Appendix F. Lander Air Resources Management Plan

F.1. Purpose

The purpose of this air resources management plan is to address air quality issues identified by the Bureau of Land Management (BLM) in its analysis of potential impacts to air quality resources for the Lander Field Office Resource Management Plan (RMP). This plan outlines the specific requirements for managing air resources and authorizing activities that have the potential to adversely impact air resources within the Lander Field Office planning area. The plan also outlines specific requirements for proponents of projects that have the potential to generate air emissions and adversely impact air resources within the planning area.

F.2. Air Quality Issues

The BLM based its identification of air quality issues on the following information:

- The air emissions inventory compiled for the planning area which estimated potential emissions of air pollutants for maximum allowable development and authorizations under each alternative
- Existing air monitoring data from the South Pass and Lander State and Local Monitoring Site (SLAMS) stations, the South Pass and Sinks Canyon National Atmospheric Deposition Program (NADP) sites, and the Bridger and North Absaroka Interagency Monitoring of Protected Visual Environments (IMPROVE) sites.
- The Reasonable Foreseeable Development (RFD) Scenario for Oil and Gas (BLM 2009d), Mineral Occurrence and Development Potential Report (BLM 2009c), and potential levels and location of development identified in Chapter 4 of the RMP.

F.2.1. Magnitude of Emissions

An air emissions inventory was compiled for the planning area to determine the relative magnitude of total air pollutant emissions and to compare emissions between alternatives. Emissions were calculated using conservative assumptions about the likelihood of potential activities occurring under each alternative that result in maximum air emissions being estimated. For example, air emissions from oil and gas activities assume that all of the potential development identified in the RFD will occur. The RFD is based upon known geologic conditions, current development technology, and industry-provided data about future planned development. Future pricing and economic or technical viability of geologic plays were not taken into account. Air emissions from non-oil and gas mineral development, such as uranium mining, were calculated assuming maximum development scenarios even though these activities are vulnerable to economic variability. Assumptions regarding the use of air emission control technologies were also very conservative. For example, air emissions from drilling activities assume a mixture of Tier 1 – Tier 3 diesel engines. However, it is likely that significant improvement in emissions could be realized over the life of the plan through the use of alternative drilling technologies.

As a result, the compiled air emissions inventory represents the emissions of air pollutants based on best available but very speculative information for future development projections. It is very likely that the emissions inventory over-estimates projected future emissions due to the

conservative assumptions used. However, it is valid for contrasting the impact of management actions and strategies on air resources among alternatives. It is also useful for identifying those activities that are likely to be major contributors to increased air emissions and developing management actions to minimize their impact to air resources.

Despite the limitations of the air emissions inventory it supports two major conclusions:

1. there is not a substantial difference in total air emissions among alternatives (Table 4.1, "Estimated Annual Emissions Summary for BLM Activities in the Lander Planning Area" (p. 540)), and
2. for the management activities analyzed, oil and gas development activities are the major contributor to total air emissions and non-oil and gas mineral development activities (mining) are the major contributor to particulate matter emissions.

The reason there is not a substantial difference in total air emissions among alternatives is the result of several factors:

- The oil and gas development in the planning area is primarily in tightly-focused discrete areas that have relatively few conflicts with other resource uses. The constraints placed on oil and gas development under all alternatives to protect other resources do not vary greatly, therefore, the projected emissions do not vary greatly.
- Under Alternative B, the most restrictive alternative, a substantial portion of the oil and gas RFD is assumed to be developed.
- Under all alternatives, existing sources of emissions are assumed to continue to comprise a substantial portion of total projected emissions.

While the BLM has discretion to make allocative decisions in these areas under any alternative, due to the high percentage of existing leases in areas with potential oil and gas development (approximately 93 percent) the ability to implement substantial restrictions on development is primarily limited to mitigation measures that can be applied during project approval. Such restrictions include cooperative development of project-specific measures to minimize impacts to air resources as outlined in this plan.

