Chapter 4 — Environmental Consequences

This chapter provides an analysis of the effects (environmental consequences) that would result from implementation of the alternatives. An environmental effect or consequence is defined as a modification or change in the existing environment brought about by the action taken. Effects can be direct, indirect, or cumulative and can be temporary (short term) or permanent (long term). Effects can vary in degree, ranging from only a slight discernable change to a drastic change in the environment. For this analysis, short-term effects are defined as occurring during the construction and drilling/completion phases. Long-term effects are caused by construction and operations that would remain longer.

The analysis evaluated the effects that would occur in the analysis area, regardless of land ownership. However, the decision on this analysis by BLM would apply only to federal lands. The effects reported for non-federal lands may occur regardless of BLM's decision. Effects on non-federal lands are included to provide a full disclosure of effects for the complete development and to support other environmental permitting associated with the development of CBNG.

Ground Water

The primary effects of CBNG development on ground water resources would be associated with the removal of ground water stored in coal seams and the subsequent recharge of aquifers through infiltration of water or injection of produced water. Development of CBNG could drawdown water in non-CBNG wells completed in the developed coal aquifers and in the overlying and underlying sand aquifers. Other potential effects on existing water wells would include changes in water yield, water quality and methane emissions.

Other effects on ground water resources would consist of potential changes in ground water chemistry, in the nature of ground water discharge to the surface, or recharge to the aquifers. The nature of ground water discharge to the surface as springs, seeps, or base flows of surface drainages could change. Surface discharge of extracted ground water from CBNG operations into surface drainages, flow-through stock reservoirs, upland or bottomland infiltration impoundments, or upland containment impoundments would enhance recharge of shallow aquifers below creek and impoundment areas. Injection of CBNG produced water would recharge the aquifer units in which the injection wells are completed.

Numerical ground water flow modeling was used to predict impacts to the ground water system from the CBNG development. The technical description of this model as well as the hydrologic data and assumptions are discussed in detail in the PRB O&G Final EIS (pages 4–2 through 4–12).

Alternative 1 — No Action

Overall, the effects of developing CBNG under this alternative would parallel those described in the PRB O&G Final EIS, but would be proportionately smaller. The projected effects on water yield, aquifer characteristics and conditions, water quality, quantity, and water use for the 285 leases are summarized below.

Yield of Produced CBNG Water

Total production of water from CBNG wells on the 285 leases is estimated at 167,317 acre-feet (Table 4–1). This estimate includes wells already completed and projections of new wells. Total production of water from new wells on the 285 leases is estimated to be 147,698 acre-feet. Most of the projection would occur in four sub-watersheds: the Upper Tongue River, Clear Creek, Crazy Woman Creek, and Upper Powder River (Table 4–1). The volume of water produced by the new wells on the 285 leases would be 5 percent of the total production projected for development of the PRB in the PRB O&G Final EIS (U.S. Bureau of Land Management 2003:Table2–8).

Table 4–1 Number of Wells and Projected Production at Maximum Development on the 285 Leases — Alternative 1

	Projected:			
Sub-watershed	No. of Wells	Production (acre-feet)	No. of New Wells	Production from New Wells (acre-feet)
Antelope Creek	23	1,521	20	1,345
Clear Creek	578	34,114	564	33,304
Crazy Woman Creek	475	28,091	378	22,333
Little Powder River	169	7,613	160	7,196
Middle Powder River	293	17,224	163	9,585
Salt Creek	23	1,357	23	1,359
Upper Belle Fourche River	97	6,402	86	5,678
Upper Cheyenne River	20	1,296	15	953
Upper Powder River	457	26,996	405	23,904
Upper Tongue River	734	42,704	723	42,040
Total[1]	2,870	167,317	2,537	147,698

Note:
1. Total may not match precisely with the value obtained by adding unit numbers because of rounding conventions.

Water produced from CBNG wells would consist of ground water pumped from storage within the developed coals and water that leaks from nearby sands into the coals as they are depressurized. The estimate of recoverable ground water stored in the coal zone and sandstones of the Fort Union and Wasatch Formations within the analysis area is around 746 million acre-feet (U.S. Bureau of Land Management 2003:Table 3–5). The total production of CBNG water projected for these 285 leases represents a very small fraction (less than 0.02 percent) of the recoverable ground water present in these formations (the entire development evaluated in the PRB O&G Final EIS also represents less than 1 percent of the

recoverable ground water). Depending on the water handling practices used within each sub-watershed under Alternative 2A (U.S. Bureau of Land Management 2003:Table 2–21), a portion of the pumped water would be recharged to the ground water system as a result of infiltration along creeks and below impoundments.

Ground water stored in the coal would be removed concurrently with leakage into the coal from above and below. The contribution from leakage would increase over the life of a well as water stored in the coal is removed. Leakage rates under large induced vertical gradients can be significant.

Aquifer Characteristics

The removal of water from the coal seam is unlikely to have any measurable effects on the physical characteristics of the aquifer and its ability to store or transport water.

Aquifer Conditions

Removal of water from the coal seam and its subsequent disposal would affect conditions in the coal-bed aquifers at various times during or after development of CBNG. The following sections discuss these effects.

Alluvial Aquifers

Depending on the water handling practices used within each sub-watershed, an estimated 80 to 95 percent of the ground water produced from new CBNG operations under this alternative (118,000–148,000 acre-feet) would be released to surface drainages or impoundments. A portion of the released water would recharge the alluvium and underlying shallow Wasatch sand and bedrock aquifers.

Water levels in alluvium likely would increase from discharges of CBNG produced water. In areas with near-surface water tables, the increase in water level may be exhibited as standing water in areas not previously displaying this condition or as wetland development, unless the number of CBNG wells releasing produced ground water to surface drainages or impoundments is carefully controlled.

Ongoing studies conducted by BLM document effects and trends associated with the infiltration of CBNG produced water into alluvial deposits. BLM studies in the Brown Reservoir; Bone Pile Creek; Burger Draw; and Caballo Creek are described in PRB O&G Final EIS. Additional studies are associated with infiltration impoundments and the potential impact to shallow ground water at Juniper, Fallen Eagle, Lower Prairie Dog, Skewed, and Wild Horse Creek Reservoir sites.

Shallow ground water monitoring is ongoing at several impoundment sites across the PRB. Due to the limited data available from these sites, the still uncertain overall fate or extent of change that is occurring due to infiltration at those sites, and the extensively variable site characteristics, both on the surface and subsurface, it is not reliable at this time to infer that findings from these monitoring wells should be directly applied to other impoundment locations across the PRB.

To address the potential impacts from infiltration on shallow ground water, the WDEQ developed a guidance document, "Compliance Monitoring for Ground Water Protection Beneath Unlined Coalbed Methane Produced Water Impoundments" (June 14, 2004), which can be accessed on their internet website. This guidance document became effective August 1, 2004. The WDEQ has established an Impoundment Task Force which is in the process of drafting an "Impoundment Monitoring Plan" to investigate the potential for existing impoundments to have affected shallow ground water. BLM would require that operators comply with the requirements outlined in the DEQ compliance monitoring guidance document (June 14, 2004) prior to discharge of federally produced water into newly constructed or upgraded impoundments.

Ground Water Use

Impacts to individual water wells completed within the coal, and in sands above the coal, would depend on proximity to CBNG production wells, depth and completion interval of the water well, and the yield required to maintain the well as a usable source. Drawdown of water levels in coal aquifers caused by development of CBNG may affect individual well users by reducing well yield. Other potential effects on water wells would be emissions of methane discussed below.

A standard agreement has been developed by CBNG operators and the Powder River Basin Resource Council to monitor and mitigate impacts to owners of individual water wells that are caused by CBNG operations. A copy of this water well agreement format is included in the PRB O&G Final EIS as Appendix G.

Ground Water Chemistry

Ground water quality within the regional aquifer systems of the PRB would not be noticeably affected under Alternative 1. Any noticeable effects on ground water quality would be expressed as effects on aquifers that would serve as injection zones during CBNG development or on existing springs derived from these aquifers. The issues associated with the potential effects on ground water chemistry or quality are specific to the local conditions associated with sites under evaluation for proposed activities. The effects would be analyzed on a site-specific basis at the APD and POD level of analysis.

Ground Water Flow Systems

Impacts on volume of recoverable ground water in storage within the PRB under Alternative 1 would likely not be noticeable. Total projected CBNG water production from both 285 leases (Table 4–1)and EIS leases represents far less than 1 percent of the recoverable ground water in the sands and coals of the Tongue River-Wasatch aquifer and the Wasatch and Fort Union Formations of the PRB (U.S. Bureau of Land Management 2003).

Flowing Artesian Wells and Springs

Wells completed in shallow aquifers that flow locally would not be likely affected by drawdown of the coal zone aquifer during development of CBNG. These wells likely would be affected; however, by increased flows due to the increased availability of shallow ground water where the CBNG produced water is infiltrating. Deep flowing artesian wells completed in the coal zone aquifer or

sandstone layers in hydraulic connection with the coal zone aquifer likely would be affected by drawdown of the coal zone aquifer during CBNG development. Decreased flows or no flow would be the likely effects on wells completed in deep aquifers.

The effects on springs that issue from shallow sources would be similar to the effects on shallow flowing artesian wells described above.

Potential effects on springs that issue from clinker outcrops along a low-permeability zone at the contact between the clinker and the coal are also not likely to occur. Large areas of clinker exposure allows a large amount of recharge, however, presence of a low-permeability zone between the clinker and the coal will channels water in the clinker to the spring rather than recharging the coal. A decrease in recharge to the spring that could potentially reduce flow for this type of spring is not projected to occur under this alternative.

Ground Water Discharge Areas

A reduction in hydraulic head within the coal aquifer projected during development of CBNG under Alternative 1 likely would reduce ground water discharge and base flows in surface drainages within the Powder River's drainage basin. Ground water discharge likely would not recover until the hydraulic head in the coal aquifer recovers sufficiently after development of CBNG.

The use of infiltration impoundments or flow-through stock reservoirs during surface discharge could cause new springs to develop where a near-surface zone of low permeability intercepts the surface, unless these water handling facilities are sited to minimize this potential effect. Siting in accordance with WDEQ and WSEO requirements and avoidance of sites where a zone of low permeability intercepts the surface downhill or downgradient from an area where considerable infiltration of CBNG produced water is occurring would minimize the potential for shallow infiltrated water to resurface.

The issues associated with the impacts of dewatering and infiltration on springs, pre-CBNG artesian wells, and ground water discharge areas are specific to the local conditions. The effects and site-specific mitigating measures or monitoring requirements would be analyzed on a site-specific basis at the APD or POD level of analysis.

Alternative 2 — Standard Lease Terms and Lease Notice

Solely from the leasing perspective and for the comparative analysis of alternatives in the EA, implementation of this alternative would result in effects similar to those described for Alternative 1. The numbers of wells involved would be the same and the CBNG wells and facilities for the disposal of water produced from CBNG wells would still have to meet the requirements of the State of Wyoming.

Alternative 3 — Modified Lease Terms

Impacts under Alternative 3 would be similar to those under Alternative 1. However, the size of the affected area and relative magnitude of impacts would be slightly lower because the number of wells would be reduced and the consequent lower CBNG production associated with no leasing in proposed ACECs. The number of CBNG wells and associated impacts are not likely to be reduced by the modification of lease terms and adding NSO and TLS.

The reduction in number of wells and associated CBNG water production would occur only in Upper Powder River sub-watershed. This reduction in the number of wells translates to 2 percent reduction in production of CBNG water in the Upper Powder River sub-watershed (Table 4–1 vs. Table 4–2). Overall, the production of water in the analysis area under Alternative 3 is estimated to be 163,776 acre-feet (Table 4–2). The scale of reduction in the production of CBNG water under this alternative is relatively small and the magnitude of effects would be on a similar scale.

Table 4–2 Number of Wells and Projected Production at Maximum Development on the 285 Leases — Alternative 3

	Projected:			
Sub-watershed	No. of Wells	Production (acre-feet)	No. of New Wells	Production from New Wells (acre-feet)
Antelope Creek	23	1,521	20	1,345
Clear Creek	578	34,114	564	33,304
Crazy Woman Creek	475	28,091	378	22,333
Little Powder River	169	7,613	160	7,196
Middle Powder River	293	17,224	163	9,585
Salt Creek	23	1,357	23	1,359
Upper Belle Fourche River	97	6,402	86	5,678
Upper Cheyenne River	20	1,296	15	953
Upper Powder River	397	23,454	345	20,363
Upper Tongue River	734	42,704	723	42,040
Total[1]	2,810	163,776	2,477	144,156

Note:
1. Total may not match precisely with the value obtained by adding unit numbers because of rounding conventions.

Alternative 4 — No Surface Disposal of Produced Water

Alternative 4 involves a small fraction of the number of CBNG wells and volumes of water produced as Alternative 1 (Table 4–3). Except for the differences associated with water handling options and the volumes of water involved, the effects on ground water resources would be similar to Alternative 1. Under this alternative, no surface disposal of CBNG produced water would be allowed. All produced water would be injected providing the injection zone is capable of ac-

cepting the anticipated volume without adverse impacts to ground water resources.

Table 4–3 Number of Wells and Projected Production at Maximum Development on the 285 Leases — Alternative 4

	Projected:			
Sub-watershed	No. of Wells	Production (acre-feet)	No. of New Wells	Production from New Wells (acre-feet)
Antelope Creek	21	1,387	18	1,210
Clear Creek	86	5,061	72	4,252
Crazy Woman Creek	97	5,758	0	0
Little Powder River	46	2,081	37	1,664
Middle Powder River	179	10,521	49	2,881
Salt Creek	0	0	0	0
Upper Belle Fourche River	33	2,176	22	1,452
Upper Cheyenne River	5	343	0	0
Upper Powder River	184	10,882	132	7,791
Upper Tongue River	62	3,629	51	2,965
Total[1]	714	41,836	381	22,216

Note:
1. Total may not match precisely with the value obtained by adding unit numbers because of rounding conventions.

Impacts on ground water resources under Alternative 4 would be expressed primarily as effects on aquifers that would serve as injection zones during CBNG development or on existing springs derived from these aquifers. The injection of CBNG produced water into disposal wells could affect the quality, quantity, and temperature of ground water contained in the injection zone or possibly other aquifers within the disposal well's area of influence. However, ground water in these deeper aquifer units has not been developed as extensively as in aquifer units above the coal zone and in the coal zone itself. Finally, testing has not shown injection to be economical because of high costs and uncertain success in disposing of large volumes of produced water over the life a group of CBNG wells.

In the absence of surface disposal, water produced from CBNG wells would not contribute to the recharge of the alluvium and shallow Tertiary ground water units from infiltration along creeks and below impoundments. Injection of water produced from CBNG wells would result in recharge only to the zones of injection, which in this analysis are assumed to be zones deeper than the Fort Union coal. The reduced recharge to the Wasatch sands and the coal zones within the Fort Union Formation could decrease the yields of water as well as contribute to drawdowns in these units. However, the absence of the CBNG contribution to recharge would likely not have a noticeable effect on yield and drawdown and it would likely not affect the recovery of water in these formations in the long term.

Impacts on the quality of ground water within the alluvium and shallow Tertiary ground water units of the PRB would be less than for the other three development

alternatives. This conclusion is based on the absence of infiltration of water produced from CBNG wells.

Under this alternative, there would be no impacts on the shallow ground water flow system, including springs, artesian wells, and ground water discharge areas. As with impacts to the quality of ground water, this conclusion is based on the absence of infiltration of water produced from CBNG wells.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to ground water. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Effects

Although the regional flow of ground water is toward the north, it is interrupted where coal aquifers are discontinuous and ground water is discharged in local flow systems. Most of this local discharge of ground water from bedrock aquifers occurs above stream level and is lost through evapotranspiration or is consumed as soil moisture and does not make a noticeable contribution to surface drainages. The discontinuous nature of the various coal zones also would limit the areal extent of drawdown in Montana, outside the analysis area, that is associated with CBNG development in the PRB within Wyoming.

Alternative 1 — No Action

The cumulative effects of the development of CBNG and coal mining would be the same as those described for Alternative 1 in the PRB O&G Final EIS. The cumulative effects on ground water resources from existing and reasonably foreseeable activities associated with the development of CBNG and coal mining were included in the regional ground water model and impact analysis described in the PRB O&G Final EIS.

Cumulatively, ground water would be removed from the coal aquifers that underlie the analysis area, which would temporarily reduce the hydraulic pressure head. This decline in head likely would cause a slight reduction in the regional discharge of ground water to surface drainages within the PRB, including drainages downstream of the analysis area in Montana. Similarities and differences in the effects associated with mining and development of CBNG are described in PRB O&G Final EIS.

Aquifer Conditions

Maximum projected drawdowns would occur in the centers of CBNG development. Within the northern portion of the analysis area, production of CBNG would occur from two or more coal-bearing units. Drawdown would depend on the depth of the target coal below the surface. In deep areas of the basin, such as the central and northwestern portions, maximum drawdowns projected by the model would exceed 800 feet. In shallow areas of the basin, such as the south-

eastern portion, modeled drawdowns would be 200 to 400 feet over most of the active CBNG well fields (U.S. Bureau of Land Management 2003).

Recovery of water levels in the coal would become apparent after water production started to decline. Initially, recovery would be primarily a result of redistribution of ground water stored in the aquifer. Redistribution is projected to result in a rapid initial recovery and is projected to occur over 25 years. By 2030, estimated 100 feet of drawdown would still exist in most of the coal seams in the PRB. The rate of recovery after 2030 would then slow dramatically, eventually recovering to within 20 feet or less of pre-operation conditions over the next hundred years (U.S. Bureau of Land Management 2003).

Coal mining along the eastern and northwestern subcrop would result in minimal recharge to the coal while the mines are active because of the ground water sink caused by pit dewatering. As mines are reclaimed and eventually shut down, the backfilled areas would become long-term recharge zones for the coal aquifer. Infiltration through backfill areas may be substantial because the permeability of the backfill materials tends to be much higher than in the original unmined materials. In addition, most of the creeks would be diverted over these backfilled areas, providing an important source of recharge water.

Drawdown effects in deep Wasatch sands were estimated by extrapolating the results from the Caballo Creek model. Maximum drawdown of the deep Wasatch sands is projected to reach about 60 feet in year 2010. Drawdowns in deep sands that occur within 100 feet of developed coals may be between 5 to 10 percent of the projected drawdowns in the coal. Drawdown in the shallow Wasatch sands is expected to occur only near mines and areas where the target coal seam for CBNG development is nearer the surface.

