

1 INTRODUCTION

The Office of Surface Mining Reclamation and Enforcement (OSMRE) is the regulatory authority for coal mining operations on Indian Lands under the Surface Mining Reclamation and Control Act of 1977 (SMCRA) (U.S. Congress, 1977). As such, OSM is responsible for the review and decisions on all permit applications to conduct surface coal mining operations within the boundaries of the Navajo Nation Reservation. BHP Navajo Coal Company's (BNCC's) Navajo Mine permit area is located on Navajo Nation lands. By regulation, OSM must prepare a Cumulative Hydrologic Impact Assessment (CHIA) for this permit area. The CHIA determines whether the proposed operation has been designed to prevent material damage to the hydrologic balance outside the permit area (30 Code of Federal Regulations (CFR) § 780.21(g)).

A CHIA is an assessment of the probable hydrologic consequences (PHC) of the proposed operation and all anticipated coal mining upon surface and groundwater systems in the cumulative impact area (CIA). The PHC is prepared by the applicant, as required by 30 CFR § 780.21(f), and approved by the regulatory authority. Congress identified SMCRA (U.S. Congress, 1977) that there is "a balance between protection of the environment and agricultural productivity and the Nation's need for coal as an essential source of energy" (SMCRA, 1977 Sec 102(f)). The hydrologic reclamation plan required by the rules at 30 CFR § 780.21(h) recognizes that disturbances to the hydrologic balance within the permit and adjacent area should be minimized, material damage outside the permit area should be prevented, applicable Federal, Tribal, and State water quality laws should be met, and the rights of present water users protected. Additionally, 30 CFR § 816.42 states "discharges of water from areas disturbed by surface mining activities shall be made in compliance with all applicable State and Federal water quality laws and regulations and with the effluent limitations for coal mining promulgated by the United States Environmental Protection Agency (USEPA) set forth in 40 CFR part 434." Discharges of disturbed area runoff at the Navajo Mine are conducted in accordance with the terms and conditions of a National Pollutant Discharge Elimination System (NPDES) permit issued by the USEPA and certified by the Navajo Nation and Hopi Tribe under the Clean Water Act (CWA).

OSMRE considered USEPA approved surface water quality standards for the Navajo Nation Environmental Protection Agency (NNEPA) as part of this assessment. Protection of existing and foreseeable water uses within the various delineated cumulative impact areas was a focus of this assessment. Additionally, potential impacts associated with the historic disposal of coal combustion by-products (CCB) at the Navajo Mine were specifically evaluated. This CHIA supersedes the CHIA written in February, 1984 (Kaman Temp 1984), and addendum from 1989 (OSMRE 1989). Findings with regard to material damage are summarized below (Table 1).

Table 1: Navajo Mine – Material Damage Summary

Water Resource	Assessment Approach	Hydrologic Balance Threshold Reached	Material Damage Limit Reached	Measures to Minimize Impact	Adequate Monitoring Program
Fruitland & PCS Quantity	Evaluation of potentiometric surface contour maps	No	No	Contemporaneous Reclamation	Yes
Alluvial Quantity	Comparison of water levels at individual wells over-time	No	No	Contemporaneous Reclamation; mining limited to ephemeral channels; stream buffer zones	Yes
Surface Water Quantity	SEDCAD modeling-assessment of pre- and post-mining impacts; Percent of HUC12 Watersheds controlled with impoundments	Yes	No		Yes
Fruitland & PCS Quality	Comparison of baseline water quality to potentially impacted or non-baseline wells, including spoil and CCB wells	No	No	Contemporaneous Reclamation; mixing of overburden/ backfill materials	Yes
Alluvial Quality	Comparison baseline (upstream/pre-mining) water quality to non-baseline (post-mining/downstream) water quality	Yes	No	Contemporaneous Reclamation; mining limited to ephemeral channels; stream buffer zones	Yes
Surface Water Quality		No	No	Contemporaneous Reclamation; mining limited to ephemeral channels; stream buffer zones; Sedimentation Ponds	Yes

The finding that the mining operation is designed to prevent material damage to the hydrologic balance outside the permit area is supported by the following chapters. The Navajo Mine CHIA is organized as follows:

- Chapter 1 describes the regulatory environment and general background of Navajo Mine.
- Chapter 2
 - Assesses the cumulative impact potential with historical and active coal mines.
 - Delineates the surface water CIA.
 - Delineates the groundwater CIA.

- Chapter 3 identifies water resource uses and water use designations within the CIAs.
- Chapter 4 provides a description of baseline surface and groundwater quantity and quality within the CIAs.
- Chapter 5 contains an impact assessment of the BNCC operation on surface and groundwater quantity and quality, and includes a determination of:
 - The minimization of impacts within the lease area; and,
 - The adequacy of the monitoring program to assess potential impacts.
- Chapter 6
 - Establishes hydrologic balance thresholds and material damage limits; and,
 - Contains the summary CHIA findings statement.

