STATE OF SOUTH DAKOTA
DEPARTMENT OF AGRICULTURE & NATURAL RESOURCES

BOARD OF MINERALS AND ENVIRONMENT

IN THE MATTER OF CLEAN NUCLEAR ENERGY CORP. URANIUM EXPLORATON PERMIT APPLICATION EXNI 453	))))))	INTERVENOR BRUCE ELLISON DISCLOSURE OF WITNESS LIST

Intervenor BRUCE ELLISON, hereby discloses a witness whom he may call as a witness in the above captioned matter, in accordance with the State's ORDER ON PRE-HEARING MOTIONS AND PROCEDURAL & SCHEDULING ORDER dated 28 August, 2025, to wit:

Susan Hey 312 N 40th Street Rapid City, SD 57702

Dated this *1st* day of *December, 2025*.

Respectfully Submitted,

/s/ Bruce Ellison

BRUCE ELLISON
P.O. Box 2508
Rapid City, SD 57709
bruce.ellison4@gmail.com

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STATE OF SOUTH DAKOTA
DEPARTMENT OF AGRICULTURE & NATURAL RESOURCES

BOARD OF MINERALS AND ENVIRONMENT

IN THE MATTER OF CLEAN NUCLEAR ENERGY CORP. URANIUM EXPLORATION PERMIT APPLICATION EXNI 453	))))))	INTERVENOR BRUCE ELLISON DISCLOSURE OF EXHIBITS

Intervenor Bruce Ellison, hereby discloses a list and copy of the potential exhibits identified to date, that he intends to offer as evidence in his presentation in this matter. In accordance with the State's ORDER ON PRE-HEARING MOTIONS AND PROCEDURAL & SCHEDULING ORDER dated 28 August, 2025, copies of this list and the herein-referenced exhibits will be made available to all parties by electronic means. See, accompanying Certificate of Service.

1. Craven Canyon Mineral Withdrawal Environmental Assessment. Hell Canyon Ranger District, Black Hills National Forest, Fall River County, South Dakota. US Dept. of Agriculture. June 2011. Personal Copy.
2. Plan of Operations for Mining Activities on National Forest System Lands. Clean Nuclear Energy Corp. Uranium Exploration Permit Application - October Jinx Project. Personal Copy. 10 June 2024.
3. Geology of the Edgemont NE Quadrangle Fall River and Custer Counties, South Dakota. US Atomic Energy Commission. 1963
4. City of Hot Springs, SD. Robert Nelson, Mayor. "Strong Opposition to Uranium Exploration near Craven Canyon, Fall River County, SD - Concerns Regarding Large-

Scale Disturbance and Water Contamination." Public Comment letter on Chord Project EXNI 453. 13 May 2025.

5. "Basin Uranium Provides Chord Permitting Update." Junior Mining Network. 16 Sept. 2024. https://www.juniorminingnetwork.com/junior-miner-news/press-releases/2964-cse/nclr/167187-basin-uranium-provides-chord-permitting-update.html Accessed 22 November 2025

6. "Nexus Uranium and Basin Uranium Announce Merger to Create North American-Focused Uranium Exploration Company." Basin Uranium Corporation. 25 June 2025. https://basinuranium.ca/nexus-uranium-and-basin-uranium-announce-merger-to-create-north-american-focused-uranium-exploration-company/ Accessed 22 November 2025

7. Chord Project Overview. Basin Uranium Corporation. No Date. https://basinuranium.ca/chord/ Accessed 1 December 2025.

Dated this *1st* day of *December, 2025*.

Respectfully Submitted,

/s/ Bruce Ellison

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CERTIFICATE OF SERVICE

It is hereby certified that a copy of the Intervenor's Disclosure of Exhibits, a copy of the listed exhibits, and Disclosure of Witnesses, were shared via electronic means with the following parties in the above captioned matter:

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Dated this *1st* day of *December, 2025*

Signature: */s/ Bruce Ellison*

EXHIBIT

Ellison 1

exhibitsticker.com

United States
Department of
Agriculture

Forest
Service

June 2011

Environmental Assessment

Craven Canyon Mineral Withdrawal

Hell Canyon Ranger District
Black Hills National Forest
Fall River County, South Dakota

Table of Contents

SUMMARY

The Black Hills National Forest proposes to recommend withdrawal of 3,957 acres of National Forest System land from mineral entry for 20 years to protect cultural resources, including rock art of great cultural, scientific and public interest. The significance of Craven Canyon from a traditional use perspective is not limited to the rock art. Rather, Craven Canyon should be viewed as an Ethnographic Landscape. National Park Service Preservation Brief 36 defines an Ethnographic Landscape as “a landscape containing a variety of natural and cultural resources that associated peoples define as heritage resources” (NPS 1994: 2). As mentioned above, some Lakota were more interested in Craven Canyon as a whole, and are not interested specifically in the rock art. For these individuals, the need for protection of Craven Canyon goes well beyond physical protection of the rock art, and includes a need for protecting the natural landscape features of Craven Canyon. For this reason, the proposed withdrawal includes consideration of the viewshed of the natural landscape as seen from the Rock Art sites. Additionally, archaeological and paleoenvironmental investigations in Craven Canyon indicate that there is still much to be learned about post-Pleistocene deposits and post-Pleistocene human activities. Much of the area north of Craven Canyon along what is known as Long Mountain has yet to be surveyed. Therefore, the proposed action also includes areas that are likely to contain additional archeological discoveries on Long Mountain.

The project area is located approximately 30 miles southwest of Custer, SD and 17 miles west of Hot Springs, SD and is within the Hell Canyon Ranger District, Black Hills National Forest, South Dakota and Wyoming. The proposed action would withdraw these lands from mineral exploration and development under the U.S. Mining Laws, subject to valid existing rights determination. There are approximately 160 acres within the proposed withdrawal area that were previously withdrawn from mineral entry (PLO 1232). There are 6 existing mining claims within this withdrawal area. This area is excluded from this proposal. Outside of the existing mineral withdrawal, but within the proposed withdrawal area (see map on page 10), there are 72 existing mining claims.

This action is needed to preserve unique prehistoric and historic cultural properties in and surrounding Craven Canyon. Currently, the Forest Service has no authority to deny mining exploration and development in this area subject to the laws and requirements under the Archeological Resources Protection Act (ARPA) of 1979, or the National Environmental Policy Act (NEPA), regulated through the Forest Service 36 CFR 228 mineral regulations. Mineral exploration and development may continue to occur on those mining claims with valid existing rights, even if a withdrawal is approved. However, no additional mining claims would be approved once the mineral withdrawal is established.

The proposed action may preclude some mining opportunities in these areas where valuable minerals may exist but a discovery associated with a mining claim has not yet been made. The proposed Craven Canyon withdrawal area has (1) a high potential for small to medium sized roll-front-type uranium and vanadium deposits in sandstone within fluvial unit 1 of the Lakota Formation and the lower unit of the Fall River Formation, (2) a moderate potential for oil and gas resources in subsurface Phanerozoic

strata, (3) a low potential for subbituminous coal resources in the basal portion of fluvial unit 1 of the Lakota Formation, and (4) a low potential for mineral materials suitable for sand and gravel, clay, and building stone.

In addition to the proposed action (Alternative 2), the Forest Service also evaluated the following alternatives:

- **No Action Alternative –** This alternative is required as a comparison to the action alternatives. Under the No Action alternative, the existing withdrawal would remain in effect. No additional area would be withdrawn from mineral entry.

  Alternative 3. This alternative would reduce the area to be withdrawn by approximately 1,308 acres. Under this alternative about 2,649 acres would be withdrawn from mineral location and entry under the U.S. Mining Laws, subject to valid existing rights. This alternative would protect the prehistoric rock art within and along the canyon walls from exploration and development activities, but may not protect known sites above the canyon. This alternative would allow mineral location and entry in some areas above the canyon wall, which may not protect the visual resources and traditional cultural properties. Under this alternative, 27 of the 46 known archaeological sites would be protected, 81% of the Long Mountain Archaeological Research Area would be protected, and 57% of the areas without previous archaeological survey would be protected. Alternative 3 would exclude approximately 72 existing claims within the project area boundary.

  Alternative 4. This alternative would reduce the area to be withdrawn by approximately 948 acres. Under this alternative about 3,009 acres would be withdrawn from mineral location and entry under the U.S. Mining Laws, subject to valid existing rights determination. This alternative would protect the prehistoric rock art within and along the canyon walls from exploration and development activities, as well as most sites above the canyon and the majority of the culturally significant viewsheds. This alternative would allow mineral location and entry in some areas above the canyon wall, which may not protect all visual resources and traditional cultural properties. However, under this alternative, the majority of culturally significant sites (85%) and viewsheds (91%) would be protected. Mineral withdrawal as proposed under Alternative 4 would include 24 existing claims within the withdrawal area boundary.

The United States Department of the Interior (USDI) Bureau of Land Management is a cooperating agency in the development of this document and will be the Decision Maker for this project. The United States Department of Agriculture (USDA) Forest Service is preparing this Environmental Assessment. Based upon the effects of the alternatives, the Responsible Official for the USDA Forest Service will make a recommendation to the Regional Forester, who will in turn transmit a recommendation to the Bureau of Land Management. The Decision Maker will decide:

1) If mineral withdrawal is warranted to preserve the resources and other values associated with Craven Canyon; and

2) If mineral withdrawal is warranted, to what extent should the withdrawal be applied?

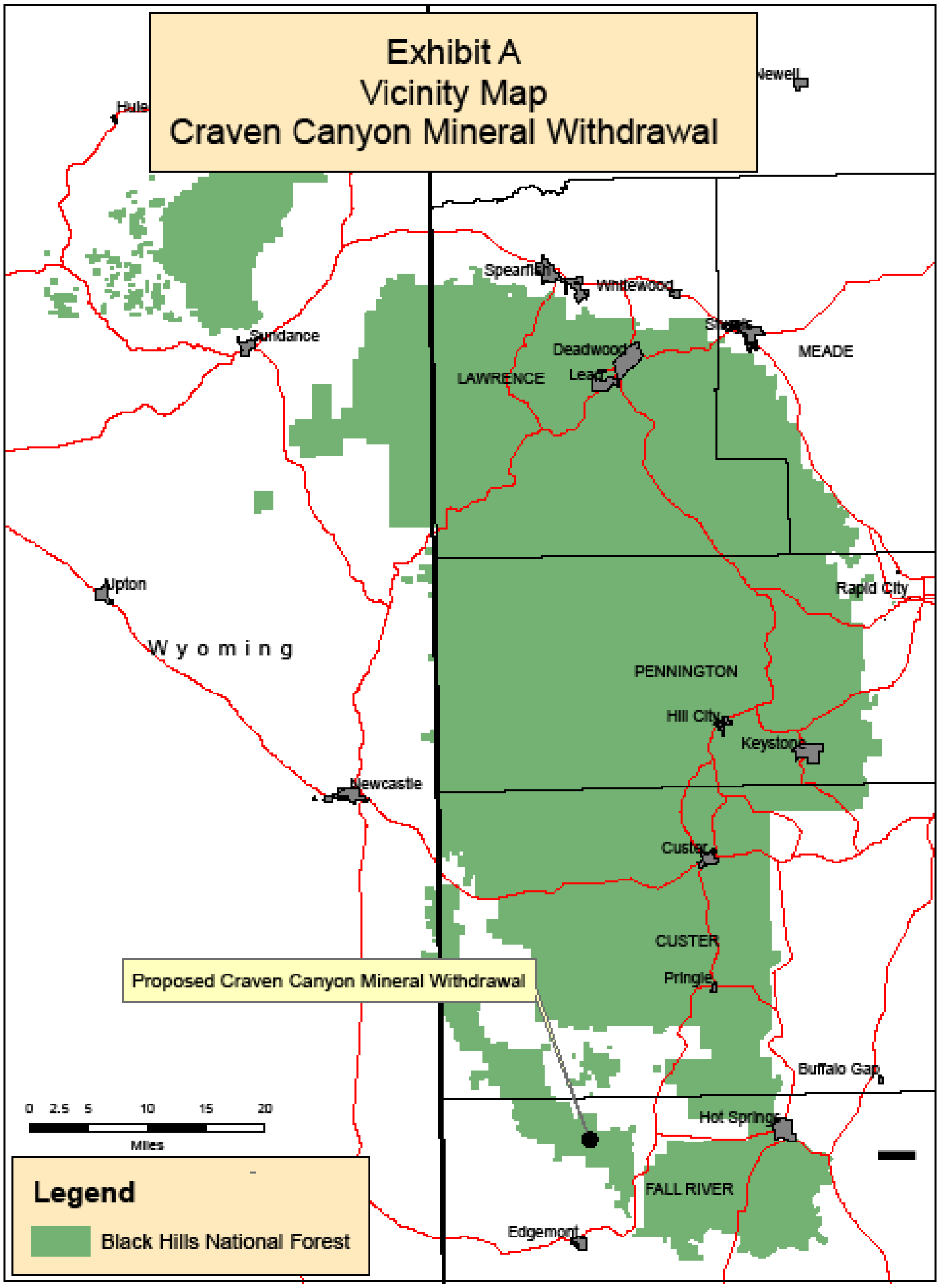


Figure 1. Vicinity Map.

CHAPTER 1. PURPOSE AND NEED FOR ACTION

Document Structure

The Forest Service has prepared this Environmental Assessment for, and in cooperation with, the BLM and in compliance with the National Environmental Policy Act (NEPA) and other relevant Federal and State laws and regulations. This Environmental Assessment discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action and alternatives. The document is organized into four parts:

- *Chapter 1 Purpose and Need for Action:* This section includes information on the history of the project proposal, the purpose of and need for the project, and the agency's proposal for achieving that purpose and need. This section also details how the Forest Service informed the public of the proposal and how the public responded.
- *Chapter 2 Alternatives, including the Proposed Action:* This section provides a more detailed description of the agency's proposed action as well as alternative methods for achieving the stated purpose. These alternatives were developed based on significant issues raised by the public and other agencies. This discussion also includes possible mitigation measures. Finally, this section provides a summary table of the environmental consequences associated with each alternative.
- *Chapter 3 Affected Environment and Environmental Consequences:* This section describes the environmental effects of implementing the proposed action and other alternatives. This analysis is organized by resource area. Within each section, the affected environment is described first, followed by the effects of the No Action Alternative that provides a baseline for evaluation and comparison of the other alternatives that follow.
- *Chapter 4 List of Preparers, and Distribution:* This section provides a list of preparers and agencies and persons consulted during the development of the environmental assessment.
- *Appendices:* The appendices provide more detailed information to support the analyses presented in the environmental assessment.

Additional documentation, including more detailed analyses of project area resources, may be found in the project planning record located at the Hell Canyon Ranger District Office in Custer, South Dakota.

Background

The southern Black Hills in general contain an unparalleled diversity of rock art styles spanning the entire breadth of human occupation of the area. The most significant representation of this diversity exists in Craven Canyon. Archaeological investigations, consultation with Native Americans, and oral histories of local ranchers have established that Craven Canyon is an irreplaceable element of the plains Native American cultural fabric.