The water levels in shallow Wasatch sands would increase because of infiltration of CBNG produced water discharged to creeks and impoundments in some areas of the basin. Recovery in the deep Wasatch sands would tend to occur after water levels in the coal recovered substantially and induced leakage from the deep Wasatch sands into the coal became minimal. Water levels would recover to within 25 feet of pre-operation levels over 20 years after CBNG development ends. Water levels would eventually recover to within less than 20 feet of pre-operation levels over the next hundred years (U.S. Bureau of Land Management 2003).

Ground Water Use

Deep artesian wells near the Powder River that are completed in the coal aquifer likely would be affected by drawdown associated with development of CBNG and would not recover for many years. Shallow artesian wells likely representing a shallow, local ground water flow system would not be affected by drawdown of the coal aquifer. However, infiltration of CBNG produced water may affect the water chemistry and increase flow rate and of shallow artesian wells.

Many issues related to water wells, including shallow artesian wells, deep-water wells near the Powder River, and monitoring wells at coal mines, would depend on site-specific geologic and hydrologic conditions and existing or proposed developments. Water well and monitoring well impacts would be analyzed on a site-specific basis at the APD or POD level of analysis.

Withdrawal of water during CBNG development can depressurize the coal aquifer and induce methane release into nearby water wells completed in the coal aquifer. Individual well users in the coal aquifer may experience an increase in emissions of methane if the wells fall within an area that experiences noticeable aquifer depressurization. Consequently, opportunities for development of ground water may be limited where gas is present in concentrations that are potentially explosive or have a negative effect on water quality. Effects of methane on well water quality and potential explosion hazards are described in PRB O&G Final EIS.

Ground Water Chemistry

Leakage

Pumping of water at CBNG wells likely would move waters with different chemistry from overlying or underlying sand layers into the coal aquifer. Although procedures for drilling and completing CBNG wells are strictly controlled by WOGCC and BLM requirements, many existing non-CBNG well bores likely do not effectively isolate the formations penetrated and may serve as conduits for mixing of waters from different aquifers. No comprehensive evaluation of the integrity of existing wells within the analysis area has been conducted.

Infiltration

The impacts to water quality from CBNG would occur due to infiltration of produced water through the unsaturated zone leaching salts and metals that are then transported them downward mixing with shallow ground water. Chemical processes that likely would be occurring and the effects of these changes on ground water quality are described in the PRB O&G Final EIS (U.S. Bureau of Land Management 2003:4–54).

Impoundments

The ground water chemistry that is characteristic of CBNG produced water would change over time as it evaporates from infiltration or containment impoundments. The processes and changes that are likely to occur are described later in this chapter under the section on Surface Water.

Water Wells

Where CBNG wells are drilled in close proximity to existing water wells, water quality in existing water wells may be temporarily affected immediately after the CBNG wells are drilled and completed. The WSEO has received reports of increased sediment, fines, and methane odor in wells where water is being produced from a zone shallower than the target coal.

Springs

Portion of CBNG produced water handled by infiltration impoundments contribute to shallow lateral flows and subsequent discharge to springs and surface drainages. CBNG produced water could mix with shallow ground water or surface water from natural sources. Chemical processes that likely would be occurring and the effects of these changes on ground water quality are described in the PRB O&G Final EIS (U.S. Bureau of Land Management 2003:4–55).

CBNG Drilling Fluids

Drilling fluids are not expected to have any effect on the Tertiary aquifer system. The WOGCC and BLM requirements for well drilling procedures ensure that each formation remains as isolated as under natural conditions and that the integrity of the well bore remains intact, protecting ground water quality in aquifers drilled by CBNG wells. Additionally, drilling fluids do not contain constituents that would contaminate the formations and the drilling mud is in contact with the formations surrounding the uncased well bore for only a short time.

Hydraulic Fracturing

Small fractures are generated during well completion by hydraulic fracturing when the producing formation immediately surrounding the CBNG well bore does not contain enough natural cleats or fractures to facilitate movement of gas toward the well. Fluids used in hydraulic fracturing may or may not be acidic, depending on the characteristics of the producing formation. Hydraulic fracturing is strictly controlled so that methane is directed toward the well bore and so that it does not induce methane to migrate away toward existing water wells. To date, no impacts of hydraulic fracturing on existing water wells have been documented (U.S. Environmental Protection Agency 2002). However, preliminary research done by Colmenares and Zoback, Stanford University, found that during water-enhance hydraulic fracturing of the coal "all of the wells with exceptionally high water production are associated with vertical fracture propagation". This may allow for significant mixing of waters from different aquifers (for example the overlying water bearing zones).

Injection

Ground water flow systems in potential injection zones below the coal zone aquifer likely would be dominated by regional flows. Ground water in these deeper aquifer units has not been developed as extensively as in aquifer units above the coal zone and in the coal zone itself. Although the effects of ground water additions that would be associated with injection operations are not well known, testing has not shown injection to be economically because of high costs and uncertain success in disposing of large volumes of produced water over the life a group of CBNG wells. In addition, the injection of CBNG produced water into disposal wells could affect the chemistry or quality, quantity, and temperature of ground water contained in the injection zone or other aquifers within the disposal well's area of influence. The injection of water produced from CBNG wells is controlled by general underground injection control (UIC) permits issued by the State of Wyoming.

Ground Water Flow Systems

Regional flow within and out of the PRB also would not be noticeably affected under this alternative. The effects on shallow Tertiary downgradient aquifers would be similar to the effects already described in this chapter for these aquifers within the analysis area. Ground water in the deeper, lower Tertiary and lower Cretaceous flow system is not hydraulically connected with the Tertiary coal zone aquifer, and would not be affected by CBNG development.

Any noticeable effects on local ground water flow systems would be expressed as effects on existing springs, flowing (artesian) wells, or ground water discharge areas.

Alternative 2 — Standard Lease Terms and Lease Notice

The cumulative effects of this alternative on ground water resources would be same as those described under Alternative 1.

Alternative 3 — Modified Lease Terms

The cumulative effects of this alternative on ground water resources would be very similar to, but slightly lower in magnitude than those described for Alternative 1. The reduction in magnitude would occur because no new CBNG wells would be completed in proposed ACECs. Thus, implementation of this alternative would result in reduced effects from the discharge of produced water from CBNG wells; however the scale of the reduction likely would not be noticeable (about 1,740 acres of 171,000 acres of leases are in proposed ACECs).

Alternative 4 — No Surface Disposal of Produced Water

The cumulative effects of this alternative on ground water resources would be much smaller than those described for Alternative 1, especially when considering the differences associated with the water handling options used on the 285 leases. Cumulative effects on ground water resources under Alternative 4 would involve primarily effects on aquifers that would serve as injection zones during the development of CBNG. As discussed above, the injection of water produced from CBNG wells on the 285 leases into disposal wells could affect the quality, quantity, and temperature of ground water receiving the injection. However, the effects of the injection would be relatively local because the requirement for no surface disposal of produced water would not apply to other leases in the PRB.

As noted above, in the absence of surface disposal, water produced from CBNG wells would not contribute to the recharge of the alluvium and shallow Tertiary ground water units. The cumulative effects on of this absence of discharge on water yields and drawdowns would be negligible, localized, and masked by the recharge from water produced by CBNG wells on other leases that surround the 285 leases considered in this analysis.

Alternative 5 — No CBNG Development on Leases

Although implementation of this alternative would not result in new CBNG-related direct or indirect effects to ground water, the ground water under the 285 leases may still experience cumulative effects from the development of CBNG on adjoining leases, from the development of conventional oil and gas resources, and from other development activities. The quantity and quality of ground water under the leases could be affected by CBNG activities on adjoining leases because the 285 leases have relatively limited areal extents and CBNG is being developed on other leases around the 285 leases. This situation would be especially

likely for the parcels that are less than 80 acres in areal extent and are surrounded by CBNG development.

Surface Water

Potential effects to surface water resources may include: (1) changes in the quality of surface water and its suitability to meet designated uses; (2) changes in the quantity and distribution of surface flows; (3) erosion and degradation of the drainage network; and (4) increased sedimentation. The magnitude of effects to surface water resources would depend on a number of factors, including the quantity and timing of discharges of produced water from CBNG wells, the quality of surface water at the point of downstream diversions, existing and future downstream designated uses, and the specific mix of water handling options implemented to prevent discharges of water produced by CBNG wells from reaching the main stem streams.

Direct and Indirect Effects

A major beneficial use of surface water in the analysis area is the production of irrigated crops. Therefore, the surface water impact analysis focuses on the potential effects to the suitability for irrigation of surface waters in the analysis area from proposed discharges of water produced from CBNG wells.

The key water quality parameters for predicting the potential effects of the development of CBNG on irrigated agriculture are SAR and salinity (as measured by electrical conductivity, EC). There are five sets of numerical standards for SAR and EC now under consideration or applicable to the water bodies that are addressed in this analysis. These five sets of values are summarized on Table 4–2 in PRB O&G Final EIS. The information displayed in this table should be applied with the three following considerations: First, it should not be assumed that any SAR or EC value within the range displayed would be deemed an appropriate level of protection for the existing or anticipated irrigated agricultural uses in these basins. Second, the water quality standards process involves adoption by a state or tribe followed by EPA review and approval, and state- or tribally adopted limits will not have Clean Water Act regulatory status until approved by EPA. Third, the water quality standards process is still under way and it is not possible to predict the outcome of the process.

A steady-state mass-balance model was used to estimate EC concentrations and SAR values after stream flows and discharges of water produced from CBNG wells have mixed. The modeling approach, assumptions, and input parameters are discussed summarily in Chapter 4 of the PRB O&G Final EIS (pages 4–2 through 4–12), and in greater detail in the Surface Water Quality Analysis Technical Report (SWQATR). The effects of the proposed development of CBNG on the quality of surface water were evaluated on sub-watershed basis and are summarized in following sections.

Alternative 1 — No Action

Overall, the projected effects of the development of CBNG on the quality of surface water under this alternative would be the same as described for Alternative 2A in the PRB O&G Final EIS (pages 4–76 through 4–121), but proportionally smaller. When considering the potential effects to surface water resources, the reader should be aware that the mass balance model used in this analysis is a tool for comparing alternatives and evaluating the relative contributions of cumulative effects.

Water Handling Methods

Under Alternative 1, the handling of water produced from CBNG wells would be as described for Alternative 2A in the PRB O&G Final EIS. The distribution of water handling methods is summarized on Table 2–21 in the PRB O&G Final EIS. These methods include direct discharge to surface drainages, passive or active treatment before surface discharge, discharge to upland and bottomland infiltration impoundments, discharge to containment impoundments, LAD, and injection. However, water produced from CBNG wells in the PRB is primarily surface disposed. Three types of surface disposal are typical in the analysis area: surface discharge to drainages, disposal in impoundments, and LAD.

With surface discharge, water produced from CBNG wells would be gathered for discharge at outfalls authorized in accordance with guidance and requirements of WDEQ. Outfalls may feed directly into drainages or into small stock reservoirs or other treatment facilities before the outflows reach surface drainages. Water produced from CBNG wells that is discharged to the surface may be suitable for irrigation and may be diverted for that purpose.

The WSEO authorizes impoundment of CBNG-produced water through a reservoir-permitting program for water produced during the recovery of CBNG (Tyrrell 2004). On-channel and off-channel impoundments may be built to store water produced from CBNG wells. Siting guidelines and permitting requirements for impoundments have been established by WDEQ to protect water quality (Wyoming Department of Environmental Quality 2002a). Compliance monitoring for protection of ground water resources beneath unlined impoundments containing water produced from CBNG wells also is regulated by WDEQ (Parfitt 2004), as discussed in Chapter 2.

Produced water that is disposed of using LAD would be spread on the land surface using irrigation equipment (essentially center-pivot irrigation equipment). All water would be contained within the LAD site. Disposal likely would be accomplished using water that is pretreated or a disposal-rest rotation cycle consisting of repeated phases of disposal, soil amendment, rest, and disposal until the limitations of repeated soil amendments are reached. LAD sites would not be designed as traditional irrigation sites, in that irrigation return flows would not be anticipated because the produced water would be applied at agronomically acceptable rates and consumptive use by crops would be 100 percent.

The projection of the production of water from CBNG wells under Alternative 1 is shown on Table 4–1. Within the 285 leases in the analysis area, the estimated maximum production of water from the CBNG wells is 167,317 acre-feet. This

number is based on total (existing and projected) number of wells within these leases under maximum development. The peak year of water production varies by sub-watershed (refer to Chapter 4 in U.S. Bureau of Land Management 2003).

Water Production and Flows

Under Alternative 1, the peak year of water production from the leases would vary by sub-watershed, but is projected to fall between the years 2003 and 2006. The amount of produced water assumed to reach the main stem of each sub-watershed during the peak year of CBNG water production would also vary and is summarized in Chapter 4 tables for Alternative 2A PRB O&G Final EIS.

In Upper Belle Fourche, Antelope Creek and Upper Cheyenne sub-watersheds, the resultant stream flow after mixing under low-flow conditions would consist almost entirely of CBNG produced water. The resultant stream flow under low-flow conditions would be similar to the natural stream flow in Salt Creek, would increase slightly in Upper Tongue River, increase moderately in Clear Creek, and increase substantially from the natural level in Little Powder River sub-watershed.

In Crazy Woman Creek and Middle Powder River sub-watersheds the resultant stream flow under low-flow conditions would nearly double and in Upper Powder River sub-watershed nearly triple from natural stream flow. The existing 7Q10 flow either could not be computed because of a lack of data or was calculated at zero; therefore, the resultant water quality under these flow conditions is assumed to be represented by the quality of CBNG produced water, if discharges were to occur during critical low-flow periods.

Water Quality

Under modeled conditions, the resultant water quality in the Upper Belle Fourche and Antelope Creek sub-watersheds, during all months of the year and during 7Q10 flow conditions would be adequate to meet the MRPL for both EC and SAR.

In Upper Cheyenne sub-watershed, with the exception of during the highest flow months and during 7Q10 flow conditions, the resultant water quality would be adequate to meet the MRPL for EC. The resultant SAR would be adequate to meet the MRPL during all months. With the exception of during high flows, the resultant water quality in the Clear Creek and Upper Tongue River sub-watersheds, would not be adequate to meet the MRPL for both EC and SAR. It would, however, be adequate to meet the LRPL for both constituents under certain flow conditions.

The resultant water quality in the Upper Powder River, Crazy Woman Creek, and Middle Powder River sub-watersheds, would not be adequate to meet the MRPL for EC but would be adequate to meet the LRPL for EC under certain flow conditions. The resultant SAR would not be adequate to meet the MRPL, with exception of the high flow months in Upper Powder River and Crazy Woman Creek sub-watersheds.

Salt Creek sub-watershed, during all months and during 7Q10 flow conditions would not be adequate to meet the MRPL and LRPL for both EC and SAR.

Irrigation Suitability

Based on modeled results, under certain flow conditions, impacts to the suitability for irrigation in Upper Belle Fourche, Antelope Creek, Upper Cheyenne, Upper Powder River, Middle Powder River, and Little Powder River sub-watersheds from CBNG development may occur. However, samples collected since the onset of CBNG production in the Upper Belle Fourche River and Little Powder River sub-watersheds have not detected changes in ambient stream water quality which were predicted by the mass balance model, and actual impacts may be less then the mass balance model predicts. In addition, discharge permits issued by the WDEQ would be the mechanism that would identify the appropriate mix of water handling methods to be employed to meet the standards. As a result, even though the model predicts impacts, ultimately those predicted impacts to the irrigation suitability from CBNG development in Wyoming and Montana may not occur.

Based on the higher water quality and value as a source of irrigation in the Clear Creek and Crazy Woman Creek sub-watersheds, current WDEQ policy would not allow any new discharge permits in this sub-watershed that would result in any decrease in baseline water quality.

Based on modeled results, impacts to the suitability for irrigation of the Upper Tongue River from CBNG development in Wyoming and Montana under this alternative would not be expected to occur.

Surface Drainages

Potential effects from discharges of CBNG produced water to surface drainages within the analysis area include alteration in flow, erosion, degradation of the stream channel, and increased sedimentation. Potential effects would be most pronounced during periods of historical low flow. Surface drainages may be affected by the discharge of CBNG produced water where channels are not stable, armored, or large enough to accommodate the anticipated flows. Localized flooding may occur with increased frequency and magnitude where the capacity of the channel or basin is insufficient to handle the increased flows. In contrast to naturally occurring flows, which fluctuate significantly with changing seasons, flows generated by discharges of CBNG produced water occur year-round with small fluctuations. Site-specific Water Management Plans (Appendix I of the PRB O&G Final EIS) submitted at the APD and POD level of analysis would be an integral part of mitigation planning to control and monitor the potential effects from increased flows in surface drainages. Potential impacts to surface drainage from CBNG production is discussed in detail in Chapter 4 in PRB O&G Final EIS.

Potential effects on stream channel erosion, degradation, and increased sedimentation would be also associated with the construction of roads, well pads, water pipelines, gas pipelines, water handling facilities, compressors, production facilities, and electric lines in the vicinity of surface water resources.

Springs

New springs may develop in areas where infiltration of CBNG produced water is recharging alluvial aquifers or Wasatch sands. Spring flow may be inhibited locally if compaction occurs during construction or production. Natural discharge from springs can be affected by a reduction in hydraulic head within the source aquifer. It is unlikely, however, that new springs would develop near properly engineered and constructed containment impoundments, provided facilities are sited and constructed in accordance with WDEQ, WSEO, and WOGCC requirements.

Water Bodies

Large reservoirs located within or downstream of the analysis area potentially would receive surface flows that contain CBNG produced water and serve as sediment traps so that discharges or releases from these reservoirs would not be compromised by suspended sediment loads.

On-channel and off-channel impoundments used to manage produced water would have to be properly permitted by WSEO. The impoundments would also have to adhere to siting guidelines, established by WDEQ. Shallow ground water systems and surface waters would not be expected to be affected by this method of water handling, provided facilities are designed and sited in accordance with these requirements. Description of on-channel and off-channel water handling methods and guidelines are provided in Chapter 2.

CBNG produced waters discharged to off-channel containment impoundments would require an NPDES permit issued by WDEQ. Concentrations of salts and trace metals may become elevated in the water contained in these impoundments after the base of the impoundment has sealed off and as evaporation occurs (initially, salts and trace metals in the water migrate downward leaching more salts and metals as it goes until the base of the impoundment seals itself off). Infiltration rates in these impoundments may also decline over time due to the effect of sodium on dispersion of clay particles and subsequent decrease in soil permeability. Thus, rates of infiltration would be less likely to decline over time if the impoundments are situated on clayey soils and sodium concentrations in produced water are not substantial. Potential effects on surface water impoundments should be analyzed on a site-specific basis, at the APD or POD level of analysis. Impacts should be mitigated through application of special conditions of approval.