1.1 Regulatory Environment

Surface coal operations within the Navajo Nation are managed through the coordinated collaboration of several regulatory agencies. Depending on the permitting action, several regulatory agencies may be involved in the review, comment, and public participation process. Regulatory agencies that may have a permitting action on the BNCC permit include:

- OSMRE (regulatory authority for coal mining operations within the Navajo Nation)
- Bureau of Indian Affairs (protect and improve trust assets of the Tribes)
- Navajo Nation Environmental Protection Agency (NNEPA) (develop and administer water quality standards)
- Navajo Nation Minerals Department (represent Tribal mineral interests)
- Navajo Nation Water Management Branch (implement Navajo Nation's Water Code)
- USEPA (issue and administer NPDES permits)
- U.S. Fish and Wildlife Service (ensure protection of threatened and endangered species)
- Bureau of Land Management (ensures maximum resource recovery)
- U.S. Army Corps of Engineers (issue permits and associated impact assessments for the discharge of fill material into waters of the United States, including wetlands under section 404 of the CWA)

The 2012 Navajo Mine CHIA has been peer reviewed by the Bureau of Indian Affairs (BIA), Navajo Nation Environmental Protection Agency (NNEPA), Navajo Nation Minerals Department (NNMD), U.S. Army Corps of Engineers (USACE), and OSM technical staff. Additionally, separate face-to-face discussions were conducted with the aforementioned organizations to review the assessment approach, and to identify any potential major concerns prior to finalization of the assessment. BIA, NNMD, and USACE concurred that the assessment approach for the 2012 Navajo Mine CHIA was reasonable, and the conclusions were appropriate. NNEPA found that the process used to determine water quantity impact was appropriate and that comparison between baseline and post-mining results was acceptable.

OSM developed a use impact assessment approach, specific to the evaluation of potential impacts from Navajo Mine. This approach developed by OSM in part referenced and used NNEPA water quality standards for comparison and also considered Baseline (background) water quality as well as research supported water quality criteria for livestock. OSM did not use NNEPA guidance for assessing the quality of Navajo Nation surface waters to determine impairment because OSM has no authority to implement 303d impaired stream listing protocols. For this reason NNEPA cannot concur with OSM's conclusions without first assessing water quality impairment using NNEPA guidance. NNEPA has expressed future plans to conduct analysis on the available data set using NNEPA guidance.

1.1.1 CHIA Revision Rationale

The CHIA is not updated at a specified interval. 30 CFR § 780.21(g)(2) states “an application for permit revision shall be reviewed by the regulatory authority to determine whether a new or updated CHIA shall be required.” A revision to the BNCC life-of-mine (LOM) permit application package (PAP) was submitted to OSMRE in March 2011. Revision updates include additions to the groundwater resources information (PAP, Chapter 6) and probable hydrologic consequences (PAP, Chapter 11). The revision was approved by OSMRE in March 2012. The factors below describe the major differences from the previous CHIA.

The 2012 CHIA for BNCC operations:

- Provides a definition for “Material Damage to the Hydrologic Balance”,
- Identifies material damage limits and hydrologic balance thresholds,
- Updates hydrologic monitoring data sets through 2010,
- Includes background baseline information for Mine Areas IV and V,
- Considers NNEPA 2007 surface water use designations and water quality standards,
- Evaluates the effects of Morgan Lake,
- Considers the effect of the Navajo Agricultural Product Industry (NAPI),
- Evaluates the impact of CCB placement within the permit area,
- Updates the methodology for impact assessment,
- Refines the surface water CIA, and
- Expands the groundwater CIA.

1.1.2 Cumulative Impact Area

A CIA is defined at 30 CFR § 701.5 as, “. . . the area, including the permit area, within which impacts resulting from the proposed operation may interact with the impacts of all anticipated mining on surface- and ground-water systems.” The CIA is an area where impacts from the coal mining operation, in combination with additional coal mining operations, may cause material damage (OSMRE 2002). The size and location of a given CIA will depend on the surface water and groundwater system characteristics, the hydrologic resources of concern, and projected impacts from the operations included in the assessment (OSMRE 2007). For this CHIA, one surface water CIA and one groundwater CIA are delineated to assess impacts associated within these distinct hydrologic resource areas.

1.1.3 Material Damage to the Hydrologic Balance

Sections 507(b) (11) and 510(b) (3) of SMCRA, and 30 CFR § 780.21 (g) require OSMRE to determine if a mining and reclamation operation has been designed to prevent material damage to the hydrologic balance outside the permit area. “Hydrologic balance” is defined at 30 CFR § 701.5 as, “the relationship between the quality and quantity of water inflow to, water outflow from, and water storage in a hydrologic unit such as a drainage basin, aquifer, soil zone, lake or reservoir. It encompasses the dynamic relationships among precipitation, runoff, evaporation, and changes in ground and surface water storage.”

“Material damage to the hydrologic balance” is not defined in SMCRA or at 30 CFR § 701.5. The intent of not developing a programmatic definition for “material damage to the hydrologic balance” was to provide the regulatory authority the ability to develop a definition based on regional environmental and regulatory conditions. Therefore, for the purpose of this CHIA;

Material damage to the hydrologic balance outside the permit area means any quantifiable permanent adverse impact from surface coal mining and reclamation operations on the quality or quantity of surface water or groundwater that exceeds the identified material damage limits and that would preclude any existing or reasonably foreseeable use of surface water or groundwater outside the permit area.