From an archaeological standpoint, the rock art sites in Craven Canyon are a highly significant cultural resource. They have yielded, and continue to yield, information about ideology, aesthetics, technology, and social organization not found in other types of archaeological sites (Sundstrom 1993; Sundstrom 2004). In addition, recent investigations by Fredlund (1996), and Sundstrom and Fredlund (2007) indicate that rock shelters and lithic scatters in Craven Canyon contain intact and deeply stratified deposits and intact paleosols not found elsewhere in the Black Hills. These sites have the potential to answer questions about paleoenvironmental conditions and human use of the Black Hills throughout the Holocene.

The importance of Craven Canyon from a cultural use perspective cannot be overstated. For peoples' whose culture, history, values, morals, and beliefs are largely or wholly oral rather than written, *places* serve as "indispensable aids for remembering and imagining" (Basso 1996:7). Lakota, Cheyenne, Arapaho, Kiowa, and many other plains peoples regard the Black Hills as sacred (La Pointe 1976). These peoples have a special connection to rock art sites in the Black Hills because they are the descendants of the people who made them. The rock art sites in Craven Canyon, and indeed the canyon itself, continue to serve as landscape repositories of history, beliefs, wisdom, and inspiration. When one place or one rock art site is damaged or altered, the corresponding piece of history, moral value, or belief is also threatened because the particular place which served as the heuristic devise for remembering is no longer intact. Thus, any adverse effect in Craven Canyon is rightly viewed as an affront to plains Native American culture and Indigenous human rights.

The Black Hills National Forest Land and Resource Management Plan, as amended (BHNF LRMP) emphasizes the management of cultural resources to protect them from loss or damage until they can be evaluated for significance, to be retained for appropriate uses, to provide opportunities for scientific study about past human behavior and environments, or to offer the public a better understanding of its collective human heritage. The Archaeological Resource Protection Act of 1979 (ARPA), the National Environmental Policy Act of 1969 (NEPA), and the Forest Service mineral regulations at 36 CFR 228 (subpart A) provide much needed protection of archeological sites and viewsheds from authorized mining activities. Even so, the mere presence of industrial activities, such as mining, are disruptive to traditional religious activities, many of which are private in nature and require a great sense of solitude.

Mining activities such as exploratory drilling, mining, blasting and the operation of heavy equipment, by their very nature, can be destructive to surface resources. Some methods of mining, such as underground mining, can be conducted with minimal surface impacts. In the Craven Canyon area, some past mining did use underground mining methods and could possibly be used in the future. The area in and around Craven Canyon has been mapped as having a high mineral reserve potential for uranium and vanadium deposits. There are 72 mining claims within the project area, and because of renewed interest in uranium exploration and development, it is foreseeable that additional claims could be filed.

Management Direction

The project area lies within Management Area (MA) 5.1A Southern Hills Forest and Grassland Areas per the Black Hills National Forest Revised Land and Resource Management Plan (BHNF LRMP, as amended). Forest Plan direction for the Craven

Canyon area emphasizes managing for sustainability of the physical, biological and visual values associated with areas of woody vegetation and open grassland. This area is dominated by open grasslands and areas of woody vegetation, with deep sandstone canyons and very little surface water available. Though forested areas exist, they do not produce commercially profitable wood fiber as a result of poor site conditions. Wildlife habitat and forage production for both livestock and wildlife are emphasized.

More specifically, the following Forest Plan goals, objectives, standards and guidelines for the Craven Canyon area were used to develop the proposed action. All alternatives proposed within this environmental assessment comply with Forest Plan standards and guidelines.

<u>Minerals</u>

Standard 1509. For classified lands not withdrawn from operations under the general mining laws (research natural areas, national recreation areas, special interest areas such as "scenic", "botanical", and "geologic", national historical sites, and "scenic" and "recreation" segments of wild and scenic rivers):

a. The status of classified lands with respect to withdrawal must be checked before an operating plan can be approved.
b. Provide for reasonable protection of the purposes for which the lands were classified.
c. Reclaim disturbed lands to a condition suitable for the purposes for which the lands were classified.
d. Pursue withdrawals where appropriate.

Guideline 1510. Developed recreation areas should be withdrawn from locatable mineral entry. Maintain existing withdrawals.

<u>Heritage Resources</u>

Objective 405. Manage all heritage sites listed in the National Register of Historic places in consultation with the State Historical Preservation Officer (SHPO) and the President's Advisory Council on Historic Preservation (ACHP).

Objective 406. Provide opportunities for the public to participate in heritage management activities, including the monitoring, excavation, and protection of archeological sites.

<u>Wildlife</u>

Standard 3102. Where caves are important nurseries or hibernacula for sensitive and local concern bat species protect the caves and maintain their microclimates when designing management activities. Protect known bat day and night roosts.

<u>R2 Sensitive and SOLC Plants</u>

The Forest Plan (USDA Forest Service 2006) states that Region 2 (R2) sensitive plant species, and plant species of local concern would be protected as follows:

Objective 221. Conserve or enhance habitat for R2 sensitive species and species of local concern (SOLC).

Guideline 4102a. Avoid the use of earth-moving equipment within national register eligible heritage resource sites, known locations of R2 sensitive species and species of local concern plants, BAs, RNAs, or in stream channels, except at designated points and with proper mitigation. Prohibit this use in the Wilderness.

Standard 4304. Treat individual plants or group of plants in areas where R2 sensitive or species of local concern plants occur. Use a treatment method that is the least risk to the species being protected.

Purpose and Need for Action

The purpose of and need for action is to protect and preserve existing Native American cultural resources including rock art of great cultural, scientific, and public interest, and traditional cultural properties with associated viewsheds. This action is needed because there is potential for damage of the unique values associated with this area from future mining activities. Lands in most of this area are currently open to mineral location and entry, mineral lease, and mineral material sale under the U.S. Mining Laws.

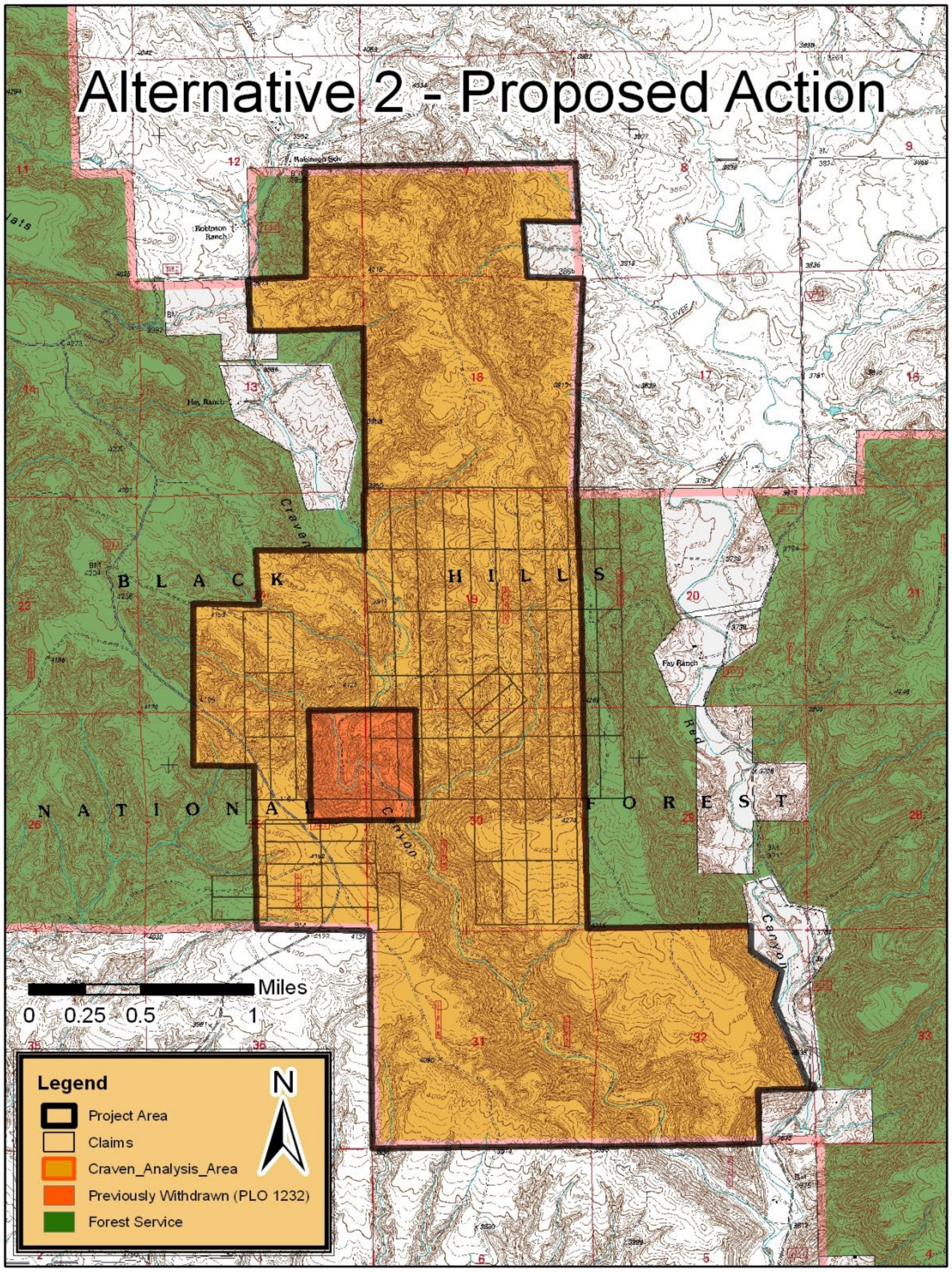
The Black Hills National Forest Land and Resource Management Plan, as amended (BHNF LRMP) emphasizes the management of cultural resources to protect them from loss or damage until they can be evaluated for significance, to be retained for appropriate uses, to provide opportunities for scientific study about past human behavior and environments, or to offer the public a better understanding of its collective human heritage.

The purposes for this withdrawal from mineral activities are to provide opportunities for scientific study about past human behavior and environments, to continue to serve the religious and cultural needs of Native Americans, and to offer the public a better understanding of its collective human heritage.

This action responds to the goals and objectives outlined in the Black Hills Forest Plan, as amended, and helps move the project area towards desired conditions described in that plan. The resource values and risks for Craven Canyon and surrounding area are described below.

Proposed Action

The proposed action was developed by the Forest Service to meet the purpose and need for action. Specifically, the Forest Service proposes to withdraw approximately 3,957 acres of National Forest System land from mineral location and entry for 20 years to protect cultural resources, including rock art of great cultural, scientific and public interest. The proposed action would withdraw these lands from mineral exploration and development under the U.S. Mining Laws, subject to valid existing rights. This means that during the life of the withdrawal (20 years, with option for renewal), new mining claims cannot be established, and mining exploration and development would not be allowed on pre-existing mining claims unless valid existing rights determination is made and a Plan of Operations is approved. Approval of a Plan of Operations would require additional site specific environmental analysis. The proposed withdrawal area is shown in Figure 2.



<u>Figure 2</u>. Proposed Action

Decision Framework

The USDI Bureau of Land Management is a cooperating agency for the development of this environmental assessment (EA) and is responsible for the final decision regarding this mineral withdrawal. Mineral withdrawals fall under the administrative responsibilities of the USDI Bureau of Land Management (43 CFR 2310.1). Section 104 of the Federal Land Policy and Management Act of 1976 gives the Secretary of the Interior authority to make, modify, extend, or revoke most withdrawals on public or reserved Federal lands. The Forest Service must apply to the Secretary of the Interior for withdrawal actions on National Forest lands (FSM 2761.01). The Forest Service initiates an application with the BLM for a mineral withdrawal, which includes a proposed action. The application and withdrawal proposal are reviewed and approved by the Recommending Official. The Recommending Forest Service Official for mineral withdrawals for the Craven Canyon area is the Rocky Mountain Regional Forester (FSM 2761.04). The Recommending Official will decide 1) if mineral withdrawal is necessary to protect the culturally significant resources within and surrounding Craven Canyon, and 2) if so, what the appropriate size of the withdrawal should be.

The BLM publishes notice of an application for withdrawal in the Federal Register along with a segregation order. The segregation order prohibits new mineral claims for a period of two years. In those two years, the Forest Service then completes an environmental assessment (EA) on behalf of, and in conjunction with, the BLM and provides supporting specialist reports to meet the requirements of the National Environmental Policy Act (1969).

The notice of application for withdrawal and order of segregation was published in the Federal Register on August 20, 2008, with comments and requests for public meetings due by November 18, 2008. For a period of two years from the August 20th date of publication in the Federal Register, the land identified in this assessment would be segregated from location or entry under the United States mining laws, unless the application to withdraw is denied or canceled or if the withdrawal is approved prior to that date.

This Environmental Assessment is not a Forest Service decision document. The Director of the BLM makes the decision on the proposed withdrawal and publishes notice of decision in the Federal Register. Therefore, the final decision is not appealable to the Forest Service (36 CFR 215.12(h).

Public Involvement

Public involvement on this project began prior to the formal scoping period. Scoping as defined by the Council on Environmental Quality (CEQ) includes refining the proposed action, identifying preliminary issues, and identifying interested and affected persons. Notices of the proposed withdrawal and segregation orders were published in the Federal Register on August 20, 2008. The proposal was listed in the Schedule of Proposed Actions in October 2008. The proposal was provided to the public and other agencies for comment during scoping which began on January 12, 2009. In addition, as part of the public involvement process, the agency provided maps and information on the Black Hills National Forest website (www.fs.fed.us/r2/blackhills). At the request of the Fall

River County Commissioners, the Forest Service met with the Commissioners on May 15, 2009 to discuss the proposed withdrawal. Using the comments from the public, other agencies, and tribal contacts the interdisciplinary team developed a list of issues to address.

Issues

The Forest Service reviewed input submitted during scoping and separated the issues into two groups: significant (as directed by the Council on Environmental Quality (CEQ) regulations (40 CFR 1500.4(g) and 1501.7)) and non-significant issues. Significant issues were defined as those directly or indirectly caused by implementing the proposed action. Non-significant issues were identified as those: 1) outside the scope of the proposed action; 2) already decided by law, regulation, Forest Plan, or other higher level decision; 3) irrelevant to the decision to be made; or 4) conjectural and not supported by scientific or factual evidence. The Council on Environmental Quality (CEQ) NEPA regulations require this delineation in Sec. 1501.7, "…identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)…" A list of non-significant issues and reasons regarding their categorization as non-significant may be found in the project record. The Forest Service identified the following significant issue during scoping.

Issue #1: Protection of culturally significant resources.

There is concern from several members of the public that disturbances associated with exploration and development of mining could impact both known and yet to be discovered archeological sites, and the viewsheds associated with the Craven Canyon setting. Archeological resources are non-renewable and cannot be re-created.

Measures:

1. Number of culturally significant sites protected.
2. Viewshed acres protected.

Issue #2: Effects on existing mining claims, and opportunities for exploration and development.

There is concern that the size of the withdrawal is too large and would have adverse effects on mining opportunities. There are approximately 72 mining claims that exist within the proposed withdrawal area. There is concern that the withdrawal would eliminate opportunities for future exploration and development of mineral resources, and that archeological resources, including rock art sites and viewsheds within the Craven Canyon area, could be protected with existing protection and mitigation measures available through the existing 160-acre Pictograph Withdrawal and through the Forest Service 36 CFR 228 mineral regulations. Mineral resources are non-renewable and are of economic importance both locally and nationally.