F.2.2. Pollutants of Concern

Air monitoring data from the South Pass SLAMs monitor located on the south western edge of the planning area measured ozone concentrations above the National Ambient Air Quality Standards (NAAQS) during the 2008-2010 time period. Seven exceedances of the 8-hour ozone standard above 75 parts per billion (ppb) were recorded in 2009 while one hour values at or above 75 ppb were recorded twice in 2008 and once in 2010. The South Pass monitor was the only monitor measuring ozone within the planning area during the 2008-2010 period. It is difficult to determine if ozone concentrations above the NAAQS are occurring throughout the planning area or if the high concentrations are unique to the South Pass area because of its proximity to and downwind location from the Upper Green River Valley (a proposed ozone non-attainment area). The emissions inventory compiled for each alternative shows that estimated emissions from BLM authorized activities such as oil and gas development have the potential to cause or contribute to increased levels of ozone which may result in exceedances of the ozone standard due to increased emissions of ozone forming precursors. Therefore, the BLM has identified ozone and the precursors, nitrogen oxides (NO_x) and volatile organic compounds (VOCs), as pollutants of concern to be addressed through specific management actions described in this plan.

Air monitoring data from the residential SLAMs monitor located in the town of Lander shows that the 98th percentile of 24-hour average concentrations for particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) averaged over the three year period 2008-2010 is approximately 30 micrograms per cubic meter (ug/m^3) or 87 percent of the NAAQS. However, the annual average of $PM_{2.5}$ concentrations at the same site over the same time period is approximately 8.4 ug/m^3 or 56 percent of the NAAQS. It is likely that the short term high concentrations in $PM_{2.5}$ are due to wintertime woodstove use and natural events such as wildfires or high wind events having a localized impact in the town of Lander. It is difficult to fully support this conclusion due to a lack of $PM_{2.5}$ monitoring data in the planning area. The emissions inventory compiled for each alternative shows that estimated emissions from BLM authorized activities such as mining and vegetation management through prescribed fire may have the potential to cause or contribute to short term localized increases in levels of $PM_{2.5}$. Therefore, BLM has identified $PM_{2.5}$ as a pollutant of concern to be addressed through specific management actions described in this plan.

Representative air monitoring data for hazardous air pollutants (HAPs) is not available for the planning area, however increases in estimated emissions of a subset of these pollutants was shown through the compilation of the emissions inventory for each alternative. Specifically, emissions of benzene, toluene, ethyl benzene, xylenes, n-hexane, and formaldehyde were estimated to increase due primarily to development of oil and gas resources. Emissions of these pollutants from leaks, venting, internal combustion, and flaring associated with BLM authorized oil and gas development have the potential to result in short term, near-field increases in concentrations of these pollutants. Therefore, BLM has identified this subset of HAPs as pollutants of concern to be addressed through specific management actions described in this plan.

F.2.3. Air Emission Generating Activities

Air emissions were estimated for 11 different categories of activities that BLM authorizes, allows, or performs and that have the potential to emit regulated air pollutants. The estimated emissions, based on the maximum development potential under each alternative were used to identify activities that have the potential to contribute to increases in concentrations of regulated air pollutants and to determine those activities that warrant specific management strategies for minimizing air quality impacts.

Under each alternative, oil and gas development activities were identified as the major contributor to increases in emissions of NO_x, VOC, and HAPs. Non-oil and gas mineral development activities, specifically sand and gravel mining and processing, and other solid minerals mining were identified as the major contributor to increases in particulate matter emissions.

F.2.4. Geographic Areas of High Potential for Development

The Mineral Occurrence and Development Potential Report and the RFD Scenario for Oil and Gas identified geographic areas of high, moderate, and low development potential for conventional oil and gas, coalbed natural gas (CBNG), and locatable and salable minerals.

One area was identified within the planning area as high potential for conventional oil and gas development and is located in the northeast corner of the planning area surrounding the town of Lysite. This area is comprised of the existing and proposed expansion of the Gun Barrel, Madden Deep, Ironhorse oil and gas development units. Areas of moderate potential for oil and gas development have been identified in the central portion of the planning area

surrounding the Beavercreek unit and in the southern portion of the planning area overlapping the Fremont-Sweetwater county border (Map 17). Moderate potential for CBNG development has been identified in these same two areas (Map 20).

