CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT (CHIA)

Proposed Smoky Hollow Mine
Andalex Resources, Inc., Tower Division
PRO/025/002
Kane County, Utah

October 3, 1995

Andalex Resources, Inc.'s proposed Smoky Hollow Mine is located in the southern Kaiparowits Plateau Coal Field, approximately 15 miles north-northeast of Big Water, Utah, 11 miles north of Lake Powell, and 25 miles north of Page, Arizona (Figure 1). Access to the area is by dirt road from Big Water. A section of this road passes through Glen Canyon National Recreation Area. The proposed mine portals will be located in Smoky Hollow, a side canyon of Warm Creek Canyon. (Squaw Canyon, situated just to the east of Smoky Hollow, is identified as Smoky Hollow on some older maps. There is another drainage named Smoky Hollow that drains eastward into Last Chance Canyon and is located just east of the Andalex permit area.) Warm Creek discharges into Lake Powell at Warm Creek Bay. The United States Bureau of Land Management (BLM) refers to the proposed Smoky Hollow Mine as the Warm Creek Project.

The Smoky Hollow Mine permit area is shown on Figures 2 and 3. In addition to the coal leases within the Smoky Hollow Mine permit, Andalex Resources has leases immediately to the north, west, and east for possible future mining within what is called the Logical Mining Permit Area (LMPA). Andalex has leases on additional coal north and east of the LMPA, but there are no current plans to mine this coal and these leases will probably be dropped in the near future. There are no active mines in the area, but 5M, Inc. has leases to the north of the Andalex leases that are subject to diligent development. Figure 2 shows the other anticipated operations in relation to the Smoky Hollow Mine permit area. Portions of both the Andalex and 5M leases are within BLM wilderness study areas. Farther to the north leases have been issued to Utah Power and Light Company (UP&L), but they are in suspension because they are in a BLM wilderness study area and have not been included in this Cumulative Hydrologic Impact Assessment (CHIA). Sunoco has a Preference Right Lease Application on coal adjacent to the UP&L leases.

This CHIA is a findings document involving an assessment of the cumulative impact of all anticipated coal mining operations on the hydrologic balance within the Cumulative Impact Area (CIA). The CHIA is not simply a determination if coal mining operations are each designed to prevent material damage beyond their respective permit boundaries when considered individually, but rather is a determination if there will be material damage resulting from effects that become cumulative outside the individual permit boundaries.