Surface Water Use

Produced water from CBNG wells is most likely to be beneficially used for irrigation, livestock watering, wildlife, wildlife habitats, and fisheries. Produced water would be available for limited use for dust suppression on access roads leading to wells under WOGCC guidelines. Water discharged to surface drainages would be available for appropriation and diversion under WSEO authorizations. Agricultural and livestock operations would thus obtain additional surface water to manage and use. Discharge and storage of CBNG produced water on upland areas in the analysis area would disperse livestock and wildlife and offer the benefit of better use of forage and reduced overgrazing and erosion.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to surface water than any of the other alternatives. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Alternative 3 — Modified Lease Terms

Under Alternative 3, CBNG produced water would be handled by the same methods as specified in Alternative 1. However, there would be no development of CBNG in the ACEC areas and standard lease terms would be modified to add No Surface Occupancy (NSO) stipulation within 500 feet of surface water and riparian areas to further protect surface water resources.

Under this alternative, the effects to surface water resources from CBNG development would be similar to those described for Alternative 1; however, the magnitude of effects would be reduced in the Upper Powder River sub-watershed due to decreased volume of CBNG produced water associated with no development in proposed ACECs (Table 4–1vs. Table 4–2).

In conjunction with the reduction in CBNG water production due to no development in proposed ACECs in the Upper Powder River sub-watershed, a reduction of beneficial use would occur in this sub-watershed. Surface owners that depended on the additional water supply may have to consider alternative water supplies. The overall reduction in the production of water from CBNG wells would be about 2 percent. This reduction would likely be negligible when compared to total CBNG water production from all leases in each sub-watershed and the magnitude of effects would likely be on the similar scale.

Additionally, potential effects on stream channel erosion, degradation, and increased sedimentation associated with the construction of roads, pipelines, and other facilities would be further reduced by adding 500 feet NSO buffer zone around perennial streams. Watersheds affected by this stipulation are listed in Table 4–4 and include Clear Creek, Crazy Woman Creek, Little Powder River, Middle Powder River and Upper Powder River sub-watersheds. Total of 777 acres of the 285 leases would be subject to NSO in these five watersheds.

Potential impacts to Antelope Creek, Salt Creek, Upper Belle Fourche River, Upper Cheyenne River, and Upper Tongue River under this alternative would be the same as under Alternative 1.

Alternative 4 — No Surface Disposal of Produced Water

Under Alternative 4, the volume of CBNG produced water would be substantially reduced from Alternative 1. Also, there would be no surface disposal of

CBNG produced water under this alternative. All produced water will be injected providing the injection zone is capable of accepting the anticipated volume without adverse impacts to ground water resources.

Table 4–4 Acres affected by NSO in each sub-watershed

Sub-watershed	Perennial Stream	Areal Extent (acres)
AntelopeCreek		0.0
ClearCreek	Clear Creek	154.0
CrazyWomanCreek	Crazy Woman Creek	163.5
LittlePowderRiver	Little Powder River	51.2
MiddlePowderRiver	Powder River	229.8
SaltCreek		0.0
UpperBelleFourcheRiver		0.0
UpperCheyenneRiver		0.0
UpperPowderRiver	Powder River	178.3
UpperTongueRiver[1]	Upper Tongue River	0.0
Total		776.7

Note:
1. No retrospective leases are located within 500 feet of Upper Tongue River

As a result, there would be no impacts to surface drainages, springs, surface water bodies, and surface water quality and use associated with surface disposal of CBNG produced water, including beneficial use.

Under this alternative, potential effects on stream channel erosion, degradation, and increased sedimentation associated with the construction activities would differ from Alternative 1 due to a small overall amount of disturbance and the varied surface disturbance associated with construction of water handling facilities.

Overall impacts to surface water resources under Alternative 4 would be substantially lower than under Alternative 1.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to surface water. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Surface Water Impact Analysis

Results of the cumulative impact analysis in the PRB under Wyoming's Alternative 2A and Montana's Alternative E are presented on Table 4–13 in PRB O&G Final EIS. Potential impacts to water quality are discussed briefly below and in

detail in the SWQATR (Greystone Environmental Consultants, Inc. and ALL Consulting, Inc. 2002) that was prepared in support of the PRB O&G Final EIS.

The water quality in the Tongue River at Ashland, Montana and Powder River at Locate, Montana, currently exceeds the MRPL for EC and SAR. Thus, any additional discharge that would reach the main stem would likely cause further degradation in terms of suitability for irrigation if the states and the EPA conclude that the MRPL is protective of irrigation uses. During low-flow conditions, surface water flow in the Tongue River would increase moderately and about twofold in the Powder River. Both EC and SAR in the resultant water would be at concentrations less than the LRPL, with exception of SAR during minimum mean monthly flow in Powder River.

Modeling indicates that the suitability of the Tongue River for irrigation may be compromised by the surface discharge of CBNG produced water during maximum CBNG development in both states. However, interstate agreements between the two DEQs have been developed to minimize impacts until protective standards are put in place. Cumulative effects to the suitability for irrigation of the Powder River would be minimized through the interim MOC requiring enhanced monitoring that the two DEQs have signed.

Alternative 1 — No Action

Surface Drainages

Both mining and CBNG development result in water collection and discharge to surface drainages. Water collected during mining is stored in sedimentation ponds and is primarily used for dust suppression. However, surface discharges may occur during storm events. Discharges from the sedimentation ponds could contain higher concentrations of dissolved solids and be of lower quality because of sediment mixing during precipitation and concentration through evaporation. In contrast, CBNG water produced from wells is essentially free of sediment, although discharge to surface drainages can increase sediment loading caused by increased stream erosion.

Culverts that carry water from upstream reaches of sub-watersheds that are undergoing CBNG development as well as diversion channels for natural flows may have to be re-sized to handle additional flows. Mining operations that partially treat water in sedimentation reservoirs may have to treat additional water if the water quality at the mine NPDES outfalls is affected by CBNG discharge. Potential effects on mine operations should be analyzed on a site-specific basis, as needed, during review of CBNG PODs or water management plans. Impacts should be mitigated through application of special conditions of approval.

By the end of the CBNG development, some surface drainages within the analysis area may be slightly deeper than they are today as a result of erosion. Careful siting and design of surface discharge outfalls would prevent or mitigate this impact.

South Dakota's 2002 303(d) list identifies water bodies downstream of the analysis area that do not support all of the designated uses (SDDNR 2002). Existing impairments to water quality caused by sedimentation and salinity in the Chey-

enne and Belle Fourche Rivers could be aggravated by discharges of CBNG produced water to surface drainages in those sub-watersheds. BMPs implemented as required by NPDES permits would minimize additional sediment loading to the drainage, however. Monitoring existing conditions at the state line between Wyoming and South Dakota would allow WDEQ to continually revise its permitting strategy for CBNG discharges in the affected drainage. Monitoring also would facilitate development of TMDL wasteload allocations that are protective of existing and future uses in both states.

Segments of the Tongue, Powder, and Little Powder Rivers in Montana downstream of the Wyoming border appear in Montana's 2000 303(d) list for water quality impairments caused by siltation and alteration in flow (MDEQ 2002). Discharges of CBNG produced water to these drainages could aggravate the existing impairments. Development of is currently underway for TMDLs, which will be used to protect the water quality in those streams and guide future CBNG development in both states. Ammonia, nitrate, and nitrite constituents in water produced from CBNG wells may add a substantial load to the Powder River because of the discharge of raw or minimally treated water.

Springs

Spring flows may have changed from present conditions. Potential effects on existing springs should be analyzed on a site-specific basis, as needed, during review of water management plans submitted at the APD or POD level of analysis. Impacts should be mitigated through application of special conditions of approval.

Water Bodies

Reservoirs downstream of the analysis area likely would receive more water and could take in additional sediment as a consequence of CBNG development. The large capacity of these reservoirs would likely minimize any increases in concentrations of suspended sediment that may occur as a result of CBNG development in upstream drainages. Additional water would better support adjudicated water uses downstream.

Water Use

Agricultural and livestock operations would obtain additional surface water to manage and use during the life of the development. Stock watering and irrigation likely would increase within the area of cumulative effects.

Alternative 2 — Standard Lease Terms and Lease Notice

The cumulative effects on surface drainages, springs, surface water bodies, and surface water use under Alternative 2 would be the same as under Alternative 1.

Alternative 3 — Modified Lease Terms

The cumulative effects on surface drainages, springs, surface water bodies, and surface water use would be similar to those described under Alternative 1. The decrease in magnitude of effects associated with lower CBNG water production

due to no development in proposed ACECs would likely not be observable. Potential effects on stream channel erosion, degradation, and increased sedimentation associated with the construction of roads, pipelines, and other facilities may be slightly reduced by 500 feet NSO buffer zone around perennial streams.

Alternative 4 — No Surface Disposal of Produced Water

The elimination of surface disposal of CBNG produced water under Alternative 4 and the reduction in the number of CBNG wells drilled would decrease the cumulative impacts to surface drainages, springs, surface water bodies, and surface water use, including beneficial use.

Potential effects on stream channel erosion, degradation, and increased sedimentation associated with the construction activities would be also different than under Alternative 1 due to less overall disturbance and different surface disturbance associated with construction of water handling facilities. Overall impacts to surface water resources under Alternative 4 would be substantially lower than under Alternative1.

Alternative 5 — No CBNG Development on Leases

Although implementation of this alternative would not result in CBNG-related direct or indirect effects to ground water, surface water present on the 285 leases may still experience cumulative effects from the development of CBNG on adjoining leases, from the development of conventional oil and gas resources, and from other development activities. The quantity and quality of ground water flowing through the leases could be affected by CBNG activities on adjoining leases because the 285 leases have relatively limited areal extents and CBNG is being developed on other leases around the 285 leases. Overall, the volumes of water produced from CBNG wells on the 285 leases would account for a small portion of the overall water produced from CBNG wells in the PRB. This situation would be especially likely for the parcels that are less than 80 acres in areal extent and are surrounded by CBNG development.

Geology and Mineral Resources

Mineral Resources

Overall, the types of effects on mineral resources would be consistent with the effects described in the PRB O&G Final EIS. The magnitude of the effects would be a fraction of those described in the EIS.

Alternative 1 — No Action

Based on an average production rate of 160,000 cubic feet of CBNG per well per day following initial dewatering, and an average of 400 million cubic feet of CBNG available per well (De Bruin et al. 2001), an estimated 1 trillion cubic feet of methane would be produced over the life of the CBNG wells included in Alternative 1, which would account for about 7 percent of the total projected for the entire PRB (U.S. Bureau of Land Management 2003). The CBNG extracted un-

der this alternative would contribute toward meeting the nation's future needs for energy.

Of the 285 leases, 30, which encompass about 16,000 acres, have been fully developed or are being developed. Based on a well spacing of 80 acres, with multiple coals seams likely to be developed in may areas, these 16,000 acres potentially could be developed by 333 wells, although currently are developed by only 144 wells. While development is not complete on 10 of the 30 leases, drainage of federal minerals is not likely to be an issue for any of the 30 leases that have already undergone development.

Development of CBNG under Alternative 1 would not be likely to affect recovery of other mineral resources in the analysis area. Oil and gas have been produced from geologic formations occurring several thousand feet below the coal zone. Salable minerals, primarily clinker, sand, and gravel, are produced from surface deposits. Bentonite, high-calcium limestone, and gypsum occurring in rocks exposed along the uplifted margins of the study, are stratigraphically below the geologic formations that may be affected by CBNG development in the PRB. No other locatable mineral deposits are known to exist in the analysis area. Development of existing mineral rights in the analysis area would be based on existing claims, lease terms, and agreements; future conflicts would be addressed on a case-by-case basis.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative would result in effects to geology and mineral resources similar to those described for Alternative 1. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative. Consequently, the wells would be expected to produce 1 trillion cubic feet of CBNG. As with Alternative 1, the CBNG extracted under this alternative would contribute toward meeting the nation's future needs for energy.

Alternative 3 — Modified Lease Terms

Under this alternative, 60 fewer wells would be drilled because of restrictions on drilling in the proposed ACECs. Without these wells, about 24 billion cubic feet of CBNG would not be recovered directly. However, some or all of this CBNG could be recovered indirectly (drained) by wells drilled on adjoining leases. The CBNG extracted under this alternative would contribute toward meeting the nation's future needs for energy; however, it contribute at a slightly lower level than Alternatives 1 or 2.

Alternative 4 — No Surface Disposal of Produced Water

Effects on mineral and energy resources would be substantially less than under Alternative 1. Under this alternative, 2,156 fewer wells would be drilled. Without these wells, 862 billion cubic feet of CBNG would not be recovered directly. However, some or all of this CBNG could be recovered indirectly (drained) by

wells drilled on adjoining leases. The CBNG extracted by the 381 wells would contribute toward meeting the nation's future needs for energy; however, the contribution of this alternative would be substantially less than Alternatives 1, 2, or 3.

Alternative 5 — No CBNG Development on Leases

Under this alternative, no CBNG would be recovered from 255 of the 285 leases with no development. Thus, 1 trillion cubic feet of CBNG would not be recovered from the leases. However, some of that CBNG would be drained by CBNG wells constructed on adjoining leases. Implementation of this alternative would not affect the recovery of other mineral resources that may be present on the leases. This alternative would not contribute any resources toward meeting the nation's future needs for energy.

Cumulative Effects

With limited development of CBNG wells (Alternatives 3 and 4) or no development of CBNG wells (Alternative 5) on the leases that have not undergone any development (255 leases encompassing about 155,000 acres), as many as 2,537 wells that could have developed federal minerals might never be drilled or produced. Under all the alternatives, development of CBNG would continue to occur on leases surrounding the 285 leases considered in this analysis. The existence of 5,180 wells that are producing or temporarily shut in wells and 4,395 well applications or permitted wells within a 3-mile radius of the 255 leases makes it likely that CBNG would be drained from about 155,000 acres of federal mineral lands.

Cumulatively, implementation of any of the alternatives would not affect the recovery of other mineral resources that may be present on the leases.

Soils

Alternative 1 — No Action

The effects on soil resources in the analysis area would be a scaled down version of the effects described under Alternative 2A in the PRB O&G Final EIS. Effects to soils would be primarily associated with the construction of roads, well pads, water pipelines, gas pipelines, water handling facilities, compressors, production facilities, electric lines, and casual use. Effects to soils result from the clearing vegetation; excavating, stockpiling, compacting, vehicle use of roads, and redistributing soils during construction and reclamation; and storing or discharging water produced from CBNG wells. Short-term disturbance on the 285 leases would be approximately 13,528 acres, and long-term disturbance would be 6,516 acres.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to soils than any of the other alternatives. This potential exists because

only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Alternative 3 — Modified Lease Terms

Effects on soil resources are expected to be reduced slightly under Alternative 3. There would be approximately 143 fewer acres of short-term disturbance and 86 fewer acres of long-term disturbance compared with Alternative 1. Beneficial effects to such a small area of land may not be noticeable on a larger scale, such as the PRB. Lease terms would be modified to add the stipulation of NSO within 500 feet of surface water and riparian areas. Soils with wind and water erosion hazards, compaction/shrink-swell potential, poor revegetation potential, and prime agricultural status, occur within 500 feet of surface water and riparian areas within the analysis area. NSO on these areas would reduce the potential effects on soil resources. No effects to soils would occur on proposed ACECs.

Alternative 4 — No Surface Disposal of Produced Water

Effects on soil resources are expected to be substantially reduced under Alternative 4. Approximately 11,563 fewer acres would be disturbed in the short-term and 5,780 fewer acres would be disturbed in the long-term compared to Alternatives 1 and 2. Compared to Alternative 3, there would be 11,420 fewer acres disturbed in the short-term and 5,694 fewer acres disturbed in the long-term. Surface disposal of water produced from CBNG wells would not be allowed. Activities associated with surface disposal would be eliminated including, excavation for reservoirs, releasing produced water into drainages, and containing produced water in reservoirs. Eliminating these activities would reduce the potential for the alteration of the physical and chemical properties of the soils. It would decrease the breakdown of soil aggregates and subsequently decrease runoff, the formation of gullies, and compaction. Sedimentation would be greatly reduced by eliminating the increase in velocity and volume of surface water in stream channels. This would prevent the dispersal and deposition of eroded soil, and decrease turbidity and transportation of sediment downstream. The deleterious effect of water high in SAR on soil productivity and reclamation potential would also be prevented. The beneficial effects of eliminating surface disposal of produced water would only occur on the 285 leases. These effects would not be seen where surface disposal would occur elsewhere in the PRB.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to ground water. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Effects

The cumulative effects of Alternatives 1 and 2 are consistent with those described for Alternative 2A in the PRB O&G Final EIS. Cumulative effects associated with Alternatives 3, 4, and 5 would be less than for Alternatives 1 and 2. However, the 285 leases discussed in this document represent only a minor portion of the development discussed in the PRB O&G Final EIS.

Alternative 3 — Modified Lease Terms

Because of the modification of lease terms under Alternative 3, cumulative effects to soils are expected to decrease slightly. All other cumulative effects (geology and mineral resources) would be consistent with those described for Alternative 2A in the PRB O&G Final EIS.

Alternative 4 — No Surface Disposal of Produced Water

Under this alternative, development of the 285 leases would be substantially less than what would occur under Alternatives 1, 2, and 3. With only 381 new CBNG wells and associated facilities, this alternative would contribute only a small amount to the overall cumulative effects that development of the rest of the PRB would cause.

Alternative 5 — No CBNG Development on Leases

Under this alternative, development of CBNG would not continue on the 285 leases. However, effects from conventional oil and gas would continue, along with any effects that resulted from previous development on the leases and development on other leases that surround the 285 leases.

Landscape Processes

The effects on landscape processes in the analysis area would be consistent with the effects described in the PRB O&G Final EIS.

