SECTIONS 1 TO 3

Page

FIGURES

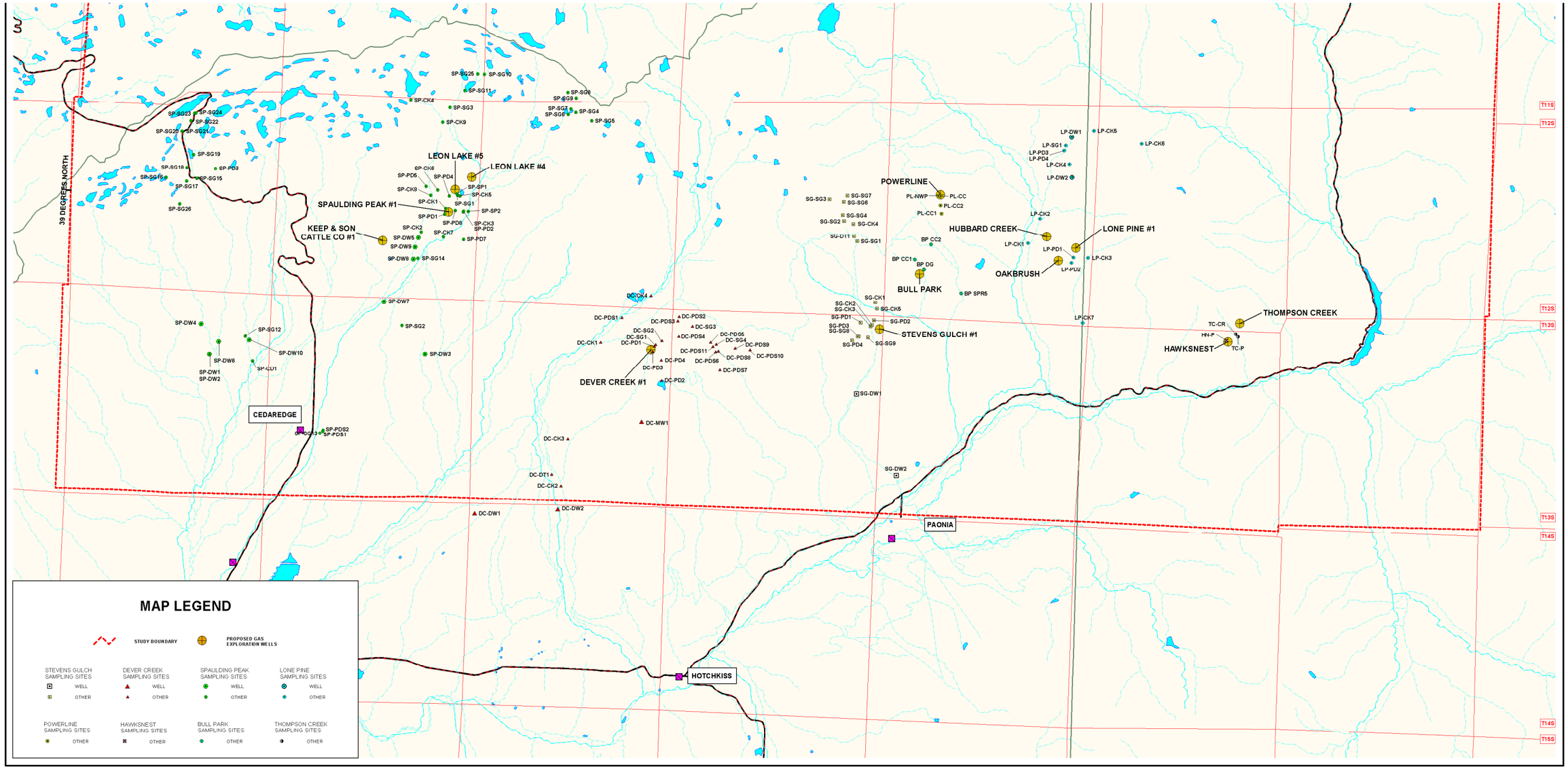
CHARACTERIZATION AND ASSESSMENT OF WATER RESOURCES ON THE SOUTHEASTERN FLANK OF THE GRAND MESA, DELTA, GUNNISON AND MESA COUNTIES, COLORADO

1.0 PURPOSE AND SCOPE

The purpose of this report is to characterize and assess the groundwater and surface water resources of the southeastern flank of the Grand Mesa in Delta, Gunnison and Mesa Counties, Colorado. The specific study area, which is 756 square miles in size, is shown in Figure 1. Emphasis is placed on water resources located in the vicinity of proposed natural gas exploratory wells, as shown on Exhibit 1. (All exhibits referred to are oversized documents, and are found in map pockets immediately behind the report.) Similarly, because the targeted natural gas is principally derived from the Mesaverde Formation, the hydrogeology of this formation is emphasized.