CHIA - SMOKY HOLLOW

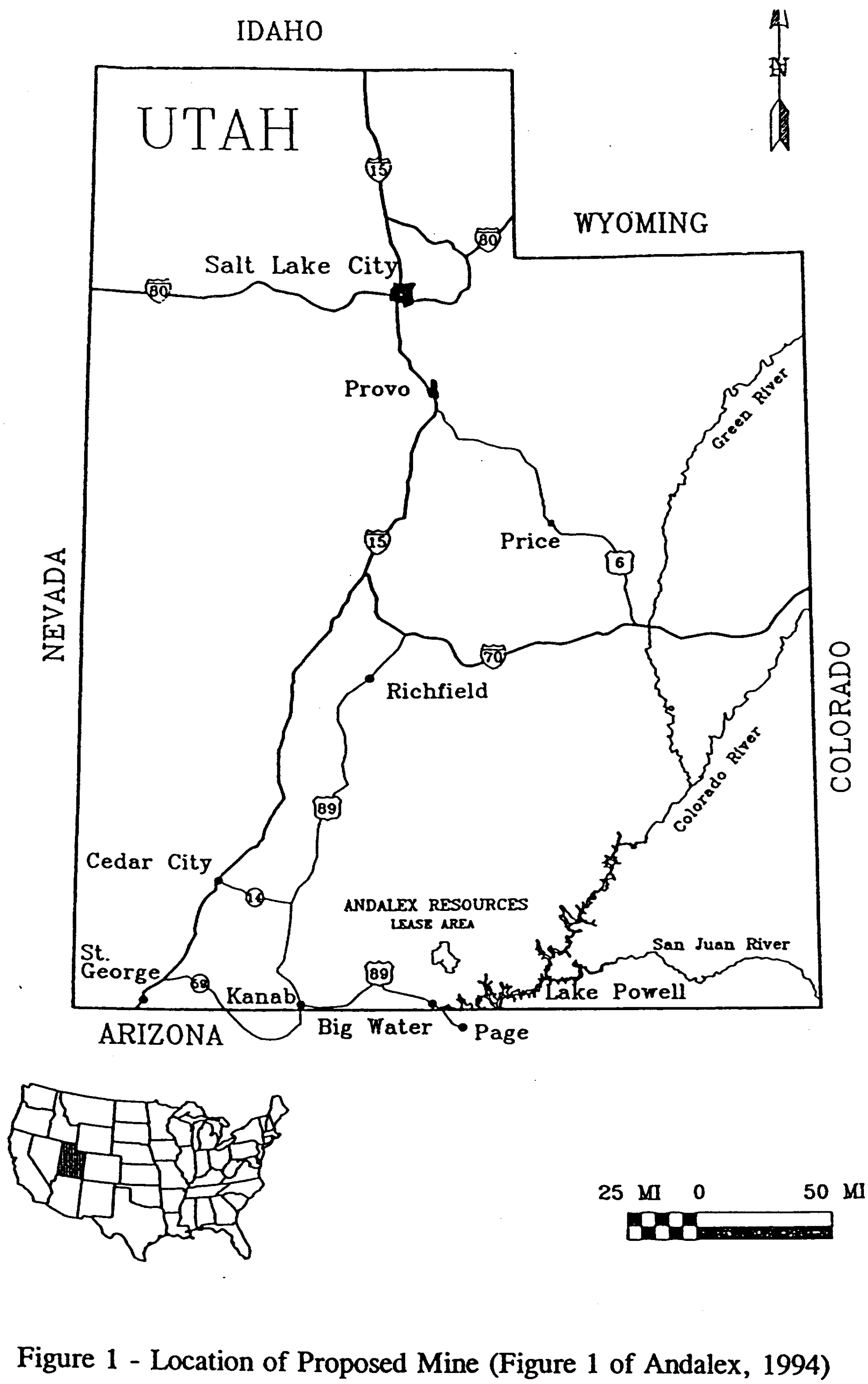

Figure 1 - Location of Proposed Mine (Figure 1 of Andalex, 1994)