SMCRA recognizes that coal mining will have some hydrologic impacts; therefore, differentiates between impacts within the permit area and outside the permit area. Disturbances to the hydrologic balance within the permit and adjacent area should be minimized, and material damage outside the permit area should be prevented (30 CFR 780.21). The Navajo Mine CHIA evaluates the entire lease area (Figure 1). The lease area includes BNCC coal mining areas prior to the enactment of SMCRA north of the permit area, and includes lease areas IV south and V. In an effort to evaluate historical CCB disposal north of the permit area, and to include baseline information from areas IV south and V, the assessment includes the entire lease area.

1.1.4 Material Damage Criteria

Except for water quality standards and effluent limitations established at 30 CFR § 816.42, the determination of material damage criteria is the discretion of the regulatory authority (48 FR 43972-43973, 1983 and 48 FR 43956, 1983). Material damage criteria for both groundwater and surface water quality should be related to existing standards that generally are based on the maintenance and protection of specified water uses such as public and domestic water supply, agriculture, industry, aquatic life, and recreation (OSMRE, 1998). A CHIA also can include material damage standards for parameters of local significance to water use (OSMRE, 1998). The 2012 Navajo Mine CHIA establishes hydrologic balance thresholds and material damage limits (Ch. 6).

1.2 Background

Navajo Mine was originally an asset of Utah International, beginning operation in 1963. Utah International was acquired by GE in 1977, and then by BHP in 1984. Navajo Mine became part of BHP Billiton with the merger of BHP and Billiton in 2001, and is currently operated by BNCC. Navajo Mine operates under Permit NM-0003(A-F). Permit NM-0003 was renewed in 1991, 1993, 1994, 1999, 2004, and 2010; pursuant to 30 CFR 774.15(c).

The Navajo Mine is located 18.6 miles southwest of Farmington, New Mexico, on a contiguous lease within the northeastern portion of the Navajo Nation (Figure 2). The Navajo Mine permit is 24,211 acres (BNCC 2011, Appendix 1-C); the original permit covered 12,092 acres. The permit area was extended in 1991, 1993, and 1994 to 12,921, 13,429, and 13,430 acres respectively (OSMRE 1994). The Navajo Mine lease area is divided into five areas (I-V) (Figure 1) (USEPA n.d.). These lands are divided into Pre-Law, Interim, Termination of jurisdiction (TOJ), and Permanent Program land classifications (Figure 1) (BNCC 2011, Ch. 11). BNCC is currently conducting surface coal mining operations, including reclamation, in permit Areas I, II and III (USEPA n.d.), and has applied to begin operations in Area IV North.

The Navajo Mine supplies approximately 8.5 million tons of coal a year to the Four Corners Power Plant (FCPP) (BNCC 2011, Ch. 11). The coal produced is transported via the Navajo Mine Railroad up to 14 miles to the FCPP (USEPA n.d.). FCPP is a five-unit, 2,040-megawatt facility, located on the Navajo Nation west of Farmington, New Mexico, and adjacent to the Navajo Mine lease area. FCPP is operated by Arizona Public Service (APS) and owned by APS and five other utilities in the Southwest (Arizona Public Service n.d.).

Navajo Mine uses strip mining as the primary mining method in the permit area for multiple coal seam mining (BNCC 2011, Ch. 11). Strip mining involves the removal of overburden material covering the coal using blasting and large draglines. The coal is then removed by truck shovels or front-end loaders and transported to coal preparation facilities using haulage trucks. Coal seams are exposed in pits ranging in depth from 5 feet to 240 feet, mine pit lengths from 1,000 feet to 15,000 feet (BNCC 2011, Ch. 11). After the coal is removed, the overburden material is regraded to the approved topography and drainages to support the approved post-mining land uses. Stockpiled topsoil and other suitable material are spread on top of the graded overburden material to support the re-establishment of approved post-mining

vegetation. BNCC must then demonstrate the persistence of reestablished vegetative cover sufficient to support post-mining land use in accordance with 30 CFR 816.116.

1.2.1 Climate

The lease area ranges in elevation from 5,000 feet to 5,600 feet above sea level (BNCC 2011, Ch. 4). The climate at Navajo Mine varies from arid to semi-arid based on Navajo Mine precipitation records (BNCC 2011). Navajo Mine has collected climatological data from two onsite meteorological monitoring stations since 1991, designated Met Station I and II. Met Station I is located in Area I, and Met Station II is located at an area referred to as “the Neck” between Area II and Area III.

Temperatures at Navajo Mine are characterized by cold winters and warm summers, with wide variations in diurnal and annual temperature (URS 2009). Summer days are typically warm (90-95°F) and dry, while nights are cool (55-60°F). During the winter months of December and January, air temperatures commonly fall below 20°F in early morning, while daytime highs typically range from 35 to 45°F. The frost-free period averages 162 days from early May to mid-October (Smeal, et al. 2006).

The average relative humidity at the Navajo Mine ranges from 33 percent in July to 65 percent in January, with an annual average of 45 percent relative humidity (BNCC 2011, Ch. 4). The area receives precipitation during the summer months, when afternoon showers form as a result of moist air from the Gulf of Mexico moving over the area, and in the fall and winter, when cold fronts moving to the east and southeast from the Pacific Ocean create steady, usually light rain and snow showers across the area (URS 2009). The majority of precipitation occurs during monsoon season (July-October), when prevailing winds shift to the southwest and carry sub-tropical moisture into the area, resulting in localized, high intensity, short duration thunderstorms (BNCC 2011, Ch. 4) (Smeal, et al. 2006) (URS 2009). However, considering the entire year, most precipitation events are of short duration and deposit less than 0.10 inch of rain per event (Smeal, et al. 2006). During the winter, snows are infrequent and light. Snow accumulations melt or sublimate within a few days, and snow depths greater than 6 inches are uncommon (Smeal, et al. 2006) (URS 2009).