Under the Preferred Alternative, the Lander Field Office identified Designated Development Areas (Map 134) based on locations of high and moderate potential oil and gas development and a need to protect other resources. The intention of these Designated Development Areas is to maximize potential oil and gas development in defined locations while minimizing impacts to other natural resources across the planning area. The locations of these Designated Development Areas provide the following benefits to air resources:

- Encourages future oil and gas development in areas of existing development thereby reducing impacts to air from new construction, new production facilities, and new compression sources that would be required in undeveloped fields,
- Encourages future oil and gas development in areas located downwind of and over 50 kilometers (31 miles) from the nearest federally designated Class I area,
- Downwind impacts from the Designated Development Areas are not likely to impact Class I or sensitive Class II areas, major population centers, or areas with ambient air concentration levels of concern,
- Encourages future oil and gas development in geographic areas of relatively flat terrain with minor shallow basins and relatively consistent west-southwesterly winds thereby minimizing potential for stagnation and cold pooling that can lead to increased ozone formation,
- Encourages future oil and gas development in areas a considerable distance from major population centers,
- Excludes oil and gas development in the Dubois area, an area of air quality sensitivity due to its proximity to federally designated Class I and identified sensitive Class II areas.

Geographic areas of high, moderate, and low potential for locatable minerals (specifically uranium, phosphate, bentonite, and gold) and salable minerals (specifically sand and gravel) were identified within the planning area. The Lander Field office has also identified specific areas that would be closed to mineral materials disposal (Map 37), and locatable mineral withdrawals (Map 24) within each of the alternatives. When these restrictions are considered in concert with the geologic locations of non-oil and gas minerals, likely locations for non-oil and gas minerals development are constrained to areas located primarily in the central and southern portions of the planning area. These potential areas of development are located in geographic areas of relatively flat terrain with minor shallow basins and relatively consistent west-southwesterly winds. Because particulate matter emissions are the primary pollutant of concern associated with non-oil and gas minerals development there is a potential for high winds in these areas to contribute to short term increases in fugitive dust emissions from storage piles, wind erosion, and construction activities. However, the likely locations for development are not located near population centers, are not located upwind from areas identified as having particulate matter concentration levels of concern, and are located downwind from Class I and sensitive Class II areas.

F.2.5. Summary of Air Quality Issues

- Recent measurements at an air monitoring station in the planning area show that measured ambient concentrations of ozone have, on several occasions, exceeded the current ozone NAAQS of 75 ppb.
- The emissions inventory showed potentially significant increases in estimated emissions of ozone forming pollutants (NO_x and VOCs) which could result in increased concentrations of

ozone if oil and gas resources are authorized and developed to the full potential evaluated under each alternative. In addition, potential increases in HAP and $PM_{2.5}$ emissions and corresponding short term increases in ambient concentrations could result if all activities are authorized and developed to the full potential evaluated under each alternative.

- The air analysis for the RMP showed that oil and gas development activities have the potential to be the major contributor to estimated NO_x, VOC, and HAP emissions. Non-oil and gas mineral development activities (i.e., sand and gravel extraction, bentonite, uranium, and gold mining) have the potential to be the major contributor to estimated $PM_{2.5}$ emissions.
- The geographic areas identified as having high potential for oil and gas or non-oil and gas minerals development are located in areas that are unlikely to impact Class I or sensitive Class II areas, major population centers, or areas with ambient air concentration levels of concern when Designated Development Areas, Areas of Critical Environmental Concerns, and closures are taken into account.

F.3. Field Office Air Resource Management Requirements

The Lander Field Office has the responsibility to implement the decisions of the RMP in a manner that protects air quality while recognizing valid and existing leasing rights. Within the planning area, most areas with high and moderate oil and gas development potential are already leased. While the BLM has limited ability to alter the conditions of existing leases, it can require specific actions and measures necessary to protect air quality in response to identified or anticipated adverse impacts at the project level stage.

