APPENDIX D
WATER MANAGEMENT PLAN

ATLANTIC RIM INTERIM DRILLING PROJECT
DOTY MOUNTAIN PROPOSED ACTION

TABLE OF CONTENTS

INTRODUCTION AND GEOGRAPHIC SETTING 1
DESCRIPTION OF WATERSHED 3
PRODUCED WATER DISPOSAL 4
BENEFICIAL USE OF PRODUCED WATER 5
HYDROLOGIC ANALYSIS OF WATERSHED 6
GROUNDWATER RESOURCES 7
DESCRIPTIONS OF FACILITIES 11
Facilities for Injection 11
Reserve Pits 12
Culverts 12
POTENTIAL EROSION 13
MONITORING AND MITIGATION 14

TABLES

Table D-1 Wells Proposed in Doty Mountain POD 2
Table D-2 Major Ion Composition of Mesaverde Groundwater 7
Table D-3 Groundwater Quality of Mesaverde Wells in the Project Area 8
Table D-4 Permitted Water Wells within 1 Mile of the Doty Mountain Project Area 9

INTRODUCTION AND GEOGRAPHIC SETTING

Warren E&P, Inc. (Warren), Double Eagle Petroleum Company (Double Eagle) and Anadarko E&P Company (AEPC), collectively referred to as "the Companies," propose to explore for and potentially develop coal bed natural gas (CBNG) resources in the Doty Mountain area (Project Area) in southwestern Carbon County, Wyoming (**Figures 1-1 and 2-1** of the EA). Exploration and development in the Project Area would occur as part of the Doty Mountain Plan of Development (POD) for the Atlantic Rim Interim Drilling Project. Wells in the Project Area, which encompasses approximately 1,920 acres, would be located about 25 miles southwest of Rawlins, Wyoming, near the intersection of Wyoming State Highway (WY) 789 and Carbon County Road 608 (Wild Cow Road). The Project Area is within the Upper Colorado River Basin.

This water management plan (WMP) for the Doty Mountain POD addresses handling of produced water during testing and production of the wells in the Doty Mountain area. The project consists of constructing, drilling, completing, testing, operating, and reclaiming 24 exploratory wells and two deep injection wells to dispose of produced water that would be located on both private and federal leases. There are no existing or plugged and abandoned wells in the Doty Mountain POD. Of the 24 proposed well locations, 16 wells would be located on surface ownership lands administered by the Bureau of Land Management (BLM) Rawlins Field Office (RFO) and would develop federal minerals. The remaining proposed wells (eight) would develop fee minerals on fee surface. One proposed deep injection well would be located on lands administered by RFO. The remaining proposed deep injection well and the compressor station would be located on fee lands. **Table D-1** summarizes the proposed wells addressed in this WMP.

Produced water from the 24 proposed shallow gas wells would be disposed of by injection. Two deep injection wells would be used.