CHIA - SMOKY HOLLOW

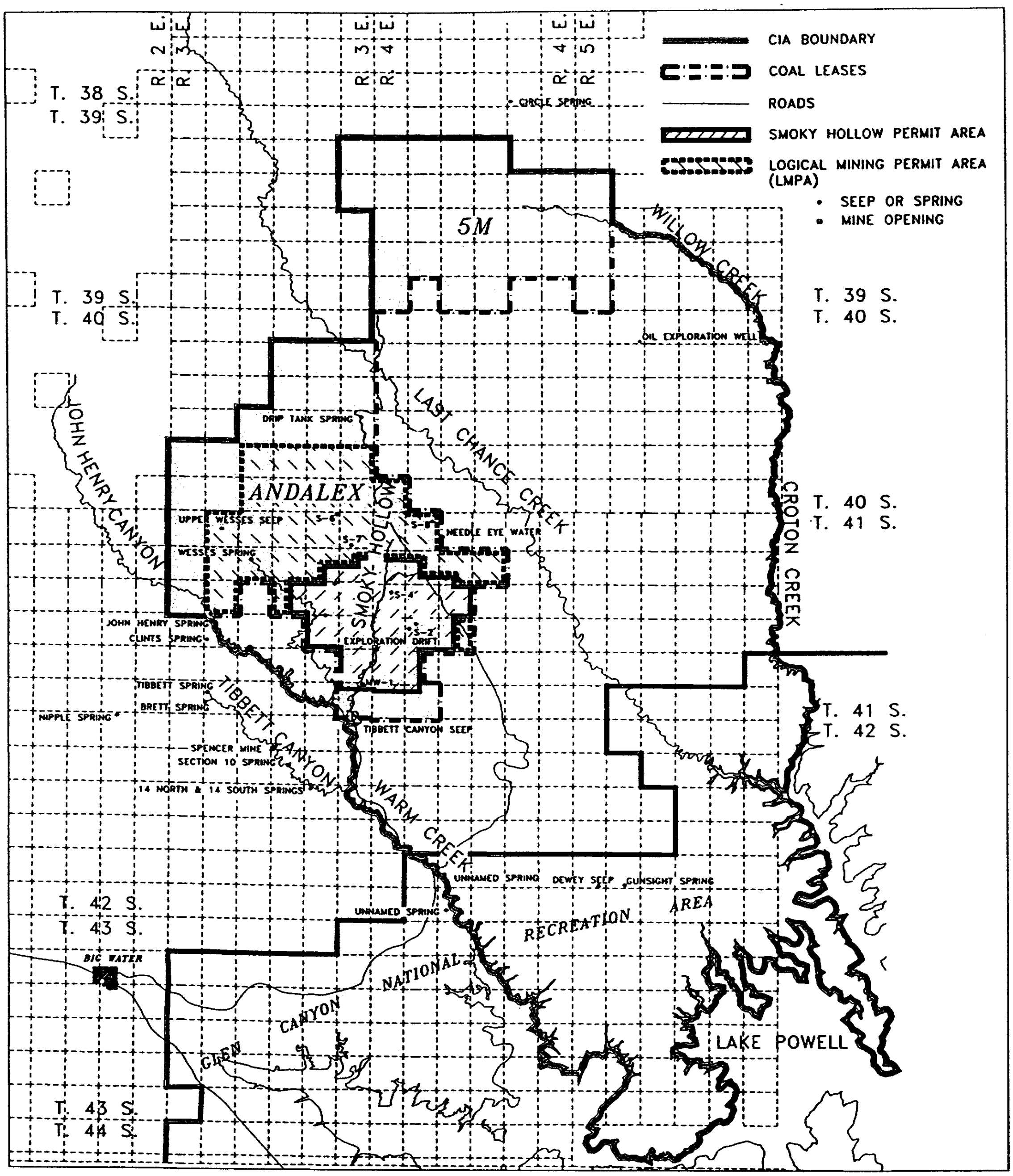

FIGURE 2 Cumulative Impact Area (CIA)

The objectives of a CHIA document are to:

1. Identify the Cumulative Impact Area (CIA).
2. Describe the hydrologic system.
3. Document the baseline conditions of surface and ground water quality and quantity.
4. Identify which hydrologic resources are likely to be impacted and determine which parameters are important for predicting future impacts to those hydrologic systems.
5. Identify relevant standards against which predicted impacts can be compared.
6. Estimate probable future impacts of mining activity with respect to the parameters identified in 4.
7. Assess probable material damage.
8. Make a statement of findings.

Material damage is not defined in either the Utah or Federal regulations. Criteria that are used to determine material damage to hydrologic resources in coal mining programs administered by other states or by the Federal Office of Surface Mining (OSM) include:

- Actual or potential violation of water quality criteria established federal, state, or local jurisdictions.
- Changes to the hydrologic balance that would significantly affect actual or potential uses as designated by the regulatory authority.
- Reduction, loss, impairment, or preclusion of the utility of the resource to an existing or potential water user.
- Short term (completion of reclamation and bond release) impairment of actual water uses that cannot be mitigated.
- Significant actual or potential degradation of quantity or quality of surface water or important regional aquifers.

This CHIA has been prepared by the Utah Division of Oil, Gas, and Mining. It complies with federal and Utah coal regulations as found in 30 CFR 784.14(f) and

R645-301-729 respectively. Sources of information used to prepare this CHIA are listed in the References section. Sources include the Kaiparowits Final Environmental Impact Statement (EIS) prepared by the BLM in 1976 and the Smoky Hollow and Logical Mining Permit Area (LMPA) Permit Application Packages (PAP's) submitted by Andalex Resources, Inc. to the Utah Division of Oil, Gas, and Mining (DOGM). Information provided in these two documents is often from other sources, most of which are not directly referenced in this CHIA. Additional information has been provided by Andalex in the Logical Mining Permit Area Permit Application Package submitted to DOGM on December 14, 1994.