Measures:

1. Active mineral claims within withdrawal area.
2. Size of withdrawal area.
3. Cost of Valid Existing Rights Determination.

CHAPTER 2. ALTERNATIVES, INCLUDING THE PROPOSED ACTION

This chapter describes and compares the alternatives considered for the Craven Canyon Mineral Withdrawal project. It includes a description and map of each alternative considered. This section also presents the alternatives in comparative form, sharply defining the differences between each alternative and providing a clear basis for choice among options by the decision maker and the public. Some of the information used to compare the alternatives is based upon the design of the alternative (i.e., location and size of the withdrawal) and some of the information is based upon the environmental, social and economic effects of implementing each alternative (i.e., the amount of high potential minerals withdrawn).

Alternatives

Alternative 1

No Action

Under the No Action alternative, current management plans would continue to guide management of the project area. No additional areas would be withdrawn to accomplish project goals. The existing mineral withdrawal (PLO 1232 - 160 acres, after partially revoked) would remain in effect. All 3,957 acres proposed for withdrawal in the Craven Canyon area would remain open to mineral exploration and development. Mineral exploration and development would continue to be subject to the laws and requirements under the Archeological Resources Protection Act (ARPA) and the National Environmental Policy Act (NEPA), regulated through the Forest Service 36 CFR 228 mineral regulations. There are 6 mining claims within the existing withdrawal area. These claimants would be required to submit a Plan of Operations, subject to approval, prior to any exploration and development activities.

Alternative 2

The Proposed Action

The Black Hills National Forest proposes to recommend withdrawal of 3,957 acres of National Forest System land from mineral location and entry for 20 years to protect cultural resources, including rock art of great cultural, scientific and public interest. The proposed action would withdraw these lands from new mining claim locations and from mineral exploration and development under the U. S. Mining Laws, subject to valid existing rights. The proposed withdrawal is intended to provide further protection of the unique resources present at Craven Canyon from adverse effects that could be caused by future mining activities. There are currently approximately 72 existing mining claims within the proposed mineral withdrawal area. The benefit of withdrawing this area from mineral location and entry is that once withdrawn, no new mining claims can be filed. The proposed action would not disallow mining of valid existing mining claims, but would preclude mining on invalid claims, as determined by a certified government minerals examiner. If an existing claim is determined to be valid, the claimant must then submit a Plan of Operations, at which time a site specific environmental analysis is completed to determine if further mitigation measures are needed for surface resources that may be impacted.

The significance of Craven Canyon from a traditional use perspective is not limited to the rock art. Rather, Craven Canyon should be viewed as an Ethnographic Landscape. National Park Service Preservation Brief 36 defines an Ethnographic Landscape as "a landscape containing a variety of natural and cultural resources that associated peoples define as heritage resources" (NPS 1994: 2). As mentioned above, some Lakota are more interested in Craven Canyon as a whole, and are not interested specifically in the rock art. For these individuals, the need for protection of Craven Canyon goes well beyond physical protection of the rock art, and includes a need for protecting the natural landscape features of Craven Canyon. For this reason, the proposed withdrawal includes consideration of the viewshed of the natural landscape as seen from the Rock Art sites. Additionally, archaeological and paleoenvironmental investigations in Craven Canyon indicate that there is still much to be learned about post-Pleistocene deposits and post-Pleistocene human activities. Much of the area north of Craven Canyon along what is known as Long Mountain has yet to be surveyed. Therefore, the proposed action also includes areas suspected to contain additional archeological discoveries on Long Mountain.

Under alternative 2, no new mining claims would be accepted within the area withdrawn. Existing mining claims (72) would remain in place; however, mineral development on those claims would be subject to a valid existing rights determination prior to any ground disturbing activities. Mineral activity on existing mining claims within the withdrawal area, including mineral exploration, would require a Plan of Operations under Forest Service 36 CFR 228 regulations. Before a Plan of Operations can be approved, valid existing rights determination must be made for each mining claim on which the activity is proposed. This determination is verified through mineral examinations conducted by a government certified mineral examiner. If minerals have not been found in sufficient quantity and quality to constitute a valid discovery of a valuable mineral deposit on the subject claims as of the date of withdrawal through to the date of the examination, then those claims will be declared null and void, and will no longer exist. Therefore, existing claims will remain after the withdrawal is established, but once an operator wishes to pursue any discovery, exploration or development, they would be required to submit a Plan of Operations, subject to approval. Undiscovered mineral resources would be lost to future exploration and development during the term of the withdrawal.

Table 1. Components of Alternative 2 – Proposed Action	
Acres to be withdrawn	**3,957 acres**
Archaeological Sites included in proposed withdrawal area	**46 (100%)**
Acres of the Long Mountain Research Area included	**386 acres (100%)**
Un-surveyed Acres included	**2,780 (100%)**
Culturally Significant Sites included	**9 (100%)**
Culturally Significant Site Viewsheds included	**16 (100%)**
Total Culturally Significant Viewshed Acres included	**621(100%)**
Existing Claims included in proposed withdrawal area	**72 (100%)**

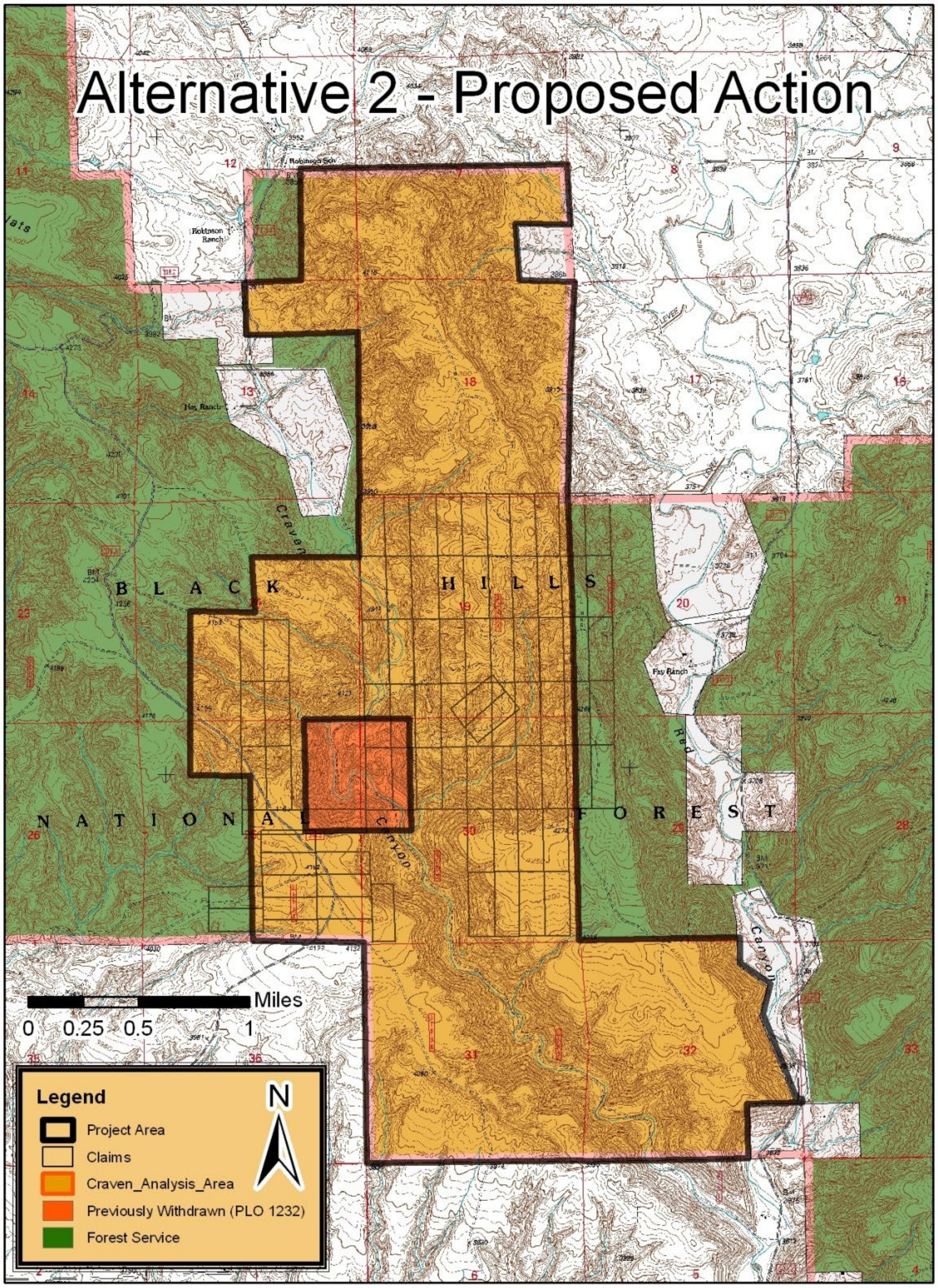


Figure 3. Alternative 2 – Proposed Action

Alternative 3

Alternative 3 was developed in response to an issue raised during public scoping. Some commenter's felt that the proposed withdrawal is larger than necessary to protect the resources at risk and would adversely affect mining opportunities. Therefore, the Interdiciplinary Team (IDT) developed Alternative 3 which would only partially withdraw the canyon, rock art sites, and significant associated viewsheds, which are considered part of this cultural site and important to Native populations. This alternative seeks to withdraw all areas of the current analysis area except areas with existing mining claims. Under this alternative approximately 2,649 acres would be withdrawn from mineral location and entry under the U.S. Mining Laws, subject to valid existing rights.

Under this alternative, the areas that are not withdrawn would continue to be open to new claim filings. If a claimant for an existing claim outside of the withdrawal area wishes to pursue discovery of their mineral resource, that may do so subject to the Archaeological Resource Protection Act of 1979 (ARPA), the National Environmental Policy Act of 1969 (NEPA), and the Forest Service mineral regulations at 36 CFR 228 (subpart A).

Under this alternative 67% of the analysis area would be included in the withdrawal. This would protect 59% of the archaeological sites, 81% of the Long Mountain Archaeological Research Area would be protected, 57% of areas without previous archaeological survey would be protected, and 89% of the culturally significant sites would be protected. This alternative would withdraw the viewshed for 63% of the culturally significant sites totaling 76% of the total viewshed acres. This alternative would partially cover heritage resources at risk, but allows more opportunities for existing and future mineral exploration and development than does Alternative 2.

Table 2. Components of Alternative 3	
Acres to be withdrawn	**2,649 acres (67%)**
Archaeological Sites included within proposed withdrawal	**27 (59%)**
Acres of the Long Mountain Research Area included	**313 acres (81%)**
Un-surveyed Acres included	**1,574 (57%)**
Culturally Significant Sites included	**8 (89%)**
Culturally Significant Site Viewsheds included	**4 (25%)**
Total Culturally Significant Viewshed Acres included	**473 (76%)**
Mining Claims included in proposed withdrawal area	**0 (0%)**

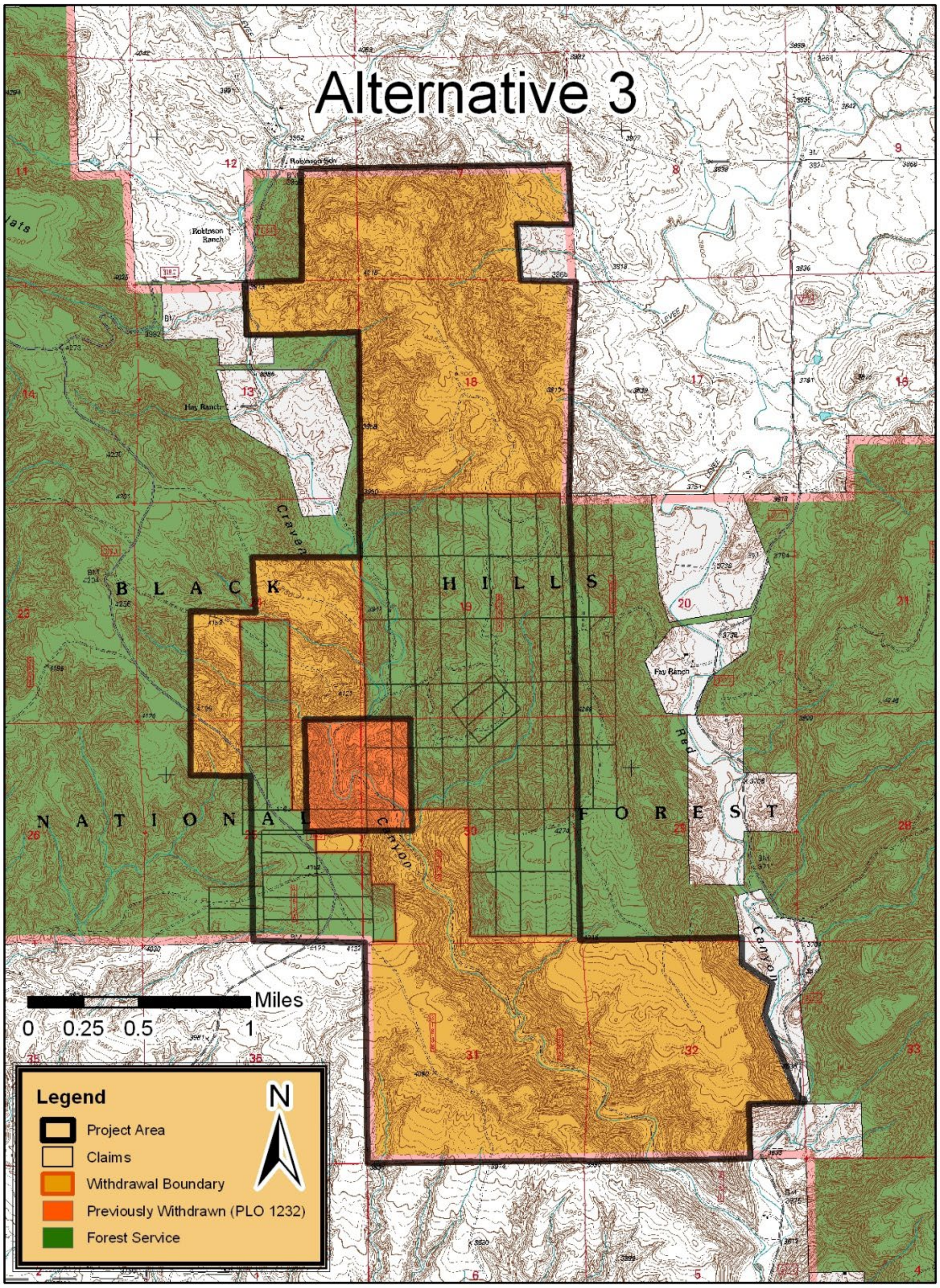


Figure 4. Alternative 3

Alternative 4

Alternative 4 was developed to reduce the number of mining claims requiring evaluation for Valid Existing Rights Determination, while also providing some protection of the physical location of archaeological sites and viewsheds. This alternative was not developed with explicit consideration of the setting or viewshed at culturally significant sites, but rather as a compromise to preserving the majority of the culturally significant sites and viewsheds, while also reducing the impact to existing and future mining claims within and outside of the withdrawal area. Additionally, this alternative would serve to reduce the cost for valid Existing Rights Determinations, which range from $40,000 to $60,000 per case to the government where the claim is within the area withdrawn.