Vegetation and Land Cover Types

Alternative 1 — No Action

The effects on vegetation and land cover types in the analysis area would be consistent with the effects described in Alternative 2A in the PRB O&G Final EIS. However, the 285 leases represent a minor proportion of the overall development discussed in the PRB O&G Final EIS. Direct effects to vegetation would occur from ground disturbance caused by construction of well pads, compressor stations, ancillary facilities, pipelines, and roads. Indirect effects to vegetation would occur as a result of CBNG activities, including a possible increase in noxious weeds; alteration of the distribution of types of vegetation caused by changes in volume and rate of surface water flows; and an increase in dust, vehicular, and equipment emissions and casual use.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to vegetation than any of the other alternatives. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Alternative 3 — Modified Lease Terms

Effects on vegetation and land cover types would be slightly reduced under Alternative 3. Approximately 13,385 acres would be disturbed in the short-term, and 6,430 acres would be disturbed in the long-term. This is compared to 13,528 and 6,516 acres, respectively, under Alternative 1. This difference represents an extremely small area of the nearly 8 million acres of land in the PRB. Lease terms would be modified to add the stipulation of NSO within 500 feet of surface water and riparian areas. The total amount of vegetation disturbed in riparian areas would be reduced. No additional vegetation would be disturbed in the proposed ACECs.

Alternative 4 — No Surface Disposal of Produced Water

Effects on vegetation and cover types would be reduced under Alternative 4. Approximately 1,965 acres would be disturbed in the short-term, and 736 acres would be disturbed over the long-term. Surface disposal of CBNG produced water would not be allowed. The alteration of the distribution of types of vegetation caused by changes in volume and rate of surface water flows would be eliminated on the 285 leases, but would continue on existing leases.

Two species that would particularly benefit from this alternative include Wyoming big sagebrush and rabbitbrush. These species are highly sensitive to inundation of their root zones. The alteration of vegetation communities resulting from high salinity in the produced water would also be eliminated. Water produced from CBNG wells and discharged using various water-handling methods can alter the concentration of salt in water available to plants.

The potential for invasion by noxious weeds would also be reduced with less disturbance and no surface disposal. The die-off of shrubs resulting from inundation would be prevented and therefore no area would be left vulnerable to invasions. Increases in salinity can favor the establishment of noxious weeds, and it is likely that higher salinity in soil along many streams and river channels has favored the establishment of saltcedar over cottonwood. This is a possible explanation for the increase of saltcedar along most of the drainages in the analysis area. Eliminating surface disposal of CBNG produced water on the 285 leases would reduce these effects.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to vegetation. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Effects

Implementation of each of the alternatives would contribute to cumulative effects to vegetation and cover types in the analysis area. Other activities that would contribute to cumulative effects include mining for coal, sand, gravel and scoria; ranching; agriculture; construction of new roads and railroads; and the development of new rural and urban housing. The cumulative effects of Alternatives 1 and 2 would be similar to those described for Alternative 2A in the PRB O&G Final EIS, but they would involve a much smaller area and scale.

Alternative 3 — Modified Lease Terms

Cumulative effects to vegetation and cover types are expected to be reduced slightly under Alternative 3. Effects from CBNG production and other management activities described above would continue, but there would be less cumulative disturbance to riparian vegetation cover types.

Alternative 4 — No Surface Disposal of Produced Water

The elimination of 2,156 CBNG wells and surface disposal of produced water under Alternative 4 would reduce the cumulative impacts to vegetation and cover types. The total acreage of vegetation disturbance resulting from CBNG disposed water would be reduced and subsequently the effects of noxious weed invasions and vegetation die-off would decrease on the 285 leases.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no further effects related to the development of CBNG on the 285 leases. However, the development of conventional oil and gas resources could still occur, which would contribute to cumulative effects in the overall area. Other activities that would contribute to cumulative effects on vegetation include mining for coal, sand, gravel, and scoria; ranching; agriculture; construction of new roads and railroads; and the development of new rural and urban housing.

Wetlands/Riparian Areas

Alternative 1 — No Action

The effects on wetlands and riparian areas in the analysis area would be consistent with the effects described in Alternative 2A in the PRB O&G Final EIS. However, because the 285 leases include only a small portion of the wetlands and riparian areas discussed in the EIS, the effects would be reduced proportionally.

These effects include habitat loss, increase in road density, increase in water quantity, changes in water quality, removal of existing wetlands, creation of new wetlands, and enlarging of existing wetlands.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to wetlands and riparian areas than any of the other alternatives. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Alternative 3 — Modified Lease Terms

Effects on wetlands and riparian areas would be slightly reduced under Alternative 3. Lease terms would be modified to add the stipulation of NSO within 500 feet of surface water and riparian areas. The total amount of wetlands and riparian areas disturbed in the analysis area would be reduced. Wetlands and riparian areas would continue to be affected by changes in water quality and quantity. No wetlands or riparian areas would be disturbed in proposed ACECs.

Alternative 4 — No Surface Disposal of Produced Water

Effects to wetlands and riparian areas would be reduced under Alternative 4. There would be fewer CBNG wells and no increases to surface water flows, and therefore, the possible future effects on the 285 leases from Alternative 1 would be eliminated including, increased erosion of channels and floodplains, loss of riparian streambank vegetation, changes to the composition and structure of wetland and riparian vegetation, and rising of the shallow ground water table in the floodplains. The future effects to wetlands and riparian areas as a result of produced water quality would also be eliminated. Substantial increases in the normal levels of salinity and sodicity in the surface waters of the analysis area would no longer affect the growth, vigor, and reproductive success of wetland and riparian ecosystems. Surface disposal of produced water would not increase sodicity in the floodplains and would therefore not cause potentially irreversible changes to soil structure that reduce permeability of rainfall and restrict root growth.

Previously existing wetlands and floodplains that expanded because of the production of water from CBNG wells would experience vegetation dieback as the hydrology returned to normal conditions. Salt scalds could appear as water evaporates and may inhibit growth of new plant species.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to wetlands and riparian areas. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Effects

The discussion of cumulative effects to vegetation and cover type is relevant to wetlands and riparian areas. Current land uses are likely to have some effect on wetlands and riparian areas via habitat degradation, road development, and water quality degradation. The cumulative effects of Alternatives 1 and 2 are consistent with those described for Alternative 2A in the PRB O&G Final EIS.

Alternative 3 — Modified Lease Terms

Cumulative effects to wetlands and riparian areas are expected to be reduced under Alternative 3. Effects from CBNG production and other management activities described above would continue, but there would be less cumulative disturbance to riparian vegetation cover types.

Alternative 4 — No Surface Disposal of Produced Water

The elimination of surface disposal of produced water under Alternative 4 would reduce the cumulative impacts to wetlands and riparian areas. These communities would continue to be affected by current land use, however the effects of increases in water quantity and changes in water quality would not be evident.

Alternative 5 — No CBNG Development on Leases

Wetlands and riparian areas would no longer be affected by the development of CBNG on the 285 leases. However, development of conventional oil and gas resources on the 285 leases and CBNG on leases upstream of the 285 leases would continue to affect wetlands and riparian areas on the 285 leases. Also, continued development of other minerals, roads, railroads, and rural and urban areas and ongoing ranching and agricultural operations would continue to affect wetlands and riparian areas cumulatively. Effects from these activities would include the loss or degradation of wetlands and riparian areas and degradation of water quality flowing onto the 285 leases.

Wildlife

Many of the effects to wildlife would be similar among alternatives and similar to the preferred alternative (2A) in the PRB O&G Final EIS. This is because the amount of development (e.g., the number of wells developed and the increase in road density) would not differ among the various alternatives. Additionally, Appendix P of the PRB O&G Final EIS reviews the mitigation measures that were designed to minimize effects to wildlife species. At a minimum, these measures are incorporated into each alternative addressed in this EA. However, some mi-

nor variations of impacts are expected due to stipulation modifications regarding proposed ACECs; sage-grouse habitats; riparian habitats; and water handling methods. Activities that contribute to cumulative effects to wildlife in the sub-watersheds of the analysis area include oil and gas development (conventional and CBNG); coal mining; uranium mining; sand, gravel, and scoria mining; ranching; agriculture; road and railroad construction; and rural and urban housing development.

Terrestrial Species

The principal effects to terrestrial wildlife may include: (1) increased direct mortality; (2) the introduction of new habitats suitable for avian and mammalian predators, and thus a potential change in predation rates on other wildlife species; (3) direct loss or degradation of habitats; (4) indirect disturbance resulting from human activity; (5) habitat fragmentation; and (6) changes in population levels, and (7) increased disease related to increase stress resulting from CBNG development. Please refer to the PRB O&G Final EIS for more information about each of these types of effects, including specific activities, and how and when these effects may occur.

Big Game

Alternative 1 — No Action

The type and relative magnitude of effects to big game under Alternative 1 would be consistent with the effects described under Alternative 2A in the PRB O&G Final EIS. This alternative would cause direct, indirect, short-term, and long-term effects to big game and their ranges on the 285 leases. Potential effects include: hunting and poaching, vehicle collisions, loss or degradation of habitats, harassment and displacement, noise, dust, nutritional status and reproductive success, habitat fragmentation, water handling facilities, and fences (for pronghorn only). Table 4–5, Table 4–6, Table 4–7, and Table 4–8 present the direct short-term and long-term effects to the ranges of each big game species under Alternative 1. Tables 4–28 and 4–29, Alternative 2A, in the PRB O&G Final EIS present estimates of the indirect effects to big game in the analysis area. Chapter 4 of the PRB O&G Final EIS qualitatively discusses the direct and indirect effects.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to big game than any of the other alternatives. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Table 4–5 Direct Short-term and Long-term Effects to Elk Ranges by Sub-watershed — Alternatives 1 and 2

	Elk Range (acres)													
	Severe		Crucial		Winter		Winter Yearlong		Yearlong		Spring, Summer, Fall		Total	
Sub-watershed	Short -term	Long -term	Short -term	Long -term	Short -term	Long -term	Short -term	Long -term	Short -term	Long -term	Short -term	Long -term	Short -term	Long -term
Fortification Creek Only														
Upper Powder River	386	190	0	0	0	0	19	9	442	218	0	0	847	417
Total	386	190	0	0	0	0	19	9	442	218	0	0	847	417
Excluding Fortification Creek														
Antelope Creek	0	0	0	0	0	0	0	0	2	1	0	0	2	1
Upper Cheyenne River	0	0	0	0	0	0	0	0	15	6	0	0	15	6
Upper Powder River	0	0	0	0	0	0	0	0	38	19	0	0	38	19
Total	0	0	0	0	0	0	0	0	55	26	0	0	55	26

Table 4–6 Direct Short-term and Long-term Effects to Mule Deer Ranges by Sub-watershed — Alternatives 1 and 2

	Mule Deer Ranges (acres)													
	Severe		Crucial		Winter		Winter Yearlong		Yearlong		Spring, Summer, Fall		Total	
Sub-watershed	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
Antelope Creek	0	0	0	0	0	0	0	0	266	98	0	0	266	98
Clear Creek	0	0	0	0	0	0	1,731	978	277	156	0	0	2,008	1,134
Crazy Woman Creek	0	0	0	0	0	0	1,713	786	857	393	0	0	2,570	1,179
Little Powder River	0	0	0	0	0	0	966	390	694	280	0	0	1,661	670
Middle Powder River	0	0	0	0	0	0	536	274	123	63	0	0	659	336
Salt Creek	0	0	0	0	0	0	712	263	1	0	0	0	713	263
Upper Belle Fourche River	0	0	0	0	0	0	0	0	440	191	0	0	440	191
Upper Cheyenne River	0	0	0	0	0	0	0	0	51	22	0	0	51	22
Upper Powder River	0	0	0	0	0	0	963	483	578	290	0	0	1,541	773
Upper Tongue River	0	0	0	0	0	0	2,866	1,502	410	215	0	0	3,276	1,716
Total	0	0	0	0	0	0	9,487	4,675	3,698	1,709	0	0	13,185	6,384

Table 4–7 Direct Short-term and Long-term Effects to Pronghorn Ranges by Sub-watershed — Alternatives 1 and 2

	Pronghorn Range (acres)													
	Severe		Crucial		Winter		Winter Yearlong		Yearlong		Spring, Summer, Fall		Total	
Sub-watershed	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
Antelope Creek	0	0	0	0	0	0	1	1	539	197	0	0	540	198
Clear Creek	0	0	0	0	0	0	29	16	1,815	1,025	0	0	1,844	1,042
Crazy Woman Creek	0	0	0	0	0	0	0	0	2,570	1,179	0	0	2,570	1,179
Little Powder River	0	0	0	0	1,012	408	0	0	139	56	0	0	1,151	464
Middle Powder River	0	0	0	0	31	16	0	0	446	227	0	0	476	243
Salt Creek	0	0	0	0	0	0	87	32	445	164	0	0	532	196
Upper Belle Fourche River	0	0	0	0	0	0	23	10	166	72	0	0	189	82
Upper Cheyenne River	0	0	0	0	0	0	3	1	93	40	0	0	96	42
Upper Powder River	0	0	0	0	6	3	240	121	896	450	0	0	1,142	573
Upper Tongue River	0	0	0	0	0	0	0	0	3,241	1,698	0	0	3,241	1,698
Total	0	0	0	0	1,049	427	383	181	10,350	5,110	0	0	11,782	5,718

Table 4–8 Direct Short-term and Long-term Effects to White-tailed Deer Ranges by Sub-watershed — Alternatives 1 and 2

	White-tailed Deer Range (acres)													
	Severe		Crucial		Winter		Winter Yearlong		Yearlong		Spring, Summer, Fall		Total	
Sub-watershed	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
Antelope Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clear Creek	0	0	0	0	0	0	0	0	137	77	0	0	137	77
Crazy Woman Creek	0	0	0	0	0	0	0	0	152	70	0	0	152	70
Little Powder River	0	0	0	0	0	0	0	0	372	150	0	0	372	150
Middle Powder River	0	0	0	0	0	0	3	1	77	39	0	0	79	41
Salt Creek	0	0	0	0	0	0	0	0	33	12	0	0	33	12
Upper Belle Fourche River	0	0	0	0	0	0	0	0	30	13	0	0	30	13
Upper Cheyenne River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Powder River	0	0	0	0	0	0	0	0	116	58	0	0	116	58
Upper Tongue River	0	0	0	0	0	0	0	0	168	88	0	0	168	88
Total	0	0	0	0	0	0	3	1	1,084	508	0	0	1,087	509

Alternative 3 — Modified Lease Terms

Direct effects to big game species under Alternative 3 would be the same as under Alternative 1, or slightly reduced (Table 4–9, Table 4–10, Table 4–11, and Table 4–12). Under Alternative 1, elk parturition areas and elk critical winter range would be protected by timing limitations, and the other ranges would not be specifically offered protection. However, any of the ranges that occur within the proposed Dry Creek Petrified Tree ACEC would be protected by the lease stipulation of NSO in the Petrified Tree SMA, and any of the ranges that occur within the proposed Fortification Creek ACEC would have a CSU stipulation for the Fortification Creek SMA. Therefore, 1) the additional restriction of no leasing in ACECs under Alternative 3 would further limit disturbance for a small amount of big game ranges within the proposed Cow Creek Breaks and Fortification Creek ACECs, and 2) effects to big game ranges within the proposed Dry Creek Petrified Tree ACEC would not differ between alternatives. Alternative 3 would also include NSO within 500 feet of surface water and riparian areas. This lease term modification may reduce the impacts to big game species through the protection of riparian forage habitats, but only in some instances. Finally, the increase in fencing that would affect pronghorn would be slightly less than for Alternatives 1 and 2.

Alternative 4 — No Surface Disposal of Produced Water

Alternative 1 direct effects to big game would also apply to Alternative 4, with the exception of the effects associated with CBNG water handling methods. Under Alternative 4, effects to big game on the 285 leases would be slightly reduced in the short-term but slightly increased in the long-term (Table 4–13, Table 4–14, Table 4–15, and Table 4–16). The restrictions on surface discharge, impoundments, and LAD in Alternative 4 would prevent some impacts to big game that are expected with Alternative 1, including: creation of drinking water sources; expansion of forage in wetland and riparian areas; and effects to pronghorn from the presence of more fences. The lack of reservoirs may benefit big game species by not creating areas for the animals to concentrate, which would increase mortality through hunting, poaching, and the transmission of diseases.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to species of big game. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Effects

The cumulative effects of activities on big game habitats in the sub-watersheds of the analysis area are discussed in the PRB O&G Final EIS. The cumulative effects for the 285 leases discussed in this EA would be similar to those for Alternative 2A on Tables 4–48, 4–49, 4–50, and 4–51 of the PRB O&G Final EIS. However, the cumulative effects would be greatly reduced under Alternative 5 relative to the other four alternatives.