I. CUMULATIVE IMPACT AREA (CIA)

The Cumulative Impact Area (CIA) is shown on Figure 2. This is the area within which the actual and anticipated coal mining activities may interact to affect the surface and ground water. The CIA is determined based on anticipated mining activities, knowledge of surface and ground water resources, and anticipated impacts of mining on those water resources. Both surface and ground water CIA's have been delineated.

The Spencer Mine was operated in Tibbett Canyon from 1910 to 1913 (Figure 3), but there are no active coal mine operations within the CIA. Mono Power proposed a group of five underground coal mines in the Smoky Hollow area that were to have produced up to 12 million tons of coal per year (USGS, 1979). Anticipated mining operations that have been included within the CIA are the proposed Smoky Hollow Mine, adjacent coal leases held by Andalex, and the 5M, Inc. coal leases. The upstream CIA boundary coincides with the lease boundaries. Downstream the CIA extends to Lake Powell, a multipurpose storage reservoir with usable storage capacity of about 33 million acre feet. Hydrologic impacts should not become cumulative or produce material damage within the lake because of dilution that will occur.

Several coal outcrops in Smoky Hollow were exposed by exploration in the 1960's and portals of a test mine were opened in 1971. These areas have been backfilled and graded, and most of the area disturbed by these operations will be assimilated in the Smoky Hollow Mine reclamation. Existing hydrologic impacts from these operations are incorporated into the baseline information.

