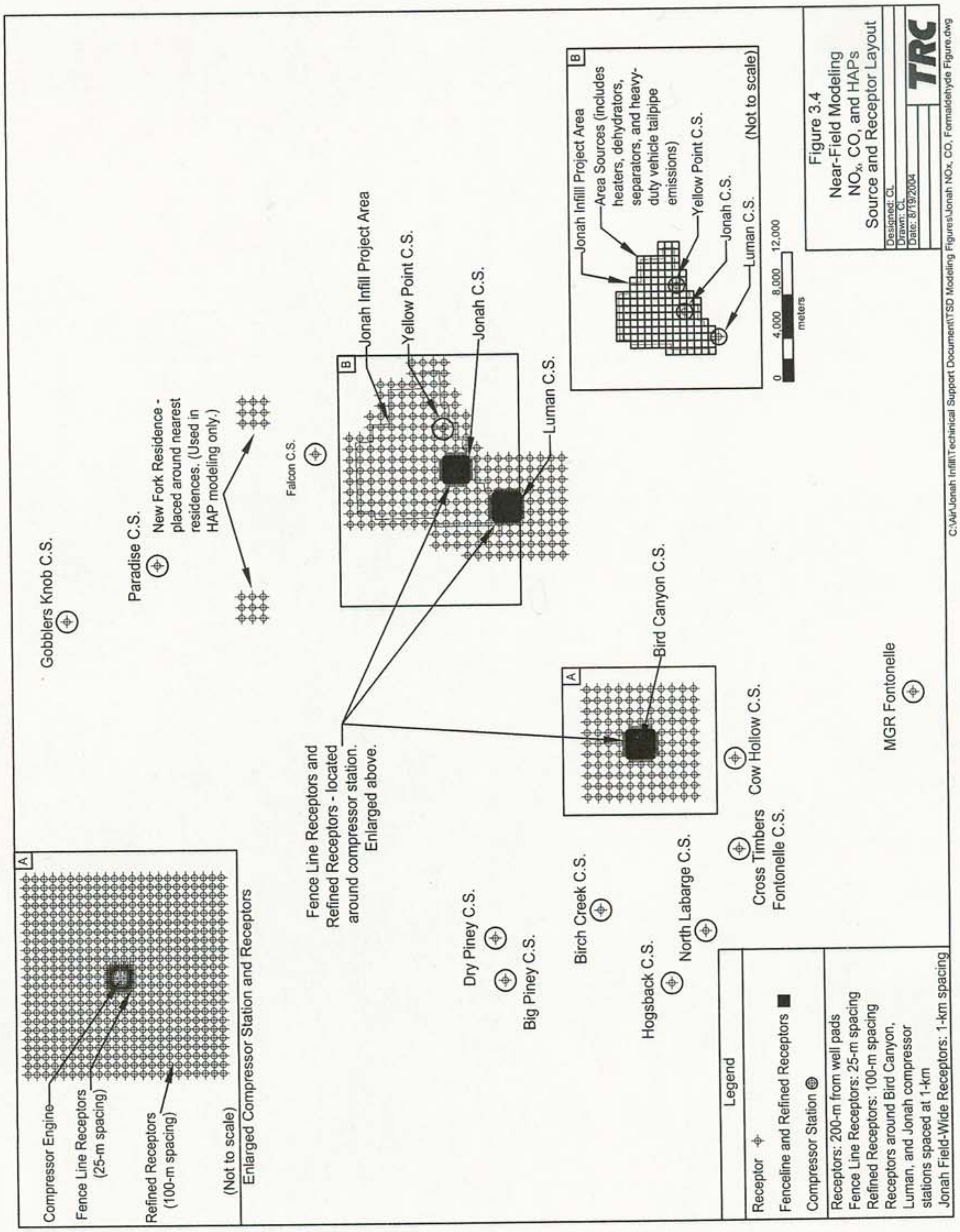

Figure 3.4 Near-field Modeling NO_x, CO, and HAPs Source and Receptor Layout.

using 1-km-spaced area sources placed throughout the JIDPA. Emissions scalars were used to adjust the heater emissions for seasonal variations. Point sources were used for modeling all compressor station emissions and water disposal well emissions. The compressor station emissions and modeling parameters utilized in near-field NO_x modeling Scenarios 1 and 2 are provided in Appendix D.