TABLE D-1 WELLS PROPOSED IN DOTY MOUNTAIN POD

Proposed Gas Wells			
Lease Number	**Well Name**	**Well Number**	**Location**
WYW-116179 (Pedco/Anadarko)	AR Federal	17-91-9-14	T17N R91W Sec. 14 NESE
	AR Federal	17-91-11-14	T17N R91W Sec. 14 NESW
	AR Federal	17-91-13-14	T17N R91W Sec. 14 SWSW
	AR Federal	17-91-15-14	T17N R91W Sec. 14 SWSE
	AR Federal	17-91-9-22	T17N R91W Sec. 22 NESE
WYW-137692 (Pedco/Anadarko)	AR Federal	17-91-1-22	T17N R91W Sec. 22 NENE
WYW-141686 (Double Eagle)	AR Federal	17-91-3-22	T17N R91W Sec. 22 NENW
	AR Federal	17-91-5-22	T17N R91W Sec. 22 SWNW
	AR Federal	17-91-7-22	T17N R91W Sec. 22 SWNE
	AR Federal	17-91-11-22	T17N R91W Sec. 22 NESW
	AR Federal	17-91-13-22	T17N R91W Sec. 22 SWSW
	AR Federal	17-91-15-22	T17N R91W Sec. 22 SWSE
WYW-133658 (Double Eagle)	AR Federal	17-91-1-14	T17N R91W Sec. 14 NENE
	AR Federal	17-91-3-14	T17N R91W Sec. 14 NENW
	AR Federal	17-91-5-14	T17N R91W Sec. 14 SWNW
	AR Federal	17-91-7-14	T17N R91W Sec. 14 SWNE
Fee Lease	AR Fee	17-91-1-23	T17N R91W Sec. 23 NENE
	AR Fee	17-91-3-23	T17N R91W Sec. 23 NENW
	AR Fee	17-91-5-23	T17N R91W Sec. 23 SWNW
	AR Fee	17-91-7-23	T17N R91W Sec. 23 SWNE
	AR Fee	17-91-9-23	T17N R91W Sec. 23 NESE
	AR Fee	17-91-11-23	T17N R91W Sec. 23 NESW
	AR Fee	17-91-13-23	T17N R91W Sec. 23 SWSW
	AR Fee	17-91-15-23	T17N R91W Sec. 23 SWSE
Proposed Deep Injection Wells			
Lease Number	**Well Name**	**Well Number**	**Location**
WYW-141686 (Double Eagle)	AR Federal	17-91-22I	T17N R91W Sec. 22 NESW
Fee Lease (Anadarko)	AR Fee	17-91-23I	T17N R91W Sec. 23 NENW

DESCRIPTION OF WATERSHED

The Project Area is located in Muddy Hydrologic Unit Code (HUC) 14050004, upstream of the Little Snake (HUC 14050003) in the Upper Colorado River Basin. The nearest perennial stream is Muddy Creek, located 1.5 miles north of the Project Area. Muddy Creek originates in the Sierra Madre Range. It flows west and south near the western border of the Project Area toward its confluence with the Little Snake River near Baggs. Four unnamed ephemeral drainages that are tributary to Dry Cow Creek traverse the Project Area. Dry Cow Creek is an intermittent stream that flows southwesterly for about 9 miles to its confluence with Cow Creek. Cow Creek is a perennial stream that is tributary to Muddy Creek.

The average annual precipitation collected at Baggs, Wyoming, from September 1, 1979, to December 31, 2002, is 10.7 inches (WRCC 2003). Precipitation is greatest during the summer, although minor peaks occur in May, July, and October. Annual precipitation increases with elevation to more than 20 inches in the Sierra Madres.

There are no designated floodplains within the Project Area. No special aquatic sites or wetlands have been identified in or near the Project Area, including the route for the lateral sales pipeline. The nearest potential riparian habitat is located along Dry Cow Creek, southwest of the Project Area. Agriculture (primarily grazing by cattle, horses, or sheep) is a primary land use in the Project Area. Other uses within and adjacent to the Project Area include wildlife habitat; oil and gas exploration, development, and transmission; and dispersed outdoor recreation.

No depletions to the Colorado River system will likely occur as a result of this project. Due to the volumes of water that will be removed from the producing formations, a dating method will be used to determine if water has entered the coal formation recently from surface sources. Water produced from the coal formation will be tested for tritium, a radioactive isotope that is present at higher levels in water exposed to the atmosphere since nuclear testing began in the 1940s. Results of less than 1 tritium unit will be considered sufficient evidence that water in the coal formation was not recently exposed to the atmosphere and is therefore unlikely to have a significant connection to surface waters in the Colorado River system. The tritium sample will be taken and analyzed before significant water production for the project begins.

Stormwater discharges during construction would be managed in accordance with a stormwater permit issued by the WDEQ.

PRODUCED WATER DISPOSAL

Aquifers and groundwater quality are not anticipated to be affected by the project provided the mitigation measures that are described in Chapter 2 of the EA are implemented. Water from the Cherokee or Deep Creek Sandstones will be analyzed and the results provided to all necessary regulatory agencies before injection begins. The proposed exploratory wells would produce water that would be disposed of by injection; therefore, no discharge of produced water to surface waters would occur under the project.