Development and implementation of appropriate protection measures is most effective at the project approval stage, because the proposed action has been defined and impacts to air quality are better able to be identified through National Environmental Policy Act analysis. As part of the project approval process the BLM will identify project-specific measures in response to identified impacts to air resources, as outlined in this air resources management plan.

F.3.1. Authorization of Air Emission Generating Activities

F.3.1.1 BLM has the authority and responsibility under Federal Land Policy and Management Act to manage public lands in a manner that will protect the quality of air and atmospheric values. Therefore, BLM may manage the pace, place, density, and intensity of leasing and development to meet air quality goals.

F.3.1.2 BLM will, prior to authorization of any activity that has the potential to emit any regulated air pollutant, consider the magnitude of potential air emissions from the project or activity, existing air quality conditions, geographic location, and issues identified during project scoping to identify pollutants of concern and to determine the appropriate level of air analysis to be conducted for the project. This analysis may include; obtaining additional air monitoring data, air dispersion modeling, photochemical grid modeling, and/or mitigation measures in addition to any applicable regulatory emission limits and standards.

F.3.1.3 BLM will require project proponents to comply with the requirements under Section F.4 of this plan. BLM will review any project specific emissions inventory submitted as required under Section F.4.1 to determine its completeness and accuracy.

F.3.1.4 In areas where Wyoming Department of Environmental Quality (DEQ) approved (or equivalent) air monitoring data shows that ambient air concentrations of a regulated pollutant are at or above 85 percent of the applicable NAAQS or Wyoming Ambient Air Quality Standard (WAAQS), BLM will require the proponent for any project that has the potential to emit the pollutant or precursors to the pollutant to comply with (a) or (b) below:

a. Demonstrate that the project will result in no net increase in annual emissions of the pollutant for the life of the project (e.g., through the application of emission control technologies, offsets, or other air emission reducing strategies); or,
b. Demonstrate that the project will not cause or contribute to a violation of the ambient air quality standard through a quantitative air quality analysis (e.g., air dispersion modeling, photochemical grid modeling or an equivalent level of analysis.

F.3.1.5 Ambient air monitoring data in the planning area shows that existing concentrations of ozone are at or above 85 percent of the WAAQS and NAAQS and the emissions inventory for the Lander RMP shows that oil and gas development activities have the potential to be a major contributor to ozone forming pollutant emissions. Therefore, the requirements of F.3.1.4 apply and project proponents for oil and gas development activities within the planning area must comply with (a) or (b) below:

a. Demonstrate that the project will result in no net increase in annual emissions of NO_x and VOCs for the life of the project (e.g., through the application of emission control technologies, offsets, or other air emission reducing strategies); or,
b. Demonstrate that the project will not cause or contribute to a violation of the ambient air quality standard for ozone through a quantitative air quality analysis (to include photochemical grid modeling or an equivalent level of analysis).

F.3.1.6 Ambient monitoring data within the planning area shows that existing concentrations of $PM_{2.5}$ are at or above 85 percent of the 24-hour National and Wyoming ambient air quality standards and the emissions inventory for the Lander RMP shows that non-mineral development and prescribed fire activities have the potential to contribute to increases in $PM_{2.5}$ ambient concentrations. Therefore, prior to BLM approval of a project that is likely to contribute to short term increases in $PM_{2.5}$ ambient concentrations, BLM will require any non-oil and gas mineral development project proponent to:

a. demonstrate that it has applied for and obtained any required air permit from Wyoming DEQ,
b. demonstrate that the project will not cause or contribute to a violation of the applicable ambient air quality standard and,
c. provide a plan for controlling and minimizing fugitive dust emissions.

Prescribed fire projects will be required to minimize impacts to air quality, and will comply with local and state smoke management plans and regulations.

F.3.2. Monitoring

As part of a comprehensive air management plan for the planning area, BLM commits to the following measures with regards to ambient air monitoring:

- BLM will work cooperatively with Wyoming DEQ to determine the best mechanism to submit, track, and approve project specific pre-construction monitoring or monitoring data required in a project specific record of decision (ROD),
- BLM will work cooperatively with Wyoming DEQ to share data collected from the existing BLM-operated Wyoming Air Resource Management System (WARMS) network and to

support Wyoming DEQ's air monitoring network through siting, operation, and funding of additional monitoring sites,
- BLM will continue to fund and operate the NADP monitoring site at Sinks Canyon.
- BLM may require project proponents to conduct pre-construction and/or project air monitoring as described in Section F.4.2.