The information and data assembled in this report provide a reasonable foundation for future evaluation of the potential water-resources impacts of the proposed natural gas exploratory wells, although impact assessment is beyond the scope of this report.

As the water quantity/quality monitoring programs described herein continue, the water resources database will expand. Consequently, periodic updates to this report may be necessary.



MAP LEGEND

STUDY BOUNDARY

PROPOSED GAS EXPLORATION WELLS

STEVENS GULCH SAMPLING SITES	DEVER CREEK SAMPLING SITES	SPAULDING PEAK SAMPLING SITES	LONE PINE SAMPLING SITES
WELL	WELL	WELL	WELL
OTHER	OTHER	OTHER	OTHER

POWERLINE SAMPLING SITES	HAWKSNEST SAMPLING SITES	BULL PARK SAMPLING SITES	THOMPSON CREEK SAMPLING SITES
OTHER	OTHER	OTHER	OTHER

WRIGHT WATER ENGINEERS, INC.
2490 W 26TH AVE. 100A
DENVER, CO. 80211
(303) 480-1700

N W E S

5000 0 5000 Feet

1" = 5000'

NOTE:
BASE MAPPING CONSISTS OF 1:100K USGS MAPS. (DELTA, PAONIA, NUCLA, MONTROSE)

BASELINE SAMPLING SITES AND PROPOSED NATURAL GAS EXPLORATION WELLS

EXHIBIT 1

2.0 STUDY TEAM

Wright Water Engineers, Inc. (WWE), a multi-disciplinary firm with offices in Denver, Glenwood Springs and Durango, Colorado, conducted this geologic and hydrologic evaluation, in association with C. Richard Dunrud, P.E. and John W. Rold, C.P.G. Key personnel involved in preparation of this report include:

- The staff of WWE—primarily Jonathan E. Jones, P.E., Chief Executive Officer; Gary Witt, P.G., Senior Hydrogeologist; Dr. Robert Weiner, Senior Water Chemist; Jane Clary, Senior Water Resources Analyst; and Jason Alexander, Geologist.

- C. Richard Dunrud, P.E.—an internationally recognized authority on coal mine subsidence and its associated effects. He worked for 30 years at the U.S. Geological Survey (USGS) and has extensive experience in the North Fork of the Gunnison River Basin, having prepared official USGS geologic maps and technical reports of the study area.

- John Rold, C.P.G.—Colorado State Geologist for over 23 years. He has considerable personal knowledge of the North Fork of the Gunnison River area due to assignments there while Colorado State Geologist and with WWE at the West Elk Mine.

WWE was assisted by Cordilleran Compliance Services (Cordilleran) in the collection of field data.

To provide guidance and independent review during the preparation of this document, WWE convened a peer review committee consisting of these experts:

- Neil Grigg, Ph.D., P.E.—Professor of Civil Engineering at Colorado State University. He has over 30 years of experience in water resources engineering.

- Tissa Illangasekare, Ph.D., P.E.—AMAX endowed Chair of Environmental Sciences and Engineering and Professor of Civil Engineering at Colorado School of Mines. He has over 25 years of experience in sub-surface hydrology and groundwater modeling.

- Paul Oldaker—consulting hydrologist/hydrogeologist for the energy related industries with over 25 years of experience. He has extensive experience in the study area, including hydrogeologic analysis of the Mesaverde Formation in the Piceance Basin for Amoco in the 1980s.

Resumes for the individuals listed above are provided in Appendix A.