Produced water from individual wells would be gathered and routed to water disposal facilities for deep injection. The water disposal facilities would be approved by the BLM and Wyoming Oil and Gas Conservation Commission (WOGCC) or the Wyoming Department of Environmental Quality (WDEQ), and the private surface owner, as needed. Best Management Practices (BMPs) would be used to control erosion and divert overland flows away from the facilities. Centrifugal pumps, reciprocating pumps, filter systems, and tanks at the disposal facility would be used to remove solids from the water stream and pump water under pressure sufficient to allow for downhole disposal. If it is not possible to safely inject the volume of produced water projected into the proposed injection wells, some or all of the exploratory wells would be shut in temporarily while alternative plans are developed and approved. These alternative plans would include additional injection wells.

BENEFICIAL USE OF PRODUCED WATER

Produced water from the 24 gas wells proposed in the Doty Mountain POD could be available for potential beneficial use if authorized separately by BLM. Before the injection wells are complete, produced water may be utilized as make-up water for nearby drilling and completion operations. Any water produced during drilling or well completing would be contained on each drilling location in the reserve pit. During well testing, water produced from the Mesaverde aquifer will be collected on location in closed tanks and trucked to an authorized disposal facility until the injection wells are operational. Once all wells have been drilled, water produced at the exploratory wells would be gathered and transported to the injection wells for disposal.

In addition, a small portion of the water produced from the wells (about 5 gallons per minute at each location shown on the Project Map) could be dispensed for use by livestock at locations specified by BLM and the surface owners. The water would be piped into tire tanks with shut-off valves that would not discharge produced water into surface drainages.

All waters used to test the integrity of the gas gathering pipelines would be injected into an authorized water disposal facility (deep injection well) in compliance with all applicable requirements.

Dust abatement would comply with all applicable WOGCC requirements. Only water suitable for livestock use would be used for dust abatement.

HYDROLOGIC ANALYSIS OF WATERSHED

A *Hydrologic Watershed Field Analysis Summary Sheet* was not completed for the drainages within the Doty Mountain Project Area. Produced water from the proposed wells will be injected; therefore, surface water within the Project Area would not be affected by the project.

GROUNDWATER RESOURCES

Water would be produced from coals in the Mesaverde Group. Groundwater would be removed from the coal seam aquifers within the Allen Ridge and Almond Formations, members of the Upper Cretaceous Mesaverde Group. Groundwater quality is variable in the Project Area. Groundwater quality is related to the depth of the aquifers, flow between aquifers, and rock type. Total dissolved solids (TDS) are generally less than 2,000 milligrams per liter (mg/L), considered slightly saline to saline, in the Project Area, with local concentrations less than 500 mg/L (meeting U.S. Environmental Protection Agency [EPA] National Secondary Drinking Water Regulations).

The targeted coal seams in the Mesaverde Group are classified as confined to semi-confined aquifers because they are bounded by confining layers that consist of impervious to semi-pervious layers of shale and siltstone. Hydraulic connection between the coal seams and any aquifer stratigraphically above or below the coal seams is limited. The hydrostatic head of the water measured in test wells completed in coal seams in the Project Area can be considerably higher than the aquifer or even the elevation of the ground level at a specific well location. Confined, or artesian, aquifer conditions of this type indicate an effective seal above and below the aquifer. However, lowering the hydraulic head in the coal seam aquifers by removing water may induce a slight leakage through the semi-pervious shale layers into the pumped aquifer. Because of the extremely low hydraulic conductivity of the confining layers and the limited number of wells proposed (24), enhanced leakage from an aquifer stratigraphically above or below the affected coal seams would be minimal.

As most existing groundwater wells and the proposed gas wells of the Project Area target aquifers in the Mesaverde Group, the results of a detailed analysis of groundwater from this unit have been included in **Table D-2.** Sodium and bicarbonate dominate as the major ionic species. Collentine et al. (1981) offer three possible explanations for this dominance: (1) exchange of dissolved calcium for sodium; (2) sulfate reduction, resulting in generation of bicarbonate; and (3) intermixing of sodium-rich, saline water from low-permeability zones within the Mesaverde or adjacent aquifers.