F.3.3. Modeling

BLM recognizes that air dispersion and photochemical grid models are useful tools for predicting project specific impacts to air quality, predicting the potential effectiveness of control measures and strategies, and for predicting trends in regional concentrations of some air pollutants. As part of a comprehensive air management plan for the planning area, BLM commits to the following with regards to air quality modeling:

- BLM will require project specific air quality modeling as outlined in Section F.4.
- BLM will ensure that project specific modeling is carried out in accordance with Environmental Protection Agency modeling guidelines and in cooperation with the air quality interagency review team.
- BLM will support and participate in regional modeling efforts through multi-state and/or multi-agency organizations such as Western Governor's Association – Western Regional Air Partnership, the Federal Leadership Forum, and Wyoming DEQ's Ozone Technical Advisory Group.

F.3.4. Mitigation

BLM recognizes that many of the activities that it authorizes, permits, or allows generate air pollutant emissions that have the potential to adversely impact air quality. The primary mechanism to reduce air quality impacts is to reduce emissions (mitigation). As part of this comprehensive air management plan for the planning area, BLM commits to the following with regards to reducing emissions:

- BLM will require project proponents to include measures for reducing air pollutant emissions in project proposals and Plans of Development as described in Section F.4,
- BLM will require additional air emission control measures and strategies within its regulatory authority and in consultation with Wyoming DEQ and other federal agencies when appropriate if an operator's proposed or committed measures are insufficient to achieve air quality goals,
- BLM will ensure that air pollution control measures and strategies (both operator committed and required mitigation) are enforceable by including specific conditions in a ROD.

F.4. Project Specific Requirements

BLM has identified activities and pollutants of concern for the planning area and this section contains specific requirements for project proponents. Mineral development activities, specifically oil and gas development and mining, have been identified as having the potential to contribute to increases in ambient concentrations of ozone, HAPs and $PM_{2.5}$. Proponents of mineral development projects must comply with Section F.4.1 and Section F.4.4.1 at a minimum. In addition, project proponents for other activities may be required to comply with Section F.4 as determined by BLM taking into account existing air quality conditions and availability of representative air monitoring data, magnitude of estimated project emissions, meteorologic and

geographic conditions in the vicinity of the project, and the current state of air pollution control technology.

F.4.1. Emissions Inventory

The proponent of a mineral development project will provide the BLM an emissions inventory that quantifies emissions of regulated air pollutants from all sources related to the proposed project, including fugitive emissions and greenhouse gas emissions, estimated for each year for the life of the project. BLM will use this estimated emissions inventory to identify pollutants of concern and to determine the appropriate level of air analysis to be conducted for the proposed project.

The BLM may require an emissions inventory for other actions depending on the magnitude of potential air emissions from the project or activity, proximity to a federally mandated Class I area, sensitive Class II area, or population center, location within a non-attainment or maintenance area, meteorologic or geographic conditions, existing air quality conditions, magnitude of existing development in the area, or issues identified during project scoping.

F.4.2. Monitoring

F.4.2.1 The proponent of a mineral development project that has the potential to emit more than 100 tons per year of any criteria air pollutant must provide a minimum of one year of baseline ambient air monitoring data for any pollutant(s) of concern as determined by BLM, if no representative air monitoring data are being collected within 50 kilometer of the project area, or existing ambient air monitoring data are insufficient, incomplete, or does not meet minimum air monitoring standards set by Wyoming DEQ. If BLM determines that baseline monitoring is required, this pre-analysis data must meet DEQ air monitoring standards, be obtained from a site within 50 kilometer of project boundary, and cover the year immediately prior to the submittal. This requirement may be waived where the life of the project is less than one year.