Under alternative 4, existing claims (24) would be required to submit a Plan of Operations, subject to approval and requiring a valid existing rights determination, as described under Alternative 2. Alternative 4 would result in 3,009 acres being withdrawn from mineral location and entry under the U.S. Mining Laws, subject to valid existing rights.

Table 3. Components of Alternative 4	
Acres to be withdrawn	**3,009 (76%) acres**
Archaeological Sites included in proposed withdrawal area	**38 (83%)**
Acres of the Long Mountain Research Area included	**386 acres (100%)**
Un-surveyed Acres included	**1,933 (70%)**
Culturally Significant Rock Art Sites included	**9 (100%)**
Culturally Significant Rock Art Site Viewsheds included	**11 (69%)**
Culturally Significant Viewshed Acres included	**563 (91%)**
Mining Claims included in proposed withdrawal area	**23 (32%)**

Under this alternative 76% of the Analysis Area would be included in the withdrawal. This would physically protect 83% of the archaeological sites. 100% of the Long Mountain Archaeological Research Interest Area would be protected under this alternative. 70% of the areas without previous archaeological survey would be protected. 100% of the culturally significant sites would be physically protected. This alternative would protect the viewshed for 69% of the culturally significant sites totaling 91% of the total viewshed acres. It does not protect the viewsheds at all culturally significant sites, though it achieves full physical protection for sites of both archaeological and cultural significance. Protecting only 70% of the un-surveyed areas leaves a considerable chance that undocumented cultural resources will not be protected from mining activities. Since this alternative protects only 91% of the significant viewshed acreage, selecting this alternative means that the remaining 9% of the viewshed acreage would require consideration under guidance from the 36 CFR 228 subpart A regulations.

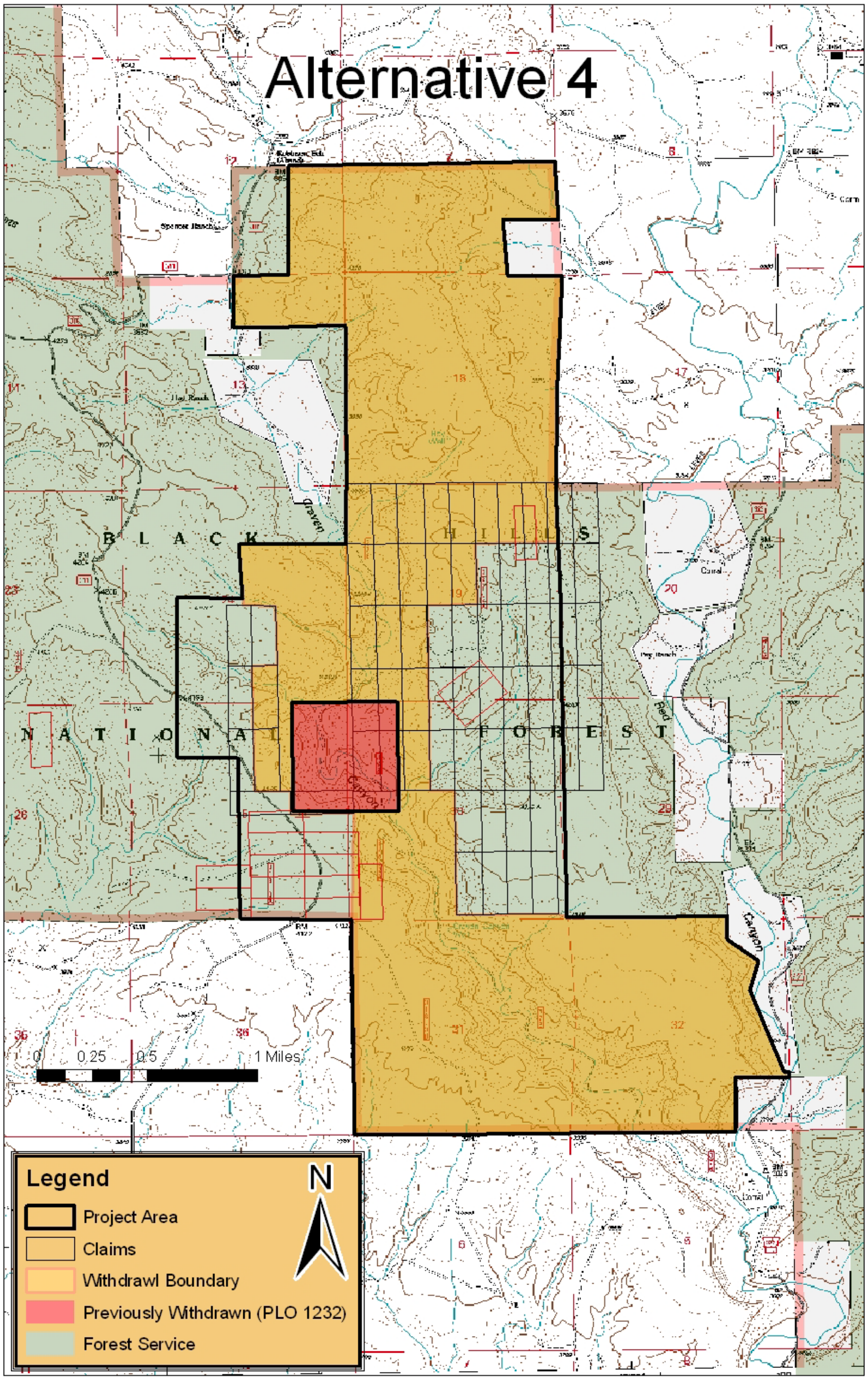


Figure 5. Alternative 4

Comparison of Alternatives

This section provides a tabular summary of the effects of implementing each alternative on the Significant Issues identified for this project. Information in the table is focused on the comparison of each alternative by using the four measures identified to compare the effects of implementing each of the alternatives.

Table 4. Comparison of Alternatives

Issue	Measure	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Effects on Existing Mining Claims	**Size of Withdrawal Area** Acres Proposed to be Withdrawn from Mineral Location and Entry	0 ac (0%)	3,957 ac (100%)	2,649 ac (67%)	3,009 ac (76%)
	Retention of Existing Mining Claims Mining Claims Included In Withdrawal area	6 existing claims	72 existing claims	6 existing claims	24 existing claims
	Potential Cost to Government to Determine Valid Existing Rights	$240,000 – $360,000	$2,880,000 – $4,320,000	$240,000 – $360,000	$960,000 – $1,440,000
Protection of Culturally Significant Resources	**Protection of Archeological Sites** Known Archeolocial Sites Included In Withdrawal area	0	46	27	39
	Protection of Culturally Significant Viewsheds Acres of Culturally Significant Viewsheds Included In Withdrawal area	0 ac	621 ac	473 ac	563 ac

CHAPTER 3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This section summarizes the physical, biological, social and economic environments of the affected project area and the potential changes to those environments due to implementation of the alternatives. It also presents the scientific and analytical basis for comparison of alternatives presented in the chart above.

Past, Present, and Reasonably Foreseeable Actions

- Uranium exploration and extraction has occurred in the project area in the past. Permit applications for uranium exploration and extraction have been submitted to federal and state agencies for areas adjacent to the analysis area, however, no permits have been issued. It is reasonably foreseeable that uranium exploration and extraction could occur within, or adjacent to the analysis area in the near future. Other activities in the analysis area include recreation, traditional cultural activities, and cattle grazing. All of these activities may have a cumulative effect on heritage resources in the form of increased soil erosion, increased visitor use, vandalism, and damage from unauthorized mining activities or mining activities that are in noncompliance with an approved plan of operation.
- Livestock grazing is expected to continue as managed under the current Allotment Management Plans for the Basin, Long Mountain and Robinson Flats Grazing Allotments.
- Surveys for rare plants, wildlife and heritage resources within the analysis area would be ongoing.
- The Black Hills National Forest Travel Management Decision (May 2010) reduced allowable motorized travel in the project area.

Heritage Resources

Affected Environment

The significance of rock art sites in the Black Hills has been established in two previous National Register of Historic Places (NRHP) nominations (Rock Art of the Southern Black Hills, 1980; Prehistoric Rock Art of South Dakota, 1993). All rock art sites in Craven Canyon discovered prior to 1993 are listed in the NRHP. Several more rock art sites have been discovered since 1993 and have been determined eligible for listing in the NRHP, but have not yet been nominated.

The southern Black Hills in general contains an unparalleled diversity of rock art styles spanning the entire breadth of human occupation of the area. The most significant representation of this diversity exists in Craven Canyon. Archaeological investigations, consultation with Native Americans, and oral histories of local ranchers have established that Craven Canyon is an irreplaceable element of the plains Native American cultural fabric.

Figure 6. Digitally enhanced image of a Paleo-Indian hunting scene at 39FA0099. (Photo taken during the 2005 Craven Canyon Passport In Time Project)

Prehistoric Context

The Black Hills are part of the greater culture area of the Northwestern Plains (Sundstrom 1989). Human occupation of this area has been divided into five broad cultural periods (Frison 1991):

Paleo-Indian	11,500 B.P. to 7,000 B.P.
Early Archaic	7,000 B.P. to 5,000 B.P.
Middle Archaic	5,000 B.P. to 3,000 B.P.
Late Archaic	3,000 B.P. to 1,500 B.P.
Late Prehistoric	1,500 B.P. to 500 B.P.

Field Surveys at Craven Canyon

All rock art sites in Craven Canyon are already listed, except those discovered after the earlier nominations were submitted. Rock art sites in the Craven Canyon District not yet listed, but eligible under the 1993 Prehistoric Rock Art of South Dakota thematic nomination are the following: 39FA1651, 39FA1652, 39FA1653, and 39FA1702.

Archaeological Significance of Craven Canyon and Long Mountain

Archaeological and paleo-environmental investigations in Craven Canyon indicate that there is still much to be learned about post-Pleistocene deposits and post-Pleistocene human activities (Sundstrom 2008). The affected environment is not limited to known archaeological sites. Instead, the affected environment also includes areas suspected to contain stratified deposits on Long Mountain (Sundstrom 2008).

From an archaeological standpoint, the rock art sites in Craven Canyon are a highly significant cultural resource. They have yielded, and continue to yield, information about ideology, aesthetics, technology, and social organization not found in other types of archaeological sites (Sundstrom 1993; Sundstrom 2004).

In addition, recent investigations by Fredlund (1996), and Sundstrom and Fredlund (2007) indicate that rock shelters and lithic scatters in Craven Canyon contain intact and deeply stratified deposits and intact paleosols not found elsewhere in the Black Hills. These sites have the potential to answer questions about paleoenvironmental conditions and human use of the Black Hills throughout the Holocene.

Traditional Cultural Use of Craven Canyon and the Importance of Viewsheds

The significance of Craven Canyon from a traditional use perspective is not limited to the rock art. Rather, Craven Canyon should be viewed as an Ethnographic Landscape. National Park Service Preservation Brief 36 defines an Ethnographic Landscape as "a landscape containing a variety of natural and cultural resources that associated peoples define as heritage resources" (NPS 1994: 2).

Some Lakota are more interested in Craven Canyon as a whole, and are not interested specifically in the rock art (Sundstrom 2008). For these individuals, the need for protection of Craven Canyon goes well beyond physical protection of the rock art, and includes a need for protecting the natural landscape features of Craven Canyon (Sundstrom 2008). For this reason, the affected environment is not limited to the physical protection of the rock art itself. The affected environment also includes a consideration of the viewshed of the natural landscape as seen from the most important rock art sites.

The importance of Craven Canyon from a cultural use perspective cannot be understated. For peoples' whose culture, history, values, morals, and beliefs are largely oral rather than written, *places* serve as "indispensable aids for remembering and imagining" (Basso 1996:7). Lakota, Cheyenne, Arapaho, Kiowa, and many other plains peoples regard the Black Hills as sacred (La Pointe 1976). These peoples have a special connection to rock art sites in the Black Hills because they are the descendants of the people who made them. The rock art sites in Craven Canyon, and indeed the canyon itself, continue to serve as repositories of history, beliefs, wisdom, and inspiration.

When one place or one rock art site is damaged or altered, the corresponding piece of history, moral value, or belief is also threatened because the particular place which served as the heuristic devise for remembering is no longer intact. Thus, any adverse effect in

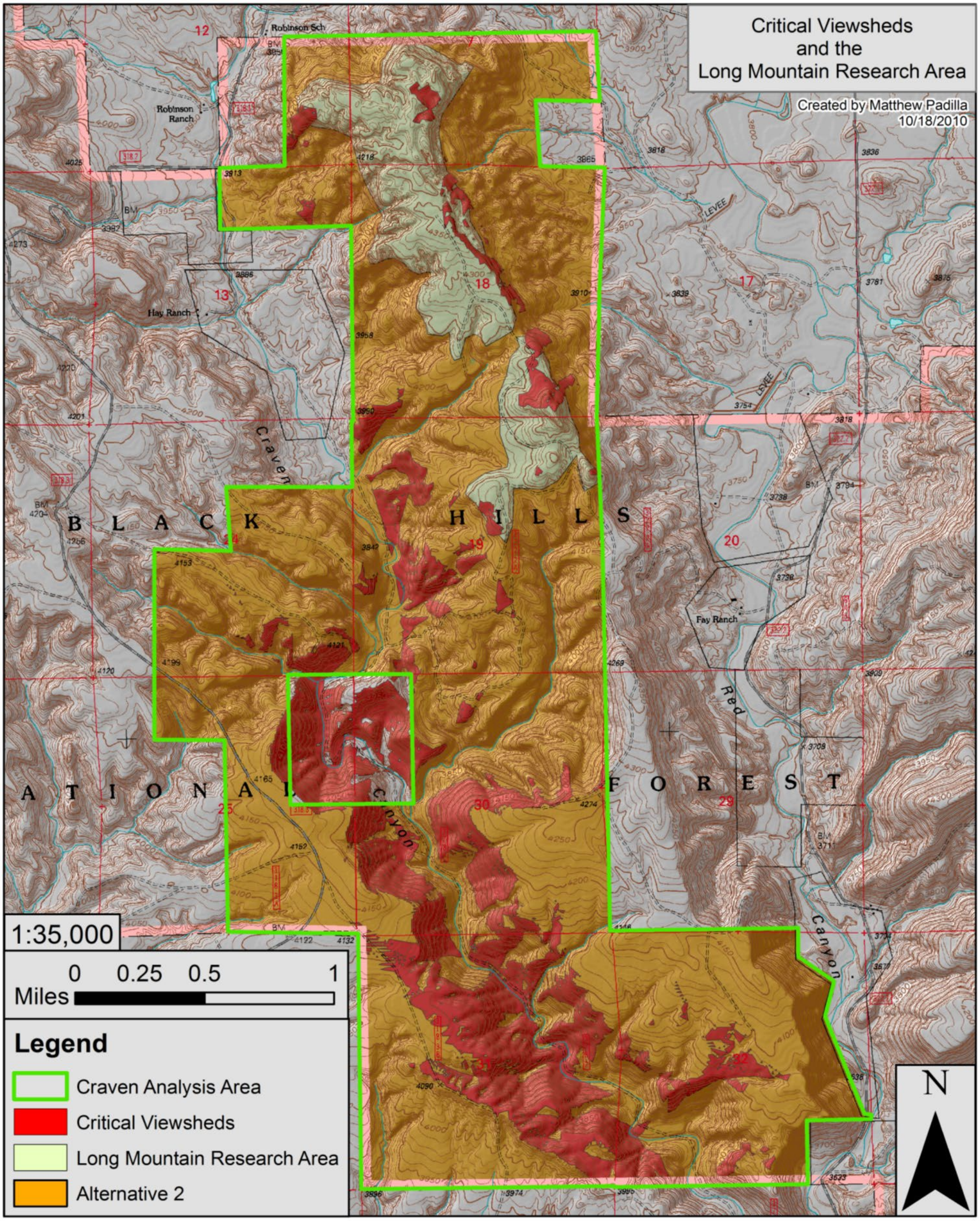


Figure 7. Culturally Significant Viewsheds

Craven Canyon is viewed by Plains Native Americans as an affront to their culture and Indigenous human rights.