CHIA - SMOKY HOLLOW

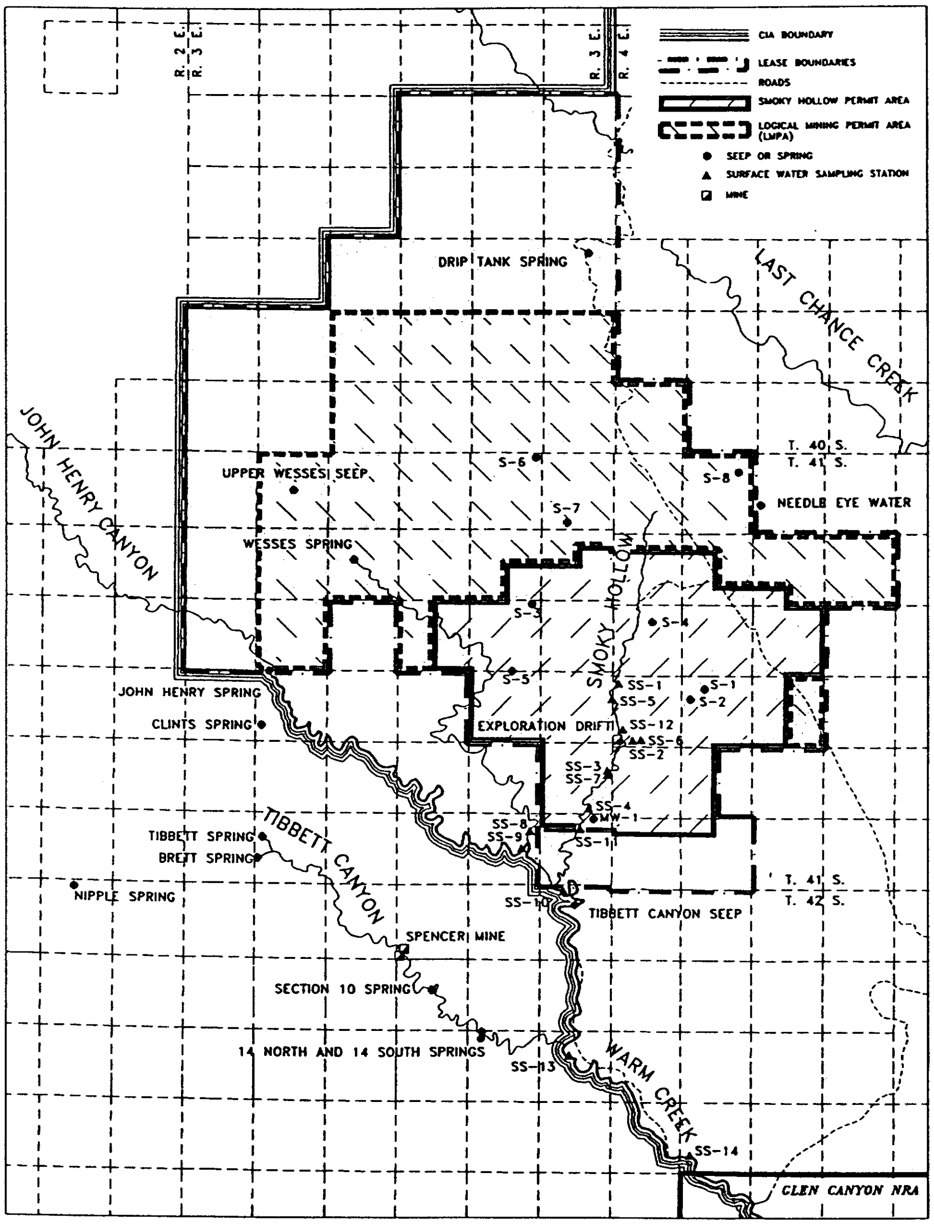

FIGURE 3 Smoky Hollow Permit Area and LMPA

The Colorado River and Lake Powell are the primary sources of surface water in the area around the southern Kaiparowits Plateau. Streams in the permit area flow only in response to heavy rainfall or snowmelt.

A ground water CIA should include the area between the anticipated mining operations and the aquifer discharge points. In the southern Kaiparowits Plateau, perched aquifers are typically shallow and receive recharge from relatively small areas near where they discharge as seeps and springs. The seeps and springs included in this CHIA are treated as an aggregate in a single ground water CIA that coincides with the surface water CIA. Several springs that are monitored by Andalex and are included in the following discussions have been left out of the CIA because they and their recharge areas are isolated from the anticipated coal mining operations by geologic structure or by deeply incised surface drainages.

There is no evidence of a regional aquifer within the potentially impacted strata above or below the coal seams. The Calico Sandstone at the base of the John Henry Member is continuous over a large area, but permeabilities are low, similar to those of other sandstones of the Straight Cliffs Formation. The coal bearing strata are separated from underlying, more permeable sandstones by six to seven hundred feet of low permeability Tropic Shale. Of these deeper sandstones, the Navajo Sandstone aquifer has the greatest potential for ground water development (Blanchard, 1986). The Navajo aquifer is recharged in distant areas to the north, west, and southwest, far beyond potential impacts from the proposed mine. It discharges to the south directly into Lake Powell.

II. HYDROLOGIC SYSTEM

Precipitation

The closest operating weather station to the permit area is located in Page, Arizona. There is a National Weather Service monitoring station at Big Water, Utah which records temperature and precipitation on a daily basis. The BLM operates several rain gauges around the Nipple Bench area. Andalex has established several locations within the permit area for recording precipitation data. Precipitation information was collected in the area from 1971 to 1974 as part of a Brigham Young University study.

The annual precipitation at Page, Arizona from 1967 to 1982 averaged 6.35 inches/year. Seasonal averages for the same years at Page, Arizona were: March to May - 1.48 inches/year; June to August - 1.31 inches/ year; September to November - 1.83 inches/ year; and December to February - 1.75 inches/year.

Brigham Young University (BYU) collected precipitation information from five locations between the proposed mine and Lake Powell from 1971 through 1974. Precipitation ranged from 3.94 to 15.12 inches/year and averaged 7.31 inches/year. A higher percentage of the yearly precipitation usually occurred during the cooler months of October through March than during the warmer months of April through September. The lowest percentage of yearly precipitation typically occurred from April through June.