TABLE D-2 MAJOR ION COMPOSITION OF MESAVERDE GROUNDWATER

Cation	Concentration (mg/L)	Anion	Concentration (mg/L)
Sodium	513	Bicarbonate[a]	1,284
Calcium	7	Carbonate[b]	9
Magnesium	3	Chloride	56
Potassium[a]	5	Sulfate	11

[a] Bicarbonate was not measured; value shown was calculated from ion balance.

[b] Concentrations of potassium and carbonate were not measured in samples from gas wells; values represent composite of U.S. Geological Survey (USGS) data for samples from Mesaverde wells in the vicinity of the project (USGS 1980).

Table D-3 presents a comparison of Mesaverde groundwater with WDEQ suitability standards. The composite results of the samples from the three gas wells analyzed indicate that the water is generally suitable for livestock but is unsuitable for domestic supply or irrigation without treatment. Parameters measured at concentrations that exceed Wyoming drinking water standards include iron, manganese, and TDS. Calculated sodium absorption ratio (SAR) (47.3) and residual sodium carbonate (41 milliequivalents per liter [meq/L]) exceed the agriculture suitability limits of 8.00 for SAR and 1.25 residual sodium carbonate.

TABLE D-3 GROUNDWATER QUALITY OF MESAVERDE WELLS IN THE PROJECT AREA

Parameter	Concentration[a]	Unit	Groundwater Suitability Standards[b]		
			Domestic	Agriculture	Livestock
Aluminum	0.045	mg/L	---	5	5
Ammonia	0.9	mg/L	0.5	---	---
Arsenic	0.0006	mg/L	0.05	0.1	0.2
Barium	0.36	mg/L	1	---	---
Beryllium	<0.002	mg/L	---	0.1	---
Boron	0.25	mg/L	0.75	0.75	5
Cadmium	<0.0002	mg/L	0.01	0.01	0.05
Chloride	56	mg/L	250	100	2,000
Chromium	0.002	mg/L	0.05	0.1	0.05
Cobalt	NM	mg/L	---	0.05	1
Copper	0.03	mg/L	1	0.2	0.5
Cyanide	<5	mg/L	0.2	---	---
Fluoride	1.0	mg/L	1.4 - 2.4	---	---
Hydrogen Sulfide	NM	mg/L	0.05	---	---
Iron	3.06	mg/L	0.3	5	---
Lead	0.004	mg/L	0.05	5	0.1
Lithium	NM	mg/L	---	2.5	---
Manganese	0.102	mg/L	0.05	0.2	---
Mercury	<0.0004	mg/L	0.002	---	0.00005
Nickel	0.041	mg/L	---	0.2	---
Nitrate	<0.03	mg/L	10	---	---
Nitrite	<0.03	mg/L	1	---	10
Oil & Grease[c]	<1	mg/L	Virtually Free	10	10
Phenol	65	mg/L	0.001	---	---
Selenium	<0.005	mg/L	0.01	0.02	0.05
Silver	<0.003	mg/L	0.05	---	---
Sulfate	11	mg/L	250	200	3000
TDS	1,322	mg/L	500	2000	5000
Uranium	NM	mg/L	5	5	5
Vanadium	NM	mg/L	---	0.1	0.1
Zinc	0.3	mg/L	5	2	25
pH	8.2	s.u.	6.5 - 9.0	4.5 - 9.0	6.5 - 8.5
SAR	47.3	<none>	---	8	---
RSC[d]	41	meq/L	---	1.25	---

TABLE D-3 GROUNDWATER QUALITY OF MESAVERDE WELLS IN THE PROJECT AREA

Parameter	Concentration[a]	Unit	Groundwater Suitability Standards[b]		
			Domestic	Agriculture	Livestock
Radium 226 + Radium 228	0.9	pCi/L	5	5	5
Strontium 90	NM	pCi/L	8	8	8
Gross alpha	NM	pCi/L	15	15	15

a Concentrations of boron, ammonia, fluoride, and nitrate/nitrite in samples from 11 Mesaverde groundwater wells (USGS 1980); remaining concentrations from three Mesaverde gas wells in Project Area.
b From WDEQ Water Quality Rules and Regulations, Chapter VIII.
c Reported as total petroleum hydrocarbons.
d Residual sodium carbonate calculated from measured calcium and magnesium concentrations and calculated concentration of bicarbonate.