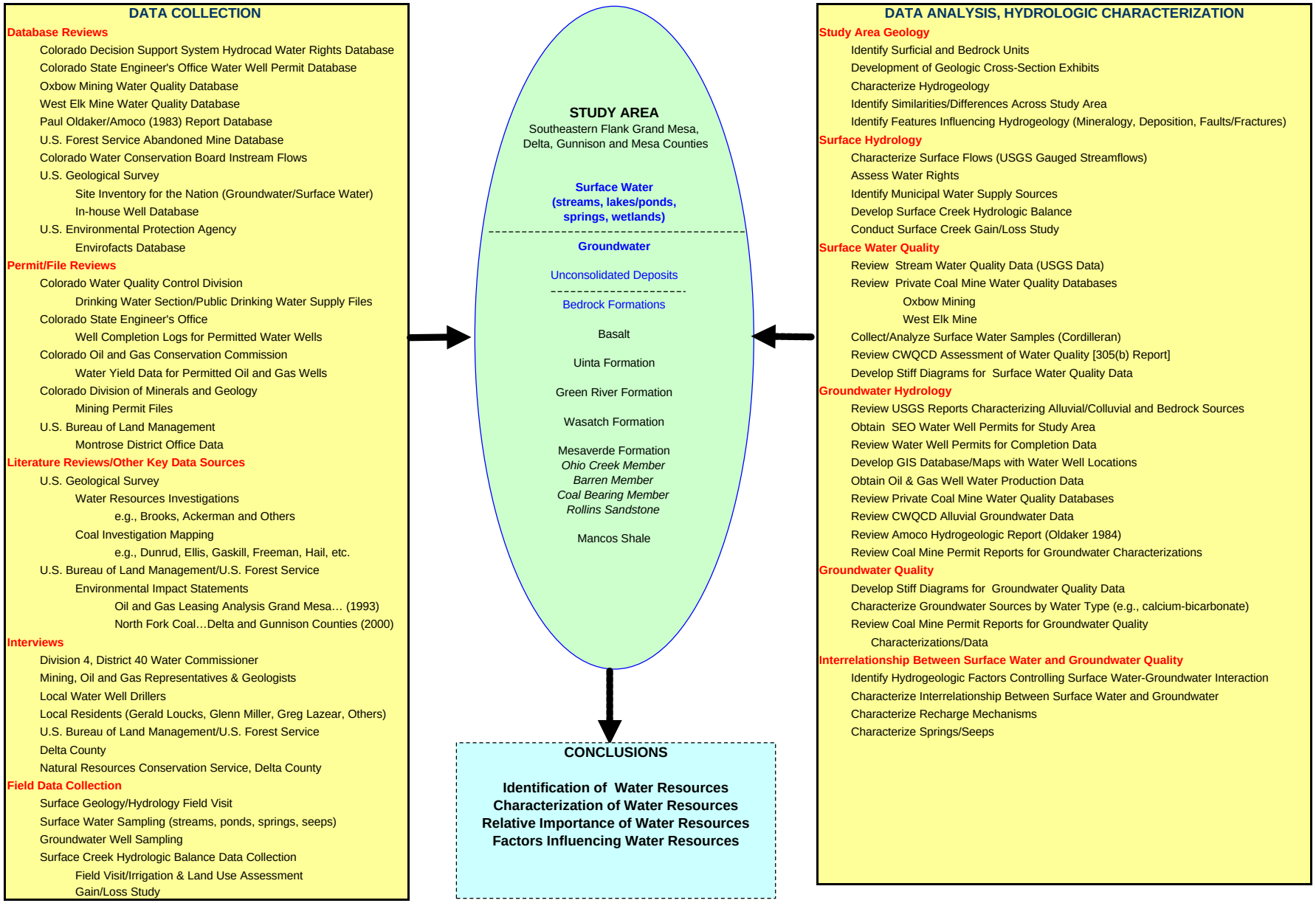
3.0 REPORT BASIS AND METHODOLOGY

This section identifies the key components of research conducted to develop this report. Figure 2 provides an overview of the data collection and evaluation activities.

3.1 Overview

WWE was tasked with the preparation of a comprehensive assessment of water resources in the study area. With that in mind, WWE has gone to great lengths to identify relevant information, to prepare an objective assessment and to present a report that provides a solid scientific foundation for interpreting hydrologic conditions in the study area. The goal has been to obtain and interpret as much baseline hydrologic and water quality information for surface water and groundwater resources within the study area (see Figure 1) as feasible. The WWE study team has thoroughly reviewed the literature, made many trips to the field, conducted interviews, and performed geologic and engineering analyses, as described herein. For example, with the assistance of Cordilleran, surface and groundwater samples have been collected in approximately 150 locations in the 756-square-mile study area (see Exhibit 1 for sampling locations). Well records at the Colorado State Engineer's Office (SEO) in Denver were comprehensively reviewed for the entire study area, and detailed hydrogeologic information on 440 permitted water wells was obtained. Water resources records and data for 19 coal mines in the study area were obtained from the Colorado Division of Minerals and Geology (CDMG). Historic documents including well logs, water quality and quantity data, etc., were obtained from archived files with the USGS, U.S. Bureau of Land Management (BLM), Amoco (now BP/America), and the Colorado Oil and Gas Conservation Commission (COGCC), among other organizations. For example, records for roughly 73 proposed or constructed oil and gas wells in the study area were reviewed at the COGCC offices in Denver. The scope of research for this report is described in more detail below.