Snowmelt is a major contributor to streamflow in the region. Snow is generally stored through most of the winter at higher altitudes and gradually melts during the spring and early summer. The potential ground water recharge for the drainages in the Kaiparowits Plateau is estimated to be only 1 gpm/mi^2.

Surface Water

Streams within the area of the proposed Smoky Hollow Mine flow only in response to heavy rainfall or snowmelt. Summer precipitation is received in the form of intense, localized thunderstorms. Intense rainfall may cause flooding at times but the areas affected are usually small and well drained. Runoff tends to be rapid and of short duration and carries a very high level of suspended solids. The magnitude of the 100 year, 6 hour precipitation event ranges from 2 inches near Lake Powell to 3 inches in the higher elevations. Streams are of little value as water supplies because they are dry much of the year.

The Colorado River and Lake Powell are the primary sources of surface water in the southern Kaiparowits Plateau area. The Glen Canyon Dam impounds a section of the Colorado River to form Lake Powell, located approximately 11 miles south of the proposed Smoky Hollow Mine. Lake Powell is a multipurpose storage reservoir that has inundated the southeastern edge of the Kaiparowits Plateau. Usable storage capacity, including bank storage, is about 33 million acre feet.

Ground Water

Ground water occurs in the Straight Cliffs Formation in small, localized perched systems related to discontinuous sandstone lenses and also thin continuous sandstones such as the Tibbett Canyon Member. Continuous regional aquifers are found in deeper formations such as the Navajo Sandstone, separated from the coal bearing strata by 600 to 700 feet of low permeability Tropic Shale and additional thicknesses of other low permeability strata. A principal factor influencing the distribution and availability of ground water is geology.

Geology

Stratigraphy

Where exposed, the Navajo Sandstone is a recognizable cliff-former, strongly jointed, and composed mostly of a fine-grained sandstone with aeolian cross-bedding. It is generally a light colored, fine- to medium-grained friable and massive sandstone that is weakly cemented with carbonate and iron oxide. It intertongues with the overlying Carmel Formation. It is estimated to be 1,100 to 1,700 feet thick beneath Smoky Hollow. The principal regional aquifer beneath the permit and adjacent areas exists in the Navajo Sandstone (Blanchard, 1986). Beneath the proposed permit area the potentiometric surface may rise to within several hundred feet of the lowest coal seam to be mined, even though the aquifer is at a depth of 1,000 feet or more. Several wells tap the Navajo where it lies at or near the land surface around the margins of the Kaiparowits Plateau, and large diameter wells can yield up to 1,000 gallons per minute.

The Carmel overlies the Navajo Sandstone and consists of interbedded shale, sandstone, limestone and gypsum. It is mainly a reddish brown very fine- to coarse-grained quartzose sandstone and pale reddish brown to grayish red mudstone. The thickness ranges from 80 to 520 feet. Ground water in the Navajo aquifer can become more saline in areas where the potentiometric surface rises and water contacts the Carmel Formation.

The orange to reddish color and massive appearance make the Entrada Formation conspicuous in outcrops. It is mostly fine-grained sandstone with lesser amounts of reddish shale. Thickness of the unit ranges from 200 to 900 feet.

The Jurassic Cow Springs Sandstone and overlying Morrison Formation are cliff forming sandstones that contain conglomerates and shale. The unconformable contact with the underlying Jurassic rocks is sharp. A regional unconformity separates the Cow Springs and Morrison from the overlying Cretaceous strata and truncates these two formations near Wahweap Creek. Maximum combined thickness in the Kaiparowits Plateau could be as much as 700 feet, but thickness beneath the CIA is not known.

The Dakota Formation is the oldest Cretaceous unit exposed in the southern Kaiparowits Plateau area. The ledge-forming Dakota is sandstone interbedded with mudstone and varying amounts of conglomerate, claystone, bentonite and coal. It is up to 250 feet thick.

The Tropic Shale is a thinly laminated to thin-bedded mudstone and shale unit with lesser amounts of sandstone, bentonitic claystone, siltstone, and limestone. It is 610 to 705 feet thick in the area of the CIA. It has low permeability and hinders vertical movement of ground water. The Tropic Shale is the principal aquiclude separating the overlying coal bearing strata of the lower Straight Cliffs Formation from the Navajo Sandstone.