Notes:

meq/L = Milliequivalents per liter
mg/L = Milligrams per liter
NM = not measured
pCi/L = Picocuries per liter
s.u. = Standard units
TDS = Total dissolved solids

Seven water wells permitted by WSEO have been completed within 1 mile of the Project Area. Six of these wells are located within a 1/2-mile radius of individual gas wells. Two of these wells yield water used for stock ponds; the remaining four are monitoring wells. Information on permitted water wells that was obtained from WSEO is shown in **Table D-4**. The maximum depth of all permitted wells is 419 feet. The water wells are much shallower than the proposed gas wells and proposed injection zones.

TABLE D-4 PERMITTED WATER WELLS WITHIN 1 MILE OF THE DOTY MOUNTAIN PROJECT AREA

Permit No.	Sec	Qtr/Qtr	Applicant	Facility Name	Use	Yield (gpm)	Well Depth	Static Depth
P33768W	15	SWNW	Union Pacific Minerals Inc.	ARW 1	Monitoring Misc.	0	280	144.88
P54262W	23	NWNW	Union Pacific Minerals Inc.	AR 201 OW	Monitoring Misc.	0	220	64
P54264W	23	SESW	Union Pacific Minerals Inc.	AR 200 OW	Monitoring Misc.	0	419	107
P56613W	23	SWNW	P H Livestock Co.	Y Pasture #1	Storage	5	120	35
P59801W	23	NENW	Wyoming Board of Land Commissioners — Pan Artic Exploration LTD	9C-16-19-89	Monitoring Misc.	Unk	Unk	Unk
P59802W	23	SWNW	Wyoming Board of Land Commissioners — Pan Artic Exploration LTD	1-16-19-89	Monitoring Misc.	Unk	Unk	Unk
P17356W	28	NENE	BLM	#4139	Storage	5	100	Unk

Deep Injection Wells for Produced Water

The proposed injection targets for the deep injection wells are the Cherokee and Deep Creek Sandstones, that occur about 3,850 feet to 4,600 feet below the surface. These sandstones are isolated above and below by competent shale barriers that would prevent initiation and propagation of fractures through overlying strata to any zones of fresh water, provided the Companies adhere to injection limits established in permits. The Cherokee and Deep Creek Sandstones consist of clean, medium to coarse-grained sandstone.

The injection wells would be drilled, cased, and cemented from total depth (50 feet below the base of the Cherokee or Deep Creek Sandstone) to the surface. The Cherokee or Deep Creek Sandstone would be tested to evaluate its suitability for disposal before any water is injected. The results of the open-hole log and injectivity test would be provided to the regulatory agencies. In addition, water from the Cherokee or Deep Creek Sandstone (or both) would be analyzed and the results would be provided to the regulatory agencies before produced water is injected. Produced water would come from coals in the Mesaverde Group.

Aquifer Protection

The injection formations for all proposed injection wells are stratigraphically below the groundwater sources that are developed by existing water wells. It is anticipated that the produced water that would be injected would be of equal or higher quality in regards to class of use as defined by WDEQ Ground Water Division regulations. Injection of the produced water is not expected to result in any deterioration in groundwater quality within the injection horizon. These sandstones are isolated above and below by competent shale barriers that would prevent initiation and propagation of fractures through overlying strata to any zones of fresh water. Maximum pressure requirements for the injection zone would be established through injectivity tests that would identify fracture pressure limits to prevent the overlying shale from being breached by fractures. Injection horizons will not be exceeded based on injectivity tests and applicable permit limits, as regulated by the State of Wyoming and BLM. The only effect on the injection horizons would consist of an increase in the hydraulic head at the injection wells. This effect would attenuate with distance from the wellbore. There are no anticipated effects in terms of groundwater quantity and quality. Effects on the injection horizon would be minimal.