Refined receptor grids were placed around the Bird Canyon, Jonah, and Luman compressor stations, which are the largest compressor stations associated with the Jonah Field operations. Model receptors were placed at 25-m intervals along the fence lines of these compressor stations and at 100-m intervals from the fence lines out to 2 km, and at 1-km intervals between 2 km and 5 km from the fence lines of the Bird Canyon and Luman compressor stations, and at 1-km intervals throughout the JIDPA. AERMAP was used to determine receptor height parameters from digitized elevation map (DEM) data. Aerodynamic building downwash parameters were considered for each compressor station.

The AERMOD model was used to predict maximum NO_x impacts for modeled Scenario 1 (direct project impacts) and modeled Scenario 2 (cumulative impacts). The maximum modeled concentrations occurred near the Luman compressor station, near the southwest end of the JIDPA. Maximum modeled NO_2 concentrations were determined by multiplying maximum predicted NO_x concentrations by 0.75, in accordance with EPA's Tier 2 NO_x to NO_2 conversion method (EPA 2003a). Maximum predicted NO_2 concentrations are given in Table 3.5.

As shown in Table 3.5, direct modeled NO_2 concentrations from both project sources and from cumulative sources are below the PSD Class II Increment for NO_2. In addition, when these NO_2 impacts are combined with representative background NO_2 concentrations, they are below the applicable WAAQS and NAAQS.

Table 3.5 Maximum Modeled Annual NO_2 Concentrations, Jonah Infill Drilling Project.

Scenario	Pollutant	Direct Modeled (µg/m^3)	PSD Class II Increment (µg/m^3)	Background (µg/m^3)	Total Predicted (µg/m^3)	WAAQS (µg/m^3)	NAAQS (µg/m^3)
Scenario 1, Project Alone, 3,100 Wells	NO_2	6.8	25	3.4	10.2	100	100
Scenario 1, Project Alone, 1,250 Wells	NO_2	6.5	25	3.4	9.9	100	100
Scenario 2, Cumulative Sources, 3,100 Wells	NO_2	18.9	25	3.4	22.3	100	100
Scenario 2, Cumulative Sources, 1,250 Wells	NO_2	18.6	25	3.4	22.0	100	100

3.4.4 CO

Maximum CO emissions would occur from the same production activities (well site and compression) that result in maximum NO_2 impacts. The modeling scenarios used to model NO_2 impacts were also used to determine maximum CO direct Project and cumulative impacts (see Figure 3.4).

AERMOD was used to predict maximum CO impacts for model Scenario 1 (direct Project impacts) and model Scenario 2 (cumulative impacts). Maximum predicted CO concentrations are shown in Table 3.6. As indicated in Table 3.6, maximum modeled CO concentrations, when combined with representative background CO concentrations, are below the applicable WAAQS and NAAQS.

Table 3.6 Maximum Modeled CO Concentrations, Jonah Infill Drilling Project.

Scenario	Pollutant	Averaging Time	Direct Modeled (μg/m^3)	Background (μg/m^3)	Total Predicted μg/m^3)	WAAQS (μg/m^3)	NAAQS (μg/m^3)
Scenario 1, Project Alone, 3,100 Wells	CO	1-Hour	425.3	3,336	3,761.3	40,000	40,000
		8-Hour	113.5	1,381	1,494.5	10,000	10,000
Scenario 1, Project Alone 1,250 Wells	CO	1-Hour	171.5	3,336	3,507.5	40,000	40,000
		8-Hour	45.8	1,381	1,426.8	10,000	10,000
Scenario 2, Cumulative Sources, 3,100 Wells	CO	1-Hour	459.1	3,336	3,795.1	40,000	40,000
		8-Hour	266.0	1,381	1,647.0	10,000	10,000
Scenario 2, Cumulative Sources, 1,250 Wells	CO	1-Hour	439.0	3,336	3,775.0	40,000	40,000
		8-Hour	262.1	1,381	1,643.1	10,000	10,000

3.4.4 O_3

O_3 is formed in the atmosphere as a result of photochemical reactions involving ambient concentrations of NO_2 and VOCs. Because of the complex photochemical reactions necessary to form O_3, compliance with ambient air quality standards cannot be determined with conventional dispersion models. Instead, a nomograph developed from the Reactive Plume Model (Scheffe 1988) was used to predict maximum ozone impacts. This screening methodology, utilizes NO_x and VOC emissions ratios to estimate ozone concentrations.

