APPENDIX F—MOAB MASTER LEASING PLAN CALPUFF FAR-FIELD AIR QUALITY ANALYSIS TECHNICAL SUPPORT DOCUMENT, APRIL 2015

F.1 INTRODUCTION

This Technical Support Document (TSD), prepared by the Bureau of Land Management (BLM) (Utah State Office and National Operations Center [NOC]), provides technical background data, methods and assumptions used in the far-field air quality analysis conducted for the Moab Master Leasing Plan (MLP). The purpose of the modeling analysis was to examine different possible development and control scenarios and their implications for management decisions related to oil, gas, and potash reasonably foreseeable development (RFD) on BLM managed lands inside and near the Planning Area of the MLP.

F.1.1 Background and Purpose

The BLM Moab Field Office has developed an RFD for oil, gas, potash, and other well drilling in the Planning Area. The RFD forms the basis for the emissions projections used in this modeling analysis. The Air Quality Memorandum of Understanding for Oil and Gas National Environmental Policy Act (NEPA) (BLM 2011) recommends that when modeling is to be done during a NEPA planning process (such as the MLP), a 3-tier emissions approach (high, medium and low) could be used to examine a range of potential future impacts. This approach of a range of emissions scenarios was utilized in the modeling analysis. It is stressed that the development scenarios do not necessarily represent actual development as it will occur over the life of the planning document, as details such as timing, location, equipment types, and extraction methods are simply not knowable at this time. Rather this analysis is meant to examine different possible development and control scenarios and their implications for management decisions related to future development. For instance, how different levels of dust control relate to possible visibility impacts at National Parks in the Planning Area may have implications for the types of management practices required of prospective resource extraction entities.

The focus of the modeling analyses is on National Ambient Air Quality Standards (NAAQS) as established by the Clean Air Act, and Air Quality Related Values (AQRV) as defined by the Federal Land Managers' AQRV Work Group (FLAG 2010). Far-field modeling was conducted by the BLM NOC to evaluate multiple source impacts over the entire Planning Area on NAAQS and AQRVs. The technical details for this modeling are presented in this TSD. In addition, near-field modeling conducted for other relevant NEPA was reviewed in the EIS for relevance to management decisions and potential controls relevant to the MLP analysis. This includes NAAQS impacts, AQRVs, and hazardous air pollutants. Cumulative impacts to regional air quality issues (primarily ozone and visibility) were evaluated by reviewing the WestJump regional modeling report and source apportionment tools to place Planning Area emissions into a regional context. Finally, greenhouse gases (GHG) were evaluated by using an emission calculating tool developed for BLM.

F.1.2 Far-Field Modeling Analysis

The Environmental Protection Agency (EPA) Guideline model CALPUFF (version 5.8.4) was used to estimate potential AQRV impacts (impacts on visibility and atmospheric deposition) at Class I areas in and near the MLP Planning Area. The Lakes Environmental CALPUFF View interface was used to simplify data entry and retrieval.

All CALPUFF model options conformed to the 2009 EPA guidance (EPA 2009) and all CALPOST model options and inputs and VISCREEN methodologies conformed to FLAG 2010 guidance (FLAG 2010).

F.2 METHODOLOGY SUMMARY

Since this dispersion modeling analysis is by necessity speculative, various assumptions had to be made regarding how development would occur over the life of the planning document. Included in these assumptions are estimates of where wells might be drilled, what types of equipment might be used, what the control efficiency of various controls and work practices might be, and what the emission rates of various activities might be. The assumptions used for the range of alternatives are detailed in the following table, and assumptions common to all scenarios are listed after that.

The modeling scenarios and associated major assumptions used in the assessment are:

<u>"High" Emissions Scenario</u>

- 9 drill rigs = 3 oil, 5 potash, 1 "other"
- No aggregation of wells on pads
- Total numbers of wells drilled: 232 oil, 416 potash, 133 other
- 100 percent of drilled oil wells go into production = 232
- Dust control = 50 percent
- Unpaved vs. paved road ratio: 20 miles unpaved (25 mile per hour (mph) limit), 20 miles paved

<u>"Medium" Emissions Scenario</u>

- 9 drill rigs = 3 oil, 5 potash, 1 "other"
- No aggregation of wells on pads
- Total numbers of wells drilled: 232 oil, 416 potash, 133 other
- 60 percent of drilled oil wells go into production = 140
- Dust control = 50 percent
- Unpaved vs. paved road ratio: 10 miles unpaved (25 mph limit), 30 miles paved

<u>"Low" Emissions Scenario</u>

- 4 drill rigs = 3 oil, no potash, 1 "other"
- Aggregated 4 wells on 1 pad
- Total numbers of wells drilled: 232 oil, zero potash, 133 other
- 60 percent of drilled oil wells go into production = 140
- Dust control = 70 percent
- Unpaved vs. paved road ratio: 5 miles unpaved (25 mph limit), 35 miles paved