The Straight Cliffs Formation is locally divided into four members, from oldest to youngest: the Tibbett Canyon, Smoky Hollow, John Henry, and Drip Tank Members. Exploratory drill-hole data reveal discontinuous, perched saturated zones in and above the coal-bearing beds. Recharge to these perched zones is limited because they are enveloped by low permeability mudstones. Horizontal and vertical hydraulic conductivity analyses of six siltstone samples ranged from 1.3×10^{-7} to 1.1×10^{-4} ft/day. X-ray diffraction analyses of mudstone showed smectites comprise a major portion of the clay minerals.

The Tibbett Canyon Member is characteristically a littoral sandstone with gray mudstone and siltstone partings dividing the sandstone beds. It is cliff forming and ranges in thickness from 70 to 185 feet in the Smoky Hollow area. Regional transmissivities of the Tibbett Canyon Member and Calico Sandstone are estimated to be similar. Data regarding the occurrence of ground water within the Tibbett Canyon Member are not available; however, it is reasonable to assume that the Tibbett Canyon Member fits the pattern of the Straight Cliffs Formation. Tibbett Canyon Seep is located in Warm Creek Canyon approximately one mile south of the Smoky Hollow permit boundary. Springs 14 South and 14 North issue from the Tibbett Canyon Member in Tibbett Canyon, a side canyon to Warm Springs Canyon. Ground water monitoring well MW-1 was installed in the Tibbett Canyon Member in 1990 and is located roughly midway between the mine and Tibbett Canyon Seep (Figure 3). The relatively impermeable Tropic Shale beneath the Tibbett Canyon Member probably promotes saturation of the member in structural troughs.

The Smoky Hollow Member of the Straight Cliffs Formation has three informal subdivisions: a basal coal zone, a middle barren zone, and the Calico Sandstone at the top. The coal zone contains dark gray carbonaceous mudstone, thin coal beds, and very thin-bedded sandstone. The barren zone consists of yellowish gray to white sandstone beds and gray shale or mudstone. Some of the mudstones are bentonitic.

The Calico Sandstone, which intertongues with the upper beds of the barren zone, consists of fine to coarse grained, poorly sorted, occasionally pebbly sandstone. This sandstone, which lies approximately 150 feet below the Red coal seam, averages 25 feet in thickness and attains a maximum thickness of 51 feet. The top of the Calico Sandstone represents a regional unconformity and the bed itself is missing near Wahweap Creek about 3 miles east-southeast of Big Water. The Calico Sandstone was also eroded from the northeastern part of the region prior to the deposition of the John Henry Member. There are no known water supply wells in the Calico Sandstone or the other units of the Smoky Hollow Member.

The John Henry Member is a slope- and ledge-forming unit of sandstone, mudstone, carbonaceous mudstone, and coal. The coal seam to be mined at Smoky

Hollow, the Red seam, is in the John Henry Member. Mudstone interbeds with the sandstones of the barren zones above and below the coal seam. Ground water was encountered in exploratory drill holes in discontinuous perched zones within the John Henry Member. Only Section 10 Spring occurs in the John Henry Member.

The Drip Tank member is mostly yellow brown to yellow gray, fine to medium grained, poorly sorted, lenticular sandstone in medium to thick beds. The sandstone is interlensed with minor mudstone and pebble conglomerate. Discontinuous ground water zones support the flow to a limited number of seeps and springs within the region. Discharge from individual springs is generally less than 1 to about 20 gallons per minute. Seeps S-1 through S-8, Needle Eye, Drip Tank, John Henry, Clint, Wesses, and Tibbett Springs issue from the Drip Tank Member. Regionally, the Drip Tank Member is considered a major water bearing unit of the Straight Cliffs Formation (Plantz, 1985), but locally it is discontinuous and deeply incised by canyons and contains limited water resources.