NO_x and VOC emissions are greatest during production activities and these emissions were used to estimate O_3 impacts. Emissions from a 1-mi^2 "patch" of 128 wells, which is the maximum proposed Project well density (128 wells per mi^2; 5-acre spacing) and the emissions from the Luman compressor station were used. This scenario was selected since the Luman station is the largest compressor station and the largest NO_x source within or adjacent to the JIDPA. The emissions assumed for the Luman station were 171.6 and 124.7 tons per year (tpy) of NO_x and

VOC, respectively, and these emissions include anticipated future compression expansion. The emissions used for the 128 well section were 5.8 tpy (NO_x) and 3,703.5 tpy (VOC), and assume that all wells have no VOC control. The ratio of total VOC emissions to total NO_x emissions is 3,828.2:177.3 or 21.6. At this ratio, the estimated maximum potential 1-hour O_3 concentration is 0.057 parts per million (ppm) or 111.8 micrograms/cubic meter ($\mu g/m^3$). Using EPA's recommended screening conversion factor of 0.7 to convert 1-hour concentrations to 8-hour values (EPA 1977), the predicted 8-hour O_3 concentration is 78.3 $\mu g/m^3$. Predicted maximum O_3 impacts are summarized in Table 3.7.

The maximum O_3 impacts shown in Table 3.7 represent the amount of O_3 that could potentially form within and nearby the JIDPA as a result of the ratio of direct project emissions of NO_x and VOC. Direct modeled concentrations shown in Table 3.7 were added to average hourly background O_3 conditions monitored as part of the Green River Basin Visibility Study (ARS 2002) during the period June 10, 1998, through December 31, 2001. This value 75.2 $\mu g/m^3$ is slightly higher than the background O_3 concentration of 62.6 $\mu g/m^3$ used in the RPM modeling to derive the Scheffe nomograph. The highest, second highest O_3 concentrations measured over the monitoring period of record, shown in Table 3.1, were not added concentrations estimated with the Scheffe method since it is overly conservative to add a maximum concentration to a screening level estimated concentration. O_3 formation is a complex atmospheric chemistry process that varies greatly due to meteorological conditions and the presence of ambient atmospheric concentrations of many chemical species. Adding NO_x and VOC emissions to the ambient air, where some amount of O_3 has already formed, is not necessarily an indication that the potential for ozone formation has increased. In fact, it could decrease, since the ambient background conditions that caused O_3 formation have changed, and the new mixture of chemical species in the atmosphere may not be conducive to O_3 formation. In addition, the concentrations shown in Table 3.7 are likely overestimates of the actual O_3 impacts that would occur, since the Reactive Plume Model nomograph used to derive these estimates was developed using meteorological conditions (high temperatures and stagnant conditions) more conducive to forming O_3 than the conditions found in southwestern Wyoming.

Table 3.7 Maximum Modeled O_3 Concentrations, Jonah Infill Drilling Project.

Pollutant	Averaging Time	Direct Modeled (μg/m³)	GRBVS Average 1-hour Background (μg/m³)	Total Predicted (μg/m³)	WAAQS (μg/m³)	NAAQS (μg/m³)
O_3	1-Hour	111.8	75.2	187.0	235	235
	8-Hour	78.3	75.2	153.5	157	157

3.5 HAP IMPACT ASSESSMENT

AERMOD was used to determine HAP impacts in the immediate vicinity of the JIDPA emission sources for short-term (acute) exposure assessment and at the nearest residences to the JIDPA for calculation of long-term risk. Sources of HAPs include well-site fugitive emissions (BTEX and n-hexane), completion flaring and venting (BTEX and n-hexane), and compressor station combustion emissions (formaldehyde). Because maximum field-wide annual emissions of HAPs occur during the production phase, only HAP emissions from production were analyzed for long-term risk assessment. Short-term exposure assessments were performed for production HAP emissions using various well densities, and for an individual well construction completion (venting and flaring) event.

Four modeling scenarios were developed for modeling short-term (1-hour) HAPs (BTEX, and n-hexane) from well-site fugitive emissions. These scenarios were developed to represent the complete range of well densities proposed for the Proposed Action and alternatives. The scenarios include one-section areas (1 mi^2), with wells at 5-, 10-, 20-, and 40-acre surface spacing. These modeling scenarios represent well densities of 128, 64, 32, and 16 wells per section, respectively. The purpose of modeling this range of well density was to determine the maximum HAP short-term (1-hour) impacts that could occur within and near the JIDPA. Volume sources were used for modeling the well-site fugitive HAP emissions. The HAP emissions for wells with uncontrolled VOC emissions were used. Flat terrain receptors were spaced evenly and at a maximum distance of 100 m from a well, throughout each section. The source and receptor layouts utilized for the short-term HAP modeling are presented in Figure 3.5.