<u>Assumptions Common to All Scenarios</u>

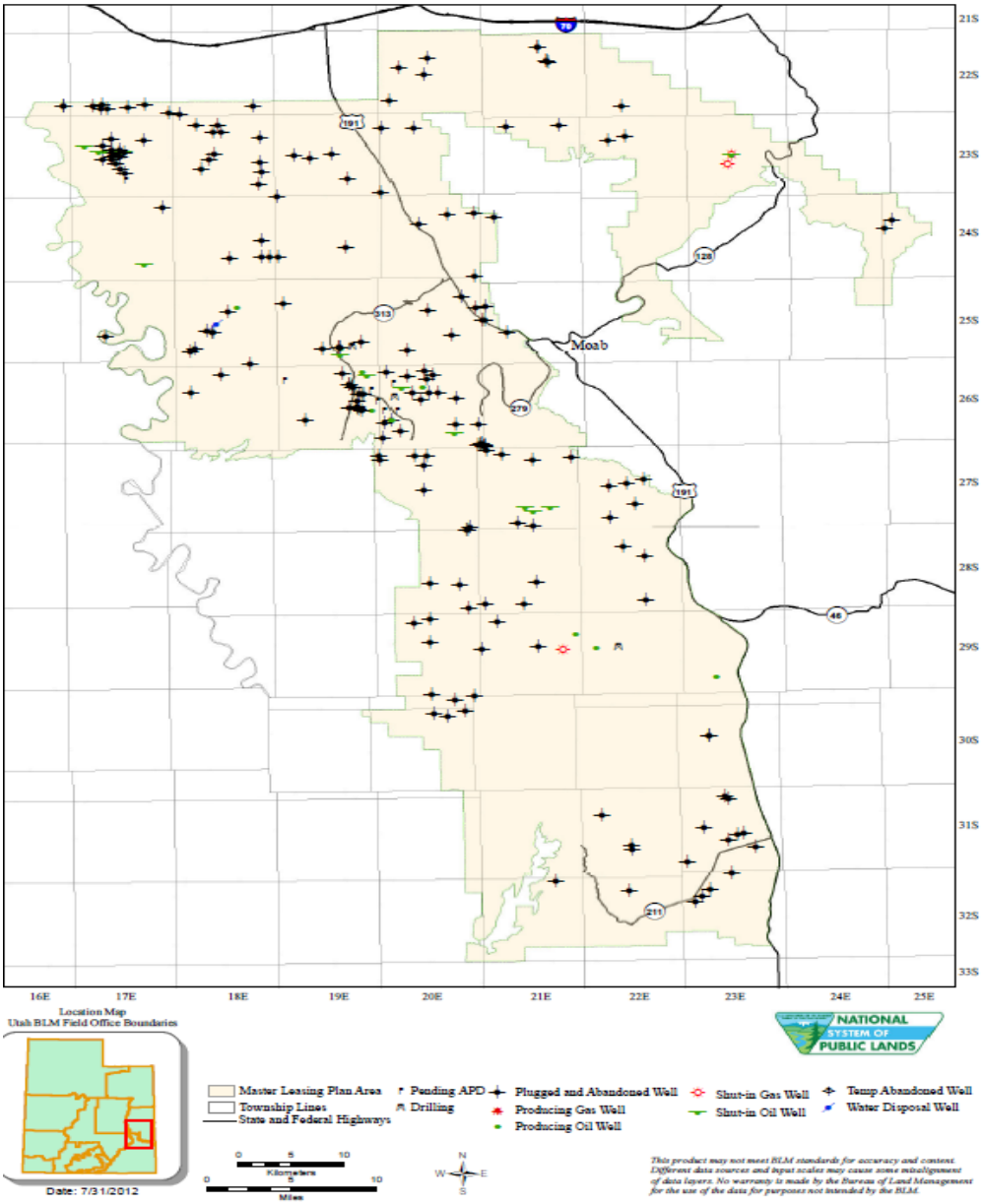
- Life of Project – 15 years
- Project Development – Equal amount of activity for each year
- Year of Project Modeled – Year 15 (14 years of wells in production plus full year of drilling)
- Meteorological Data – 2006, 2007 EPA National 12km Weather Research and Forecasting Model (WRF) data; 2008 4km WRF data from WestJump Air Quality Study
- Receptors – National Park Service receptor sets for Arches and Canyonlands National Parks

- Location of wells – Distributed throughout project area in proportion to the number of existing wells in each Township and Range (T&R) section
- Location of Rigs – Randomly placed throughout project area, weighted toward higher well count sections
- Post-processing to account for Elemental Carbon impacts, total nitrogen and sulfur deposition

F.2.1 Well and Pad Count Methodology

Spatial allocation of wells BLM was extrapolated from previous and existing well locations from historical maps. The number per square of T&R was made into an average congregate and inserted into the CALPUFF model as a centroid of the T&R. A resized version of the map is shown in Figure F-1.

Figure F-1. Spatial Allocation of Wells



F.2.2 Modeling Methodology

The EPA Guideline model CALPUFF (version 5.8.4) was used to estimate potential AQRV impacts (impacts on visibility [regional haze] and atmospheric deposition) at the Class I areas. The Lakes Environmental CALPUFF View interface was used to simplify data entry and retrieval.

All CALPUFF model options conformed to the 2009 EPA guidance (EPA 2009) and all CALPOST model options and inputs conformed to FLAG 2010 guidance (FLAG 2010).

Meteorological Data

The 2008 4km resolution WRF meteorological model output produced as part of the Western Regional Air Partnership, WestJumpAQMS (ENVIRON et al. 2012a) was used as the meteorological dataset for input into the CALPUFF modeling. 2006 and 2007 12km resolution WRF data from EPA national data sets was also used to provide for three complete years of meteorological data.

A subset of WRF modeling outputs was extracted for the air quality modeling domain and processed into CALPUFF-ready format using the Mesoscale Model Interface Program (MMIF) meteorological preprocessor version 3.0 (ENVIRON 2012b)

The WRF model output was processed with MMIF with the following options selected:

- Output for CALPUFF version 5.8;
- The WRF vertical layers will be interpolated to the Federal Land Manager (FLM)/EPA-recommended vertical layers using the TOP option;
- The Pasquill-Gifford stability classes will be calculated with the Golder option; and
- Planetary boundary layer heights will be recalculated.

Emissions

The Moab MLP area was divided into cells by T&R lines. The potential locations of future oil wells were identified within the Plan area. Wells within each T&R cell were placed at the center of the cell. Locations of drill rigs were also identified in the Plan area and placed at the center of the respective cell. A few of these cell center locations were determined to be within or near the border of a Class I area. These sources were moved, so that no source was closer than 4km to a Class I boundary.