Table 4–9 Direct Short-term and Long-term Effects to Elk Ranges by Sub-watershed — Alternative 3

	Elk Range (acres)													
	Severe		Crucial		Winter		Winter Yearlong		Yearlong		Spring, Summer, Fall		Total	
Sub-watershed	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
Fortification Creek Only														
Upper Powder River	352	170	0	0	0	0	17	8	404	195	0	0	774	373
Total	352	170	0	0	0	0	17	8	404	195	0	0	774	373
Excluding Fortification Ck.														
Antelope Creek	0	0	0	0	0	0	0	0	2	1	0	0	2	1
Upper Cheyenne River	0	0	0	0	0	0	0	0	15	6	0	0	15	6
Upper Powder River	0	0	0	0	0	0	0	0	35	17	0	0	35	17
Total	0	0	0	0	0	0	0	0	52	24	0	0	52	24

Table 4–10 Direct Short-term and Long-term Effects to Mule Deer Ranges by Sub-watershed — Alternative 3

	Mule Deer Range (acres)													
	Severe		Crucial		Winter		Winter Yearlong		Yearlong		Spring, Summer, Fall		Total	
Sub-watershed	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
Antelope Creek	0	0	0	0	0	0	0	0	266	98	0	0	266	98
Clear Creek	0	0	0	0	0	0	1,731	978	277	156	0	0	2,008	1,134
Crazy Woman Creek	0	0	0	0	0	0	1,713	786	857	393	0	0	2,570	1,179
Little Powder River	0	0	0	0	0	0	966	390	694	280	0	0	1,661	670
Middle Powder River	0	0	0	0	0	0	536	274	123	63	0	0	659	336
Salt Creek	0	0	0	0	0	0	712	263	1	0	0	0	713	263
Upper Belle Fourche River	0	0	0	0	0	0	0	0	440	191	0	0	440	191
Upper Cheyenne River	0	0	0	0	0	0	0	0	51	22	0	0	51	22
Upper Powder River	0	0	0	0	0	0	875	431	525	258	0	0	1,400	689
Upper Tongue River	0	0	0	0	0	0	2,866	1,502	410	215	0	0	3,276	1,716
Total	0	0	0	0	0	0	9,399	4,622	3,645	1,677	0	0	13,044	6,300

Table 4–11 Direct Short-term and Long-term Effects to Pronghorn Ranges by Sub-watershed — Alternative 3

	Pronghorn Range (acres)													
	Severe		Crucial		Winter		Winter Yearlong		Yearlong		Spring, Summer, Fall		Total	
Sub-watershed	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
Antelope Creek	0	0	0	0	0	0	1	1	539	197	0	0	540	198
Clear Creek	0	0	0	0	0	0	29	16	1,815	1,025	0	0	1,844	1,042
Crazy Woman Creek	0	0	0	0	0	0	0	0	2,570	1,179	0	0	2,570	1,179
Little Powder River	0	0	0	0	1,012	408	0	0	139	56	0	0	1,151	464
Middle Powder River	0	0	0	0	31	16	0	0	446	227	0	0	476	243
Salt Creek	0	0	0	0	0	0	87	32	445	164	0	0	532	196
Upper Belle Fourche River	0	0	0	0	0	0	23	10	166	72	0	0	189	82
Upper Cheyenne River	0	0	0	0	0	0	3	1	93	40	0	0	96	42
Upper Powder River	0	0	0	0	5	3	218	107	814	401	0	0	1,037	511
Upper Tongue River	0	0	0	0	0	0	0	0	3,241	1,698	0	0	3,241	1,698
Total	0	0	0	0	1,048	426	361	167	10,268	5,061	0	0	11,677	5,655

Table 4–12 Direct Short-term and Long-term Effects to White-tailed Deer Ranges by Sub-watershed — Alternative 3

	White-tailed Deer Range (acres)													
	Severe		Crucial		Winter		Winter Yearlong		Yearlong		Spring, Summer, Fall		Total	
Sub-watershed	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
Antelope Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clear Creek	0	0	0	0	0	0	0	0	137	77	0	0	137	77
Crazy Woman Creek	0	0	0	0	0	0	0	0	152	70	0	0	152	70
Little Powder River	0	0	0	0	0	0	0	0	372	150	0	0	372	150
Middle Powder River	0	0	0	0	0	0	4	2	77	39	0	0	79	41
Salt Creek	0	0	0	0	0	0	0	0	33	12	0	0	33	12
Upper Belle Fourche River	0	0	0	0	0	0	0	0	30	13	0	0	30	13
Upper Cheyenne River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Powder River	0	0	0	0	0	0	0	0	105	52	0	0	105	52
Upper Tongue River	0	0	0	0	0	0	0	0	168	88	0	0	168	88
Total	0	0	0	0	0	0	4	2	1,073	501	0	0	1,076	503

Table 4–13 Direct Short-term and Long-term Effects to Elk Ranges by Sub-watershed — Alternative 4

	Elk Range (acres)													
	Severe		Crucial		Winter		Winter Yearlong		Yearlong		Spring, Summer, Fall		Total	
Sub-watershed	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
Fortification Creek Only														
Upper Powder River	318	122	0	0	0	0	16	6	365	141	0	0	699	269
Total	318	122	0	0	0	0	16	6	365	141	0	0	699	269
Excluding Fortification Ck.														
Antelope Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Cheyenne River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Powder River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4–14 Direct Short-term and Long-term Effects to Mule Deer Ranges by Sub-watershed — Alternative 4

	Mule Deer Range (acres)													
	Severe		Crucial		Winter		Winter Yearlong		Yearlong		Spring, Summer, Fall		Total	
Sub-watershed	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
Antelope Creek	0	0	0	0	0	0	0	0	234	83	0	0	234	83
Clear Creek	0	0	0	0	0	0	151	59	40	16	0	0	191	75
Crazy Woman Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Powder River	0	0	0	0	0	0	178	65	190	69	0	0	368	133
Middle Powder River	0	0	0	0	0	0	153	61	6	2	0	0	159	64
Salt Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Belle Fourche River	0	0	0	0	0	0	0	0	92	35	0	0	92	35
Upper Cheyenne River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Powder River	0	0	0	0	0	0	288	111	174	67	0	0	462	177
Upper Tongue River	0	0	0	0	0	0	198	75	11	4	0	0	209	79
Total	0	0	0	0	0	0	969	371	747	276	0	0	1,716	647

Table 4–15 Direct Short-term and Long-term Effects to Pronghorn Ranges by Sub-watershed — Alternative 4

	Pronghorn Range (acres)													
	Severe		Crucial		Winter		Winter Yearlong		Yearlong		Spring, Summer, Fall		Total	
Sub-watershed	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
Antelope Creek	0	0	0	0	0	0	1	1	476	169	0	0	478	170
Clear Creek	0	0	0	0	0	0	0	0	179	71	0	0	179	71
Crazy Woman Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Powder River	0	0	0	0	256	93	0	0	41	15	0	0	296	107
Middle Powder River	0	0	0	0	0	0	0	0	133	53	0	0	133	53
Salt Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Belle Fourche River	0	0	0	0	0	0	0	0	34	13	0	0	34	13
Upper Cheyenne River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Powder River	0	0	0	0	0	0	94	36	324	124	0	0	418	160
Upper Tongue River	0	0	0	0	0	0	0	0	198	75	0	0	198	75
Total	0	0	0	0	256	93	96	37	1,385	520	0	0	1,737	649

Table 4–16 Direct Short-term and Long-term Effects to White-tailed Deer Ranges by Sub-watershed — Alternative 4

	White-tailed Deer Range (acres)													
	Severe		Crucial		Winter		Winter Yearlong		Yearlong		Spring, Summer, Fall		Total	
Sub-watershed	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
Antelope Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clear Creek	0	0	0	0	0	0	0	0	14	6	0	0	14	6
Crazy Woman Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Powder River	0	0	0	0	0	0	0	0	25	9	0	0	25	9
Middle Powder River	0	0	0	0	0	0	1	0	2	1	0	0	3	1
Salt Creek	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Belle Fourche River	0	0	0	0	0	0	0	0	1	1	0	0	1	1
Upper Cheyenne River	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Powder River	0	0	0	0	0	0	0	0	5	2	0	0	5	2
Upper Tongue River	0	0	0	0	0	0	0	0	3	1	0	0	3	1
Total	0	0	0	0	0	0	1	0	51	19	0	0	51	19

Raptors

Some raptor species are addressed in the Threatened, Endangered, and Sensitive species section, whereas others are included in the discussion below.

Alternative 1 — No Action

The type and relative magnitude of effects to raptors under Alternative 1 would be consistent with the effects described under Alternative 2A in the PRB O&G Final EIS. However, the 285 leases represent a minor proportion of the development discussed in the EIS. Thus, the effects would be proportionally less. The effects to general raptor habitats are essentially the same as effects to vegetation, which are presented in the PRB O&G Final EIS. Potential effects of this alternative to raptors include: increased direct mortality; the introduction of new perches; water handling facilities; harassment and displacement; noise; availability of prey; direct loss, degradation, or disturbance of habitats; habitat fragmentation; and changes in population levels.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to raptors than any of the other alternatives. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Alternative 3 — Modified Lease Terms

Effects to raptor species would be slightly reduced under Alternative 3. Modifying the lease stipulations to include no leasing in the proposed ACECs may preserve some suitable raptor habitats. Also, the stipulation for NSO within 500 feet of surface water and riparian areas may reduce impacts to raptors and their habitats in some instances. The TLS for greater sage-grouse described below also would benefit nesting raptors.

Alternative 4 — No Surface Disposal of Produced Water

Under this alternative, effects to raptors would be substantially less than those for Alternative 1. Disturbance of habitats would be less (381 acres instead of 13,528 acres). Also, facilities for the surface disposal of CBNG water would not affect raptors because they would not be constructed. These effects include the disruption or improvement in the availability of raptor prey species or both. The effects are described in the PRB O&G Final EIS.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to species of raptors that occur or potentially occur on the 285 leases. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Effects

Implementation of each of the alternatives would contribute to cumulative effects to raptors. The PRB O&G Final EIS describes how increased development can negatively and positively affect raptors in the sub-watersheds of the analysis area. However, the cumulative effects would be greatly reduced under Alternatives 4 and 5 relative to the other three alternatives.

Upland Game Birds

The greater sage-grouse and the plains sharp-tailed grouse were identified during the scoping process as the upland game birds of specific concern. The greater sage-grouse is discussed in the section on Threatened, Endangered, and Sensitive species. The plains sharp-tailed grouse is discussed below.

Alternative 1 — No Action

The type and relative magnitude of effects to the plains sharp-tailed grouse under Alternative 1 would be consistent with the effects described under Alternative 2A in the PRB O&G Final EIS (U.S. Bureau of Land Management 2003:Table 4–52). However, the 285 leases represent a minor proportion of the development discussed in the EIS. The effects may include: increased direct mortality; vehicle or power line collision; the introduction of new perches for raptors and thus a potential change in predation rates; direct loss or degradation of habitats; water handling facilities; indirect disturbance resulting from human activity; habitat fragmentation; and changes in population levels. Table 2–2 presents the overall projected acres of short-term and long-term disturbance for the Clear Creek and Upper Tongue River sub-watersheds under Alternative 1.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to sharp-tailed grouse than any of the other alternatives. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Alternative 3 — Modified Lease Terms

Overall, short-term and long-term disturbance for the Clear Creek and Upper Tongue River sub-watersheds would not differ between Alternative 3 and Alternative 1 (Table 2–2). In addition, no known plains sharp-tailed grouse leks or protective buffers are located in the affected proposed ACECs. The stipulation for NSO within 500 feet of surface water and riparian areas may reduce impacts to grouse habitats on the 285 leases.

Alternative 4 — No Surface Disposal of Produced Water

Implementation of this alternative would result in effects to the plains sharp-tailed grouse that substantially less than those described for Alternative 1. Overall, the lease terms of Alternative 4 would result in a reduction of short-term and long-term disturbance across all sub-watersheds (Table 2–2). In addition, the effects of the surface disposal of water on the plains sharp-tailed grouse would not occur under Alternative 4. These effects, such as the increase of wetland and ri-

parian habitats and sources of drinking water, are described in the PRB O&G Final EIS.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to sharp-tailed grouse that occur or potentially occur on the 285 leases. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Effects

Implementation of each of the alternatives would contribute to cumulative effects to sharp-tailed grouse. The impacts are described for each of the sub-watersheds of the analysis area in the PRB O&G Final EIS (U.S. Bureau of Land Management 2003:Table 4–52). However, the cumulative effects would be greatly reduced under Alternatives 4 and 5 relative to the other three alternatives.

Waterfowl

Alternative 1 — No Action

The type and relative magnitude of effects to waterfowl under Alternative 1 would be consistent with the effects described under Alternative 2A in the PRB O&G Final EIS. However, the 285 leases represent a minor proportion of the development discussed in the EIS. Potential effects include: direct disturbance or mortality; exposure to produced water; collision with vehicles or power lines; increased raptor predation; loss or degradation of habitats; water handling facilities; harassment, displacement, and noise; and habitat fragmentation. However, effects to waterfowl are expected to be minimal because water habitat is limited within the leases of concern.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to waterfowl than any of the other alternatives. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Alternative 3 — Modified Lease Terms

Effects to waterfowl under Alternative 3 may be slightly reduced. The lease stipulation modification for no leasing in the proposed ACECs would apply to a negligible amount of water habitat, but the stipulation for NSO within 500 feet of surface water and riparian areas may reduce impacts to waterfowl habitats and provide secure nesting areas.

Alternative 4 — No Surface Disposal of Produced Water

Implementation of this alternative would result in effects to waterfowl that are substantially less than those described for Alternative 1. The PRB O&G Final EIS presents a discussion of the potential direct and indirect, and positive and negative, effects to waterfowl from various methods of water handling and expo-

sure to CBNG production water. The potential for these effects would be eliminated under Alternative 4 because surface disposal would not be allowed. The elimination of surface disposal reservoirs would decrease the amount of potential habitats available for waterfowl, relative to Alternatives 1, 2, and 3.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to species of waterfowl that occur or potentially occur on the 285 leases. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Effects

Implementation of each of the alternatives would contribute to cumulative effects to waterfowl on the 285 leases. The PRB O&G Final EIS describes how various water handling methods can negatively and positively affect waterfowl in the sub-watersheds of the analysis area. However, the cumulative effects would be greatly reduced under Alternatives 4 and 5 relative to the other three alternatives.

Migratory Birds

Alternative 1 — No Action

The type and relative magnitude of effects to migratory birds under Alternative 1 would be consistent with the effects described under Alternative 2A in the PRB O&G Final EIS. These effects would only be seen on the 285 leases. Potential effects include: direct mortality; collisions with vehicles or power lines; loss or degradation of habitats; harassment and displacement; noise; habitat fragmentation; and population effects. Table 2–2 presents the projected acres of short-term and long-term disturbance by sub-watershed for Alternative 1.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in greater adverse effects to migratory birds than any of the other alternatives. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Alternative 3 — Modified Lease Terms

Overall, the projected acres of short-term and long-term disturbance are slightly less under Alternative 3. Effects to migratory birds would be slightly reduced under Alternative 3. Under this alternative, some suitable habitats may be preserved by modifying the lease stipulations to include no leasing in proposed A-CECs. The stipulation for NSO within 500 feet of surface water and riparian areas may reduce impacts in some instances. The TLS for sage-grouse also would be beneficial for migratory birds by providing disturbance-free nesting and foraging habitats during the breeding season.

Alternative 4 — No Surface Disposal of Produced Water

Implementation of this alternative would result in effects to migratory birds that are substantially less than those described for Alternative 1. Overall, the lease terms of Alternative 4 would result in a substantial decrease in short-term disturbance and long-term disturbance (Table 2–2). In addition, the increase in riparian habitats from water handling facilities, and the associated effects on migratory birds, would be eliminated under Alternative 4. These effects are described in the PRB O&G Final EIS.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to species of migratory birds that occur or potentially occur on the 285 leases. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Effects

Implementation of each of the alternatives would contribute to cumulative effects to migratory birds. Migratory birds would continue to be affected by vehicle collisions, power line collision, loss or degradation of habitat, harassment and displacement, noise, and habitat fragmentation related to conventional oil and gas development, previous CBNG development, and current development elsewhere in the PRB. Evaluating the extent of cumulative effects is difficult because of the general lack of data on migratory birds in the analysis area and the range of effects that would occur in varying degrees to various species. Table 4–54 in the PRB O&G Final EIS presents information on population trends of species of migratory birds in the analysis area. The cumulative effects would be greatly reduced under Alternatives 4 and 5 relative to the other three alternatives.

Aquatic Species

Potential direct and indirect effects to aquatic species in the analysis area include: (1) changes in timing and quantity of stream flows; (2) changes in sedimentation; (3) changes in concentrations of salts in streams; (4) changes in concentrations of metals; (5) changes in water temperatures; (6) accidental spills of fuels or drilling fluids; (7) changes in species diversity; and (8) trans-boundary effects on water quality. Please refer to the PRB O&G Final EIS for more information about each of these types of effects, and how and when these effects may occur.

It is assumed that wells that discharge produced water on the surface and wells that discharge water to infiltration ponds may have potential effects on aquatic species. Water produced from wells and managed using other methods of water handling (containment, LAD, and injection) would not have effects on surface waters because none of the discharged water under these methods would reach drainages in the sub-watersheds.

Alternative 1 — No Action

The type and relative magnitude of effects to aquatic species under Alternative 1 would be consistent with the effects described under Alternative 2A in the PRB O&G Final EIS. Approximately 31 percent of the proposed wells would dis-

charge produced water on the surface and 55 percent would discharge produced water to infiltration reservoirs. However, effects to aquatic species are expected to be minimal because water habitat is limited within the 285 leases.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to aquatic life than any of the other alternatives. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Alternative 3 — Modified Lease Terms

Effects to aquatic species may be slightly reduced under Alternative 3. The lease stipulation modification for no leasing in proposed ACECs would apply to a negligible amount of water habitat, but the stipulation for NSO within 500 feet of surface water and riparian areas may reduce impacts, including erosion and sedimentation.

Alternative 4 — No Surface Disposal of Produced Water

The only acceptable method of water disposal under Alternative 4 would be injection; therefore, the effects associated with the discharge of produced water on the surface and to infiltration ponds would be eliminated under Alternative 4. These effects (both negative and positive) to aquatic species are described in the PRB O&G Final EIS.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to aquatic species that occur or potentially occur on the 285 leases. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Effects

The proposed alternatives, combined with the potential for future CBNG projects within the PRB that are not addressed in this document, would lead to cumulative effects to aquatic species. These effects are described in the PRB O&G Final EIS and include: fluctuations in stream flow; fluctuations in sedimentation; increases in concentrations of salt; increases in contaminants in waterways; and changes in water quality, habitats, and species diversity. Although each alternative would contribute to cumulative effects in varying degrees, the cumulative effects would be greatly reduced under Alternatives 4 and 5 relative to the other three alternatives.

Threatened, Endangered, and Sensitive Species

Potential effects to threatened, endangered, and sensitive (special-status) species would be similar to those described for vegetation and wildlife in the preceding sections and in the PRB O&G Final EIS. However, the 285 leases represent a minor proportion of the development discussed in the EIS. Direct effects to spe-

cial-status plant species would occur from disturbance or removal of individuals or populations from construction of well pads, compressor stations, ancillary facilities, associated pipelines, water-handling facilities, and roads. Indirect effects to special-status plant species would include an increase in the potential for introduction and spread of noxious weeds that may displace native plants, and alteration or destruction of suitable habitats caused by changes in water quality and quantity.

Effects to special-status wildlife species would include: (1) direct injury or mortality, including poaching, poisoning or trapping; (2) indirect injury or mortality, including effects from water disposal, electrocution by or collisions with aboveground utility lines and poles, and collisions with vehicles; (3) harassment or displacement of individuals during the various phases of development; and (4) direct disturbance, destruction, or fragmentation of habitats as the result of development and production activities, including water disposal, that may change the availability and effectiveness of the habitat. Activities contributing to cumulative effects in the sub-watersheds in the analysis area include: oil and gas extraction; coal mining; uranium mining; sand, gravel, and scoria mining; ranching; agriculture; road and railroad construction; and rural and urban housing development. More detail regarding the potential direct and indirect impacts of the development of CBNG on each special-status species is included in Chapter 4 of the PRB O&G Final EIS, including Table 4–57, Appendix J (Biological Assessment), and Appendix K (Biological Opinion). More detail regarding the cumulative effects within the sub-watersheds of the analysis area is provided in Chapter 4 of the PRB O&G Final EIS. Because the greater sage-grouse was identified to be of particular concern during the scoping process, the potential impacts of the alternatives are discussed in more detail for this species.