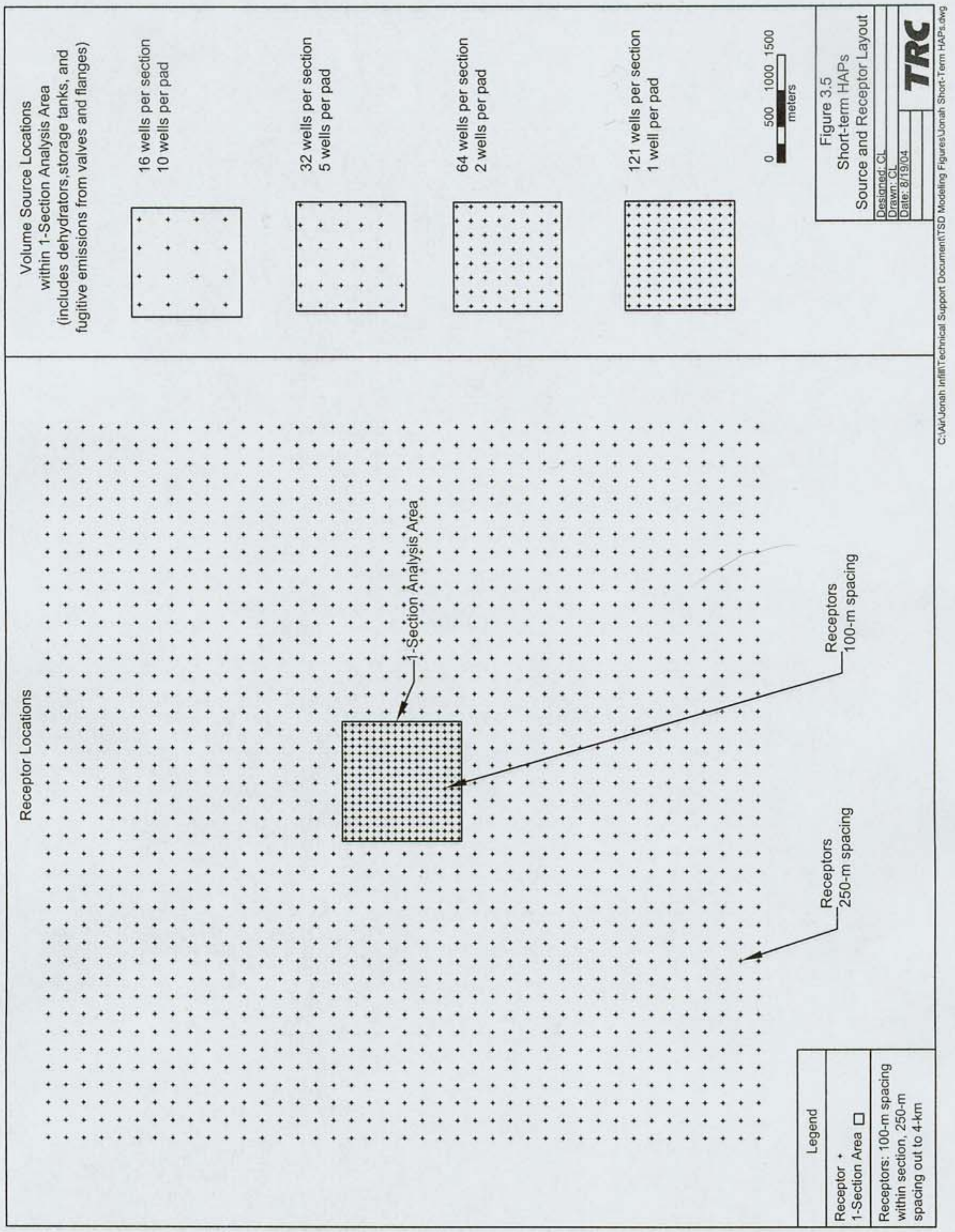

Figure 3.5 Short-term HAPs Source and Receptor Layout.