Emissions estimates were calculated using the Oil Template from the Emissions Inventory Toolkit developed for BLM by URS Corporation (URS 2012). Potash and other well drilling were assumed to have similar emissions characteristics as oil and gas during drilling activities. Production emissions estimates were also based on outputs from the emissions calculator; however potash production emissions estimates were not estimated or modeled due to the extremely high level of uncertainty associated with emissions estimates for this activity. The template calculates emissions of criteria pollutants (PM_{10}, $PM_{2.5}$, NOX, SO_2), and GHGs (GHGs; CO_2, CH_4, N_{20}, CO_{2eq}) based on the level of production and number of wells drilled. Only criteria pollutants and GHGs were calculated for this analysis. Carbon Monoxide (a criteria pollutant) was not included in the modeling analysis as there is very little potential for emissions of this pollutant to cause or contribute to any recognizable air quality issue. Emission factors used in the toolkit originate from the EPA AP-42 Emissions Factor document (EPA 2004), EPA NONROADS and MOBILE models, and the American Petroleum Institute. A summary of the total modeled emissions is shown in the table below. These modeled emissions represent the end of the buildout of each scenario - when the drill rigs are drilling the last of the wells and the maximum number of them are in production.

Table F-1. Total Modeled Emissions at Year 15 (tons per year per scenario)

Scenario	PM10	PM2.5	NO_2	SO_2
High	849.1	97.0	230.4	3.5
Med	350.1	45.3	127.6	1.9
Low	117.5	17.3	92.7	1.3

Source Characteristics

Because there is no specific project proposed at this time, source characteristics (stack height, exit velocity, etc.) are also not available. Therefore, the stack parameters are taken from other past modeling analyses.

The Monument Butte Draft Environmental Impact Statement air quality analysis (BLM 2014) was chosen because of its proximity to the Moab area and was completed in 2014. The source parameters are listed in Table F-2 and Table F-3 below.

Table F-2. Volume Source Parameters

Parameter	Value (units)
Release Height[1]	3.83 (meters)
Length of Side[2]	110 (meters)
Initial Lateral Dimension[3] (σ_y)	25.58 (meters)
Initial Vertical Dimension[4] (σ_z)	1.82 (meters)

1 – Average of pad construction and unpaved road sources (3.05+4.6)/2;
2 – From pad construction source
3 – Calculated (110 meters/4.3) per Lakes software, originally from ISC3 Model users guide
4 - Average of pad construction and unpaved road sources (1.5+2.13)/2

Table F-3. Drill Rig Source Parameters[1]

Parameter	Value (units)
Stack Height	6.1 (meters)
Exit Temperature	800 (Kelvin)
Exit Velocity	50 (meters/second)
Inside Stack Diameter	0.2 (meters)

1 – All values from drill rig source

Background Data – Ammonia and Ozone

No ammonia monitoring data are available in the project area; therefore a value of one ppm was used, which is appropriate for the arid climate of the project area. However, hourly ozone monitoring data is available near Canyonlands National Park. Three years of data (2006 to 2008) were downloaded from CASTNet monitoring site ("Island in the Sky" station, air quality site number: AQS-49-037-0101) and processed into a format readable by CALPUFF.

Receptors

Receptors from two nearby Class I areas were used in the analyses. The two Class I areas are:

- Arches National Park
- Canyonlands National Park

Receptor sets for each of these areas were downloaded from the National Park Service web site (http://www.nature.nps.gov/air/maps/receptors/index.cfm) by the Lakes software. No "sensitive" Class II areas were included in the modeling.

Land Use and Terrain Data

Digital terrain and land use data were obtained from WebGIS website (www.webgis.com). The CALPUFF View software will automatically download all relevant terrain and land use data based on the defined modeling domain. The data were then processed with the geophysical processor to obtained gridded land use and terrain values to feed into CALPUFF.

F.3 RESULTS

Table F-4. Moab Master Leasing Plan Modeling Results – National Ambient Air Quality Standards

Nitrogen Dioxide – 1-hour Concentrations (µg/m3)									
Class I Area	**2006**			**2007**			**2008**		
	high	**med**	**low**	**high**	**med**	**low**	**high**	**med**	**low**
Arches National Park	2.86	1.36	1.31	4.13	1.98	1.93	1.94	1.13	1.13
Canyonlands National Park	4.80	2.17	2.11	4.26	2.08	1.79	9.18	3.73	3.96

Nitrogen Dioxide – Annual Concentrations (µg/m3)									
Class I Area	**2006**			**2007**			**2008**		
	high	**med**	**low**	**high**	**med**	**low**	**high**	**med**	**low**
Arches National Park	0.03	0.02	0.01	0.02	0.02	0.01	0.06	0.04	0.03
Canyonlands National Park	0.05	0.02	0.02	0.04	0.02	0.01	0.13	0.07	0.06

PM2.5 – 24-hour Concentrations (µg/m3)									
Class I Area	**2006**			**2007**			**2008**		
	high	**med**	**low**	**high**	**med**	**low**	**high**	**med**	**low**
Arches National Park	0.20	0.08	0.04	0.19	0.08	0.03	0.30	0.12	0.06
Canyonlands National Park	0.35	0.17	0.06	0.26	0.12	0.04	0.84	0.33	0.16

PM2.5 – Annual Concentrations (µg/m3)									
Class I Area	**2006**			**2007**			**2008**		
	high	**med**	**low**	**high**	**med**	**low**	**high**	**med**	**low**
Arches National Park	0.02	0.01	0.00	0.02	0.01	0.00	0.06	0.02	0.01
Canyonlands National Park	0.03	0.01	0.01	0.03	0.01	0.00	0.11	0.05	0.02

PM10 – 24-hour Concentrations (µg/m3)									
Class I Area	**2006**			**2007**			**2008**		
	high	**med**	**low**	**high**	**med**	**low**	**high**	**med**	**low**
Arches National Park	1.82	0.68	0.25	1.72	0.69	0.24	2.65	1.00	0.35
Canyonlands National Park	3.06	1.33	0.42	2.25	0.94	0.30	7.50	2.66	1.00