Alternatives 1, 2, and 3 may adversely affect individuals of all species of birds listed, but are not likely to result in a loss of viability on federal lands or range wide, or result in a trend toward federal listing. The exceptions include the bald eagle (*Haliaeetus leucocephalus*), which is likely to be adversely affected. The boundaries of one lease falls within ½ mile of two bald eagle nests and the boundaries of two leases fall within 1 mile of identified roosts. Consequently, development of these alternatives would affect these resources. Alternatives 1, 2, and 3 may adversely affect individuals, may result in a loss of viability on federal lands or range wide, or result in a trend toward federal listing of the long-billed curlew (*Numenius americanus*). There would be no effect to the fox sparrow (*Passerella iliaca*) or the pygmy nuthatch (*Sitta pygmaea*). Alternatives 1, 2, and 3 are likely to adversely affect, but not likely to jeopardize continued existence of the mountain plover (*Charadrius montanus*) or its habitat.

Alternatives 1, 2, and 3 may adversely affect individuals of all species of mammals, amphibians, fishes and reptiles listed, but are not likely to result in a loss of viability on federal lands or range wide, or result in a trend toward federal listing. The exception is the black-footed ferret (*Mustela nigripes*), which the alternatives may affect, but are not likely to adversely affect. The Yellowstone cutthroat trout (*Oncorhynchus clarkibouvieri*) would not be affected.

Alternatives 1, 2 and 3 would not affect any listed plants, excluding the Ute ladies'-tresses orchid (*Spiranthes diluvialis*), which is likely to be adversely affected.

Alternative 4 may adversely affect individuals of all species of birds, mammals, amphibians and reptiles listed, but is not likely to result in a loss of viability on federal lands or range wide, or result in a trend toward federal listing. Effects would be reduced due to the lack of surface disposal of water. The exceptions include the burrowing owl (*Athene cunicularia*), the ferruginous hawk (*Buteo regalis*) and the upland sandpiper (*Bartramia longicauda*), for which this alternative may result in a loss of viability on federal lands or range wide, or result in a trend toward federal listing. Alternative 4 is also likely to adversely affect, but not likely to jeopardize continued existence of the mountain plover or its habitat. Alternative 4 would not affect the snowy egret (*Egretta thula*), the peregrine falcon (*Falco peregrinus anatum*), and the greater sandhill crane (*Grus canadensis tabida*). The black-footed ferret may be affected by Alternative 4, but is not likely to be adversely affected.

Alternative 4 would not affect any listed plants or fishes, excluding the Ute ladies'-tresses orchid, which is likely to be adversely affected.

Implementation of Alternative 5 would result in no additional CBNG-related effects to species of threatened, endangered, or sensitive species. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Greater Sage-grouse

Alternative 1 — No Action

The type and relative magnitude of effects to the greater sage-grouse under Alternative 1 would be consistent with the effects described under Alternative 2A in the PRB O&G Final EIS. Effects, both positive and negative, would be limited to the 285 leases. Potential effects include: (1) increased direct mortality (including legal hunting, poaching, and collision with power lines and vehicles); (2) the introduction of new perches for raptors and thus a potential change in rate of predation; (3) direct loss or degradation of habitats; (4) indirect disturbance resulting from human activity (including harassment, displacement, and noise); (5) habitat fragmentation (particularly through construction of roads); and (6) changes in population. Each of these effects is discussed in detail in the PRB O&G Final EIS.

Table 4–17 presents the expected short-term and long-term impacts within sage-grouse leks and protective buffers under Alternative 1. Mitigation under Alternative 1 includes CSU within the 0.25-mile buffer and TLS within the 2-mile buffer. For each of these buffers, the table presents the acreages of leases that overlap with the sage-grouse buffer and could be disturbed by CBNG development in the future. Therefore, the short-term and long-term acreages are the expected amount of sage-grouse habitat to which the CSU and TLS stipulations would be applied under Alternative 1. Short-term disturbance for the 0.25-mile

Table 4–17 Expected Impacts within Sage-grouse Leks and Protective Buffers by Sub-watershed, Alternatives 1 and 2

	Expected Impacts (acres)					
	0.25-mile buffer		2-mile buffer			
Sub-watershed	Long-term (acres)	Portion of Total Area Extent in Leases (percent)	Short-term (acres)	Portion of Total Area Extent in Leases (percent)	Long-term (acres)	Portion of Total Area Extent in Leases (percent)
Antelope Creek	0		249	34	92	13
Clear Creek	7	5	262	8	124	4
Crazy Woman Creek	39	4	1,560	10	623	4
Little Powder River	0		188	14	78	6
Middle Powder River	0		0		0	
Salt Creek	0		0		0	
Upper Belle Fourche River	7	3	263	7	114	3
Upper Cheyenne River	0		94	8	42	4
Upper Powder River	5	4	265	8	110	3
Upper Tongue River	0	6	652	12	312	6
Total	58	4	3,506	10	1,495	4

buffer is not included because no additional construction is expected to occur within this buffer.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to sage-grouse than any of the other alternatives. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Although implementation of this alternative would not change the amount of disturbance that would occur within the buffers shown on Table 4–17, it could result in substantially higher effects to sage-grouse. This alternative would remove the CSU stipulation and TLS that protect breeding habitats for the sage-grouse. Without these stipulations, operators may be able to construct in or around leks and nesting areas during the breeding season. Disturbance in these areas during the breeding season could result in the grouse abandoning breeding areas, including leks by males and nesting areas by females.

Alternative 3 — Modified Lease Terms

Table 4–18 presents the expected short-term and long-term impacts within sage-grouse leks and protective buffers under Alternative 3. Under this alternative, an NSO would be applied to the area within 0.25 mile of each lek and a TLS would be applied to the area within 3 miles of leks on BLM land and 2 miles on FS land. For each of these buffers, the table presents the acreages of leases that overlap with the sage-grouse buffer and could be disturbed by CBNG development in the future. Therefore, the short-term and long-term acreages are the potential

Table 4–18 Expected Impacts within Sage-grouse Leks and Protective Buffers by Sub-watershed, Alternative 3

	Expected Impacts (acres)					
	0.25-mile buffer		3-mile buffer			
Sub-watershed	Long-term (acres)	Portion of Total Area Extent in Leases (percent)	Short-term (acres)	Portion of Total Area Extent in Leases (percent)	Long-term (acres)	Portion of Total Area Extent in Leases (percent)
Antelope Creek	0		285	34	105	12
Clear Creek	7	5	639	9	360	5
Crazy Woman Creek	39	4	1,834	9	851	4
Little Powder River	0		406	13	164	5
Middle Powder River	0		0		0	
Salt Creek	0		0		0	
Upper Belle Fourche River	7	3	344	7	150	3
Upper Cheyenne River	0		125	8	54	3
Upper Powder River	5	4	560	8	281	4
Upper Tongue River	0	6	1,331	11	696	6
Total	58	4	5,524	10	2,662	5

amount of sage-grouse habitats that could be disturbed outside the breeding season but to which the TLS would be applied. Short-term disturbance for the 0.25-mile buffer is not included because no additional construction is expected to occur within this buffer. Comparing Table 4–17 and Table 4–18, the areal extent of sage-grouse habitats protected by the TLS and potentially subject to disturbance would be slightly greater under Alternative 3.

Alternative 4 — No Surface Disposal of Produced Water

Effects to the greater sage-grouse under Alternative 4 would be substantially less than those under Alternative 1 because it would ultimately include the same specific protective measures and would involve the construction of substantially fewer wells and facilities. Additionally, the effects associated with the surface disposal of CBNG water would be eliminated under Alternative 4. These effects are described in the PRB O&G Final EIS. Potential positive effects include the expansion of brood rearing and summering habitats, and additional sources of drinking water. Potential negative effects to sage-grouse include the loss of sagebrush shrublands habitats, and habitat fragmentation.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to sage-grouse. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Effects

The proposed alternatives, combined with the potential for future CBNG projects within the PRB that are not addressed in this document, may lead to potential cumulative effects. These effects are described in the PRB O&G Final EIS and include: increased mortality, especially from collisions, with vehicles and power lines and increased raptor predation; displacement and harassment; physical degradation of destruction of breeding grounds and reproductive areas; and habitat fragmentation. Table 4–58 in that document indicates the level of cumulative impacts to sage-grouse habitats within the sub-watersheds of the analysis area.

Cultural Resources

The cultural resources management objective of the BLM Buffalo Field Office, including stewardship considerations in addition to Section 106 and NEPA compliance is to "Protect, preserve, interpret, and manage significant cultural resources for their informational, educational, scientific, and recreational values".

These objectives are achieved through:

1. Inventory;
2. Evaluation;
3. Native American Consultation;
4. Management Options; and
5. Monitoring

Inventory is the process of gathering together information on the cultural resources that are present in the area of a proposed undertaking. Levels of inventory include an overview that reviews documentation of previously known resources and intensive pedestrian survey that inspects the area of potential effect (APE) for all evidence of previously known and undocumented cultural resources. BLM would require site-specific pedestrian inventories for cultural resources before approving any federal action involving federal surface, federal minerals, federal funding, or federal permits. Cultural resource surveys are conducted for all surface-disturbing activities, including (not limited to) individual wells, pipelines, roads, and water impoundments as part of the APD process. Block surveys at the well field or POD level would be advantageous for planning, management, and development and eliminate the need for many follow-up or in-fill surveys. Cultural resource inventories must conform with the *Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation* (48 *Federal Register* 44716), current Wyoming standards and guidelines, including the BLM Handbook H–8111–1 Cultural Resources Wyoming Handbook, and guidance for completion of the Wyoming Cultural Properties Form.

Evaluation is the process of assessing the importance of a cultural resource site. All cultural resource sites and many Native American traditional places are evaluated in accordance with the National Register Criteria (36 CFR 60.4 (a-d)) and within a defined historic context. The National Register Criteria assess whether a site is eligible for listing on the National Register of Historic Places at the national, state, or local level. A site that is listed on or is eligible for the Na-

tional Register of Historic Places is considered a historic property. Typically, the majority of cultural resource sites are evaluated as not eligible. Cultural resources are evaluated as completely as possible during initial documentation. If a site cannot be conclusively evaluated from surface evidence and limited testing, the additional information or specialized analysis necessary to complete the evaluation are identified and a recommendation is made for the most prudent and expedient procedure to complete the evaluation. Additional studies might include archival or other documentary research, evaluation of the resource by a specialist, analysis of specialized samples, subsurface test excavations, or other forms of well-defined research that are beyond the scope of surface survey. BLM would require all cultural resource sites within each alternative's APE be evaluated for their eligibility for inclusion in the National Register of Historic Places.

BLM would contact tribes that may have legitimate concerns within or related to proposed undertakings and convey the major findings of cultural resource inventories. The tribes may raise concerns about the treatment of cultural resources, natural resources, or natural landscape features that have traditional religious or cultural value. These groups also have concerns about handling inadvertent discoveries of human remains. (The plan for handling human remains in the PRB is provided in U.S. Bureau of Land Management 2003:Appendix L.) Consultation is the government-to-government identification of concerns and discussion of their resolution.

Management options are standard treatments of historic properties, Native American concerns, or inadvertent discoveries. The preferred option for the treatment of historic properties would be avoidance and protection. In most cases, the historic property can be avoided and protected by minor adjustments or stipulations to the proposed undertaking, especially if an adequate area has been surveyed for cultural resources. If a historic property could not feasibly be avoided, data recovery or other mitigation measures would be proposed. The nature and level of mitigation would depend on the nature and extent of the adverse effect to the historic property. Mitigation must be approved by the BLM or FS, in consultation with the SHPO and, if applicable, the surface owner. Any data recovery plan must discuss the property in terms of the historic context and identify the research questions that would be addressed by the anticipated data classes.

For specific actions, monitoring would be conducted to: (1) verify that actions have complied with constraints and stipulations; (2) verify that the constraints and stipulations have achieved the intended objectives; and (3) evaluate whither management plans and objectives have achieved their goals. Monitoring activities would include inspecting construction for compliance, inspecting for potential discovery situations during construction, and monitoring of ongoing operations.

Additional information on these objectives and their implementation in the BFO is presented in the PRB O&G Final EIS.

Alternative 1 — No Action

The total square miles of potential impact is 22.8. Assuming that site density is uniform throughout each sub-watershed, the number of sites per square mile from

Table 3–61 in the PRB O&G Final EIS was used as a multiplier to estimate the number of sites in the area of potential effect given the square miles of new disturbance. The number of cultural resource sites identified will be greater because an area larger than the proposed surface disturbance is surveyed. The potential number of sites affected by watershed varies from a high of 142 to a low of one (Table 4–19). All areas of ground disturbance associated with federal actions will be surveyed for cultural resources during the APD process. Until those surveys are completed, only rough estimates can be made of the actual number of eligible cultural resource sites that would be affected by the proposed oil and gas development and the nature of the effects.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to cultural resources than any of the other alternatives. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Table 4–19 Estimated Square Miles of Total CBNG Surface Disturbance and Potentially Affected Cultural Resource Sites by Sub-watershed and Alternative

	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
Sub-watershed	Square miles	Sites	Square Miles	Sites	Square Miles	Sites	Square miles	Sites
Antelope Creek	0.8	4	0.8	4	0.8	4	0.7	4
Clear Creek	3.1	142	3.1	142	3.1	142	0.3	14
Crazy Woman Creek	4.0	86	4.0	86	4.0	86	0.0	0
Little Powder River	2.6	12	2.6	12	2.6	12	0.6	3
Middle Powder River	1.0	5	1.0	5	1.0	5	0.2	1
Salt Creek	1.1	9	1.1	9	1.1	9	0.0	0
Upper Belle Fourche River	0.7	3	0.7	3	0.7	3	0.1	1
Upper Cheyenne River	0.2	1	0.2	1	0.2	1	0.0	0
Upper Powder River	2.4	12	2.4	12	2.2	11	0.7	4
Upper Tongue River	5.1	68	5.1	68	5.1	68	0.3	4
Total	21	342	21	342	20.8	341	2.9	31

Source: U.S. Bureau of Land Management 2003

Alternative 3 — Modified Lease Terms

Implementation of this alternative would result in a potential number of sites affected that is slightly less than what would occur under alternatives 1 or 2 (Table 4–19). The primary difference between this alternative and alternatives 1 and 2 is

the slightly less amount of disturbance that would occur the Upper Powder River sub-watershed.

Alternative 4 — No Surface Discharge of Produced Water

Implementation of this alternative would result in a potential number of sites affected that is substantially less than what would occur under the three previous alternatives (Table 4–19). The primary difference between this alternative and the other three alternatives is the fewer wells and no facilities for the surface disposal of water produced by CBNG wells.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to cultural resources. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Management Options

Because of the requirements for compliance with federal regulations including, but not limited to Section 106 of the National Historic Preservation Act, NEPA, and the Archeological Resources Protection Act, all areas on federal lands or that involve federal minerals proposed for disturbance would be inventoried for cultural resources. Equivalent regulatory mandates are not in place for private or State of Wyoming lands (with private or state minerals). However, if a project involves a federal permit or authorization, federal historic preservation requirements would apply.

It is evident that all of the alternatives have the potential to affect historic properties. As development progresses the opportunities for avoiding direct or indirect effects to historic properties will diminish (for example, at least a portion of 9 of the 285 leases fall within the 1/4-mile buffer of the Bozeman Trail). As more wells are developed it would become increasingly difficult to avoid visual and auditory impacts to cultural landscapes. Because of long-term planning and management considerations, cultural resource inventories should target entire PODs rather than piecemeal actions.

The following types of management situations may be encountered:

1. The resource is not a historic property, and no further work is required. The majority of cultural resources are not historic properties;
2. The historic property is within an area of proposed disturbance, but the proposed action can be altered within areas of existing inventory to avoid direct adverse effects and protect the property from indirect adverse effects;
3. The historic property is within an area of proposed disturbance but the proposed action can be altered, relocated, or constrained within areas of existing

inventory so that only non-contributing portions of the historic property are affected and contributing portions can be protected from adverse impact;

4. The historic property is not immediately within the area of proposed impact, but its location and setting are intrinsic to its eligibility, and the proposed action can be altered, relocated, or constrained in such a way that its intrusion on the viewshed and adverse effect contributing to aspects of the setting can be minimized;
5. The historic property is within an area of proposed impact but is a small property eligible under Criteria c or d and the property itself, its significant attributes, or its important data are not intrinsically tied to their location or setting and can be moved, collected, documented, or studied at minimal cost;
6. The historic property and feasible design of the proposed action are such that avoidance and protection of the property is not a viable alternative. In such a case, the cultural resource professional would propose a prudent and feasible recordation or data recovery plan to submit to BLM for review; or
7. The historic property was not identified or predicted by the cultural resource inventory and was encountered during development or operation of the facilities.

Monitoring would assess the effectiveness of management strategies in achieving management objectives. If management activities are not achieving these objectives, the strategies would be modified to improve their effectiveness.

Land Use and Transportation

Land Use

Rangeland is the primary land use that would be affected by development of CBNG on the 285 leases. Direct effects to land uses would occur from construction and operation of the proposed facilities for any of the alternatives. Short-term effects are defined as occurring during the construction and drilling/completion phases. Long-term effects are caused by construction and operations that would remain longer. The acres of short- and long-term disturbance for each of the alternatives are estimated based on the proposed number of wells and other facilities within each watershed. Facility-specific disturbances were estimated using data collected from existing oil and gas development in the analysis area. Indirect effects to land uses are reasonable foreseeable results of related activities that occur later or are removed in distance from the primary action.

Alternative 1 — No Action

The effects to land uses from the development of CBNG wells and ancillary facilities would be the same as described for the proposed action in the PRB O&G Final EIS, but would be limited to land within each lease area. Implementation of Alternative 1 would cause short-term disturbance of as many as 13,528 acres. After pipelines have been reclaimed and well pads and compressor stations reclaimed in part, long-term disturbance associated with the new CBNG wells would encompass about 6,516 acres. The roads and water handling facilities would represent most of the long-term disturbance.

Most of the short-term and long-term disturbance would involve rangelands. About 91 percent (12,244 acres) of area disturbed by the initial construction of facilities (short-term disturbance) would involve rangeland. In addition, 91 percent of the long-term disturbance (5,935 acres) would involve rangeland. Almost 7 percent of the short- and long-term disturbance would occur in the forested land use type. The remaining 2 percent of short-term and long-term disturbance would be distributed among the other land use types.