1.2.2 Regional Geology

The area of interest for this CHIA is within the Colorado Plateau physiographic province of the Western United States, geographically west of the 100th meridian west longitude (BNCC 2011, Ch. 4). The Colorado Plateau covers approximately 130,000 square miles (mi²) and includes parts of Arizona, Colorado, New Mexico, and Utah (Hereford, Webb and Graham 2005). The Navajo Mine is located on the western flank of the San Juan Structural Basin in northwestern San Juan County approximately 15 miles southwest of Farmington, New Mexico (Figure 3). This basin is an asymmetric, structural basin with a northwest trending axis parallel to the Hogback Monocline in northwest New Mexico. The basin is bounded on the northwest by the Hogback Monocline and on the north by the San Juan Uplift. The eastern rim is formed by the Brazos Uplift and the Nacimiento Uplift. The Zuni Uplift and the Chaco Slope form the southern margin of the basin while the Defiance Uplift and Four Corners Platform complete the northwestern basin rim (Figure 3) (BNCC 2011, Ch. 5). The San Juan Watershed lies on the eastern edge of the Colorado Plateau and extends from northwestern New Mexico into portions of northeastern Arizona along the New Mexico/Arizona border, southwestern Colorado, and the southeastern most corner of Utah. The San Juan Watershed is approximately 140 miles wide by 200 miles long, and covers a total area of 21,600 square miles (URS 2009).





The rock strata in the southern part of the lease area strike north-south while the strata in the northern part strike northeast-southwest (BNCC 2011, Ch. 5). The geologic formation dips gently to the east toward the center of the San Juan Basin at an angle of one to two degrees, and steepens toward the outcrop areas where the fairly abrupt monocline (Hogback) can be observed (BNCC 2011, Ch. 6). The stratigraphic section in the lease area reflects the Late Cretaceous transition of shallow marine depositional environment to a terrestrial fluvial depositional environment (BNCC 2011, Ch. 5). During the late

Cretaceous geologic period, the shoreline of a vast shallow inland sea shifted back and forth across the basin and ultimately receded, depositing alternating marine and nonmarine sediments (BNCC 2011, Appendix 6.D). The strata in the lease area have not been intensively folded, and faults in the strata have limited displacement and extent (BNCC 2011, Section 11.6). The mine lease area surface, and adjacent areas, are comprised of the Lewis Shale, Pictured Cliffs Sandstone Formation, Fruitland Formation, Kirtland Shale and unconsolidated alluvial deposits in the valleys of the San Juan River, Chaco River, and the Chaco River tributaries (BNCC 2011, Ch. 6). A generalized stratigraphic section and geologic map of the lease area are presented in Figures 4 and 5.