To avoid or mitigate potential impacts to existing water wells, the Companies would offer a water well agreement to all potentially affected landowners with properly permitted water wells within the circle of influence for each proposed gas well (a 1/2-mile radius). If a water well agreement is not reached with the landowner, the Companies have agreed to mitigate the impacts of the proposed wells in accordance with State of Wyoming water laws. Furthermore, the Companies have applied for the permits to appropriate groundwater for each well from WSEO, concurrently with the Applications for Permit to Drill. The Companies would provide copies of all groundwater appropriation permits approved by WSEO to BLM.

DESCRIPTIONS OF FACILITIES

Multiple facilities would be installed to accomplish water management for the Doty Mountain POD. These proposed facilities include two deep injection, temporary reserve pits on drill locations (off-channel), and necessary culverts. Each facility is explained below and is shown in **Figure 2-1**.

The Companies would operate all wells, pipelines, and ancillary production facilities in a safe manner, as set forth in standard industry operating guidelines and procedures.

FACILITIES FOR INJECTION

Produced water from individual wells would be gathered and routed to an interconnected system that would provide for the transfer of water between injection facilities, as needed. The system would route the water to central injection facilities and on to one of two deep injection wells. Produced water-gathering pipelines would be constructed from the wellhead to the injection facilities along the well access road wherever feasible. The water flowlines would be installed together in the same trench or ditch as the gas-gathering lines wherever practical, and would be buried.

The deep injection wells and facilities would be approved by the BLM, WDEQ, and WOGCC as needed and would be located in Sections 22 and 23 of T17N R91W.

The approximate minimum injection capacity of the AR Federal 17-91-22I and the AR Fee 17-91-23I injection wells would be 5,000 barrels per day (bbls/day) for each well. The approximate maximum injection capacity for each well would be 20,000 bbls/day.

Transfer pumping stations may be used during production operations to transfer produced water from the gas wells to the injection facilities. The transfer pumping stations would be needed in areas where differences in elevation require supplemental pumping to transfer the produced water. If transfer pumping stations are required, they will be identified in the MSUP. Each pumping station would contain up to two 400-barrel water tanks, an inlet separation vessel, and a small centrifugal water pump. Each pumping station would consist of a pad that is about 125 feet by 125 feet that would disturb an estimated 0.4 acre, including cut and fill slopes. A berm would be constructed to contain any potential spills. A small pump house would be constructed immediately outside the bermed area to enclose the pump. A typical water transfer facility is illustrated in **Appendix B**.

RESERVE PITS

Temporary reserve pits would be constructed at each drill location to contain drilling fluids and initial pressure testing. These pits would be reclaimed after well completion operations and no discharge of produced water would occur in these pits after the initial well completion operations. The Companies estimate that each reserve pit would be open for 2 to 8 weeks to allow pit fluids to evaporate.

The reserve pits would be constructed in cut rather than fill materials. Fill material would be compacted and stabilized, as needed. The subsoil material of the pits would be inspected to assess stability and permeability and to evaluate whether reinforcement or lining would be required. If lining is required, the reserve pit would be lined with reinforced synthetic liner at least 12 mils thick and with a bursting strength of 175 by 175 pounds per inch (American Society for Testing and Materials [ASTM] Standard D 75179). Use of closed or semi-closed drilling systems would be considered in situations where a liner may be required.

Two feet of freeboard would be maintained in all reserve pits to ensure they are not in danger of overflowing. Drilling operations would be shut down if leakage is found outside the pit until the problem is corrected.

CULVERTS

The main access road and existing improved and unimproved roads within the Project Area cross channels at a number of locations. Some proposed road improvements would cross drainages that may require culverts to be installed. The proposed access road to the Project Area uses existing improved, unimproved, and proposed roads that avoid channel crossings where possible to minimize environmental effects. Proposed culverts will be a minimum of 18 inches in diameter and will be sized according to BLM requirements to adequately manage existing and potential flows. The locations of proposed culverts are shown in **Figure 2-1**. These culverts will be monitored to evaluate whether capacity is adequate and the potential for buildup of ice during winter.