The anticipated effects to the recreational land uses and visual resource areas, such as WSAs and other SMAs on BLM lands, are analyzed in Recreational Resources, and Visual Resources. NSO for mineral development has been stipulated for the Fortification Creek WSA and most of the other SMAs. No direct land use effects would occur in the Fortification Creek WSA, Cantonment Reno, or Weston Hills Recreation Areas because no facilities are proposed in these areas. Indirect effects to these areas may include some visible facilities, noise, and increased access and human activity associated with CBNG development.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to land use than any of the other alternatives. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Alternative 3 — Modified Lease Terms

As shown on Table 2–1, fewer wells would be developed with this alternative and the areal extent of short- and long-term disturbance would be less. Consequently, the effects of the disturbance on land use types would be less than under alternatives 1 and 2. However, the overall pattern of effects to land use would be similar to that which would occur under alternatives 1 and 2.

Although the overall level of disturbance would be less, the pattern of disturbance would be similar to alternatives 1 and 2. Most of the short-term and long-term disturbance would involve rangelands. Almost 90 percent (12,107 acres) of the area disturbed by the initial construction of facilities (short-term disturbance) and 91 percent of the long-term disturbance (6,430 acres) would involve rangeland. About 7 percent of the short- and long-term disturbance would occur in the forested land use type. The remaining 2 percent of short-term and long-term disturbance would be distributed among the other land use types.

Alternative 4 — No Surface Disposal of Produced Water

There would be limited development of CBNG and no surface disposal of produced water from CBNG facilities developed on the 285 leases under this alternative. Surface water disposal methods such as containment reservoirs result in a long-term removal of land from existing land uses, as described for the preferred alternative in the PRB O&G Final EIS. However, additional facilities would be

constructed for the injection wells needed to dispose of the water produced from the CBNG wells.

As with alternatives 1, 2, and 3, most of the short-term and long-term disturbance would involve rangelands. About 85 percent (1,669 acres) of the area that would be disturbed by the initial construction of facilities (short-term disturbance) and 85 percent of the long-term disturbance (627 acres) would involve rangeland. Almost 8 percent of the short- and long-term disturbance would occur in the forested land use type. The remaining 7 percent of short-term and long-term disturbance would be distributed among the other land use types.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to land use. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Consistency with Land Use Plans

Implementation of alternatives 1, 2, 3, 4, or 5 would be consistent with land use plans of the State of Wyoming, the planning goals of the three affected counties, and planning goals of numerous incorporated areas within the analysis area. The results of the analysis of federal land use plans are presented in Chapter 5 of the PRB O&G Final EIS.

Cumulative Land Use Effects

The wells that would be drilled under the alternatives considered in this document are part of the preferred alternative approved in the ROD for the PRB O&G Final EIS. Consequently, the cumulative effects to land use would be the same as the cumulative effects described in the PRB O&G Final EIS.

Transportation

For alternatives 2 through 4, the potential direct and indirect effects to transportation resources are the same as those described for the proposed action.

Increases in average daily traffic counts would occur on the primary access roads into the analysis area, predominantly I–25, I–90, U.S. Highways 14 and 16, State Highways 59 and 387, and the county roads. CBNG development within the 285 lease areas would require some portion of the total number of employees commuting on analysis area highways, as well as other traffic generated by CBNG development that was evaluated for the preferred alternative in the PRB O&G Final EIS.

Alternative 1 — No Action

For the No Action Alternative, the direct effects to transportation resources would involve primary access roads as described in the PRB O&G Final EIS. These effects include an increase in vehicular traffic on existing roadways in the analysis area from daily travel of employees. The risk of traffic accidents would

increase on roads used to access the analysis area in proportion to the additional traffic.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative would result in adverse effects to transportation similar to Alternative 1. This potential exists because although only SLT and Lease Notice No. 1 would be applied, they would not affect transportation. Also, none of the other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, would affect transportation.

Alternative 3 — Modified Lease Terms

Because fewer new wells would be drilled and fewer pads, roads, and pipelines would be constructed under Alternative 3, the number of average workers per day would be less than required for Alternatives 1 and 2. The effects to transportation would be proportionately smaller from the implementation of Alternative 3.

Alternative 4 — No Surface Disposal of Produced Water

Under implementation of Alternative 4, the effects to transportation resources would be substantially less than those described for Alternatives 1, 2, and 3 and would include a relatively small amount of increased vehicular traffic and a proportionate risk of traffic accidents on existing roadways in the analysis area from daily travel of employees.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to transportation. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Transportation Effects

Cumulative effects to transportation would occur from CBNG development in the analysis area as described for the preferred alternative and in the PRB O&G Final EIS. Direct effects to the primary access routes within the analysis area, including state, BLM, FS, and county roads, would occur as a result of vehicular traffic associated with implementation of any of the alternatives. The additional traffic is expected to increase the rate of degradation of the existing public roadways in the analysis area, primarily in the Upper Powder River and Upper Belle Fourche River sub-watersheds.

Cumulative transportation-related effects development of CBNG resources in the analysis area are summarized as follows:

- In the short term, the average daily traffic would increase by approximately 7,627 additional vehicle trips (based on an estimated 5,620 work-

ers per day) during the peak activity year (2007), distributed over the various roads within the entire analysis area.

- Long-term increases in traffic would vary proportionately with the number of employees and activities required for each year of the development.
- Based on the distribution of well locations by watershed, 63 percent of the additional daily traffic would occur within the Upper Powder River and Upper Belle Fourche River sub-watersheds. Traffic would be dispersed throughout these two sub-watersheds and would result in a relatively large increase in traffic on state and local roads during the life of the development. The increased volume primarily would affect State Highways 59 and 387.
- Most of the remainder of the additional daily traffic would occur in the Clear Creek, Crazy Woman Creek, Upper Tongue River, Antelope Creek, and Little Powder River sub-watersheds as a result of the relatively high numbers of proposed wells and facilities
- The estimated increases to average daily traffic are more than a 25 percent increase compared with the existing average daily traffic counts for some of the roads in analysis area.
- The estimated increase in risk of traffic accidents from additional vehicles would be approximately the same percent increase as for the average daily traffic counts compared with the existing daily traffic counts for the roads in the analysis area.
- Indirect effects would include, but are not limited to, minor traffic delays from short-term closures at some road crossings, increased wear and tear on existing roads, additional air emissions, fugitive dust from roads, noise, increased potential access to remote areas, an increased risk of vehicle collisions with livestock and wildlife, and visual intrusion of additional vehicles and activities.

The cumulative impacts to transportation resources also include the potential for overlapping restrictions and federal stipulations to affect the ability of the operators to obtain access to leases on private or state lands. Access for entry to state or private lands that are surrounded by federal lands is not likely to be limited by federal mitigation requirements for CBNG development in the analysis area.

Visual Resources

Development of CBNG in the 285 lease areas would alter the physical setting and visual quality of the landscape and would affect the landscape as experienced from sensitive viewpoints, including travel routes and popular use areas. The proposed facilities would introduce new elements into the landscape and would alter the existing form, line, color, and texture, which characterize the existing landscape. The direct (short- and long-term) and indirect effects to the analysis area landscape are evaluated for the preferred alternative in the PRB O&G Final EIS.

Alternative 1 — No Action

Short-term effects during the construction period of CBNG facilities on the 285 leases would occur to the visual character of the landscape from well pad construction, well drilling, and associated construction of ancillary facilities, such as access roads, power lines, pipelines, and compressor stations.

Lands and federal minerals administered by the BLM are managed with VRM objectives. Although proposed CBNG wells on state, fee mineral on private lands, and Forest Service lands are not managed for BLM's VRM objectives, the inventory provides an assessment of the existing scenic quality and the ability of these lands to absorb effects to the landscape from development.

Table 4–20 summarizes the long-term disturbances for Alternative 1 by sub-watershed and VRM Class inventory. The areal extent of the disturbance shown on the table includes the existing long-term disturbance from facilities that already have been constructed on 30 of the 285 leases.

Table 4–20 Distribution of Long-term Pad Disturbances by Visual Resource Management Class and Sub-watershed, Alternatives 1 and 2

	Class II		Class III		Class IV		Class V		Total	
Sub-watershed	No. of Pads	Disturbance (acres)	No. of Pads	Disturbance (acres)	No. of Pads	Disturbance (acres)	No. of Pads	Disturbance (acres)	No. of Pads	Disturbance (acres)
Antelope Creek	0	0	0	0	20	198	0	0	20	198
Clear Creek	0	0	20	79	273	1,055	0	0	294	1,134
Crazy Woman Creek	0	0	35	116	321	1,063	0	0	356	1,179
Little Powder River	0	0	5	19	152	651	0	0	156	670
Middle Powder River	0	0	0	0	81	336	0	0	81	336
Salt Creek	0	0	1	10	22	253	0	0	23	263
Upper Belle Fourche River	13	32	0	0	61	145	7	16	81	192
Upper Cheyenne River	0	0	0	0	16	42	0	0	16	42
Upper Powder River	1	3	39	120	218	662	0	0	258	784
Upper Tongue River	0	0	1	5	372	1,712	0	0	373	1,716
Total	14	35	101	348	1,535	6,117	7	16	1,657	6,516

The short-term disturbance associated with implementation of this alternative could disturb as many as 13,528 acres or less than one percent of the PRB. Most of the disturbance would result from construction of pipelines and roads on federal, state, and private lands inventoried with VRM Class IV. Temporary disturbances would not conflict with VRM objectives because for each well pad and associated access road and power line, construction disturbances would occur over a period of less than 2 years, after which they would be reclaimed back to long-term disturbances associated with operations and maintenance. VRM objectives address modifications to the landscape from long-term facilities.

The largest effects would be to residential areas and isolated residences in the Upper Powder, Upper Belle Fourche, Clear Creek, Little Powder, Antelope, and Upper Tongue River sub-watersheds. Facilities would also be most visible to travelers on affected highways during the time when they are within the line of sight as they travel toward the facility.

The visual effects of surface discharges of produced water from CBNG wells is evaluated for the preferred alternative in the PRB O&G Final EIS. Most of the effects from water produced by facilities on the 285 leases would occur in areas inventoried with VRM Class IV. Construction and operation of each well and the ancillary facilities would be consistent with VRM Class IV objectives. Consequently, none of the disturbed acreage would be displaced from the existing BLM inventory of lands managed with VRM Class IV. The proposed facility developments would be consistent with management objectives.

There are 101 well pads proposed for lands inventoried with VRM Class III objectives. Class III lands in the analysis area are located primarily along major transportation routes and recreation areas. Class III objectives are to provide for management activities that may contrast with the basic landscape elements but remain subordinate to the existing landscape character. There is the potential that Class III objectives for some facilities would not be met because the facilities would not be subordinate to the existing landscape character. BLM objectives for some Class III facilities would be met if every attempt were made to minimize adverse visual effects through careful location of facilities, minimal disturbance of the site, and painting facilities so they harmonize with the colors of the surrounding landscape.

There are 14 well pads proposed for lands inventoried with VRM Class II objectives. The facilities would be within the Class II areas along I–90 east of Gillette. The Class II objectives would be met if mitigation measures were used to maintain the existing character of the landscape, and not attract the attention of the casual observer. Mitigation measures must repeat the basic elements of form, line, color, and texture found in the natural features of the landscape within the foreground distance zone to achieve this objective. Successful mitigation in the foreground distance zone would include locating facilities to use the terrain and vegetation to screen them from the highways. If the mitigation measures would not enable facilities to meet Class II objectives, one of the following two options must be implemented to comply with BLM management objectives: (1) the facilities would be relocated to a site outside of the VRM Class II area on BLM lands; or (2) the BLM RMP would be amended to change the affected VRM Class II areas to VRM Class III areas.

There are 7 well pads proposed for lands inventoried with VRM Class V. The proposed facilities on BLM lands would be consistent with BLM management objectives for VRM Class V areas, which provide for areas where the natural character has been drastically altered.

The BFO has developed a management decision to implement the management objective of maintaining or improving scenic values, visual quality, and establish visual resource management priorities in conjunction with other resource values. Visual resources are to be managed in accordance with objectives for VRM

classes that have been assigned to the planning area, which constitutes most of the analysis area. No activity or occupancy is allowed within 200 feet of the edge of state and federal highways. Facilities or structures such as power lines, oil wells, and storage tanks are required to be screened, painted, and designed to blend with the surrounding landscape except where safety indicates otherwise. Any facilities or structures proposed in or near WSAs would be designed so as not to impair suitability as wilderness.

BLM lands in the Fortification Creek WSA and the Fortification Creek SMA are inventoried with VRM Class III. An NSO for mineral development has been stipulated for the WSA. A CSU has been stipulated for the Fortification Creek SMA, which encompasses the WSA, to protect scenic values. Proposed facilities in the SMA must meet Class III objectives to protect scenic values. There is potential that Class III objectives would not be met because the facilities would not be subordinate to the existing landscape character. BLM objectives for some Class III facilities would be met if every attempt were made to minimize adverse visual effects through careful location of facilities, minimal disturbance of the site, and painting facilities so they harmonize with the colors of the surrounding landscape. No facilities are proposed for the WSA because of the NSO.

The federal lands on that portion of the TBNG that is within the analysis area are managed with the SIO of Low. Thus, all proposed wells and well pads projected for construction on TBNG lands would be managed with the Low SIO.

Alternative 2 – Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to visual resources than Alternative 1. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Alternative 3 – Modified Lease Terms

There would be no leasing of proposed ACECs under this alternative. Lease terms would be modified to add stipulations to protect various resources. As a result of additional stipulations, well sites would be shifted or developed according to a TLS, but the stipulations would not preclude maximum development of 80-acre spacing outside of the ACECs.

There are six proposed ACECs in the analysis area. Portions of four leases covering 1,575 acres would not be developed under Alternative 3. The Dry Creek Petrified Tree ACEC is located entirely within VRM Class 4 areas. The Fortification Creek ACEC is within a VRM Class 3 area. Alternative III would impact a smaller number of acres in VRM Class 3 and 4 areas than Alternatives 1 and 2, as shown on Table 4–21.

Table 4–21 Distribution of Long-term Pad Disturbances by Visual Resource Management Class and Sub-watershed, Alternative 3

	Class II		Class III		Class IV		Class V		Total	
Sub-watershed	No. of Pads	Disturbance (acres)	No. of Pads	Disturbance (acres)	No. of Pads	Disturbance (acres)	No. of Pads	Disturbance (acres)	No. of Pads	Disturbance (acres)
Antelope Creek	0	0	0	0	20	198	0	0	20	198
Clear Creek	0	0	20	79	271	1,055	0	0	291	1,134
Crazy Woman Creek	0	0	35	116	321	1,063	0	0	356	1,179
Little Powder River	0	0	5	19	152	651	0	0	156	670
Middle Powder River	0	0	0	0	81	336	0	0	81	336
Salt Creek	0	0	1	10	22	253	0	0	23	263
Upper Belle Fourche River	13	32	0	0	61	145	7	16	81	192
Upper Cheyenne River	0	0	0	0	16	42	0	0	16	42
Upper Powder River	1	3	39	107	215	589	0	0	255	698
Upper Tongue River	0	0	1	5	372	1,712	0	0	373	1,716
Total	14	34	101	335	1,529	6,045	7	16	1,651	6,430

Alternative 4 — No Surface Disposal of Produced Water

There would be no surface disposal of produced water from CBNG facilities developed on the 285 leases under this alternative. Surface water disposal methods such as containment reservoirs result in long-term effects to visual resources and management, as described for the preferred alternative in the PRB O&G Final EIS. These effects to the visual quality of the landscape within the lease areas would not occur under Alternative 4. Table 4–22 shows the short- and long-term disturbance acres by sub-watershed and VRM Class inventory for Alternative 4. The overall long-term disturbance acres would be less than those under Alternatives 1, 2, and 3.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to visual resources. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Effects

The cumulative well development scenario is represented by the 39,367 CBNG wells under the preferred alternative and 12,077 CBNG wells already drilled or permitted within the analysis area. The non-CBNG cumulative scenario includes 2,546 existing wells and 3,200 new wells.

Table 4–22 Distribution of Long-term Pad Disturbances by Visual Resource Management Class and Sub-watershed, Alternative 4

	Class II		Class III		Class IV		Class V		Total	
Sub-watershed	No. of Pads	Disturbance (acres)	No. of Pads	Disturbance (acres)	No. of Pads	Disturbance (acres)	No. of Pads	Disturbance (acres)	No. of Pads	Disturbance (acres)
Antelope Creek	0	0	0	0	26	170	0	0	26	170
Clear Creek	0	0	8	10	61	65	0	0	69	75
Crazy Woman Creek	0	0	0	0	0	0	0	0	0	0
Little Powder River	0	0	0	0	59	134	0	0	59	134
Middle Powder River	0	0	0	0	40	64	0	0	40	64
Salt Creek	0	0	0	0	0	0	0	0	0	0
Upper Belle Fourche River	3	6	1	0	21	29	1	1	26	36
Upper Cheyenne River	0	0	0	0	0	0	0	0	0	0
Upper Powder River	0	0	8	10	154	168	2	0	164	178
Upper Tongue River	0	0	0	0	44	79	0	0	45	79
Total	3	6	17	20	404	708	3	1	428	736

The cumulative effect on the landscape would consist of existing, permitted, and proposed CBNG development on federal, state, and private lands in the analysis area, and existing, proposed, and reasonably foreseeable coal mining in the analysis area. The cumulative effect of all existing and proposed development would result in a larger number of disturbed acres from well pads and access roads that may be visible from transportation routes and recreation areas. Ongoing CBNG development on federal, state, and private lands would increase the industrial character of those areas that include considerable modification from other oil and gas development and from coal mining, and change the visual character of the predominantly rural landscape in much of the analysis area to rural/industrial.

Recreational Resources

The potential effect of the construction and operation of the proposed facilities on recreational resources is related to the amount of recreational opportunity that is created by the alternatives versus the opportunity that is lost for recreational pursuits. None of the 285 leases would affect developed recreational facilities under any of the alternatives.

Alternative 1 — No Action

Under the No Action alternative, the primary effect of the CBNG development on recreational opportunities would be the alteration of the experience on federal and state lands used for hunting. Direct effects, including short- and long-term disturbances that would displace or otherwise affect dispersed recreational activities in the 285 leases would occur from the development of CBNG facilities in

the lease areas. Indirect effects to recreation would occur if the alternative resulted in a change in the level of visitation to the area or would alter growth in the affected counties, thereby changing the use of existing recreational facilities and uses. These effects are evaluated in the PRB O&G Final EIS.

In addition, reservoirs may provide recreational opportunities, such as fishing, increased waterfowl hunting, increased hunter success for big game and other species that may be attracted to the reservoirs. The increased access may lead to an increasing number of hunters. Outfitting and hunter numbers may decrease from CBNG, as those seeking a semi-primitive experience may not wish to hunt within a gas field.