F.4.2.2 The BLM may require monitoring for the life of the mineral development project depending on the magnitude of potential air emissions from the project or activity, proximity to a federally mandated Class I area, sensitive Class II area, or population center, location within a non-attainment or maintenance area, meteorologic or geographic conditions, existing air quality conditions, magnitude of existing development in the area, or issues identified during project scoping.

F.4.2.3 The BLM may require project proponents of other air emission generating projects to conduct baseline or life of project air monitoring depending on the magnitude of potential air emissions from the project or activity, proximity to a federally mandated Class I area, sensitive Class II area, or population center, location within a non-attainment or maintenance area, meteorologic or geographic conditions, existing air quality conditions, magnitude of existing development in the area, or issues identified during project scoping.

F.4.3. Modeling

F.4.3.1 The proponent of a mineral development project that has the potential to emit more than 100 tons per year of any criteria pollutant will be required to conduct air quality modeling for any pollutant(s) of concern, as determined by BLM, unless the project proponent can demonstrate that the project will result in no net increase in emissions of the pollutant(s) of concern. BLM, in

cooperation with the interagency review team, will determine the parameters for the modeling analysis through the development of a project specific modeling protocol.

F.4.3.2 BLM may require air quality modeling for other air emission generating projects or for projects, actions, or management activities with estimated emissions below the threshold listed in F.4.3.1 if other criteria that warrant an air dispersion or photochemical modeling analysis are identified for purposes of analyzing project direct, indirect or cumulative impacts to air quality. Such criteria may include the magnitude of potential air emissions from the project or activity, proximity to a federally mandated Class I area, sensitive Class II area, or population center, location within a non-attainment or maintenance area, meteorologic or geographic conditions, existing air quality conditions, magnitude of existing development in the area, or issues identified during project scoping.

F.4.4. Mitigation

F.4.4.1 The proponent of a mineral development project will be required to minimize air pollutant emissions by complying with all applicable state and federal regulations and may be required to apply mitigation including but not limited to best available control technology, best management practices, emissions offsets, and other control technologies or strategies identified by the BLM or Wyoming DEQ in accordance with delegated regulatory authority.

F.4.4.2 The proponent of a mineral development project that has the potential to emit any regulated air pollutant will be required to provide a detailed description of operator committed measures to reduce project related air pollutant emissions including greenhouse gases and fugitive dust. Project proponents for oil and gas development projects should refer to the table of mitigation measures included in Appendix U (p. 1545) of the RMP (and in Table F.1, “Mitigation Table for Oil and Gas Development Activities” (p. 1410) below) as a reference for potential control technologies and strategies. The list is not intended to preclude the use of other effective air pollution control technologies that may be proposed.

F.4.4.3 BLM may require the proponent of other air emission generating projects to comply with F.4.4.1 and F.4.4.2 based on the magnitude of potential air emissions from the project or activity, proximity to a federally mandated Class I area, sensitive Class II area, or population center, location within a non-attainment or maintenance area, meteorologic or geographic conditions, existing air quality conditions, magnitude of existing development in the area, or issues identified during project scoping.

F.4.4.4 BLM may require project proponents to submit a contingency plan that provides for reduced operations in the event of an air quality episode. Specific operations and pollutants to be addressed in the contingency plan will be determined by BLM on a case-by-case basis taking into account existing air quality and pollutants emitted by the project.