SO2 – 1-hour Concentrations (µg/m3)									
Class I Area	**2006**			**2007**			**2008**		
	high	**med**	**low**	**high**	**med**	**low**	**high**	**med**	**low**
Arches National Park	0.08	0.04	0.04	0.10	0.04	0.04	0.03	0.02	0.02
Canyonlands National Park	0.11	0.04	0.05	0.11	0.04	0.04	0.14	0.05	0.06

SO2 – 3-hour Concentrations (µg/m3)									
Class I Area	**2006**			**2007**			**2008**		
	high	**med**	**low**	**high**	**med**	**low**	**high**	**med**	**low**
Arches National Park	0.03	0.01	0.01	0.03	0.01	0.01	0.02	0.01	0.01
Canyonlands National Park	0.04	0.01	0.01	0.04	0.01	0.01	0.06	0.02	0.02

Table F-5. Moab Master Leasing Plan Modeling Results – Deposition

	Nitrogen deposition (kg/ha/yr)			**Sulfur deposition** (kg/ha/yr)		
Arches National Park – Deposition						
Met Data Year	**high**	**med**	**low**	**high**	**med**	**low**
2006	0.00466	0.00260	0.00197	0.000215	0.0001199	0.0000825
2007	0.00457	0.00254	0.00199	0.000206	0.0001151	0.0000834
2008	0.01074	0.006075	0.00483	0.000349	0.0001985	0.0001420

	Nitrogen deposition (kg/ha/yr)			**Sulfur deposition** (kg/ha/yr)		
Canyonlands National Park – Deposition						
Met Data Year	**high**	**med**	**low**	**high**	**med**	**low**
2006	0.00578	0.00306	0.00223	0.000231	0.000121	0.0000804
2007	0.00551	0.00291	0.00222	0.000222	0.000116	0.0000778
2008	0.01795	0.01019	0.00857	0.000544	0.000311	0.000235

Table F-6. Moab Master Leasing Plan Modeling Results – Visibility

Meteorological Data Year	Days > 0.5 dv	Days > 1.0 dv	Max percent change dv
Arches National Park – Visibility			
2006			
High	22	1	12.20%
Med	1	0	5.05%
Low	0	0	2.90%
2007			
High	14	1	10.03%
Med	0	0	4.28%
Low	0	0	2.35%
2008			
High	83	13	19.41%
Med	7	0	8.59%
Low	0	0	4.59%
Canyonlands National Park – Visibility			
2006			
High	53	11	20.39%
Med	5	0	8.94%
Low	0	0	4.50%
2007			
High	42	8	14.05%
Med	6	0	6.18%
Low	0	0	3.52%
2008			
High	159	86	46.74%
Med	71	23	19.30%
Low	22	0	9.83%

Table F-7. Emissions Input Files

HIGH	Summary Emissions per DRILL RIG or PRODUCING WELL	PM_{10}	$PM_{2.5}$	NO_x	SO_2
	Drill-Rig POINT SOURCE emissions total (RIG-##)	0.346	0.290	5.201	0.0906
	Drill-Rig VOLUME SOURCE emissions total (VRG-##)	9.854	1.369	0.0466	0.0001
	Production well VOLUME SOURCE emissions total (SRC-##)	3.780	0.411	0.614	0.0083
	Total Emissions	**13.979**	**2.071**	**5.862**	**0.099**

HIGH SCENARIO - VOLUME SOURCES										
Source Name	X Coord	Y Coord	Effect. Height	Base Elev.	Initial Sigma y	Initial Sigma z	SO2	NOx	PM10	PM2.5
	km	km	m	m	m	m/s	0.008	0.614	3.780	0.411
1 SRC_4	-1084.768	-201.044	3.83	1930.63	25.58	1.82	0.027	2.002	12.336	1.343
2 SRC_5	-1075.412	-201.92	3.83	1902.51	25.58	1.82	0.063	4.672	28.783	3.133
3 SRC_7	-1095.471	-209.684	3.83	1950.08	25.58	1.82	0.009	0.667	4.112	0.448
4 SRC_8	-1086.141	-210.985	3.83	2017.87	25.58	1.82	0.009	0.667	4.112	0.448
5 SRC_11	-1109.006	-107.008	3.83	1384.12	25.58	1.82	0.018	1.335	8.224	0.895
6 SRC_13	-1089.754	-109.806	3.83	1464.26	25.58	1.82	0.027	2.002	12.336	1.343
7 SRC_14	-1080.278	-111.771	3.83	1439.27	25.58	1.82	0.036	2.670	16.447	1.790
8 SRC_15	-1070.743	-113.094	3.83	1390.83	25.58	1.82	0.009	0.667	4.112	0.448
9 SRC_18	-1119.86	-115.239	3.83	1312.95	25.58	1.82	0.163	12.014	74.013	8.057
10 SRC_19	-1110.389	-116.637	3.83	1370.62	25.58	1.82	0.081	6.007	37.007	4.028
11 SRC_20	-1100.754	-118.012	3.83	1369.41	25.58	1.82	0.054	4.005	24.671	2.686
12 SRC_21	-1095.099	-119.379	3.83	1423.09	25.58	1.82	0.018	1.335	8.224	0.895
13 SRC_22	-1077.892	-117.014	3.83	1421.38	25.58	1.82	0.018	1.335	8.224	0.895
14 SRC_23	-1072.468	-122.657	3.83	1472.97	25.58	1.82	0.018	1.335	8.224	0.895
15 SRC_24	-1062.787	-123.994	3.83	1539.35	25.58	1.82	0.018	1.335	8.224	0.895
16 SRC_28	-1121.243	-124.791	3.83	1329.76	25.58	1.82	0.018	1.335	8.224	0.895
17 SRC_29	-1111.766	-126.18	3.83	1465.99	25.58	1.82	0.036	2.670	16.447	1.790
18 SRC_30	-1102.109	-127.564	3.83	1523.43	25.58	1.82	0.018	1.335	8.224	0.895
19 SRC_31	-1092.669	-128.899	3.83	1411.98	25.58	1.82	0.036	2.670	16.447	1.790
20 SRC_32	-1089.455	-130.533	3.83	1373.67	25.58	1.82	0.009	0.667	4.112	0.448
21 SRC_36	-1046.04	-135.958	3.83	1819.22	25.58	1.82	0.018	1.335	8.224	0.895