Figure 2
Overview of Data Collection and Hydrologic Characterization and Assessment Process
(Note: Representative data collection, analysis and characterization sources and tasks listed)



3.2 Literature, Internet and Photograph Reviews

A considerable amount of literature was reviewed, as documented by the references listed at the end of this report. WWE utilized not only readily available information, but also documents that were more difficult to locate and obtain. An excellent example of this was well logs and field data from Amoco (now BP/America), which Mr. Paul Oldaker (one of WWE's peer reviewers) retained in his files from his work in the study area during the early-to-mid 1980s. Exhibit 2 shows the published groundwater data sources within the study area, as identified by the SEO, Amoco and the USGS.

Considerable information is available via the internet that was utilized in this report. For example, the Web site for the Colorado Division of Water Resources provided spatial data on precipitation, soils, and irrigated areas. The base mapping for a number of the exhibits in this report was obtained from the USGS Web site.

WWE reviewed aerial photography of the entire study area with regard to surficial geology and land use features.

3.3 Interviews and Meetings

Numerous interviews were conducted in the course of preparing this report, both in person and over the phone. Representative individuals and organizations interviewed include the following:

1. U.S. Geological Survey[1]
2. U.S. Bureau of Land Management
3. U.S. Forest Service
4. Local coal mines, including, for example, representatives of Oxbow Mining and the West Elk Mines

[1] In 1983, 1985 and 1986 the USGS published three reports regarding water resources in the study area. The 1983 report was authored by Mr. Tom Brooks, and the 1985 and 1986 reports by Mr. Brooks and Mr. D. J. Ackerman (see references). With the assistance of the Lakewood, Colorado USGS office, WWE was able to locate Mr. Ackerman, who continues to work for the USGS at the Idaho National Engineering Laboratory (INEL), although WWE was not able to locate Mr. Brooks. WWE conducted a telephone interview with Mr. Ackerman.

5. Colorado State Engineer's Office
6. Colorado Oil and Gas Conservation Commission
7. Colorado Department of Public Health and Environment
8. Colorado Division of Minerals and Geology
9. Water Division 4, District 40 Commissioner, Mr. Jim Boyd
10. Local water well drillers
11. Local residents including, as examples: Mr. Bruce Bertram, Mr. Gerald Loucks, Mr. Glenn Miller and Mr. Greg Lazear
12. Mr. George Hampton, geologist who spent extensive time in the study area for Amoco during the 1980s
13. Current BP/America (formerly Amoco) staff with knowledge of the study area

3.4 Field Studies

Members of the WWE team, including the three peer reviewers (Drs. Grigg and Illangasekare and Mr. Oldaker) have spent time in the field during the course of preparing this report. Field studies have been wide-ranging. For example, Mr. Dwight Kimsey, adjunct WWE soil scientist/agronomist with nearly 50 years of experience, interviewed the local water commissioner, Mr. Jim Boyd, and inspected portions of the study area to observe irrigation systems. In early December 2002, WWE staff conducted gain-loss studies on Surface Creek at multiple locations near Cedaredge (see Section 5.5.2).

Throughout the course of preparing this report, WWE has worked closely with staff from Cordilleran to gather surface water and groundwater quantity and quality data at approximately 150 locations. Exhibit 1 provides locations for the baseline surface water and groundwater sampling sites. The resulting data are provided herein (see Sections 5.2.5 and 6.3 and Appendix B). Cordilleran staff have made numerous trips to the field to gather such data. Richard Dunrud has traveled to the study area on three separate occasions for geologic reconnaissance. On prior assignments, WWE staff and Messrs. Dunrud and Rold, have conducted considerable field work in the study area that is relevant for this report, as well.

3.5 Colorado State Engineer's Office Records

One of the more important sources of data for this report is water well permit records at the SEO in Denver. The SEO maintains a comprehensive and well-organized collection of water well permit records throughout the state. WWE focused on records within the study area, as defined on Figure 1. Within this area, WWE obtained approximately 440 water well permits with identifiable water sources, nearly all of which are domestic. The nature of these wells is explained in detail in Section 6.2. Exhibit 7 shows the locations of these 440 water wells as described in the SEO database.

3.6 Colorado Oil and Gas Conservation Commission Records

Oil and gas well records from the Denver offices of the COGCC provided another source of information. Exhibit 3 shows the locations of 73 oil and gas wells in the study area. WWE reviewed the COGCC database for information on each of these oil or gas wells, particularly regarding the amount of groundwater produced.