Legend

Mine Lease Boundary

-  Pre-Law
-  Interim Program
-  Permanent Program
-  TOJ Lands

Meteorological Station

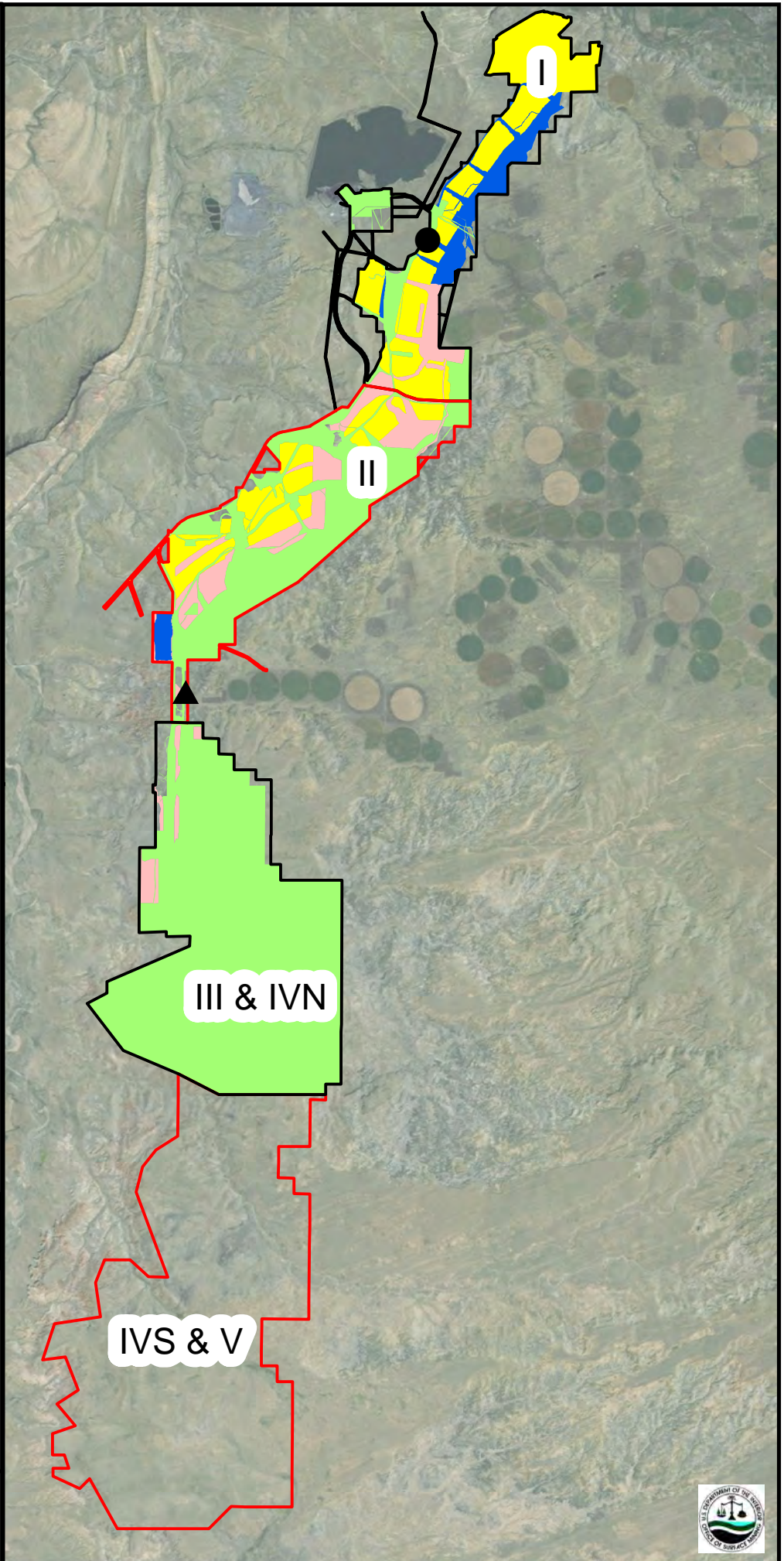
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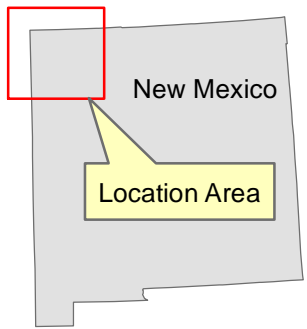
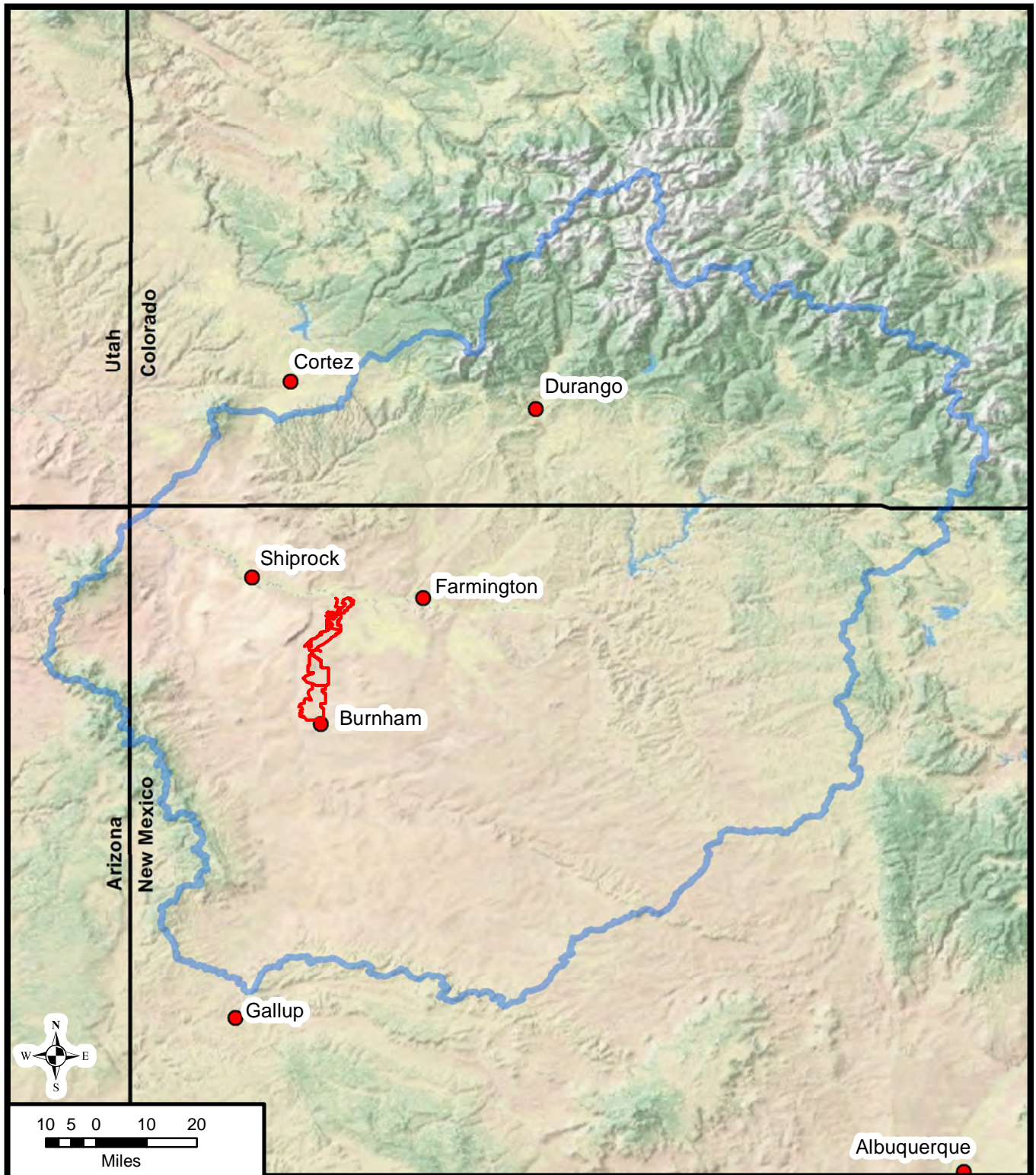
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**BNCC Navajo
Mine Areas**