Environmental Effects

This section compares the effects of all alternatives on Heritage Resources. This comparison includes an analysis of archaeological sites, research areas, spiritual-use, and the viewsheds from the most important rock art sites.

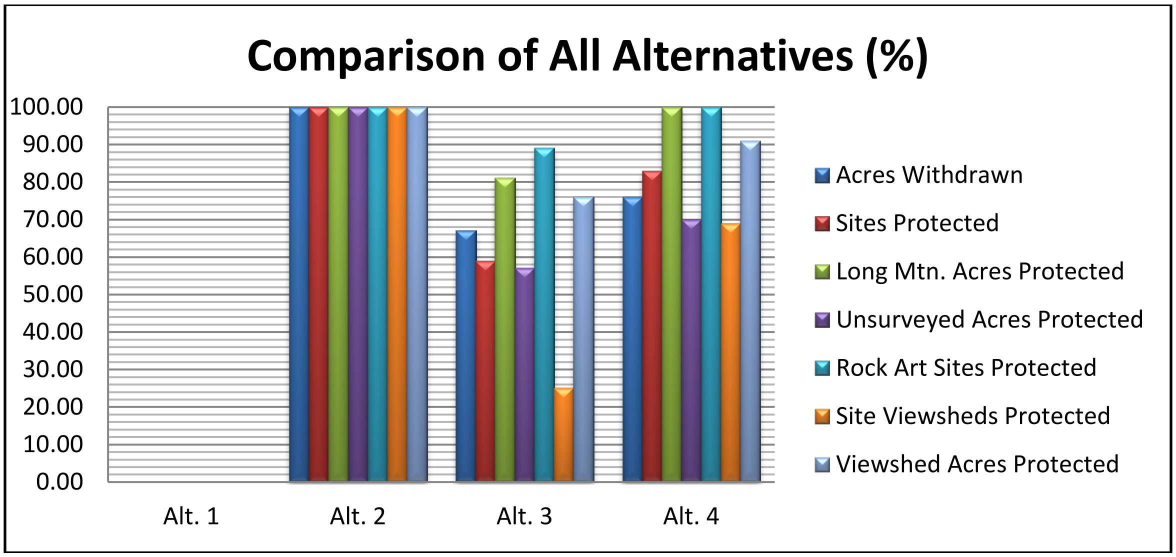


Figure 8. Comparison of All Alternatives on Heritage Resources

Summary of Effects from all Alternatives	Alt. 1		Alt. 2		Alt. 3		Alt. 4	
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Acres Withdrawn	0	0	3957	100	2649	67	3009	76
Archaeological Sites Protected	0	0	46	100	27	59	38	83
Acres of the Long Mountain Research Interest Area Protected	0	0	386	100	313	81	386	100
Unsurveyed Acres Protected	0	0	2780	100	1574	57	1933	70
Culturally Significant Rock Art Sites Protected	0	0	9	100	8	89	9	100
Culturally Significant Rock Art Site Viewsheds Protected	0	0	16	100	4	25	11	69
Culturally Significant Rock Art Viewshed Acres Protected	0	0	621	100	473	76	563	91

Table 5. Summary of Effects from All Alternatives on Heritage Resources.

Alternative 1: No Action

Under the No Action Alternative, potential impacts to cultural resources due to mining activities such as hard rock uranium extraction could occur. However, before mining activities could begin, a Plan of Operations must be submitted and any activity would be subject to laws and requirements under the Archeological Resources Protection Act (ARPA) and the National Environmental Policy Act (NEPA), regulated through the Forest Service 36 CFR 228 mineral regulations.

Archaeological resources are non-renewable, and ethnographic landscapes cannot be recreated. Taking no action would allow all 3,957 acres of the analysis area open to new mining claim locations and mineral exploration and development, and places archeological resources at risk of damage if mining is not properly mitigated and administered. At risk are 46 known archaeological sites, 386 acres of the Long Mountain Archaeological Research Interest Area, 9 rock art sites of traditional cultural significance, and the viewshed from these sites.

Under the No Action alternative the existing 160 acre withdrawal (PLO 1232, partially revoked) would remain in place for the protection of significant rock art sites within a portion of Craven Canyon. However, as discussed above in the affected environment section, there are a total of 46 archaeological sites in the current analysis area, whereas there are only 9 archaeological sites in the previously withdrawn area. Furthermore, the current analysis addresses more than just the physical protection of known archaeological sites. There is also consideration of viewsheds of traditional cultural importance, areas where no cultural resource inventories have been conducted, and areas where preliminary studies suggest a great deal of archaeological and paleoenvironmental potential--all of which would not have the added protection that a withdrawal can provide if the no action alternative is chosen.

Under the No Action alternative, mining regulations outlined in 36CFR228 could be effective in protecting the archeological sites from physical harm, however, there are 19 archaeological sites located within known claims that would require mitigation. Furthermore, the affected environment includes more than just the physical boundary of the 46 archaeological sites. It includes areas with high potential for future research, areas without previous adequate survey, and viewsheds from culturally significant rock art sites--all of which would remain unprotected under the no action alternative.

Alternative 2: Proposed Action

Alternative 2 would result in the withdrawal of the entire analysis area (3,957 acres) from mineral entry and development. Withdrawal would prevent any new claims from being filed, and would require existing claims to submit a Plan of Operations, subject to a Valid Rights Determination, prior to any ground disturbing activities.

Under this alternative, all archaeological sites, all areas of the Long Mountain Archaeological Research Interest Area, all areas without previous archaeological survey, all culturally significant sites, and the viewsheds from these sites will be protected from mineral exploration and development. This alternative meets all aspects of the purpose and need.

Summary of Alternative 2	(n)	(%)
Acres Withdrawn	3957	100
Archaeological Sites Protected	46	100
Acres of the Long Mountain Research Interest Area Protected	386	100
Unsurveyed Acres Protected	2780	100
Culturally Significant Rock Art Sites Protected	9	100
Culturally Significant Rock Art Site Viewsheds Protected	16	100
Culturally Significant Rock Art Viewshed Acres Protected	621	100

Table 6. Summary of impacts to Heritage Resources under Alternative 2. This alternative proposes the withdrawal of the entire analysis area from mineral entry and development. (Subject to the rights of existing valid claims)

Alternative 3

Alternative 3 would withdraw all areas of the current analysis area with the exception of areas with existing mining claims. Alternative 3 would result in 2,649 acres being withdrawn.

Summary of Alternative 3	(n)	(%)
Acres Withdrawn	2649	67
Archaeological Sites Protected	27	59
Acres of the Long Mountain Research Interest Area Protected	313	81
Unsurveyed Acres Protected	1574	57
Culturally Significant Rock Art Sites Protected	8	89
Culturally Significant Rock Art Site Viewsheds Protected	4	25
Culturally Significant Rock Art Site Viewshed Acres Protected	473	76

Table7. Summary of impacts to Heritage Resources under Alternative 3. This alternative would withdraw all areas of the current analysis area except areas with existing mining claims.

Under this alternative 67% of the Analysis Area would be included in the withdrawal. This would protect 59% of the Archaeological Sites. Approximately 81% of the Long Mountain Archaeological Research Interest Area would be protected under this alternative, 57% of the area without previous archaeological survey would be protected, and 89% of the culturally significant sites would be protected. This alternative would protect the viewshed for 25% of the culturally significant sites totaling 76% of the total viewshed acres. This is the least favorable alternative for Heritage Resources because it achieves the lowest amount of cultural resource protection, and does not fully meet the purpose and need.

Alternative 4

Alternative 4 emphasizes protecting the physical location of archaeological sites. The alternative was not developed with explicit consideration of the setting or viewshed at culturally significant sites. Under alternative 4, existing claims that have the potential to physically damage archaeological sites are included in the withdrawal. Existing claims that do not have the potential to physically damage archaeological sites are not included in this alternative. Alternative 4 would result in 3,009 acres being withdrawn. This alternative is subject to the rights of existing valid claims.

Summary of Alternative 4	(n)	(%)
Acres Withdrawn	3009	76
Archaeological Sites Protected	38	83
Acres of the Long Mountain Research Interest Area Protected	386	100
Unsurveyed Acres Protected	1933	70
Culturally Significant Rock Art Sites Protected	9	100
Culturally Significant Rock Art Site Viewsheds Protected	11	69
Culturally Significant Rock Art Viewshed Acres Protected	563	91

Table 8. Summary of impacts to Heritage Resources under Alternative 4. This alternative would withdraw all areas of the current analysis area and claims that have the potential to physically damage archaeological sites.

Under this alternative 76% of the Analysis Area would be included in the withdrawal. This would physically protect 83% of the archaeological sites. All (100%) of the Long Mountain Archaeological Research Interest Area would be protected under this alternative. Approximately 70% of the areas without previous archaeological survey would be protected, and all (100%) of the culturally significant sites would be physically protected. This alternative would protect the viewshed for 69% of the culturally significant sites totaling 91% of the total viewshed acres. It does not protect the viewsheds at all culturally significant sites, though it achieves full physical protection for sites of both archaeological and cultural significance. Protecting only 70% of the unsurveyed areas leaves a considerable chance that undocumented cultural resources will not be protected from mining activities. Since this alternative protects only 91% of the significant viewshed acreage, selecting this alternative means that the remaining 9% of the viewshed acreage would require consideration under guidance from the 36 CFR 228 subpart A regulations.

Cumulative Effects

Archaeological resources are non-renewable. The cumulative effect of taking no action to provide additional protection to this area from mineral exploration and development is that more archaeological sites could be impacted if mining activity were to occur. It is possible that in order for future mining to occur, some archeological sites may have to be mitigated by complete removal from the landscape. The result would be fewer archeological resources in their original context from future studies to learn about past human life-ways. Fewer places would be available for the Lakota and Cheyenne to seek wisdom and inspiration. Eventually, Craven Canyon could lose some of its essential character as a place of significant Native American history and inspiring natural beauty. That character would be replaced with industrial activity until mining and reclamation is completed. Even then, reclamation cannot totally replace the natural beauty and human history that currently exists.

Mineral Resources

Affected Environment

The area proposed for withdrawal is in Fall River County, South Dakota, on the Hell Canyon Ranger District of the Black Hills National Forest about 7 miles (11.3 km) north of the town of Edgemont, South Dakota. The withdrawal is from location and entry under the United States mining laws for a period of 20 years, subject to valid existing rights. There are 295 active lode mining claims within the same two townships as the proposed withdrawal area with 72 of those claims occurring in or partly within the subject withdrawal area. The subject area occurs mainly over outcrops of Early Cretaceous Inyan Kara Group sedimentary rocks with an underlying sequence of Mesozoic and Late Paleozoic sedimentary rocks. The Inyan Kara Group is known for hosting deposits of uranium and because of such, has been mapped in detail. It has been divided into the Lakota and Fall River Sandstone and further into several members and units. Massive fluvial sandstone from the Chilson Member of the Lakota Formation form high vertical cliffs in Craven Canyon. Craven Canyon lies in the heart of the Edgemont uranium mining district. Mineralization is roll-front-type uranium and vanadium deposits. Several past producing uranium mines occur in and adjacent to the proposed withdrawal area. Those to the east of the canyon occur in fluvial unit 1 of the Lakota Formation and those to the west occur in the lower unit of the Fall River Sandstone. Several mining companies are actively seeking uranium resources in the area. One company is currently conducting exploration drilling just west of National Forest System land near Dewey, South Dakota. Another two companies have approached the Forest Service about exploration and the potential impacts to their mining claims from the proposed withdrawal. None have submitted a Notice of Intent or Plan of Operations. A field investigation conducted for this proposed withdrawal confirmed the presence of uranium mineralization and past mining within the subject area.

Locatable Minerals

Locatable minerals in this report refer to minerals that typically are obtained by the public through filing mining claims on public domain land. The subject proposed withdrawal area is covered by mineral potential designations provided in DeWitt and others (1986). DeWitt has four different mineral potential designations in the general area of the proposed withdrawal labeled M2, N1, O3, and O5. M2 represents large (>10,000,000 tons) bedded sedimentary deposits (high-calcium limestone) in the Minnekahta Limestone. N1 represents medium (100,000 to 1,000,000 tons) bedded sedimentary deposits (gypsum) in the lower part of the Spearfish Formation and the lower part of the Gypsum Spring Formation. M2 and N1 both are listed as high resource potential (H/D). O3 represents a high potential (H/D) for medium (10,000 to 50,000 ton) stratabound roll-front deposits of uranium and vanadium in the Inyan Kara Group rocks. O5 represents moderate potential (M/C) for medium to large stratabound roll-front deposits of uranium and vanadium in the deeply buried Inyan Kara Group rocks that could be exploited by solution mining (in-situ mining).

The Craven Canyon proposed withdrawal area is covered mostly by Inyan Kara Group sedimentary rocks; the majority of which is fluvial unit 1 of the Lakota Formation. The middle unit of the Fall River Sandstone makes up the next largest exposure in the subject area. The presence of fluvial unit 1 of the Lakota Formation represents a favorable geologic setting (factor 1). The identification of visible carnotite mineralization in sandstone and the high scintillometer readings indicates roll-front mineralization of potentially economic concentrations (factors 2 and 3) occur within the subject area. Several adits and open pit glory holes occur where mineralization is evident and known production of uranium and vanadium came from these workings (factors 4 and 5). Lastly, DeWitt and others (1986) have given a mineral potential designation of O3 for the subject area (factor 6). O5 designations occur to the southwest of the subject area where upper Cretaceous sedimentary rocks overlie the lower Cretaceous Inyan Kara Group rocks. All six mineral potential determination factors exist for medium (10,000 to 50,000 ton) stratabound roll-front deposits of uranium and vanadium in the Inyan Kara Group rocks. The Minnekahta Limestone, Spearfish, and Gypsum Spring Formations deeply underlie the Inyan Kara Group sedimentary rocks exposed on the subject area. Due to the shallow southwest dip of the strata, their surface exposures occur several miles to the northeast of the subject area. Therefore, no mineral potential determination factors occur within the subject area for high-calcium limestone or gypsum. The Craven Canyon proposed withdrawal area has a high potential (H/D) for uranium and vanadium roll-front deposits hosted in fluvial unit 1 of the Lakota Formation. There is no indicated potential (O/B and C) for any other locatable mineral resource.