HIGH SCENARIO - VOLUME SOURCES										
22 SRC_39	-1094.259	-138.728	3.83	1522.36	25.58	1.82	0.045	3.337	20.559	2.238
23 SRC_45	-1114.592	-145.996	3.83	1518.63	25.58	1.82	0.018	1.335	8.224	0.895
24 SRC_46	-1105.117	-147.348	3.83	1770.9	25.58	1.82	0.154	11.346	69.901	7.609
25 SRC_47	-1095.648	-148.682	3.83	1571.31	25.58	1.82	0.217	16.018	98.684	10.742
26 SRC_51	-1096.645	-158.279	3.83	1336.31	25.58	1.82	0.081	6.007	37.007	4.028
27 SRC_52	-1088.212	-159.551	3.83	1492.89	25.58	1.82	0.063	4.672	28.783	3.133
28 SRC_53	-1078.796	-160.851	3.83	1665.26	25.58	1.82	0.045	3.337	20.559	2.238
29 SRC_55	-1094.988	-166.869	3.83	1581.06	25.58	1.82	0.027	2.002	12.336	1.343
30 SRC_56	-1089.54	-169.147	3.83	1775.48	25.58	1.82	0.027	2.002	12.336	1.343
31 SRC_57	-1080.097	-170.456	3.83	1626.78	25.58	1.82	0.018	1.335	8.224	0.895
32 SRC_60	-1090.868	-178.719	3.83	1842.41	25.58	1.82	0.027	2.002	12.336	1.343
33 SRC_70	-1074.204	-192.359	3.83	1809.97	25.58	1.82	0.009	0.667	4.112	0.448
34 SRC_72	-1076.68	-211.87	3.83	2140.71	25.58	1.82	0.027	2.002	12.336	1.343
35 SRC_73	-1128.017	-104.249	3.83	1279.39	25.58	1.82	0.009	0.667	4.112	0.448
36 SRC_74	-1118.472	-105.631	3.83	1329.6	25.58	1.82	0.063	4.672	28.783	3.133
37 SRC_76	-1113.183	-136.033	3.83	1526.44	25.58	1.82	0.072	5.339	32.895	3.581
38 SRC_77	-1103.724	-137.395	3.83	1624.99	25.58	1.82	0.063	4.672	28.783	3.133
39 SRC_78	-1088.825	-144.388	3.83	1347.14	25.58	1.82	0.027	2.002	12.336	1.343
40 SRC_79	-1086.169	-150.007	3.83	1322.9	25.58	1.82	0.036	2.670	16.447	1.790
41 SRC_38	-1124.027	-135.036	3.83	1361.93	25.58	1.82	0.009	0.667	4.112	0.448
42 SRC_59	-1100.337	-177.389	3.83	1459.56	25.58	1.82	0.036	2.670	16.447	1.790
43 SRC_61	-1081.402	-180.037	3.83	1777.49	25.58	1.82	0.018	1.335	8.224	0.895
44 SRC_62	-1071.93	-181.35	3.83	1858.66	25.58	1.82	0.009	0.667	4.112	0.448
45 SRC_67	-1098.645	-188.423	3.83	1531.05	25.58	1.82	0.045	3.337	20.559	2.238
46 VRG-18	-1119.86	-115.239	3.83	1312.95	25.58	1.82	0.091	5.201	0.346	0.290
47 VRG-19	-1110.389	-116.637	3.83	1370.62	25.58	1.82	0.091	5.201	0.346	0.290
48 VRG-76	-1113.183	-136.033	3.83	1526.44	25.58	1.82	0.091	5.201	0.346	0.290
49 VRG-46	-1105.117	-147.348	3.83	1770.9	25.58	1.82	0.091	5.201	0.346	0.290
50 VRG-47	-1095.648	-148.682	3.83	1571.31	25.58	1.82	0.091	5.201	0.346	0.290
51 VRG-52	-1088.212	-159.551	3.83	1492.89	25.58	1.82	0.091	5.201	0.346	0.290
52 VRG-60	-1090.868	-178.719	3.83	1842.41	25.58	1.82	0.091	5.201	0.346	0.290
53 VRG-05	-1075.412	-201.92	3.83	1902.51	25.58	1.82	0.091	5.201	0.346	0.290
54 VRG-57	-1080.097	-170.456	3.83	1626.78	25.58	1.82	0.091	5.201	0.346	0.290

MEDIUM	Summary Emissions per DRILL RIG or PRODUCING WELL	PM_{10}	$PM_{2.5}$	NO_x	SO_2
	Drill-Rig POINT SOURCE emissions total (RIG-##)	0.346	0.290	5.201	0.0906
	Drill-Rig VOLUME SOURCE emissions total (VRG-##)	8.872	1.271	0.0466	0.0001
	Production well VOLUME SOURCE emissions total (SRC-##)	2.040	0.238	0.614	0.0083
	Total Emissions	**11.257**	**1.800**	**5.862**	**0.099**