Figure 1





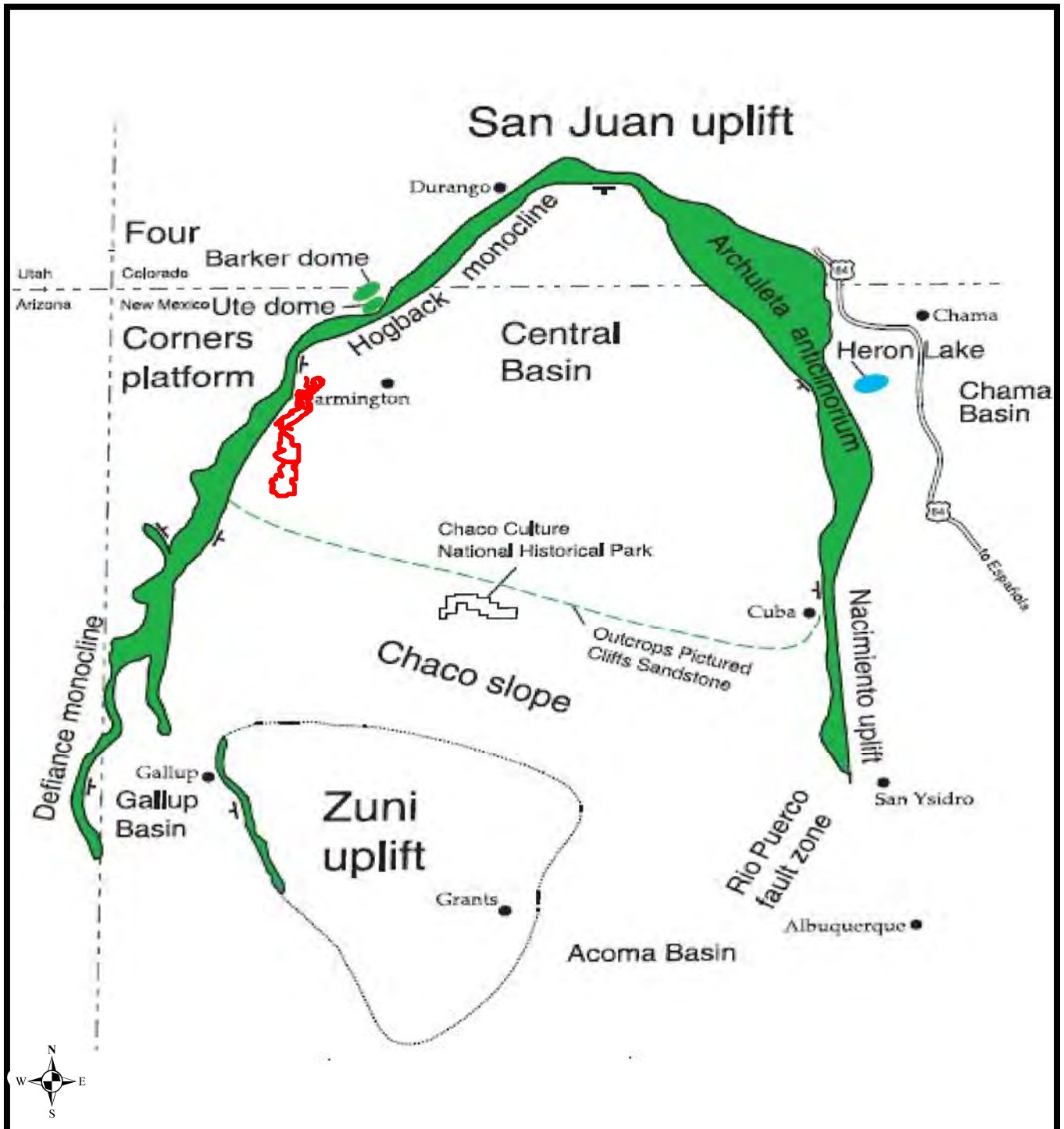
Legend

-  Lease Area
-  San Juan Watershed
-  Communities



**Navajo Mine
Location Map**

Figure 2



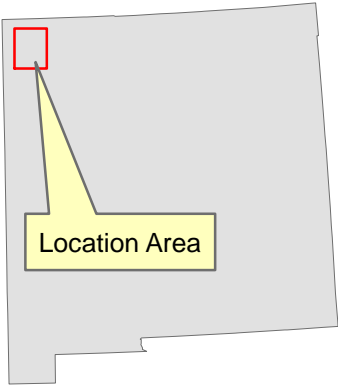
Modified from Lorenz, J.C. and Cooper, S.P., 2003