3.7 Colorado Division of Minerals and Geology Records for Local Coal Mines

Considerable insight into the hydrogeologic characteristics of the Mesaverde Formation was provided by reviewing CDMG records for 19 active and inactive coal mines within the study area. The CDMG requires mines to characterize surface and sub-surface hydrology, including water quality. Many mines have prepared Probable Hydrologic Consequences documents and Annual Hydrology Reports; these proved to be valuable information sources. In addition, CDMG has prepared Cumulative Hydrologic Impact Analysis documents, which not only summarize surface water and groundwater resources throughout the study area, but also anticipate hydrologic impacts to these resources from the extraction of coal and the subsequent overburden subsidence. As discussed in Section 6.5, a consistent finding among the reports is that there is very little groundwater within the Mesaverde Formation, and, with few exceptions, when groundwater is encountered, it is associated with small, discontinuous sandstone lenses. One exception to this was fault-related inflows that the Mountain Coal Company experienced at

West Elk Mine in 1996-97. Based on age-dating results of these inflows, and other analyses, the water was determined to be over ten thousand years old and hydrodynamically separate from other ground and surface waters (May 1998). To obtain more detailed background information on this topic, which is presented herein in Section 6.5.2, interviews were conducted with representatives of Mountain Coal Company and files were reviewed from CDMG and WWE (WWE consulted for the West Elk Mine on this matter).

3.8 U.S. Geological Survey Monitoring Wells in Study Area

Considerable time was spent conducting interviews with representatives of the USGS and SEO to locate well logs, data and other information on approximately one-dozen USGS monitoring wells in the study area that were referenced in the USGS reports by Brooks (1983), Brooks and Ackerman (1985), and Ackerman and Brooks (1986). The USGS apparently turned some of these wells over to the SEO for continued monitoring in the early 1990s. A more detailed discussion of these wells can be found in Section 6.4.1.

3.9 U.S. Bureau of Land Management and Amoco Well Logs

Another valuable historic source of data is coal mining-related information from the BLM obtained by interviewing staff from the BLM and other federal agencies, and searching through archived records at the USGS offices in Lakewood.

Historic water, oil and gas well logs and reports from Amoco (now BP/America) also provided considerable insight into the geology and hydrogeology of the study area.

3.10 U.S. Forest Service and U.S. Bureau of Land Management Environmental Assessment

WWE staff met with representatives of the USFS and BLM to discuss natural gas permitting on federal lands in Delta and Gunnison Counties. WWE also reviewed two environmental impact assessments completed by these agencies in the vicinity of the study area, including the *Final Environmental Impact Statement Oil and Gas Leasing Analysis, Grand Mesa, Uncompahgre and*

Gunnison National Forests (USFS 1993) and the *North Fork Coal Environmental Impact Statement Delta and Gunnison Counties, Colorado* (BLM and USFS 2000).

3.11 Public Water Supplies

Large, public water supply systems in the study area, for such communities as Hotchkiss, Paonia, Cedaredge and Orchard City, are derived from surface supplies (frequently on the Grand Mesa) or alluvial groundwater "under the direct influence of surface water," rather than deep bedrock groundwater. WWE has obtained background on these systems from various sources including Drinking Water Section files at the Colorado Water Quality Control Division of the Colorado Department of Public Health and Environment.

3.12 Engineering and Geologic Analysis

Considerable engineering and geologic analyses were conducted during the preparation of this report. For example, one area of particular importance is the nature and character of groundwater within the Mesaverde Formation, since the formation is the targeted source of natural gas. As described above, there are extensive water well data in the study area available from the SEO; such data provide insight into the hydrogeologic properties of the Mesaverde Formation. In addition, water quality data for wells reported to be completed in the Mesaverde Formation were obtained from multiple sources and carefully analyzed. Comparisons between surface water chemistry and groundwater chemistry, described in Section 6.6, provide insight into the water sources for Mesaverde Formation wells. WWE and Messrs. Rold and Dunrud also conducted thorough research to develop geologic cross sections of the study area, as contained in Exhibits 5 and 6.

3.13 Summary and Potential for Periodic Report Updates

To summarize, the WWE team has undertaken a large-scale effort to gather, organize and interpret water resources data for the 756-square-mile study area defined in Figure 1. As a result, substantial information and data related to groundwater and surface water quantity (hydrology) and quality have been obtained. As this report is widely disseminated and reviewed,

other data sources may be identified. WWE welcomes the identification of other sources and is prepared to integrate new information and data into subsequent versions of this report. With that said, the information contained herein provides an adequate baseline or foundation upon which an assessment can be made regarding the probable impacts of exploratory natural gas wells in the study area.