MEDIUM SCENARIO - POINT SOURCES												
	3 oil rigs, 5 potash rigs, and 1 "other" drill rig operating											
Source Name	**X Coord**	**Y Coord**	**Stack Height**	**Base Elev.**	**Stack Diam.**	**Exit Velocity**	**Exit Temp**	**Bldg Dwash**	**SO2**	**NOx**	**PM10**	**PM2.5**
	km	**km**	**m**	**m**	**m**	**m/s**	**K**					
1 RIG-18	-1119.9	-115.24	6.1	1312.95	0.2	50	800	0	0.0906	5.20	0.346	0.290
2 RIG-19	-1110.4	-116.64	6.1	1370.62	0.2	50	800	0	0.0906	5.20	0.346	0.290
3 RIG-76	-1113.2	-136.03	6.1	1526.44	0.2	50	800	0	0.0906	5.20	0.346	0.290
4 RIG-46	-1105.1	-147.35	6.1	1770.9	0.2	50	800	0	0.0906	5.20	0.346	0.290
5 RIG-47	-1095.6	-148.68	6.1	1571.31	0.2	50	800	0	0.0906	5.20	0.346	0.290
6 RIG-52	-1088.2	-159.55	6.1	1492.89	0.2	50	800	0	0.0906	5.20	0.346	0.290
7 RIG-60	-1090.9	-178.72	6.1	1842.41	0.2	50	800	0	0.0906	5.20	0.346	0.290
8 RIG-05	-1075.4	-201.92	6.1	1902.51	0.2	50	800	0	0.0906	5.20	0.346	0.290
9 RIG-57	-1080.1	-170.46	6.1	1626.78	0.2	50	800	0	0.0906	5.20	0.346	0.290

MEDIUM SCENARIO - VOLUME SOURCES										
Source Name	**X Coord**	**Y Coord**	**Effect. Height**	**Base Elev.**	**Initial Sigma y**	**Initial Sigma z**	**SO2**	**NOx**	**PM10**	**PM2.5**
	km	**km**	**m**	**m**	**m**	**m/s**	0.008	0.614	2.040	0.238
SRC_4	-1084.768	-201.044	3.83	1930.63	25.58	1.82	0.016	1.176	3.910	0.457
2 SRC_5	-1075.412	-201.92	3.83	1902.51	25.58	1.82	0.037	2.744	9.123	1.067
3 SRC_7	-1095.471	-209.684	3.83	1950.08	25.58	1.82	0.005	0.392	1.303	0.152
4 SRC_8	-1086.141	-210.985	3.83	2017.87	25.58	1.82	0.005	0.392	1.303	0.152
5 SRC_11	-1109.006	-107.008	3.83	1384.12	25.58	1.82	0.011	0.784	2.607	0.305
6 SRC_13	-1089.754	-109.806	3.83	1464.26	25.58	1.82	0.016	1.176	3.910	0.457
7 SRC_14	-1080.278	-111.771	3.83	1439.27	25.58	1.82	0.021	1.568	5.213	0.609
8 SRC_15	-1070.743	-113.094	3.83	1390.83	25.58	1.82	0.005	0.392	1.303	0.152

MEDIUM SCENARIO - VOLUME SOURCES										
9 SRC_18	-1119.86	-115.239	3.83	1312.95	25.58	1.82	0.096	7.057	23.460	2.742
10 SRC_19	-1110.389	-116.637	3.83	1370.62	25.58	1.82	0.048	3.529	11.730	1.371
11 SRC_20	-1100.754	-118.012	3.83	1369.41	25.58	1.82	0.032	2.352	7.820	0.914
12 SRC_21	-1095.099	-119.379	3.83	1423.09	25.58	1.82	0.011	0.784	2.607	0.305
13 SRC_22	-1077.892	-117.014	3.83	1421.38	25.58	1.82	0.011	0.784	2.607	0.305
14 SRC_23	-1072.468	-122.657	3.83	1472.97	25.58	1.82	0.011	0.784	2.607	0.305
15 SRC_24	-1062.787	-123.994	3.83	1539.35	25.58	1.82	0.011	0.784	2.607	0.305
16 SRC_28	-1121.243	-124.791	3.83	1329.76	25.58	1.82	0.011	0.784	2.607	0.305
17 SRC_29	-1111.766	-126.18	3.83	1465.99	25.58	1.82	0.021	1.568	5.213	0.609
18 SRC_30	-1102.109	-127.564	3.83	1523.43	25.58	1.82	0.011	0.784	2.607	0.305
19 SRC_31	-1092.669	-128.899	3.83	1411.98	25.58	1.82	0.021	1.568	5.213	0.609
20 SRC_32	-1089.455	-130.533	3.83	1373.67	25.58	1.82	0.005	0.392	1.303	0.152
21 SRC_36	-1046.04	-135.958	3.83	1819.22	25.58	1.82	0.011	0.784	2.607	0.305
22 SRC_39	-1094.259	-138.728	3.83	1522.36	25.58	1.82	0.027	1.960	6.517	0.762
23 SRC_45	-1114.592	-145.996	3.83	1518.63	25.58	1.82	0.011	0.784	2.607	0.305
24 SRC_46	-1105.117	-147.348	3.83	1770.9	25.58	1.82	0.090	6.665	22.157	2.590
25 SRC_47	-1095.648	-148.682	3.83	1571.31	25.58	1.82	0.128	9.410	31.280	3.657
26 SRC_51	-1096.645	-158.279	3.83	1336.31	25.58	1.82	0.048	3.529	11.730	1.371
27 SRC_52	-1088.212	-159.551	3.83	1492.89	25.58	1.82	0.037	2.744	9.123	1.067
28 SRC_53	-1078.796	-160.851	3.83	1665.26	25.58	1.82	0.027	1.960	6.517	0.762
29 SRC_55	-1094.988	-166.869	3.83	1581.06	25.58	1.82	0.016	1.176	3.910	0.457
30 SRC_56	-1089.54	-169.147	3.83	1775.48	25.58	1.82	0.016	1.176	3.910	0.457
31 SRC_57	-1080.097	-170.456	3.83	1626.78	25.58	1.82	0.011	0.784	2.607	0.305
32 SRC_60	-1090.868	-178.719	3.83	1842.41	25.58	1.82	0.016	1.176	3.910	0.457
33 SRC_70	-1074.204	-192.359	3.83	1809.97	25.58	1.82	0.005	0.392	1.303	0.152
34 SRC_72	-1076.68	-211.87	3.83	2140.71	25.58	1.82	0.016	1.176	3.910	0.457
35 SRC_73	-1128.017	-104.249	3.83	1279.39	25.58	1.82	0.005	0.392	1.303	0.152
36 SRC_74	-1118.472	-105.631	3.83	1329.6	25.58	1.82	0.037	2.744	9.123	1.067
37 SRC_76	-1113.183	-136.033	3.83	1526.44	25.58	1.82	0.043	3.137	10.427	1.219
38 SRC_77	-1103.724	-137.395	3.83	1624.99	25.58	1.82	0.037	2.744	9.123	1.067
39 SRC_78	-1088.825	-144.388	3.83	1347.14	25.58	1.82	0.016	1.176	3.910	0.457
40 SRC_79	-1086.169	-150.007	3.83	1322.9	25.58	1.82	0.021	1.568	5.213	0.609
41 SRC_38	-1124.027	-135.036	3.83	1361.93	25.58	1.82	0.005	0.392	1.303	0.152
42 SRC_59	-1100.337	-177.389	3.83	1459.56	25.58	1.82	0.021	1.568	5.213	0.609