A single scenario was developed for modeling long-term (annual) fugitive HAP emissions. This scenario utilized the same 1-km spaced area sources placed throughout the JIDPA that were used for modeling NO_x emissions from well site heaters (see Section 3.4.3 and Figure 3.4). Fugitive HAP model runs were performed for both 3,100 and 1,250 wells in production. Field-wide emissions scenarios were developed using the individual well emissions provided in Section 2.2, assuming 50% of condensate storage tanks are equipped with a control device and 25% of dehydrators are equipped with a control device. Receptor grids (3 x 3) using 1-km spacing were placed at the nearest residential locations along the New Fork River north of the JIDPA (see Figure 3.4). Receptor elevations were determined from U.S. Geological Survey (USGS) DEM data using AERMAP.

For modeling formaldehyde emissions from compressor station sources, an analysis similar to that performed for NO_2 and CO (see Sections 3.4.3 and 3.4.4) was used. Formaldehyde emissions from anticipated future compression expansions at the Bird Canyon, Falcon, Gobblers Knob, Jonah, Luman, and Paradise compressor stations were modeled in combination with emissions from the WDEQ-AQD inventory of existing regional compressor stations. These emissions are provided in Appendix D. Modeled Scenarios 1 and 2 were analyzed as described in Section 3.4. The modeling parameters and receptor grids developed for the NO_x and CO impacts analyses and the receptor grids at the nearest residential locations along the New Fork River were utilized for modeling formaldehyde impacts. Long-term impacts are reported for the residential receptor locations. The source and receptor layout for modeling formaldehyde impacts is presented in Figure 3.4.

Reference Exposure Levels (RELs) are defined as concentrations at or below which no adverse health effects are expected. Since no RELs are available for ethylbenzene and n-hexane, the available Immediately Dangerous to Life or Health (IDLH) values were used. These REL and IDLH values are determined by the National Institute for Occupational Safety and Health (NIOSH) and were obtained from EPA's Air Toxics Database (EPA 2002). Modeled short-term HAP concentrations are compared to REL and IDLH values in Table 3.8. As shown in Table 3.8

Table 3.8 Maximum Modeled 1-Hour HAP Concentrations, Jonah Infill Drilling Project.

HAP	Direct Modeled Concentration by Modeling Scenario (μg/m^3)				REL or IDLH[1] (μg/m^3)
	5-Acre Spacing	10-Acre Spacing	20-Acre Spacing	40-Acre Spacing	
Benzene	996	566	590	309	1,300
Toluene	1,994	1,132	1,181	619	37,000
Ethylbenzene	109	62	64	34	35,000
Xylene	1,085	616	643	337	22,000
n-Hexane	536	304	317	166	39,000
	Project Alone	Cumulative Sources			
Formaldehyde	22.1	31.9	--	--	94

[1] EPA (2002).

the maximum predicted short-term HAP impacts within and near the JIDPA would be below the REL or IDLH values under all Project alternatives.

Additional modeling analyses with AERMOD were performed to quantify the maximum short term HAP (BTEX and n-hexane) concentrations that could potential occur from well site completion venting and flaring. For wells that require these activities, it is estimated that venting operations could last up to 4 hours and flaring could last up to 80 hours. A single volume source was used for modeling completion venting and a single point source was used for modeling flaring. 100-m spaced receptors beginning at a distance of 100 m from each source were used. The results of these modeling analyses indicated that from flaring operations short-term HAP concentration would be below the REL or IDLH values. From venting operations short-term benzene concentrations could potentially exceed the thresholds within 500 meters of a completion venting operation, however, all other HAP concentrations would be below the REL or IDLH.

Long-term (annual) modeled HAP concentrations at the nearest residence are compared to Reference Concentrations for Chronic Inhalation (RfCs). A RfC is defined by EPA as the daily inhalation concentration at which no long-term adverse health effects are expected. RfCs exist for both non-carcinogenic and carcinogenic effects on human health (EPA 2002). The maximum predicted annual HAP concentrations at the nearest residential area are compared to the corresponding non-carcinogenic RfC in Table 3.9.

As shown in Table 3.9 the maximum predicted long-term (annual) HAP impacts at the nearest residence locations along the New Fork River would be below the RfCs for all analyzed alternatives. In addition, formaldehyde impacts at the nearest residence are shown to be below the RfC thresholds when Project source impacts are combined with regional source impacts.

Long-term exposures to emissions of suspected carcinogens (benzene and formaldehyde) were evaluated based on estimates of the increased latent cancer risk over a 70-year lifetime. This analysis presents the potential incremental risk from these pollutants, and does not represent a total risk analysis. The cancer risks were calculated using the maximum predicted annual concentrations and EPA's chronic inhalation unit risk factors (URF) for carcinogenic constituents

Table 3.9 Maximum Modeled Long-term (Annual) HAP Concentrations, Jonah Infill Drilling Project.