Alternative 2 — Standard Lease Terms and Lease Notice

Implementation of this alternative could result in substantially greater adverse effects to recreational resources than any of the other alternatives. This potential exists because only SLT and Lease Notice No. 1 would be applied. No other protective measures, such as stipulations from the 1985 RMP and the mitigation measures and COAs identified in the PRB O&G Final EIS, are part of this alternative.

Alternative 3 — Modified Lease Terms

Under Alternative 3, there would be no CBNG development on federal leases within the proposed ACECs. The effects to dispersed recreation from direct short- and long-term disturbance would be less than were described for Alternative 1 because a smaller number of facilities would be developed and a smaller number of acres would be removed from existing uses.

Alternative 4 — No Surface Disposal of Produced Water

Under Alternative 4, the effects to dispersed recreation resources within lease areas would be substantially less than those described for Alternatives 1, 2, and 3. The actual disturbance from construction would involve 1965 long term and 736 short term acres. However, there would be no impoundments, which would reduce the opportunities for some wildlife-related recreational opportunities. Overall, there would be a smaller potential for adverse effects to recreational opportunities in the analysis area from Alternative 4 than would occur from Alternatives 1, 2, and 3.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to recreational resources. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, no additional effects would occur.

Cumulative Effects

Cumulative effects to recreational opportunities would occur from CBNG development in the analysis area as described for the preferred alternative in the PRB O&G Final EIS.

The cumulative acreage likely to be affected long-term by production facilities under the Proposed Action (approximately 91,650 acres) is not likely to have a cumulative effect on hunting and fishing opportunities.

Cumulative effects from the increased human presence associated with the cumulative energy development in the PRB are likely to cause increased levels of legal and illegal hunting. Conversely, the mines in the area have become refuges for big game animals during hunting seasons because most are closed to hunting.

Secondary effects related to energy development on recreational land uses have and would continue to result from the growth in the human population. The demand for outdoor recreational activities, including hunting and fishing, have increased proportionately. However, at the same time these demands are increasing, wildlife habitat and populations are being restricted by increased surface disturbance.

Demand for hunting licenses may increase to the point that a lower success in drawing specific licenses would occur; hunting and fishing may become less enjoyable as a result of the more limited success and overcrowding; poaching may increase; the increase in people and traffic has and may continue to result in shooting of nongame species and road kills; and increased off-road activities have and would continue to result in disturbance of wildlife during sensitive wintering or reproductive periods. Travel management during hunting season, including seasonal road closures to the public, could disperse hunters throughout the area, reduce hunting pressure in popular areas, and facilitate a more enjoyable experience for hunters.

Noise

The noise effects of the alternatives evaluated in this analysis would be the same as described for Alternative 2A in the PRB O&G Final EIS. Levels of construction noise would fall below 55 dBA at approximately 1,500 feet from construction. Any residences within 1,500 feet of construction would experience temporary noise levels above 55 dBA during daylight hours. Nighttime noise levels would remain at existing levels because construction would not occur at night. Noise from each construction site would be relatively short term, and the individual sites would be sufficiently widespread so that elevated noise levels from each site would not overlap in time or space with other sites.

Noise during the drilling phase would also be elevated above pre-existing levels. Typically, the noise from a drilling rig is 74 dBA at 200 feet from the rig. Noise emanating from drilling rigs would decrease to 60 dBA at 1,000 feet, to 57 dBA at 1,500 feet, and to 54 dBA at 2,000 feet. Any residences within 1,500 feet of a

drilling rig would experience noise above 55 dBA for the 1 to 4 days anticipated to drill the natural gas wells.

The highest operational noise would occur around compressor stations. As discussed in the PRB O&G Final EIS, noise from compressor engines would be noticed — in other words, would be audible — at distances ranging from 1,800 feet of the compressor station during the daytime and to 9,000 feet from the compressor station during the nighttime hours. Attenuation of the noise by the installation of barriers is how the operators are addressing the noise from compressor engines.

A noise barrier can achieve at least a 5 dBA noise level reduction when it is tall enough to just break the line of sight between the noise source and the receptor. An approximate 1.5 dBA reduction can generally be achieved with each 3.5 feet of height after it breaks the line of sight. For more details on noise barriers, please refer to the discussion in the PRB O&G Final EIS.

West Nile Virus

The PRB FEIS and ROD included a programmatic mitigation measure that states, "The BLM will consult with appropriate state agencies regarding WNV. If determined to be necessary, a condition of approval will be applied at the time of APD approval to treat mosquitoes for any CBNG discharge waters that become stagnant." This development is likely to result in standing surface water which may potentially increase mosquito breeding habitat. BLM has consulted with applicable state agencies, County Weed and Pest and the State Health Department, per above mitigation in the PRB ROD page 18, regarding the disease and the need to treat. BLM has also consulted with the researchers that are studying the dynamics of WNV species and its effects in Wyoming.

There is no evidence that treatment, either through the use of larvicides or malithion, on a site specific or basin-wide scale will have any effect on the overall spread of the disease. The State agencies have not instituted state-wide treatment for mosquitoes due to WNV, nor are they requiring any mitigation specific to permitting for CBNG operations.

Cumulatively, there are many sources of standing water, beyond CBNG discharge, throughout the PRB that would add to the potential for mosquito habitat. Sources include; natural flows, livestock watering facilities, coal mining operations, and outdoor water use and features in and around communities.

BLM will keep monitoring this issue by continuing to consult with the State agencies and the researchers working in the area in order to stay abreast of the most current developments and any need to apply mitigation. Based on current information, we determined that no significant impacts in the spread of WNV would occur from the implementation of the alternatives.

Socioeconomics

The workforce that is required for development under Alternatives 1, 2, 3, or 4 is included in the total workforce evaluated in the PRB O&G Final. The effects to population, employment, housing, community and government services, and environmental justice would therefore be similar to the effects described for the preferred alternative in the PRB O&G Final EIS, only proportionally less.

Direct effects to the economies of the State of Wyoming and Sheridan, Campbell and Johnson Counties are evaluated for each alternative below. Direct effects would result from revenues produced by producing wells, which would generate federal mineral royalties, sales and use taxes, and ad valorem taxes paid to each county. Severance taxes are paid on fee wells, which are not included in this analysis because all wells would develop federal minerals.

Other direct effects for each alternative would be the potential loss of revenue associated with recreational opportunities within the Project area. There is potential for the loss of hunting and outfitter revenues as a result of CBNG development. The BFO has identified concerns over the quality of hunting opportunities from outfitters and at least one outfitter has not renewed his permit.

All CBNG wells would be producing from federally owned oil and gas mineral estate. Federal royalties are estimated using 12.5 percent of the estimated sales value for each well. After administrative costs are deducted, half of the royalties would be retained by the federal government and used for the General Fund and various other funds. The remaining half would be distributed to the State of Wyoming and used for schools, roads, and other public works. For this analysis, royalties are estimated as percentage of the total project yield for each well multiplied by the market price for the product. As described in the PRB FEIS, assuming each well produces 400 mcf, each well would generate an estimated $792,000 to $1.3 million (constant 2001 dollars) total sales value. Federal royalties for each well would be an estimated $67, 058 over the life of the project.

Sales and use taxes are applied to the tangible goods and services that are purchased or used during the drilling and completions of each CBNG well. A total sales and use tax of 5 percent includes 4 percent collected by the State of Wyoming and 1 percent for the counties. The drilling and completion costs were estimated to be $60,000 per well in the PRB EIS. The taxable value per CBNG well is 60 percent of the total costs, or $36,000 per CBNG well. The calculated sales and use tax per well would be $1,800, of which $1,440 would be collected by the state, and $360 would be collected by the affected county.

Additional project revenues would be generated through the collection of an ad valorem or property tax levied on improvements constructed by the operators. Because this tax assessment is based on value added to property, revenues would increase based upon the number and location of wells. No estimate of the assessment of improvements associated with well development were available, however, assessed value would be determined as a percentage of the actual cost of the facilities. Theoretically, revenues would gradually increase over the first 10 years in all three counties, provide a steady revenue stream for a period of years, and then decline as facilities are dismantled and reclaimed. County ad

valorem tax rates for Campbell, Johnson, and Sheridan Counties vary slightly. In Campbell County, the rate is 6.3 percent, and in Johnson and Sheridan Counties the tax rate is 6.8 percent. The taxable value per CBNG well is estimated to be $36,000 as described in the PRB O&G Final EIS.

There would also be sales and use taxes associated with water handling facilities for discharged water for each alternative. Because sales taxes are based on tangible goods and the design of the water handling methods remain on a conceptual level, tangible goods were based on estimates and assumptions. These costs are incomplete estimates that are presented only to be used as a comparative analysis. For each alternative, with the exception of Alternatives 4 and 5, the sales taxes generated from each type of water handling facility as a percentage of the total sales taxes paid for each alternative would be the same as described for Alternative 2A in the PRB O&G Final EIS. This method is based on the assumption that water handling methods for Alternatives 1, 2, and 3 would be the same as described for the PRB FEIS Alternative 2A water handling methods.

Most indirect effects to the local and regional economies would be related to the multiplier effect of direct project employment, and the circulation and recirculation of payroll dollars paid to CBNG employees. Indirect effects are analyzed in the PRB FEIS. Other indirect effects would occur to all counties in Wyoming from the distribution of half the federal royalties generated by wells under each alternative to the State of Wyoming. The State would use these funds for schools, roads, and other public projects.

Alternative 1 — No Action

Direct impacts to local and regional economies would occur from revenues generated from the 2,870 wells located on 285 leases. The revenue generated from the existing wells has already started and is currently contributing to the regional economy. The revenues generated from new and the existing CBNG wells are described below.

The existing wells are currently generating federal royalties that are expected to total an estimated $7.6 million over the life of the wells. Federal royalties for the new wells would be an estimated $185.9 million over the life of the project. Total federal royalties would be $193.5 million.

Sales and use taxes would generate a total of $77 million over the life of the project. An estimated $61.6 million of the total would be collected by the state, and the counties would collect the remaining $15.4 million.

Table 4–23 shows revenues earned by federal and county governments from royalties paid on sales of CBNG, sales and use taxes, and local ad valorem tax revenue by county jurisdiction. These projections are subject to the number, locations, and life span of facilities and gas production.

Table 4–23 Federal Royalties, Sales and Use Tax, and Ad Valorem Taxes contributed to Federal, State and County Governments from Alternatives 1 and 2

Governments Receiving Tax Distributions	Number of Wells	Federal Royalties (dollars)	Sales and Use Tax[1] (dollars)	Net Ad Valorem (dollars)[2]	Total (dollars)
Federal Government	2,870	$192,456,460	$0	$0	$192,456,460
State of Wyoming[3]	2,870	$0	$61,586,067	$0	$61,586,067
Campbell	738	$0	$3,959,795	$1,674,076	$5,633,871
Johnson	803	$0	$4,308,231	$1,965,938	$6,274,169
Sheridan	1,329	$0	$7,128,491	$3,252,883	$10,381,374
Total	2,870	$192,456,460	$76,982,584	$6,892,897	$276,331,941

Notes:
1. 4 percent paid to state, 1 percent paid to county of well location.
2. Net present value of ad valorem tax discounted at 10 percent.
3. Fifty percent of total federal royalties are distributed to state by the federal government, and not included in table as they are not paid directly to the state.

Source: U.S. Bureau of Land Management 2003

The sales and use taxes associated with water handling facilities would be an estimated $3.9 million, which would result in a total sales and use tax revenue generated by Alternative 1 of $80.1 million. The total revenues earned by the federal, state, and county governments would be an estimated $280 million over the life of the project.

Alternative 2 — Standard Lease Terms and Lease Notice

Revenues from federal mineral royalties, sales and use taxes, and ad valorem taxes are based on the CBNG production of the wells proposed for Alternative 2. The number of wells, the estimated CBNG production, and the types of water handling methods for Alternative 2 are the same as described for Alternative 1. Therefore, the royalties, sales and use taxes (including sales and use taxes from water handling facilities), and ad valorem taxes would be the same as the estimates provided for Alternative 1 in Table 4–23.

Alternative 3 — Modified Lease Terms

There would be no leasing of proposed ACECs under this alternative. As a result, there would be fewer CBNG wells developed and about 3 percent less revenues generated from royalties, sales and use taxes, and ad valorem taxes that the revenues generated under Alternative 3 than described for Alternatives 1 and 2. The 2,810 wells would contribute estimated revenues of $271 million over the life of the wells to local, state, regional, and national economies, as shown in Table 4–24.

Table 4–24 Federal Royalties, Sales and Use Tax, and Ad Valorem Taxes contributed to Federal, State and County Governments from Alternative 3

Governments Receiving Tax Distributions	Number of Wells	Federal Royalties (dollars)	Sales and Use Tax[1] (dollars)	Net Ad Valorem (dollars)[2]	Total (dollars)
Federal Government	2,810	$188,432,980	$0	$0	$188,432,980
State of Wyoming[3]	2,810	$0	$60,298,554	$0	$60,298,554
Campbell	678	$0	$3,637,916	$1,537,996	$5,175,912
Johnson	803	$0	$4,308,231	$1,965,938	$6,274,169
Sheridan	1,329	$0	$7,128,491	$3,252,883	$10,381,374
Total	2,810	$188,432,980	$75,373,192	$6,756,817	$270,562,989

Note:
1. 4 percent paid to state, 1 percent paid to county of well location.
2. Net present value of ad valorem tax discounted at 10 percent.
3. 50 percent of total federal royalties is distributed to state, and not included in table.
Source: U.S. Bureau of Land Management 2003

The sales and use taxes associated with water handling facilities would be an estimated $3.8 million, adding an additional 5 percent to sales and use tax revenues generated by Alternative 3, resulting in a total of $79.2 million. The total revenues earned by the federal, state, and county governments would be an estimated $280 million over the life of the project.

Alternative 4 — No Surface Disposal of Produced Water

There would be no surface disposal of produced water from CBNG facilities developed on the 285 leases under this alternative. The 381 wells located on the leases would generate considerably smaller revenues by about 75 percent than would be realized from the implementation of Alternative 1. The royalties, sales and use taxes, and ad valorem taxes from CBNG well construction and production revenues would $68.7 million, as shown in Table 4–25.

Table 4–25 Federal Royalties, Sales and Use Tax, and Ad Valorem Taxes contributed to Federal, State and County Governments from Alternative 4

Governments Receiving Tax Distributions	Number of Wells	Federal Royalties (dollars)	Sales and Use Tax[1] (dollars)	Net Ad Valorem (dollars)[2]	Total (dollars)
Federal Government	714	$47,879,412	$0	$0	$47,879,412
State of Wyoming[3]	714	$0	$15,321,412	$0	$15,321,412
Campbell	326	$0	$1,748,873	$739,368	$2,488,241
Johnson	200	$0	$1,072,928	$489,600	$1,562,528
Sheridan	188	$0	$1,008,552	$460,224	$1,468,776
Total	714	$47,879,412	$19,151,765	$1,689,192	$68,720,369

Note:
1. Four percent paid to state, 1 percent paid to county of well location.
2. Net present value of ad valorem tax discounted at 10 percent.
3. Fifty percent of total federal royalties is distributed to state, and not included in table.
Source: U.S. Bureau of Land Management 2003

Revenues from taxes paid on capital costs, operation and maintenance, and reclamation would be generated from injection wells. There would be no costs associated with other water disposal methods, which include construction costs of facilities and revenues lost from existing uses such as grazing on land displaced by surface water-handling facilities. There would be 44 injection wells required for water disposal under Alternative 4 at an estimated cost of $90,000 per injection well (based on PRB FEIS estimates). Sales and use tax revenues from the installation of injection wells would be $ 4 million. The total revenues earned by the federal, state, and county governments would be an estimated $72.7 million over the life of the project.

Alternative 5 — No CBNG Development on Leases

Implementation of this alternative would result in no additional CBNG-related effects to socioeconomics. Effects associated with the existing CBNG wells would continue throughout the life of those wells. However, with no further development of CBNG, drainage of federal minerals would occur and the royalties associated with those minerals would be lost. Lost federal royalties could range from $48 to $192 million dollars, as these are the estimated federal royalties that would be paid under Alternatives 1, 2, 3 and 4.

Cumulative

The cumulative effects analysis in the PRB FEIS estimated that the cumulative federal royalties from CBNG development would total $2.5 billion and $337 million from non-CBNG wells (net present value discounted at 10 percent) over the life of the project. Approximately half would be paid to the State of Wyoming and half to the federal government. State mineral royalties, sales and use tax, severance tax, and ad valorem taxes would generate $3.2 billion in revenue from CBNG wells and $688 million from non-CBNG wells to be distributed by the state and counties, for schools, roads, and other community infrastructure. An additional $5.7 million in sales and use tax would be generated from water handling facilities.

The cumulative effects of employment, including effects on the population, community services and infrastructure, and the contributions of employees earnings to the federal, state, and local economies is discussed in the cumulative effects section of the PRB FEIS. The CBNG wells developed under the retrospective leases would use the same labor force that is described in the PRB FEIS, and would not require any additional workers; therefore the cumulative effects would be the same.

Air Quality and Climate

As discussed in the PRB O&G Final EIS for Alternative 2A, potential direct air quality impacts of any of the five alternatives considered in this EA would not violate any local, state, tribal, or federal air quality standards. Based on extensive air quality modeling of potential direct air quality impacts, localized short-term increases in CO, NO_x, PM_{10}, and SO_2 concentrations would occur, but all maxi-

mum concentrations are expected to be below applicable NAAQS and WAAQS (U.S. Bureau of Land Management 2003). All maximum near-field direct NO_2, PM_{10} and SO_2 concentrations are expected to be below applicable PSD Class II increments (U.S. Bureau of Land Management 2003:Table 3–90), and all maximum far-field direct concentrations are expected to be below applicable PSD Class I increments (see U.S. Bureau of Land Management 2003:Appendix F).

Although potential direct impacts to even the most sensitive far-field lakes would not be significant, a "just noticeable change" in visibility was predicted to occur at 10 mandatory federal Class I areas, ranging from one day at two areas up to four days at both the Bridger and Washakie Wilderness Areas. The maximum potential direct visibility impacts were predicted to occur on 16 days per year within both the tribal designated PSD Class I Northern Cheyenne and the PSD Class II Crow Indian Reservations. A detailed description of the air quality impact analysis is presented in the Air Quality appendix (Appendix F) of the PRB O&G Final EIS.