Leasable Minerals

DeWitt and others (1986) also identified mineral resource potential for leasable mineral resources. They have four different mineral potential designations in the general area of the proposed withdrawal labeled OG7, OG8, CO1, and CO2. OG7 represents a high potential (H/D) for small stratabound oil and gas deposits (<1,000,000 barrels of oil (BBL); <400,000 million cubic feet of gas (MCF)) in monocline and anticline structural traps within the Minnelusa Formation at the Barker Dome field. The Barker Dome field has produced from the Minnelusa Formation since 1955. OG8 represents a moderate potential (M/D) for medium-sized deposits of oil and gas (1,000,000 to 20,000,000 BBL; 400,000 to 5,000,000 MCF) in all subsurface Phanerozoic strata. Only 13 test wells on NFS land have been drilled in this zone. CO1 represents a low potential (L/C) for small deposits of subbituminous coal (<50,000 tons) in bedded sedimentary deposits within the Inyan Kara Group rocks. CO2 represents a moderate potential (M/D) for small deposits of subbituminous coal (<50,000 tons) in bedded sedimentary deposits within the Inyan Kara Group rocks where it has been produced from small mines and by local ranchers for heating.

The Craven Canyon proposed withdrawal area overlies several subsurface Phanerozoic sedimentary rock units with the early Cretaceous Inyan Kara Group representing the majority of the surface rock exposure. A moderate potential coal area is in Coal Canyon and extends eastward to about 1 mile west of the proposed withdrawal area. The Barker Dome structure, with a high potential for oil and gas, trends in a northwest-southeast direction terminating at the northwest corner of the proposed withdrawal area. Therefore, neither area designation (OG7 or CO2) applies to the Craven Canyon area. The Inyan Kara Group and the underlying strata do represent a favorable geologic setting (factor 1) for coal and oil and gas occurrences. DeWitt and others (1986) have designated a moderate potential for oil and gas resources, and a low potential for coal resources for the area covered by the proposed withdrawal (factor 6). A field investigation indicated no surface evidence of any structural traps extending into the withdrawal area. In addition, there was no evidence of the basal fissile shale known to locally contain coal beds. Therefore, factors 2 through 5 do not apply to the subject area for potential leasable resources. Based on the available information and the field investigation the designations developed by Dewitt and others (1986) are correct. This area has a moderate potential (M/B) for oil and gas resources because of the close proximity to a known structural trap, and a low potential (L/B) for subbituminous coal resources.

Salable Minerals

Because the Cretaceous sedimentary rocks are known to contain silt and mudstone layered in with the sandstone, alluvium in drainages from these units are not considered favorable for sources of sand and gravel. Clay has been mined from the Fuson Member of the Lakota Formation but has generally been of marginal quality for refractory bricks and therefore this mining has been very limited. The Fall River Sandstone in Hot Springs, South Dakota has been quarried for building construction stone. Many areas of the Black Hills, both on and off the Forest, have a high mineral material resource potential. DeWitt and others (1986) show those areas with the best potential. None of those areas occur within the proposed withdrawal area.

Environmental Effects

Locatable minerals such as uranium will still be available under all alternatives on mining claims with valid existing rights. Regardless if under a withdrawal or not, operations on these subject mining claims will be managed under Forest Service 36 CFR 228 subpart A regulations. Both ARPA and NEPA would be invoked to provide special mitigation measures to protect significant archaeological resources and other significant resources.

In an area withdrawn from mineral entry, the only activity that can be conducted on a mining claim is the maintenance of claim corners. Any other mining related activities would require surface disturbance and the submission of a Plan of Operations. This would in turn trigger the requirement of a valid existing rights determination. There would be no mining related activities permitted on the claim during the valid existing rights determination, which could take up to one year or more. If the claim is not valid (minerals are not sufficient in quantity or quality), the proposed Plan of Operations would not be approved and the claim would be declared null and void for the term of the withdrawal. If the claim is valid, operations on the claim would be managed under Forest Service 36 CFR 228, subpart A regulations, which require special mitigation measures to protect significant resources, such as the rock art found in Craven Canyon.

Alternative 1, No Action

Under the No Action alternative, no changes are proposed to the existing opportunities for mineral exploration and development. Archeological resources are protected from adverse impacts caused by mining activities under existing laws and regulations. Where a mining proposal would violate an environmental law such as ARPA, the Forest Service would not accept that proposal until such time as impacts to the resource of concern are shown to be reasonably mitigated.

Alternative 2, Proposed Action

Under alternative 2, approximately 3,957 acres are proposed for withdrawal from mineral location and entry. New claims could no longer be located. Existing claims would remain until contested or abandoned. Mineral development on any claim found to be valid may still occur. Mineral activity on the mining claims within the withdrawal area, including mineral exploration, would require a Plan of Operations under Forest Service 36 CFR 228, subpart A regulations. Before a Plan of Operations can be approved, valid existing rights must be verified for each mining claim on which the activity is proposed. Valid existing rights are verified through mineral examinations conducted by a government certified mineral examiner. If minerals have not been found in sufficient quantity and quality to constitute a valid discovery of a valuable mineral deposit on the subject claims as of the date of withdrawal, and any time afterwards through to the date of the examination, then those claims will be declared null and void, and would no longer exist. Also, undiscovered or economically unproven mineral resources would be impacted by remaining lost to future exploration and development during the term of the withdrawal.

Alternative 3

Under this alternative approximately 2,649 acres would be withdrawn from mineral entry. This alternative proposes to exclude all (approximately 72) existing mining claims from withdrawal. These claims would not have to show valid existing rights prior to exploration and development. Exploration to prove out new resources may still occur as always within the un-withdrawn areas. Operators would still be required to file a Notice of Intent or Plan of Operations where significant surface resource disturbance might occur and to conduct mitigation to protect those resources. Operators would still be entitled to reasonable access even if that access is across withdrawn areas, however, the Forest Service may change the access to avoid the withdrawn areas if that access is still reasonable.

Alternative 4

Under this alternative, approximately 3,009 acres would be withdrawn from mineral entry. This alternative proposes to exclude most (approximately 49) existing mining claims from withdrawal. This alternative represents a compromise between Alternative 2 (Proposed Action) and Alternative 3.

New claims could no longer be located within the withdrawn area, as described under Alterative 2. Existing claims (approximately 23) within the withdrawal would remain until contested or abandoned. Mineral development on any claim found to be valid may still occur. Mineral activity on the mining claims within the withdrawal area, including mineral exploration, would require a Plan of Operations under Forest Service 36 CFR 228, subpart A regulations. Before a Plan of Operations can be approved, valid existing rights must be verified for each mining claim on which the activity is proposed. Valid existing rights are verified through mineral examinations conducted by a government certified mineral examiner. If minerals have not been found in sufficient quantity and quality to constitute a valid discovery of a valuable mineral deposit on the subject claims as of the date of withdrawal, and any time afterwards through to the date of the examination, then those claims will be declared null and void, and will no longer exist. Also, undiscovered or economically unproven mineral resources will be impacted by remaining lost to future exploration and development during the term of the withdrawal.

Those claims located outside of the withdrawn area would not have to show valid existing rights prior to exploration and development. Exploration to prove out new resources may still occur as always within the un-withdrawn areas. Operators are still required to file a Notice of Intent or Plan of Operations where significant surface resource disturbance might occur and to conduct mitigation to protect those resources.

Cumulative Effects

Mineral resources are non-renewable and are also commodity resources that contribute to the socio-economics of the region. Locatable minerals refer to minerals that are typically obtained by the public through filing mining claims on public domain lands, such as gypsum, uranium and vanadium. The proposed withdrawal area has been mapped as having a high mineral resource potential for uranium and vanadium, which are both considered important to national security. Renewed exploration for uranium in the Craven Canyon area is foreseeable if mining industry's interest for U.S. uranium resources continues to be strong. If all or part of the project area is withdrawn from mineral entry, over time there could be a reduction of available claims. As validity is determined, those claims that are determined to be invalid would become null and void. As technology improves, should there be new ways to extract minerals without damage to surface resources, or if what is considered invalid today becomes valid in the future, those opportunities to retrieve that mineral resource would be lost.

Leasable minerals refer to oil and gas, and coal deposits. Based on field investigations, the proposed withdrawal area has a moderate potential for oil and gas resources, and a low potential for coal resources. Because other areas with much higher potential for these minerals exist elsewhere, it is not likely that mining these resources within the project area would occur in the near future.

Salable minerals refer to minerals found in sedimentary rock such as clay, silt, sand and gravel. Because of the likely unsuitability of this mineral material, the remoteness of the subject area from markets, and the abundance of suitable resources in other areas of the Black Hills, including areas much closer to potential markets, there is unlikely to be an interest to extract mineral material from the subject area other than an occasional small amount for local personal use. Furthermore, because of the potential for archeological resources to occur in Quaternary sediments, the Forest is unlikely to allow mineral material excavations in this area. The potential for occurrences of suitable mineral material resources in Craven Canyon is low (L /C) with the potential for any commercial development being equally low.

Wildlife Resources

Affected Environment

The Craven Canyon area contains a diverse mix of habitats. There is an upper plateau above the sharply dissected canyon ravines. This has open meadow, ponderosa pine, with rocky mountain juniper. Some of the pine stands are dense, mature (old growth) in character. In the canyon bottom, plains cottonwood, green ash, and other riparian associated species (e.g. rushes) occur. Understory species include: common juniper, currants, silver sage, and cactus. A variety of grasses are present including grammas, needle grasses, bluegrass, buffalo grass, and brome grasses.

The Craven Canyon area provides habitat for a variety of mammal, bird, amphibian and reptile species. Some of these species use the area for breeding as well as foraging habitat. District records list prairie falcons and golden eagles nesting in the steep cliff habitat of Craven Canyon. Spade-foot toads have been recorded breeding in the intermittent ponds that occur after spring rains. The riparian habitat in the canyon bottom contains mature cottonwood trees which provide nesting and roosting habitat for species like Lewis woodpecker, northern flicker, and hoary bat. The scattered stands of mature, dense ponderosa pine provide habitat for the fringed myotis, brown creeper and northern goshawk. Other species that occur in the Craven Canyon vicinity include: prairie dog, badger, various species of bats, hawks, owls, swallows, grasshopper sparrow, meadow lark, rock wren, bobcats, coyote, mule deer, turkey, red squirrel, busy tailed woodrat, and other small mammals.

Environmental Effects

Effects common to all Action Alternatives

Threatened, Endangered, and Sensitive Species

The Fish and Wildlife Service (USFWS) lists identify no T&E species for Fall River County, South Dakota. There are a number of Rocky Mountain Region (R2) Sensitive Species that are known to occur or have suitable habitat in the project area. A separate Biological Evaluation would accompany this report. Since there would be no ground disturbing activities associated with this (administrative) project there would be ‘No Impact’. However, allowing additional mining claims in the project area could result in a loss of habitat if mining were to occur.

Species of Local Concern (SOLC)

The four bat species and the bighorn sheep (R2SS) are known or strongly suspected to be present in the project area. Since there would be no ground disturbing activities associated with this (administrative) project there would be ‘No Impact’. However, allowing additional mining claims in the project area could result in a loss of habitat if mining were to occur.

Management Indicator Species (MIS)

Black Hills National Forest has selected nine (9) Management Indicator Species (MIS) to monitor effects of projects. They are: beaver, brown creeper, white-tailed deer, ruffed grouse, golden-crowned kinglet, song sparrow, grasshopper sparrow, black-backed woodpecker, and mountain sucker. Of these only the grasshopper sparrow has suitable habitat that could be affected by the project. Alternatives that withdraw acres from mineral entry would maintain the upland grassland habitat used for nesting and foraging habitat by the grasshopper sparrow. Alternative 2 (proposed action) would be expected maintain the best situation for the grasshopper sparrow of all alternatives. Alternative 1 (no action) could allow future mining operations that would likely result in a reduction of grassland habitat in the project area.

Migratory Birds

Historic information has both golden eagles and prairie falcons nesting within the project area. Due to lack of suitable habitat the red-napped sapsucker is not suspected to occur in the Craven Canyon Mineral Withdraw Project Area. Alternative 2 would provide the best outcome for these migratory birds by protecting cliff nesting habitat. Alternative 1 (no action) could allow mining activities to reduce habitat and create human (noise) disturbance.

Botany/Range/Weeds Resources

Affected Environment

Rangeland Resources

The Craven Canyon Mineral Withdrawal Analysis Area includes portions of the Basin, Robinson Flats and Long Mountain grazing allotments (Figure 6).

The area is currently grazed as follows:

Allotment	Unit	Number of livestock	Average length of time	Grazing system
Basin	Red Canyon	65 cow/calf pairs	40 days	2-unit deferred rotation
	North Red Canyon	65 cow/calf pairs	79 days	2-unit deferred rotation
Robinson Flats	Coal Canyon	71 cow/calf pairs	55 days	2-unit deferred rotation
	Elbow Canyon	126 yearlings	90 days	2-unit deferred rotation
	Gravel Pit	126 yearlings	30 days	2-unit deferred rotation
Long Mountain	South	30 cow/calf pairs	43 days	2-unit deferred rotation
	North	30 cow/calf pairs	47 days	2-unit deferred rotation

Table 9. Grazing Allotments within and adjacent to Craven Canyon.