HAP	Direct Modeled Concentration at Nearest Residence by Modeling Scenario (μg/m^3)		Non-carcinogenic RfC[1] (μg/m^3)
	3,100 Wells	1,250 Wells	
Benzene	0.85	0.35	30
Toluene	1.73	0.71	400
Ethylbenzene	0.09	0.04	1,000
Xylene	0.93	0.38	430
n-Hexane	0.35	0.14	200
	Project Alone	Cumulative Sources	
Formaldehyde	0.003	0.02	9.8

[1] EPA (2002).

(EPA 2002). Estimated cancer risks were evaluated based on the Superfund National Oil and Hazardous Substances Pollution Contingency Plan (EPA 1993), where a cancer risk range of 1 x 10^{-6} to 1 x 10^{-4} is generally acceptable. Two estimates of cancer risk are presented: 1) a most likely exposure (MLE) scenario; and 2) a maximum exposed individual (MEI) scenario. The estimated cancer risks are adjusted to account for duration of exposure and time spent at home.

The adjustment for the MLE scenario is assumed to be 9 years, which corresponds to the mean duration that a family remains at a residence (EPA 1993). This duration corresponds to an adjustment factor of 9/70 = 0.13. The duration of exposure for the MEI scenario is assumed to be 50 years (i.e., the LOF), corresponding to an adjustment factor of 50/70 = 0.71. A second adjustment is made for time spent at home versus time spent elsewhere. For the MLE scenario, the at-home time fraction is 0.64 (EPA 1993), and it is assumed that during the rest of the day the individual would remain in an area where annual HAP concentrations would be one quarter as large as the maximum annual average concentration. Therefore, the final MLE adjustment factor is (0.13) x [(0.64 x 1.0) + (0.36 x 0.25)] = 0.0949. The MEI scenario assumes that the individual is at home 100% of the time, for a final MEI adjustment factor of (0.71 x 1.0) = 0.71.

For each constituent, the cancer risk is computed by multiplying the maximum predicted annual concentration by the URF and by the overall exposure adjustment factor. The cancer risks for both constituents are then summed to provide an estimate of the total inhalation cancer risk.

The modeled long-term risk from benzene and formaldehyde are shown in Table 3.10 for both the 3,100-well and 1,250-well scenarios. For each scenario, the maximum predicted formaldehyde concentration representative of cumulative impacts was used. Under the MLE scenario, the estimated cancer risk associated with long-term exposure to benzene and formaldehyde is below 1 x 10^{-6} for both 3,100-well and 1,250-well cases. Under the MEI analyses, for each modeling scenario, the incremental risk for formaldehyde is less than 1 x 10^{-6}, and both the incremental risk for benzene and the combined incremental risk fall on the lower end of the cancer risk range of 1 x 10^{-6} to 1 x 10^{-4}.

Table 3.10 Long-term Modeled MLE and MEI Cancer Risk Analyses, Jonah Infill Drilling Project.

Modeling Scenario	Analysis	HAP Constituent	Modeled Concentration (μg/m^3)	Unit Risk Factor 1/(μg/m^3)	Exposure Adjustment Factor	Cancer Risk
3,100 Wells	MLE	Benzene	0.85	7.8×10^{-6}	0.0949	0.63×10^{-6}
		Formaldehyde	0.02	1.3×10^{-5}	0.0949	0.02×10^{-6}
Total Combined						0.6×10^{-6}
3,100 Wells	MEI	Benzene	0.85	7.8×10^{-6}	0.71	4.73×10^{-6}
		Formaldehyde	0.02	1.3×10^{-5}	0.71	0.18×10^{-6}
Total Combined						4.9×10^{-6}
1,250 Wells	MLE	Benzene	0.35	7.8×10^{-6}	0.0949	0.26×10^{-6}
		Formaldehyde	0.02	1.3×10^{-5}	0.0949	0.02×10^{-6}
Total Combined						0.3×10^{-6}
1,250 Wells	MEI	Benzene	0.35	7.8×10^{-6}	0.71	1.94×10^{-6}
		Formaldehyde	0.02	1.3×10^{-5}	0.71	0.18×10^{-6}
Total Combined[1]						2.1×10^{-6}

[1] Total risk is calculated here; however, the additive effects of multiple chemicals are not fully understood and this should be taken into account when viewing these results.