The Wahweap Formation, an interbedded sandstone-mudstone unit, conformably overlies the Straight Cliffs Formation and crops out over the northern part of the CIA. Plantz (1985) indicated that discharge from seeps and springs in the Wahweap is from less than 1 to about 5 gpm. Andalex' surveys located only one seep, Upper Wesses Seep, in the Wahweap Formation. Seepage was observed near the base of the Wahweap Formation beneath the base of a sandstone ledge underlain by fine-grained sediments. Total seepage at this site was less than 0.5 gpm. None of the exploratory drill holes encountered ground water in the Wahweap Formation.

Thin alluvial deposits of clay, silt, and sand are found in the canyon bottoms. Landslides are located along canyon sides and Tropic Shale outcrops. Poorly stratified gravel, sand, and clay deposits form terraces and the dissected remnants of erosional terraces in the southern parts of the CIA. Wind blown sand is found on benches and pediment surfaces.

Structure

Overall, the Kaiparowits Plateau is a structural basin, with the basin center located approximately 15 miles northwest of the proposed Smoky Hollow Mine. The northeast side of the basin is Fiftymile Mountain and the west side is the East Kaibab monocline. The Paunsaugunt Fault terminates the basin on the north, and the Colorado River has eroded Glen Canyon down through the south side of the basin. Surface drainage is to the southeast, toward Glen Canyon. Internal structure of the basin is characterized by asymmetric synclines and anticlines. Most of these folds plunge toward the basin center, with fold axes typically oriented north-south to northwest-southeast. A few anticlines, Smoky Hollow anticline being one, are double plunging. Faults are normal and often parallel to the fold axes, but they are not major structural features. Throws are generally small, 200 feet being the largest noted by Doelling and Graham (1972).

The proposed Smoky Hollow Mine is near the crest of the Smoky Mountain anticline, which plunges to the northwest at about 2 degrees, against the regional drainage. Dip on the west flank of the anticline is approximately 2 to 3 degrees to the southwest, and on the east flank it is 2 to 8 degrees to the northeast. Smoky Mountain coincides with the crest of the Smoky Hollow anticline. Last Chance Canyon, east of the mountain, coincides with the Last Chance syncline. Sections of Warm Creek, Tibbett, and Wesses Canyons follow the more sinuous Warm Creek syncline on the west flank of Smoky Mountain. Based on information from drilling, ground water flow appears to be diverted around the north plunging nose of the Smoky Hollow anticline and into the Warm Creek and Last Chance Synclines.

Seeps and Springs

Andalex initially identified and observed eight seeps and springs in the Smoky Hollow area and began baseline sampling and analysis in 1988. Andalex had spring and seep surveys conducted in and around the Smoky Hollow Mine permit area in September 1990 and February 1992. The September 1990 survey located five seeps or damp areas in an area that extended at least one-quarter mile beyond the boundary of the proposed Smoky Hollow permit area. The February 1992 survey included the eight previously known seeps and springs, the five seeps located in the September 1990 survey, plus two additional springs identified from a U.S. Geological Survey (USGS) topographic map. Wesses Spring was added to the list of monitored sites in 1993. During November 1994 and April 1995 additional survey work was performed within the LMPA and at least one-half mile to the north and west beyond the LMPA boundary. The November 1994 survey located 4 additional seeps within the LMPA, but no additional seeps or springs were found in adjacent areas. No additional sites were found during the April 1995 field work. Locations of the seeps and springs are shown on Figures 2 and 3. Several seeps and springs that were not included in the Andalex surveys but that are within or adjacent to the CIA have been identified from USGS topographic quadrangles and are also shown on Figure 2.

Section 10 Spring (Figure 2), located in Section 10, T. 42 S., R. 3 E. (Tibbett Bench 7 1/2 minute topographic quadrangle) was visited by Andalex in October 1988, September 1990, and in February 1992. No water, moist soil, efflorescence, alkali deposits, trees, unusual vegetation, or signs of use by cattle or wildlife were observed at this location or anywhere along the canyon bottom. This spring site is the only one investigated that is in the John Henry member of the Straight Cliffs Formation.