The area is predominately stony hills, shallow and silty range sites, as defined by the Natural Resource Conservation Service (NRCS) with numerous rock outcrops. Rangeland vegetation is a mixture of mid and short, warm and cool season grasses. Typical cool season grasses include needleandthread (Hesperostipa comata) and western

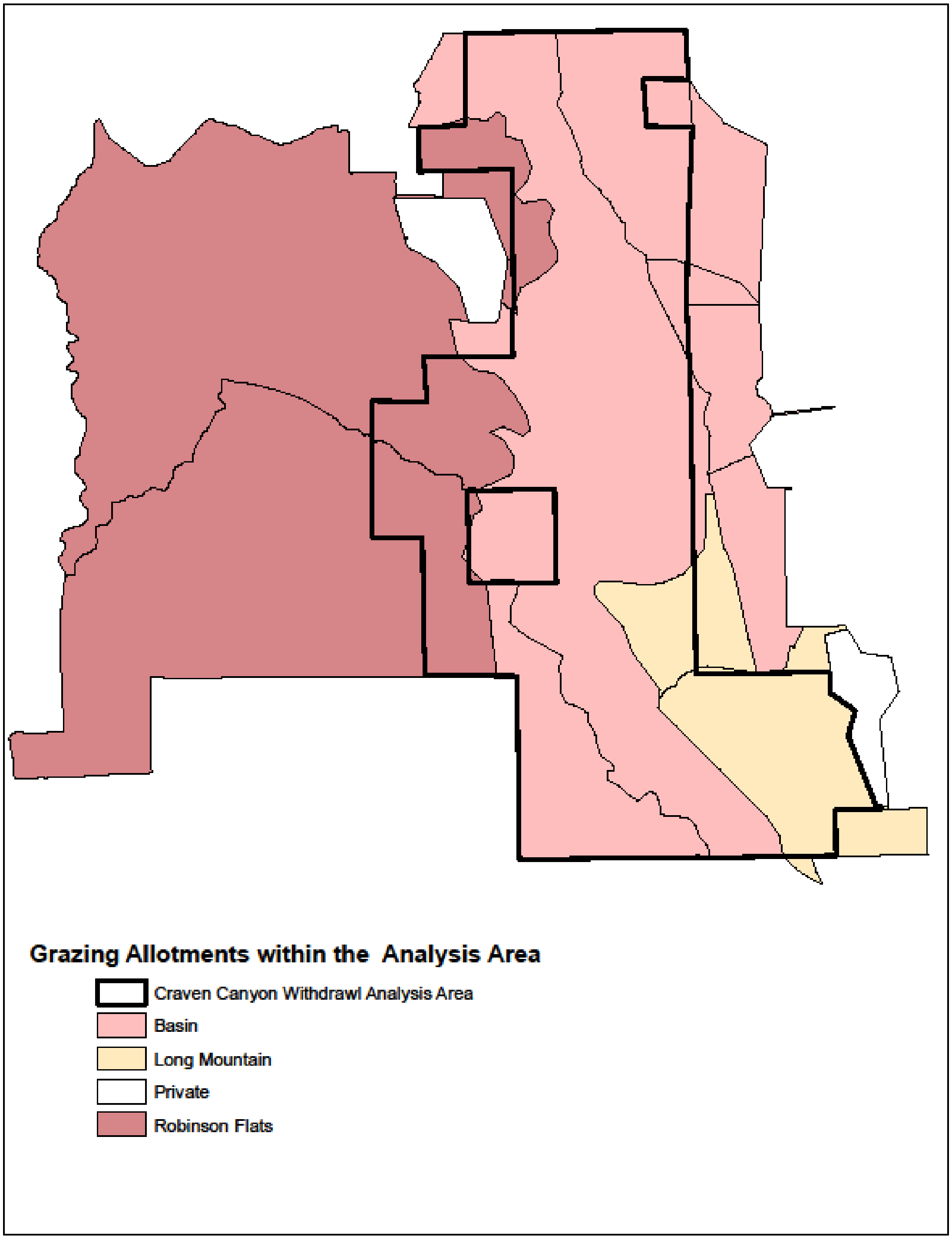


Figure 6. Grazing Allotments

wheatgrass (Pascopyrum smithii). Warm season grasses include little bluestem (Schizachyrium scoparium) and gramas (Bouteloua spp.). Forbs such as sageworts (Artemisia spp.) and scurfpeas (Psoralea spp.) are common. Ponderosa pine (Pinus ponderosa) and Rocky Mountain juniper (Juniperus scopulorum) are scattered throughout the area. Shrubs such as skunkbush sumac (Rhus trilobata) are present, but are not dominant.

Noxious Weeds

There are some known locations of Canada thistle (Cirsium arvense) in the draw bottoms, but in general, noxious weeds are not currently a problem throughout the analysis area. However, they do have the potential to become an issue with disturbance of the area.

R2 Sensitive and Species of Local Concern

R2 Sensitive Plant Species - R2 sensitive species are species identified by the Regional Forester for which population viability is currently of concern, as evidenced by significant current or predicted downward trends in population numbers or density, or by significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution (USDA Forest Service 2009). Appendix A lists the R2 sensitive plant species that are known to occur or are likely to occur on the Black Hills National Forest.

The Forest Service has established direction in the Forest Service Manual to guide habitat management for proposed, endangered, threatened, and sensitive plant species. The direction establishes the process, objectives, and standards for conducting a Biological Evaluation. This process ensures that these species receive full consideration in the decision making process.

Based on the conditions present (i.e. – elevation, community types, soil types, xeric conditions, etc) in the project area and the fact that most R2 sensitive plant species found in the Black Hills are associated with higher elevations and moister conditions, there are no areas present within the project area that would be considered habitat for most of the current list of R2 sensitive plant species. The exceptions to this generalization are Iowa moonwort (Botrychium campestre) and narrowleaf grapefern (Botrychium lineare).

Rangewide Iowa moonwort is considered a grassland species, associated with sandy grassland habitats in prairies, dunes, railroad sidings, and fields over limestone. The north end of the project area is located within the Red Valley Region. Some of the soils in this region may have formed from limestone parent material.

Typical habitat descriptions for narrowleaf grapefern are problematic because known sites are so different across its currently known range. This species may be a habitat generalist since habitat across the range for narrowleaf grapefern is quite variable and its range stretches from sea level in Quebec to approximately 10,000 feet in Colorado. In the Black Hills area, this species is often found growing in the same locations as Iowa moonwort. No individuals of these two species have been located within the project area.

Plant Species of Local Concern (SOLC)

Species of Local Concern are species that do not meet the criteria for sensitive status. These could include species with declining trends in only a portion of Region 2, or those that are important components of diversity in a local area. The local area is defined as NFS lands within the Forest. (FSM 2620.5 Black Hills Supplement 2600-2005-1).

Forest Service Manual 2622.01 directs us to consider species of local concern during project design and to evaluate the effects to the species from alternatives considered through the National Environmental Policy Act (NEPA) process. Based on known conditions of this project area, it is believed that suitable habitat is lacking for all Black Hills plants species of local concern.

Environmental Effects

Alternative 1: (No Action) – Direct and Indirect effects

Under the no action alternative the area would remain available for mineral entry under the General Mining Law, as amended. If the area remains available to mineral entry and mineral exploration and development occur in the area, there is a potential for decrease in forage available for grazing, increase of noxious weeds as soil is disturbed, and potentially a loss of probable habitat for the two R2 sensitive species which may have habitat in the area. However, all these potential impacts would be addressed as plans of operation for mining are issued for each entry.

Alternative 2: (Proposed Action) – Direct and Indirect effects

Under Alternative 2, if the area is withdrawn from mineral entry there would not be the potential for mining to impact rangeland vegetation in the future as roads are built for exploration and uranium extracted from the area; there would not be the potential for noxious weeds to become an issue due to soil disturbance from exploration and/or mining; and there would be no impacts from exploration and/or mining on the potential suitable R2 sensitive species habitat.

Alternative 3: Direct and Indirect effects

If implemented, Alternative 3 would have the same effects on the rangeland resources, noxious weeds and R2 sensitive species habitat as Alternative 2 except as follows:

Under this alternative 2,649 acres would be withdrawn from mineral entry, so 1,319 more acres have the potential of being impacted from mining and/or exploration (those impacts would be addressed as plans of operation are approved).

Alternative 4: Direct and Indirect effects

If implemented, Alternative 4 would have the same effects on the rangeland resources, noxious weeds and R2 sensitive species habitat as Alternative 2 except as follows:

Under this alternative 3,009 acres would be withdrawn from mineral entry, so 948 more acres have the potential of being impacted from mining and/or exploration (those impacts would be addressed as plans of operation are approved).

Cumulative Effects

The cumulative impact area for this analysis is the Craven Canyon Mineral Withdrawal Project area; activities beyond the project area have a diminished effect on the rangeland vegetation, noxious weeds and rare plant habitat within the project area. The timing limit for the cumulative effects analysis is estimated at 20 years, ten years prior to present and ten years in to the future, which allows for an adequate length of time to record vegetative changes.

Past, present and reasonably foreseeable activities within the Craven Canyon Mineral Withdrawal project area include wildfire, grazing, temporary road construction and maintenance, noxious weed control, wildlife habitat improvement projects, and dispersed recreational use on both the public land and private land in the area.

Any past, present or foreseeable future activity that causes soil disturbance has the potential to introduce and increase the rate of spread of noxious weeds and other exotic plants. This can be detrimental to rare plants and native rangeland vegetation, as invasive species have the ability to out-compete desired native plants. The herbicides used in noxious weed control can also be detrimental to rare plants if the individuals are inadvertently exposed to the herbicides.

When properly managed, livestock grazing can have positive impacts on the rangeland vegetation. The grazing in the Craven Canyon Mineral Withdrawal project area would continue as identified in the Allotment Management Plans for the Basin, Long Mountain and Robinson Flats Allotments.

Aside from the direct impact on the vegetation (i.e. – removal of vegetation, soil compaction and introduction of invasive species), road construction has the indirect impact of making formerly inaccessible areas available to both humans and grazing animals. Opening a new area to grazing can have a positive impact, by helping to distribute grazing animals. It can also have a negative impact by allowing access to areas that may be rare plant habitat. The likelihood of gates being left open (which increases the chance of livestock being in unauthorized areas) increases as the number of roads increase.

In the Craven Canyon Mineral Withdrawal area, the primary impacts from recreational use to the rangeland vegetation and rare plant habitat are the negative direct impacts to the vegetation (i.e. – removal of vegetation, soil compaction, introduction of invasive species) that may result from recreational use. Recreational use in an area increases the likelihood of plant collecting which can have an impact on rare plant populations.

All of the above uses are limited in intensity and duration and therefore when combined with the alternatives analyzed, including the no action alternative, do not result in cumulative impacts to the rangeland vegetation, or to the rare plant habitat.

Economics

Affected Environment

The Black Hills has a rich history of mining and this area is no different. The first discovery of uranium (carnotite) in Fall River County was in Craven Canyon in June 1951. Soon deposits of uranium had been found in the Inyan Kara Group extending from Dewey (about 14 miles (22.5 km) northeast of Craven Canyon) to Chilson Canyon (about 7 miles (11.3 km) southeast of Craven Canyon). The Edgemont mining district was organized in the late 1950's. Uranium and vanadium were produced from this district until the 1970's. The project area is within the Edgemont uranium mining district. Possible locatable mineral deposits in the Edgemont area include uranium and vanadium roll-front sandstone hosted deposits, and sedimentary rock units containing high calcium limestone and gypsum. Possible leasable mineral deposits include oil and gas in structural traps and minor deposits of subbituminous coal.

Production has come from a number of mines in the Edgemont area many of which were small, one-man operations. The Forest Service has begun reclaiming open pits but essentially little reclamation has been done on the numerous open pits, underground mines, and associated overburden and waste dumps occurring in the area.

Based on BLM's LR2000 mining claim data, Forest Service System lands are blanketed with hundreds of active lode mining claims on Inyan Kara Group sandstones from Deadhorse Canyon (4.5 miles (7.2 km) northeast of Edgemont) northwestward to Dewey. Claims are held by both companies and private citizens, and have been recently located starting in 1998 but mostly from 2002 to 2008. The companies are uranium companies and include Powertech Uranium Corp., Strathmore Minerals Corp. and Great Bear Uranium Corp., Tournigan USA Inc., Neutron Energy, and NCA Nuclear Inc. This increase in recent uranium mining claims has occurred throughout the western U.S. likely in response to both increased uranium metal prices and a changing U.S. energy policy. It appears this resurgence in uranium claims was primarily focused in areas of historic uranium activity prior to any new exploration activity.

In addition to the mining industry, there is also interest in the interpretative (recreational) opportunities associated with Craven Canyon. Some individuals have expressed interest in commercial endeavors (tours) that would provide public opportunities for gaining historical knowledge about Craven Canyon and opportunities for viewing the rock art within the canyon.

Environmental Effects

Under all action alternatives withdrawal of National Forest System lands could reduce opportunities for exploration and development of the mineral resources. This could in turn have some impact to local economies. However, mineral exploration and development could also result in adverse environmental impacts as discussed above. In Fall River County, income from mining activities makes up less than 1% on the total income for the county (Bureau of Economic Analysis, U.S. Department of Commerce).

Alternative 1 would have the least economic impact as it pertains to development and extraction of the mineral resources since all areas, except the existing withdrawal, would be available for mineral development subject to the protection and mitigation measures in 36 CFR 228 subpart A regulations. All of the action alternatives would have some impact to the potential development of mineral resources and therefore to the local economies.

Under all Alternatives, each of the existing claims within areas withdrawn from mineral entry, including the existing mineral withdrawal (PLO 1232 - 160 acres, after partially revoked) would be subject to a Valid Existing Rights Determination by a government certified mineral examiner. The cost to the government for validity testing of claims within the withdrawal area could range from $40,000 to $60,000 per case estimate. Additionally, the claimant would be required to wait for the validity determination and any associated environmental analysis before any operations could commence. This wait time could range from 1 to 3 years, or more.

Cumulative Effects

There are approximately 77,354 acres withdrawn from mineral entry on the Black Hills National Forest. Most mining in the Black Hills occurs on private lands. The Forest Plan EIS (USDA Forest Service 2005) cited very little in the way of expected mineral development in Fall River County or the Black Hills. Mineral development on the Forest was expected to have "little if any effect on the local or national economy" (ibid). Mining operations occurring on private lands in Fall River County and other areas in the Black Hills are likely to have a much larger effect on the economy.

Watershed and Soils

The FEMA DFIRM database was consulted for information on floodplains. The USFWS Wetlands Online Mapper (http://wetlandsfws.er.usgs.gov/wtlnds/launch.html) was consulted for information on wetlands in the project area. There are no floodplains and no wetlands in the project area. There are no ground disturbing activities proposed and no construction associated with this proposed mineral withdrawal.

CHAPTER 4. LIST OF PREPARERS, AND AGENCIES AND PERSONS CONSULTATED

The Forest Service consulted the following individuals, Federal, State, and local agencies, tribes and non-Forest Service persons during the development of this environmental assessment.

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FEDERAL, STATE, AND LOCAL AGENCIES:

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Fall River County Commission

Edgemont Chamber of Commerce

State of South Dakota

South Dakota Department of Agriculture

South Dakota Department of Environment and Natural Resources

South Dakota Department of Game, Fish and Parks

South Dakota Department of Transportation

South Dakota State Historic Preservation Officer

TRIBES:

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Cheyenne/Arapaho Tribes of Oklahoma

Crow Creek Sioux Tribe

Eastern Shoshone Tribe

Flandreau Santee Sioux Tribe

Grey Eagle Society

Lower Brule Sioux Tribe

Mandan Hidatsa & Arikara Tribes

Northern Arapaho Tribe

Northern Cheyenne Tribe

Oglala Sioux Tribe

Rosebud Sioux Tribe

Santee Sioux Tribe

Sisseton-Wahpeton Sioux Tribe

Spirit Lake Sioux Tribe

Standing Rock Sioux Tribe

Three Affiliated Tribes

Yankton Sioux Tribe

OTHERS:

Adjacent Landowners

Association of Professional Archeologists

Biodiversity Conservation Alliance

Defenders of the Black Hills

Mintec Corporation

Scott's Rock Shop

South Dakota Mining Association

Sierra Club, Black Hills Group

Society for American Archeology

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USDA, Forest Service **PLAN OF OPERATIONS FOR MINING ACTIVITIES** FS-2800-5 (Rev. 3/08)

ON NATIONAL FOREST SYSTEM LANDS

OMB 0596-0022

USE OF THIS FORM IS OPTIONAL! **1st TIME USERS SHOULD DIRECT QUESTIONS REGARDING THIS FORM OR REGULATIONS (36 CFR 228A) TO THE FOREST SERVICE DISTRICT OFFICE NEAREST YOUR AREA OF INTEREST.**

Submitted by:	M. Blady (signature)	Director	06/10/2024
	Signature	Title	Date *(mm/dd/yy)*

Plan Received by:			
	Signature	Title	Date *(mm/dd/yy)*

EXHIBIT

Ellison 2

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I. GENERAL INFORMATION

A. Name of Mine/Project: October Jinx Project

B. Type of Operation: Lode Mineral Exploration

C. Is this a new operation? Yes

If continuing a previous operation, this plan (☐ replaces/☐ modifies/☐ supplements) a previous plan of operations. *(check one)* ____________________

D. Proposed start-up date of operation: Oct 1, 2024

E. Expected total duration of this operation: 2 months, including 3 weeks of active drilling, plus aquifer testing and reclamation

F. If seasonal, expected date of annual reclamation/stabilization close out: N/A

G. Expected date for completion of all required reclamation: 2 weeks after the end of drilling

PRINCIPALS

A. Name, address, and phone number of operator:

Clean Nuclear Energy Corp (herein referred to as Clean Nuclear or Operator)
Attn: Mr. Mike Blady
503-905 Pender St. W
Vancouver, British Columbia, Canada V6C 1L6
(604) 720-3474

B. Name, address, and phone number of authorized field representative (if other than the operator):

Mr. John Glasscock
Project Manager
Clean Nuclear Energy Corp.
PO Box 2498
Laramie, WY 82073
(307) 760-9512

Authorization of field representative to act on behalf of the Operator is attached.