MEDIUM SCENARIO - VOLUME SOURCES										
43 SRC_61	-1081.402	-180.037	3.83	1777.49	25.58	1.82	0.011	0.784	2.607	0.305
44 SRC_62	-1071.93	-181.35	3.83	1858.66	25.58	1.82	0.005	0.392	1.303	0.152
45 SRC_67	-1098.645	-188.423	3.83	1531.05	25.58	1.82	0.027	1.960	6.517	0.762
46 VRG-18	-1119.86	-115.239	3.83	1312.95	25.58	1.82	0.0001	0.047	8.87	1.27
47 VRG-19	-1110.389	-116.637	3.83	1370.62	25.58	1.82	0.0001	0.047	8.87	1.27
48 VRG-76	-1113.183	-136.033	3.83	1526.44	25.58	1.82	0.0001	0.047	8.87	1.27
49 VRG-46	-1105.117	-147.348	3.83	1770.9	25.58	1.82	0.0001	0.047	8.87	1.27
50 VRG-47	-1095.648	-148.682	3.83	1571.31	25.58	1.82	0.0001	0.047	8.87	1.27
51 VRG-52	-1088.212	-159.551	3.83	1492.89	25.58	1.82	0.0001	0.047	8.87	1.27
52 VRG-60	-1090.868	-178.719	3.83	1842.41	25.58	1.82	0.0001	0.047	8.87	1.27
53 VRG-05	-1075.412	-201.92	3.83	1902.51	25.58	1.82	0.0001	0.047	8.87	1.27
54 VRG-57	-1080.097	-170.456	3.83	1626.78	25.58	1.82	0.0001	0.047	8.87	1.27

LOW	Summary Emissions per DRILL RIG or PRODUCING WELL	PM_{10}	$PM_{2.5}$	NO_x	SO_2
	Drill-Rig POINT SOURCE emissions total (RIG-##)	0.197	0.155	2.305	0.0314
	Drill-Rig VOLUME SOURCE emissions total (VRG-##)	1.257	0.184	0.0116	0.00004
	Production well VOLUME SOURCE emissions total (SRC-##)	0.821	0.117	0.614	0.0083
	Total Emissions	**2.275**	**0.456**	**2.931**	**0.040**

LOW SCENARIO - POINT SOURCES												
	3 oil rigs and 1 "other" rig operating - NO Potash well drilling											
Source Name	**X Coord**	**Y Coord**	**Stack Height**	**Base Elev.**	**Stack Diam.**	**Exit Velocity**	**Exit Temp**	**Bldg Dwash**	**SO2**	**NOx**	**PM10**	**PM2.5**
	km	**km**	**m**	**m**	**m**	**m/s**	**K**					
1 RIG-18	-1119.9	-115.24	6.1	1312.95	0.2	50	800	0	0	0	0	0
2 RIG-19	-1110.4	-116.64	6.1	1370.62	0.2	50	800	0	0.0314	2.31	0.197	0.155
3 RIG-76	-1113.2	-136.03	6.1	1526.44	0.2	50	800	0	0.0314	2.31	0.197	0.155
4 RIG-46	-1105.1	-147.35	6.1	1770.9	0.2	50	800	0	0	0	0	0
5 RIG-47	-1095.6	-148.68	6.1	1571.31	0.2	50	800	0	0	0	0	0
6 RIG-52	-1088.2	-159.55	6.1	1492.89	0.2	50	800	0	0.0314	2.31	0.197	0.155
7 RIG-60	-1090.9	-178.72	6.1	1842.41	0.2	50	800	0	0	0	0	0
8 RIG-05	-1075.4	-201.92	6.1	1902.51	0.2	50	800	0	0.0314	2.31	0.197	0.155