Table F.1. Mitigation Table for Oil and Gas Development Activities

Mitigation Measure	Environmental Benefits	Environmental Liabilities	Feasibility
Control Strategies for Drilling and Compression			
Directional Drilling	Reduces construction related emissions (dust and vehicle and construction equipment emissions). Decreases surface disturbance and vegetation impacts (dust and CO_2 and nitrogen flux). Reduces habitat fragmentation	Could result in higher air impacts in one area with longer sustained drilling times.	Depends on geological strata
Improved engine technology (Tier 2 or better) for diesel drill rig engines	Reduced NO_x, PM, CO, and VOC emissions	–	Dependent on availability of technology from engine manufacturers
Selective Catalytic Reduction (SCR) for drill rig engines and/or compressors	NO_x emissions reduction, decreased formation of visibility impairing compounds, decreased formation of ozone. NO_x control efficiency of 95 percent achieved on drill rig engines. NO_x emission rate of 0.1 grams per horsepower hour achieved for compressors	Potential NH_3 emissions and formation of visibility impairing ammonium sulfate. Regeneration/disposal of catalyst can produce hazardous waste.	Not applicable to 2-stroke engines
Non-selective catalytic reduction (NSCR) for drill rig engines and/or compressors	NO_x emissions reduction, decreased formation of visibility impairing compounds, decreased formation of ozone. NO_x control efficiency of 80-90 percent achieved for drill rig engines. NO_x emission rate of 0.7 grams per horsepower hour achieved for compressor engines greater than 100 horsepower.	Regeneration/disposal of catalysts can produce hazardous waste.	Not applicable to lean burn or 2-stroke engines
Natural Gas fired drill rig engines	NO_x emissions reduction, decreased formation of visibility impairing compounds, decreased formation of ozone	–	Requires onsite processing of field gas.
Electrification of drill rig engines and/or compressors	Decreased emissions at the source. Transfers emissions to more efficiently controlled source (EGU)	Displaces emissions to EGU.	Depends on availability of power and transmission lines
Improved engine technology (Tier 2 or better) for all mobile and non-road diesel engines.	Reduced NO_x, PM, CO, and VOC emissions	–	Dependent on availability of technology from engine manufacturers

Mitigation Measure	Environmental Benefits	Environmental Liabilities	Feasibility
Green (also known as closed loop or flareless) completions	Reduction in VOC and CH_4 emissions. Reduces or eliminate flaring and venting and associated emissions. Reduces or eliminates open pits and associated evaporative emissions. Increased recovery of gas to pipeline rather than atmosphere.	Temporary increase in truck traffic and associated emissions.	Need adequate pressure and flow. Need onsite infrastructure (tanks/dehydrator). Availability of sales line. Green completion permits required by Wyoming BACT in some areas
Green workovers	Same as above.	Same as above.	Same as above.
Minimize venting and/or use closed loop process where possible during "blow downs"	Same as above.	–	Best Management Practices required by Wyoming BACT
Reclaim/remediate existing open pits, no new open pits	Reduces VOC and GHG emissions. Reduces potential for soil and water contamination. Reduces odors.	May increase truck traffic and associated emissions.	Requires tank and/or pipeline infrastructure.
Electrification of wellhead compression/pumping	Reduces local emissions of fossil fuel combustion and transfers to more easily controlled source.	Displaces emissions to EGU	Depends on availability of power and transmission lines
Wind (or other renewable) generated power for compressors	Low or no emissions.	May require construction of infrastructure. Visual impacts. Potential wildlife impacts.	Depends on availability of power and transmission lines
Control Strategies Utilizing Centralized Systems			
Centralization (or consolidation) of gas processing facilities (separation, dehydration, sweetening, etc.)	Reduces vehicle miles traveled (truck traffic) and associated emissions. Reduced VOC and GHG emissions from individual dehy/separator units.	Temporary increase in construction associated emissions. Higher potential for pipe leaks/groundwater impacts.	Requires pipeline infrastructure.
Liquids Gathering systems (for condensate and produced water)	Reduces vehicle miles traveled and associated emissions. Reduced VOC and GHG emissions from tanks, truck loading/unloading, and multiple production facilities.	Temporary increase in construction associated emissions. Higher potential for pipe leaks/groundwater impacts.	Requires pipeline infrastructure.
Water and/or fracturing liquids delivery system	Reduced long term truck traffic and associated emissions.	Temporary increase in construction associated emissions. Higher potential for pipe leaks/groundwater impacts.	Requires pipeline infrastructure. Not feasible for some terrain.
Control Strategies for Tanks, Separators, and Dehydrators			
Eliminate use of open top tanks	Reduced VOC and GHG emissions.	–	Required by Wyoming BACT for produced water tanks in some areas.