- Legend**
- Navajo Mine Lease Boundary
 - Areas of steep dip; strike and dip symbols show direction of dip

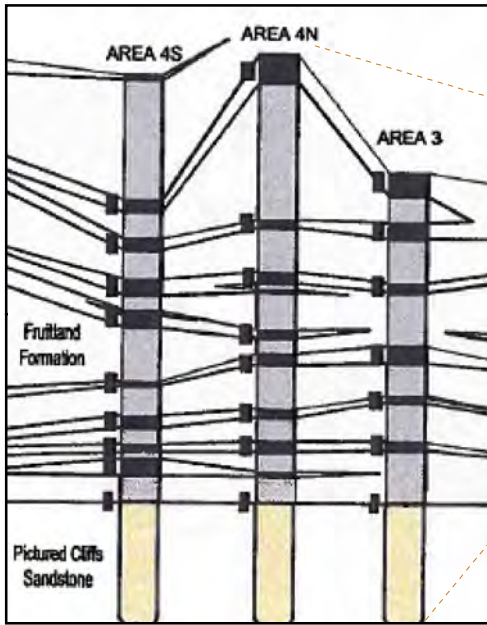
**San Juan Basin
Structural Geology
NW New Mexico**

Figure 3

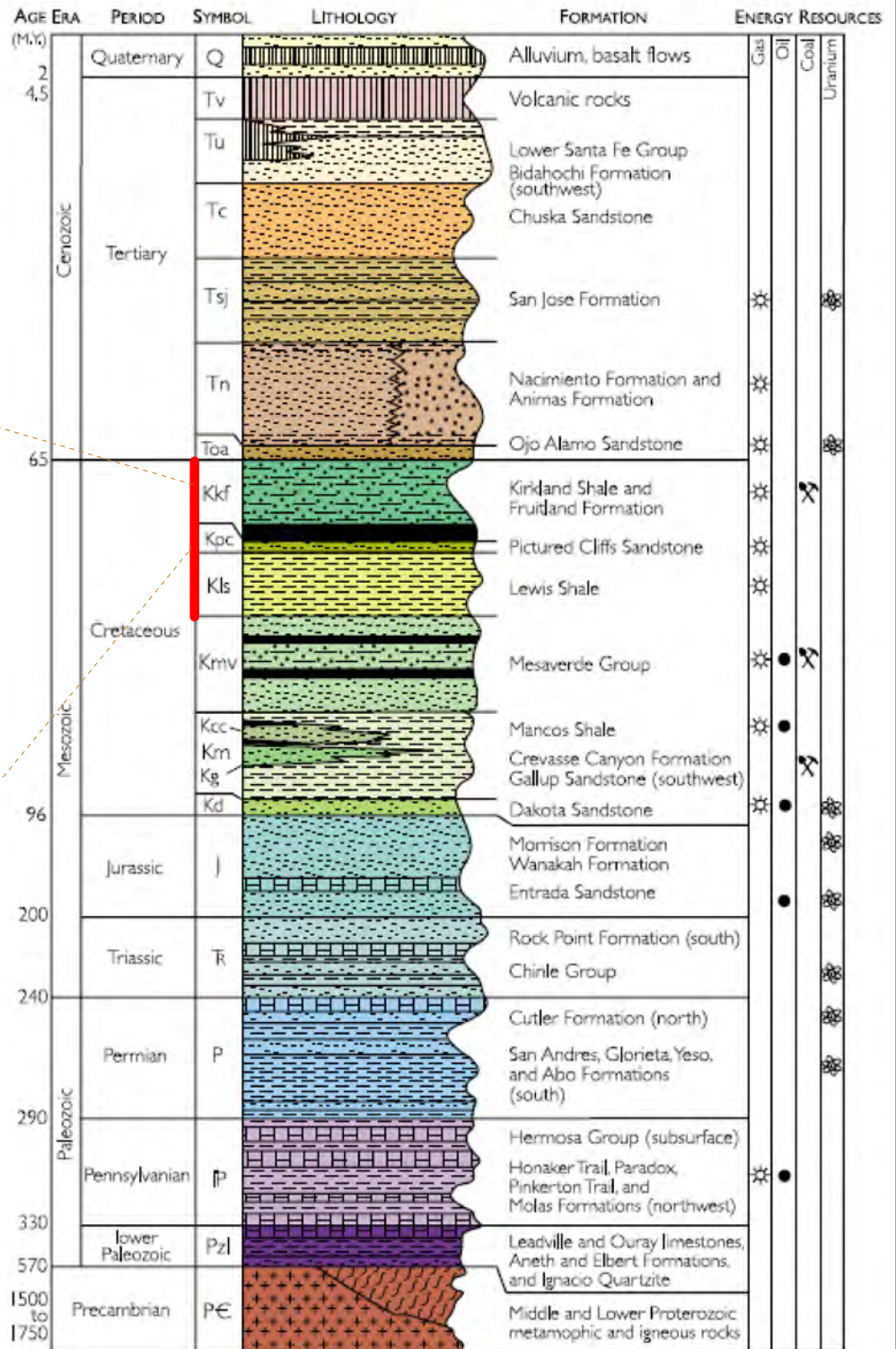


Location Area

Navajo Mine Area Lithology



Modified from Fassett, J. E. (1977), USGS Prof. Paper 1625-B

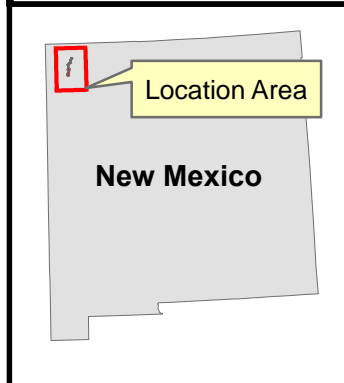