LOW SCENARIO - POINT SOURCES												
9 RIG-57	-1080.1	-170.46	6.1	1626.78	0.2	50	800	0	0	0	0	0

LOW SCENARIO - VOLUME SOURCES										
Source Name	X Coord	Y Coord	Effect. Height	Base Elev.	Initial Sigma y	Initial Sigma z	SO2	NOx	PM10	PM2.5
	km	km	m	m	m	m/s	0.008	0.614	0.821	0.117
1 SRC_4	-1084.768	-201.044	3.83	1930.63	25.58	1.82	0.016	1.192	1.596	0.228
2 SRC_5	-1075.412	-201.92	3.83	1902.51	25.58	1.82	0.038	2.781	3.723	0.532
3 SRC_7	-1095.471	-209.684	3.83	1950.08	25.58	1.82	0.005	0.397	0.532	0.076
4 SRC_8	-1086.141	-210.985	3.83	2017.87	25.58	1.82	0.005	0.397	0.532	0.076
5 SRC_11	-1109.006	-107.008	3.83	1384.12	25.58	1.82	0.011	0.795	1.064	0.152
6 SRC_13	-1089.754	-109.806	3.83	1464.26	25.58	1.82	0.016	1.192	1.596	0.228
7 SRC_14	-1080.278	-111.771	3.83	1439.27	25.58	1.82	0.022	1.589	2.127	0.304
8 SRC_15	-1070.743	-113.094	3.83	1390.83	25.58	1.82	0.005	0.397	0.532	0.076
9 SRC_18	-1119.86	-115.239	3.83	1312.95	25.58	1.82	0.102	7.550	10.105	1.443
10 SRC_19	-1110.389	-116.637	3.83	1370.62	25.58	1.82	0.048	3.576	4.787	0.684
11 SRC_20	-1100.754	-118.012	3.83	1369.41	25.58	1.82	0.032	2.384	3.191	0.456
12 SRC_21	-1095.099	-119.379	3.83	1423.09	25.58	1.82	0.011	0.795	1.064	0.152
13 SRC_22	-1077.892	-117.014	3.83	1421.38	25.58	1.82	0.011	0.795	1.064	0.152
14 SRC_23	-1072.468	-122.657	3.83	1472.97	25.58	1.82	0.011	0.795	1.064	0.152
15 SRC_24	-1062.787	-123.994	3.83	1539.35	25.58	1.82	0.011	0.795	1.064	0.152
16 SRC_28	-1121.243	-124.791	3.83	1329.76	25.58	1.82	0.011	0.795	1.064	0.152
17 SRC_29	-1111.766	-126.18	3.83	1465.99	25.58	1.82	0.022	1.589	2.127	0.304
18 SRC_30	-1102.109	-127.564	3.83	1523.43	25.58	1.82	0.011	0.795	1.064	0.152
19 SRC_31	-1092.669	-128.899	3.83	1411.98	25.58	1.82	0.022	1.589	2.127	0.304
20 SRC_32	-1089.455	-130.533	3.83	1373.67	25.58	1.82	0.005	0.397	0.532	0.076
21 SRC_36	-1046.04	-135.958	3.83	1819.22	25.58	1.82	0.011	0.795	1.064	0.152
22 SRC_39	-1094.259	-138.728	3.83	1522.36	25.58	1.82	0.027	1.987	2.659	0.380
23 SRC_45	-1114.592	-145.996	3.83	1518.63	25.58	1.82	0.011	0.795	1.064	0.152
24 SRC_46	-1105.117	-147.348	3.83	1770.9	25.58	1.82	0.097	7.152	9.573	1.367
25 SRC_47	-1095.648	-148.682	3.83	1571.31	25.58	1.82	0.135	9.934	13.296	1.899
26 SRC_51	-1096.645	-158.279	3.83	1336.31	25.58	1.82	0.048	3.576	4.787	0.684
27 SRC_52	-1088.212	-159.551	3.83	1492.89	25.58	1.82	0.038	2.781	3.723	0.532

LOW SCENARIO - VOLUME SOURCES										
28 SRC_53	-1078.796	-160.851	3.83	1665.26	25.58	1.82	0.027	1.987	2.659	0.380
29 SRC_55	-1094.988	-166.869	3.83	1581.06	25.58	1.82	0.016	1.192	1.596	0.228
30 SRC_56	-1089.54	-169.147	3.83	1775.48	25.58	1.82	0.016	1.192	1.596	0.228
31 SRC_57	-1080.097	-170.456	3.83	1626.78	25.58	1.82	0.016	1.192	1.596	0.228
32 SRC_60	-1090.868	-178.719	3.83	1842.41	25.58	1.82	0.022	1.589	2.127	0.304
33 SRC_70	-1074.204	-192.359	3.83	1809.97	25.58	1.82	0.005	0.397	0.532	0.076
34 SRC_72	-1076.68	-211.87	3.83	2140.71	25.58	1.82	0.016	1.192	1.596	0.228
35 SRC_73	-1128.017	-104.249	3.83	1279.39	25.58	1.82	0.005	0.397	0.532	0.076
36 SRC_74	-1118.472	-105.631	3.83	1329.6	25.58	1.82	0.038	2.781	3.723	0.532
37 SRC_76	-1113.183	-136.033	3.83	1526.44	25.58	1.82	0.043	3.179	4.255	0.608
38 SRC_77	-1103.724	-137.395	3.83	1624.99	25.58	1.82	0.038	2.781	3.723	0.532
39 SRC_78	-1088.825	-144.388	3.83	1347.14	25.58	1.82	0.016	1.192	1.596	0.228
40 SRC_79	-1086.169	-150.007	3.83	1322.9	25.58	1.82	0.022	1.589	2.127	0.304
41 SRC_38	-1124.027	-135.036	3.83	1361.93	25.58	1.82	0.005	0.397	0.532	0.076
42 SRC_59	-1100.337	-177.389	3.83	1459.56	25.58	1.82	0.022	1.589	2.127	0.304
43 SRC_61	-1081.402	-180.037	3.83	1777.49	25.58	1.82	0.011	0.795	1.064	0.152
44 SRC_62	-1071.93	-181.35	3.83	1858.66	25.58	1.82	0.005	0.397	0.532	0.076
45 SRC_67	-1098.645	-188.423	3.83	1531.05	25.58	1.82	0.027	1.987	2.659	0.380
46 VRG-18	-1119.86	-115.239	3.83	1312.95	25.58	1.82	0	0	0	0
47 VRG-19	-1110.389	-116.637	3.83	1370.62	25.58	1.82	0.00004	0.012	1.26	0.18
48 VRG-76	-1113.183	-136.033	3.83	1526.44	25.58	1.82	0.00004	0.012	1.26	0.18
49 VRG-46	-1105.117	-147.348	3.83	1770.9	25.58	1.82	0	0	0	0
50 VRG-47	-1095.648	-148.682	3.83	1571.31	25.58	1.82	0	0	0	0
51 VRG-52	-1088.212	-159.551	3.83	1492.89	25.58	1.82	0.00004	0.012	1.26	0.18
52 VRG-60	-1090.868	-178.719	3.83	1842.41	25.58	1.82	0	0	0	0
53 VRG-05	-1075.412	-201.92	3.83	1902.51	25.58	1.82	0.00004	0.012	1.26	0.18
54 VRG-57	-1080.097	-170.456	3.83	1626.78	25.58	1.82	0	0	0	0

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