Culverts in roads will be covered with a minimum of 12 inches of fill or one-half the diameter of the pipe, whichever is greater, as per BLM requirements. The inlet and outlet will be set flush with the existing ground surface and aligned in the center of the draw. Before the area is backfilled, the bottom of the pipe will be bedded on stable ground that does not contain expansive or clay soils, protruding rocks that would damage the pipe, or unevenly sized material that would not form a good seat for the pipe. The site will be backfilled with unfrozen material and rocks no larger than 2 inches in diameter. Care would be exercised to thoroughly compact the backfill under the haunches of the conduit. The backfill would be brought up evenly in 6-inch layers on both sides of the conduit. Additional culverts would be installed in the existing access road as needed or as directed by BLM.

POTENTIAL EROSION

Surface disturbance associated with road construction, drilling, and installing pipelines or utilities could increase the potential for erosion. These disturbances would include removing vegetation and stockpiling topsoil, constructing roads, and digging shallow excavations for drill pads or facilities. The Companies would implement the mitigation measures described in Chapter 2 of the EA to control wind and water erosion at disturbed sites so that interim drilling and development in the Project Area would not affect surface drainages. The Companies have committed to the practices described in Chapter 2 that, when combined with existing regulatory requirements, would provide for design and implementation of surface-disturbing activities in a manner that would divert and control runoff and provide for re-establishment of vegetation in disturbed areas. All concentrated water flows would be discharged within the right of way for an access road onto or through structures that would dissipate energy (such as riprapped aprons and culvert outflows) and into established vegetation. These measures, collectively, would represent best management practices (BMPs) for erosion control.

Increased surface water runoff and off-site sedimentation caused by soil disturbance, impairment to surface water quality, and changes in stream channel morphology may be caused by construction of roads, drill locations, and pipeline crossings. Construction would occur over a relatively short period, however. Impacts from construction would likely be greatest in the short term and would decrease over time as a result of stabilization, reclamation, and revegetation. Construction disturbance would not be uniformly distributed across the Project Area, but instead would be concentrated near the drill locations and access or utility routes.

MONITORING AND MITIGATION

Aquifers and groundwater quality are not anticipated to be affected by the project provided the mitigation measures that are described in Chapter 2 of the EA are implemented. A groundwater monitoring program is being established for the Atlantic Rim EIS study area. Water from the Cherokee or Deep Creek Sandstones will be analyzed and the results provided to all necessary regulatory agencies before injection begins. It is anticipated that the produced water that would be injected would be of equal or higher quality in regard to class of use as defined by WDEQ Ground Water Division regulations.

Testing of CBNG resources likely would lower the hydraulic head in the affected coal seam aquifer. (The reduction of hydraulic head in an aquifer also is referred to as drawdown.) Relative to the available drawdown within the aquifer, the effect on the coal aquifer during the interim drilling project is expected to be small. BLM has requested that three to six groundwater monitoring wells be installed within the Atlantic Rim EIS study area during the interim drilling project. The locations of these monitoring wells have not yet been finalized, however. The effects of interim drilling and development on the coal aquifer, including drawdown, will be monitored by these wells and they will provide data for a groundwater model to look at potential impacts from alternatives in the EIS. Monitoring wells do not count toward the limit of 24 proposed wells in a POD under the Interim Drilling Policy.

The water level also may be lowered or drawn down in existing wells within the 1/2-mile radius of individual exploratory wells completed in the Mesaverde aquifer. The potential yield from the nearby water wells may be affected by removal of groundwater. Other wells completed in the coal seams could be affected by the project; however, no other wells permitted by the WSEO are known to occur within 1 mile of the Project Area. Potential effects on water wells would be minimized by a water well agreement, as described in the Master Surface Use Program (MSUP) (**Appendix B** of the EA) and the other mitigation measures described in Chapter 2 of the EA.