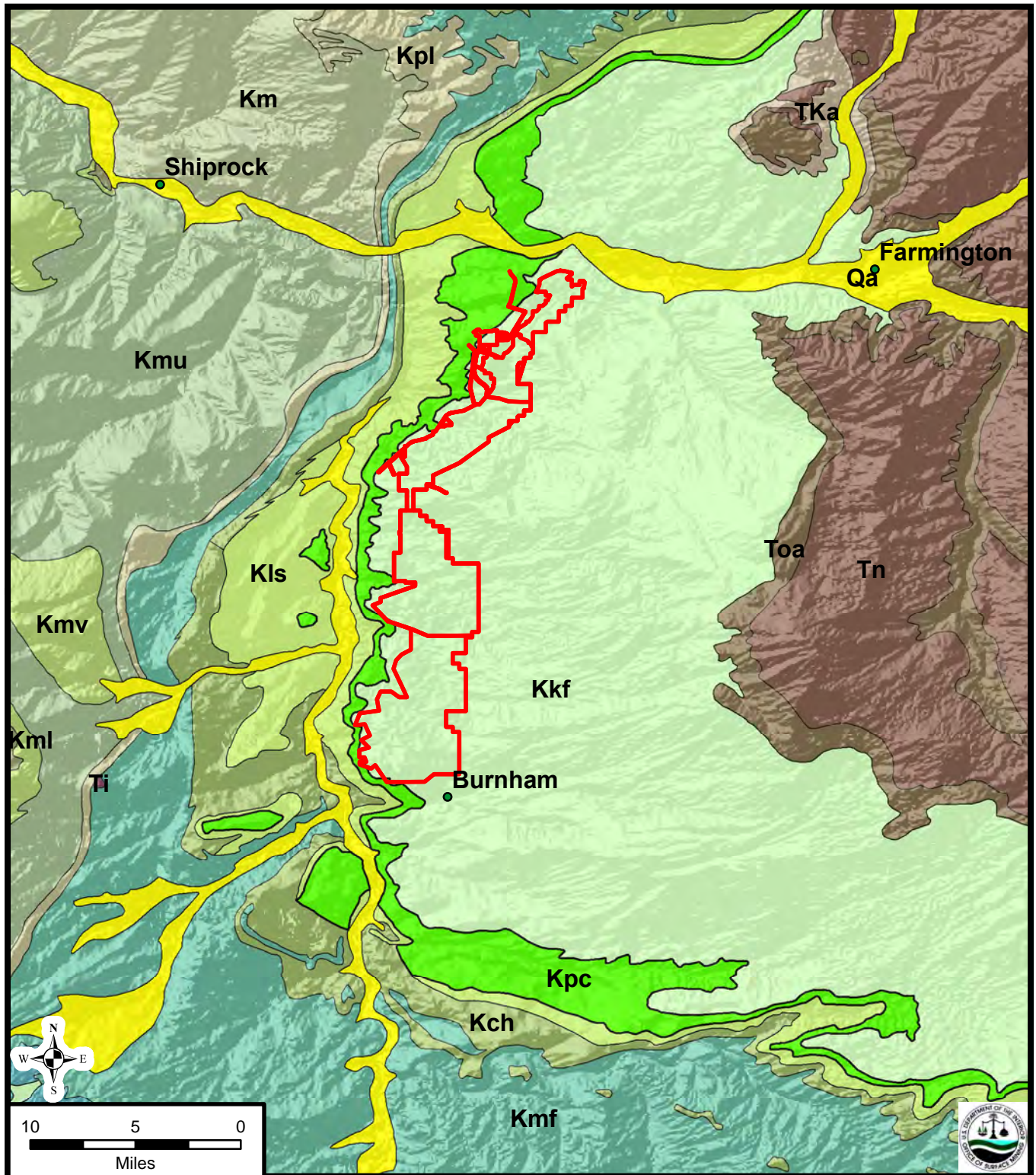


Navajo Mine and Surrounding Area Stratigraphy

Figure 4

From: Brister, B. S. and Price, L. G., 2002





Legend

Navajo Mine Lease Boundary

Navajo Mine Geology

- Qa - Quaternary Alluvium
- Kkf - Kirtland Shale - Fruitland fm.
- Kpc - Pictured Cliffs Sandstone
- Kls - Lewis Shale

**Navajo Mine Area
Geologic Map
NW New Mexico**

Figure 5