Mitigation Measure	Environmental Benefits	Environmental Liabilities	Feasibility
Capture and control of flashing emissions from all storage tanks and separation vessels with vapor recovery and/or thermal combustion units.	Reduces VOC and GHG emissions.	Pressure build up on older tanks can lead to uncontrolled rupture.	98 percent VOC control if ≥ 10 TPY required statewide by Wyoming BACT
Capture and control of produced water tank emissions.	Reduces VOC and GHG emissions.	–	98 percent VOC control and no open top tanks required by Wyoming Department of Environmental Quality in some areas
Capture and control of dehydration equipment emissions with condensers, vapor recovery, and/or thermal combustion.	Reduces VOC, HAP, and GHG emissions.	–	Still vent condensers required and 98 percent VOC control if ≥ 8 TPY required statewide and in CDA by Wyoming BACT. All dehy emissions controlled at 98 percent in JPAD (no 8 TPY threshold)
Control Strategies for Misc. Fugitive VOC Emissions			
Install and maintain low VOC emitting seals, valves, hatches on production equipment.	Reduces VOC and GHG emissions.	–	–
Initiate an equipment leak detection and repair program (including use of FLIR cameras, grab samples, organic vapor detection devices, visual inspection, etc.)	Reduction in VOC and GHG emissions.	–	–
Install or convert gas operated pneumatic devices to electric, solar, or instrument (or compressed) air driven devices/controllers.	Reduces VOC and GHG emissions.	Electric or compressed air driven operations can displace or increase combustion emissions.	–
Use "low" or "no bleed" gas operated pneumatic devices/controllers.	Reduces VOC and GHG emissions.	–	or closed loop required statewide by Wyoming BACT
Use closed loop system or thermal combustion for gas operated pneumatic pump emissions.	Reduces VOC and GHG emissions.	–	Required statewide by Wyoming BACT (98 percent VOC control or closed loop)
Install or convert gas operated pneumatic pumps to electric, solar, or instrument (or compressed) air driven pumps.	Reduces VOC and GHG emissions.	Electric or compressed air driven operations can displace or increase combustion emissions.	Required statewide by Wyoming BACT if no thermal combustion used.
Install vapor recovery on truck loading/unloading operations at tanks.	Reduces emissions of VOC and GHG emissions.	Pressure build up on older tanks can lead to uncontrolled rupture.	Wyoming BACT analysis required if VOC ≥ 8 TPY or HAP≥ 5 TPY.
Control Strategies for Fugitive Dust and Vehicle Emissions			
Unpaved surface treatments including watering, chemical suppressants, and gravel.	20 percent - 80 percent control of fugitive dust (particulates) from vehicle traffic.	Potential impacts to water and vegetation from runoff of suppressants.	–

Mitigation Measure	Environmental Benefits	Environmental Liabilities	Feasibility
Use remote telemetry and automation of wellhead equipment.	Reduces vehicle traffic and associated emissions.	–	–
Speed limit control and enforcement on unpaved roads.	Reduction of fugitive dust emissions.	–	–
Reduce commuter vehicle trips through car pools, commuter vans or buses, innovative work schedules, or work camps.	Reduced combustion emissions, reduced fugitive dust emissions, reduced ozone formation, reduced impacts to visibility.	–	–
Miscellaneous Control Strategies			
Use of ultra-low sulfur diesel in engines, compressors, construction equipment, etc.	Reduces emissions of particulates and sulfates.	–	Fuel not readily available in some areas.
Reduce unnecessary vehicle idling.	Reduced combustion emissions, reduced ozone formation, reduced impacts to visibility, reduced fuel consumption.	–	–
Reduced pace of (phased) development.	Peak emissions of all pollutants reduced.	Emissions generated at a lower rate but for a longer period. LOP, duration of impacts is longer.	May not be economically viable or feasible if multiple mineral interests.

CO_2 Carbon Dioxide
NO_X Nitrous Oxides
CO Carbon Monoxide
EGU Electric Generating Unit
VOC Volatile Organic Compound
CH_4 Methane
NH_3 Ammonia
BACT Best Available Control Technology
GHG Greenhouse Gas
HAP Hazardous Air Pollutant
LOP life of plan
TPY Tons per year
JPAD Joint Precision Airdrop System
FLIR Forward Looking Infrared