C. Name, address, and phone number of owners of the claims (if different than the operator):

Cowboy Uranium, LLC
PO Box 2498
Laramie, WY 82073
(307) 760-9512

All of the project claims within the area are listed in Appendix 1.

D. Name, address, and phone number of other lessees, assigns, agents, etc., and briefly describe their involvement with the operation, if applicable:

Not Applicable

III. PROPERTY OR AREA

The October Jinx Project comprises unpatented lode claims located in the Hell Canyon Ranger District of the Black Hills National Forest (BHNF) in Fall River County, South Dakota. The project area is located in Section 25, Township 7 South, Range 2 East, and Section 30, Township 7 South, Range 3 East of the Black Hills Meridian. The unpatented claims are listed in Appendix 1.

IV. DESCRIPTION OF THE OPERATION

A. **Access.** ***Show on a map (USGS quadrangle map or a National Forest map, for example) the claim boundaries, if applicable, and all access needs such as roads and trails, on and off the claim. Specify which Forest Service roads will be used, where maintenance or reconstruction is proposed, and where new construction is necessary. For new construction, include construction***

specifications such as widths, grades, etc., location and size of culverts, describe maintenance plans, and the type and size of vehicles and equipment that will use the access routes.

Figure 1 shows the October Jinx Project area and existing principal access roads to the mineral exploration prospect areas where work is proposed. Principal highways and primary Forest Service roads are also depicted.

Elbow Canyon Road provides local access to the project area, and the site will be accessed from the south (Figure 1). The existing access road is adequate for entry to the work area and does not require construction, vegetation removal, or road widening. Clean Nuclear will retain all snags that are not considered a hazard to property or life. Access to individual drill sites will involve using existing two-tracks and trails as well as short distances of overland travel to the drill pad.

No routine road maintenance is proposed during operation under the Plan. The U.S. Forest Service (USFS) provides guidance on road usage to protect the roads, and Clean Nuclear will follow the USFS rules and instructions. If using roads by the Operator results in degradation of road conditions on USFS lands, then the Operator commits to performing maintenance, with prior notification and consultation with the USFS, as required to restore the road to preoperational condition.

No new construction of roads, bridges, or culverts will be required for operations under this Plan. Vehicles used in the operation of the Project are listed in Section IV (D) below.

Any unexpected road or trail damage would be repaired as soon as possible. The USFS would be consulted to approve the proposed maintenance and inspect the repair. Contractor equipment would not exceed local road weight restrictions without prior approval by applicable authorities. All existing USFS-authorized improvements including but not limited to fences, roads, trails, water tanks, gates, and utility lines, are considered protected improvements and should be protected during project implementation. Should any improvement be damaged, the Hell Canyon Ranger District will be contacted, and it must be returned to its original condition as soon as possible. All access routes for equipment and water haulage that are not defined in the Plan of Operations (POO) shall be provided to the USFS for review and approval.

B. Map, Sketch or Drawing. ***Show location and layout of the area of operation. Identify any streams, creeks or springs if known. Show the size and kind of all surface disturbances such as trenches, pits, settling*** **ponds*****, stream channels and runoff diversions, waste dumps, drill pads, timber disposal or clearance, etc. Include sizes, capacities, acreage, amounts, locations, materials involved, etc.***

Figure 1 shows access to the proposed monitoring well drill sites. Figures 2 and 3 show detailed topography of the project site. All of the drill sites are listed in Table 1.

Figure 1. Project Location and Access

Drill sites are positioned near Elbow Canyon Road, on relatively flat topography, and in areas that were previously impacted by wildfire and historic uranium exploration in the 1970s and 1980s. After drilling is completed at the drill sites, the pad will be recontoured (if needed), seeded, and mulched during final reclamation, as described in Section V(I).

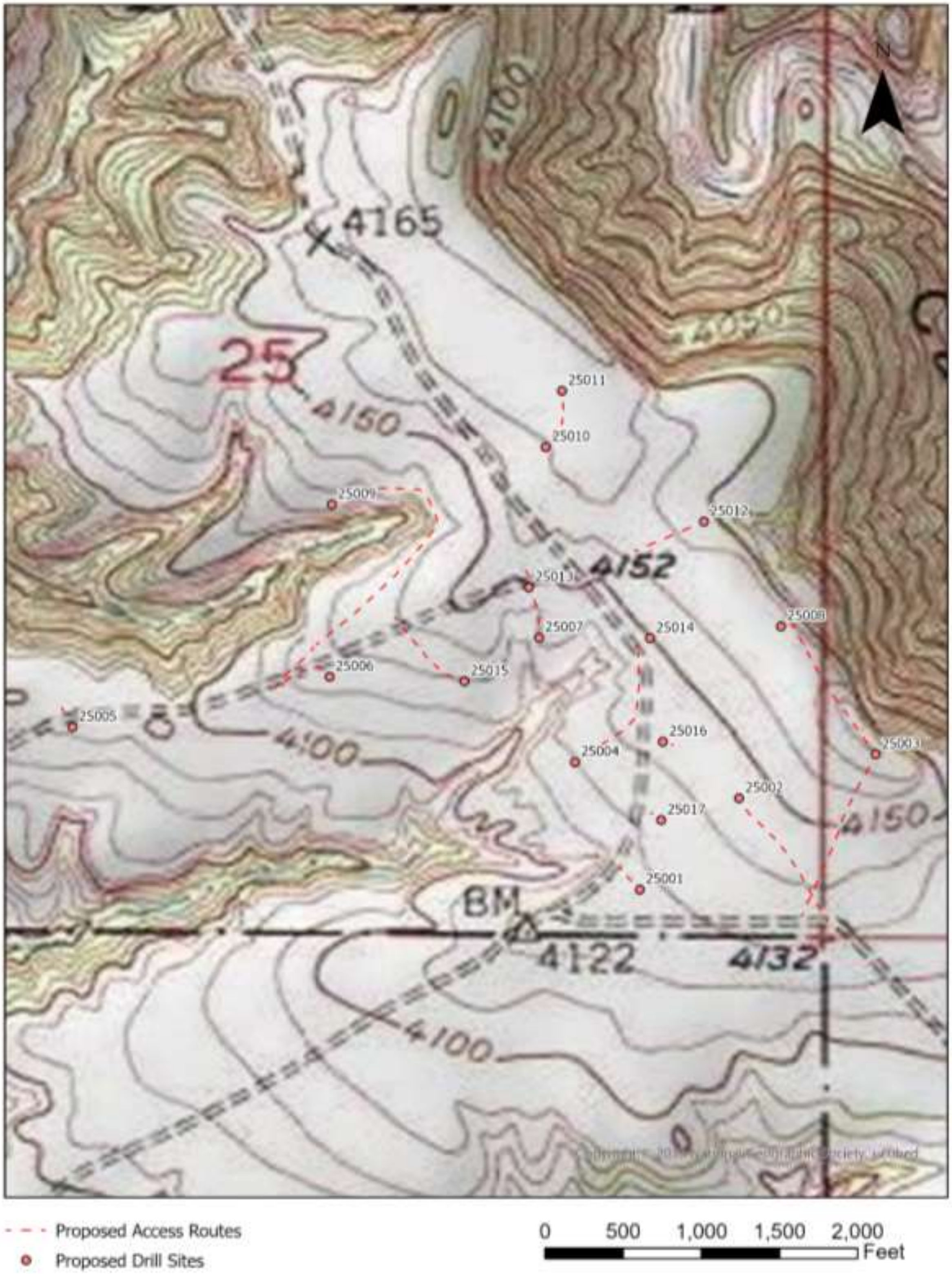

Figure 2. Topographic Map of Proposed Exploration Drill Sites

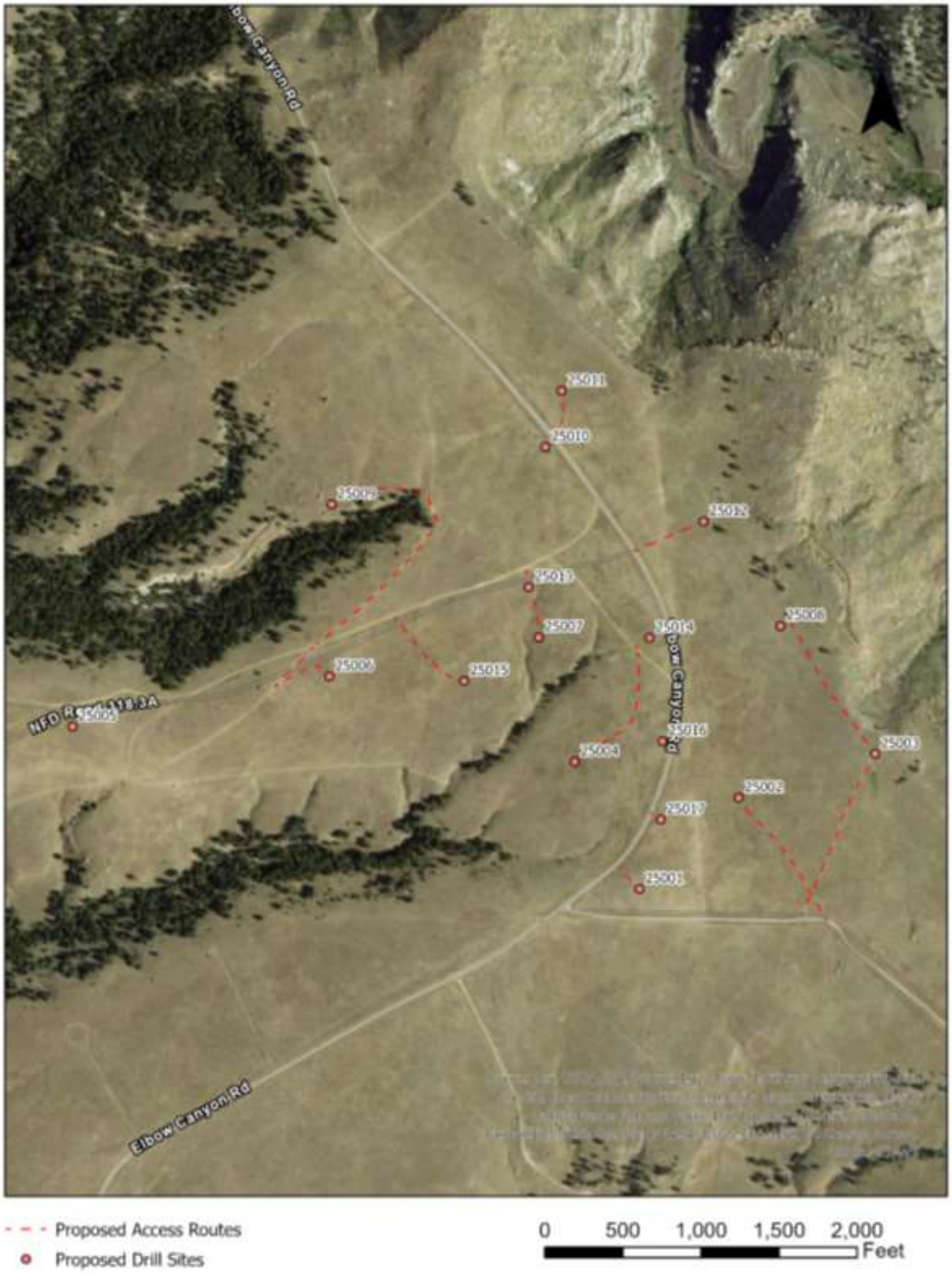

Figure 3. Aerial Photograph of Proposed Exploration Drill Sites

Table 1 Proposed Drill Sites

Hole I.D.	Northing*	Easting	Approximate Collar Elevation (ft)	Approximate Total Depth (ft)
BUC-25001	410365	1073966	4132	500
BUC-25002	410767.6	1074446	4148	500
BUC-25003	410944.2	1075089	4171.5	500
BUC-25004	410967.5	1073689	4132	500
BUC-25005	411228.2	1071360	4093	500
BUC-25006	411410.9	1072565	4128	500
BUC-25007	411550.9	1073547	4139.5	500
BUC-25008	411556.2	1074675	4162.5	500
BUC-25009	412207.5	1072608	4121	500
BUC-25010	412432.6	1073615	4170.5	500
BUC-25011	412688.3	1073701	4177	500
BUC-25012	412055	1074337	4160	600
BUC-25014	411525.9	1074062	4152	600
BUC-25013	411784.5	1073509	4149.5	500
BUC-25015	411363.7	1073191	4130.5	500
BUC-25016	411045.2	1074103	4147	600
BUC-25017	410682.2	1074079	4138	600

*Datum NAD 27 South Dakota South

C. **Project Description:** ***Describe all aspects of the operation including mining, milling, and exploration methods, materials, equipment, workforce, construction and operation schedule, power requirements, how clearing will be accomplished, topsoil stockpile, waste rock placement, tailings disposal, proposed number of drillholes and depth, depth of proposed suction dredging, and how gravels will be replaced, etc. Calculate production rates of ore. Include justification and calculations for settling pond capacities, and the size of runoff diversion channels.***

Introduction and Geology

The primary purpose of this Plan is to provide documentation and support for a request for authorization of a program of reverse circulation drilling 17 exploration holes test for exploration of subsurface uranium mineralization and to conduct an aquifer characterization study on the October Jinx Project. Seventeen potential drill sites are shown in Figures 2 through 3. Some of the proposed 17 sites may not be used depending on the results of drilling previous holes. One truck, track or skid-mounted drill rig, is planned to be used.

Drill sites will be approximately 60 foot (ft) by 60 ft per drill pad, times 17 drill pads, or 1.4 acres total disturbance. Materials used for the Project would be stored at a 12 ft by 80 ft (0.02 acre) staging area located on state lands in Section 36 along Elbow Canyon Road or along the two-track road immediately north of the USFS boundary; materials would not be stored on roads or at other locations. All materials would be removed after completing drilling at a particular drill site.

An estimate of the average required depth of drillholes is 500 ft, based on surface geology and knowledge of local stratigraphy. However, depending on the geology encountered in each hole, the Operator will have equipment to drill to a maximum depth of 700 ft. Each drill site would have a single vertical hole drilled.

The general geology of the area is provided in Figure 4. At the site, the surface geology consists of Cretaceous age Inyan Kara Group, including the upper Fall River Formation, Fuson Shale Member, and Lakota Formation. At depth, the other typical Mesozoic and Paleozoic formations that occur throughout the Black Hills are likely to occur at the Project. The Fall River Formation is between 65 and 125 ft thick, and the Lakota Formation is 200 to 500 ft thick.

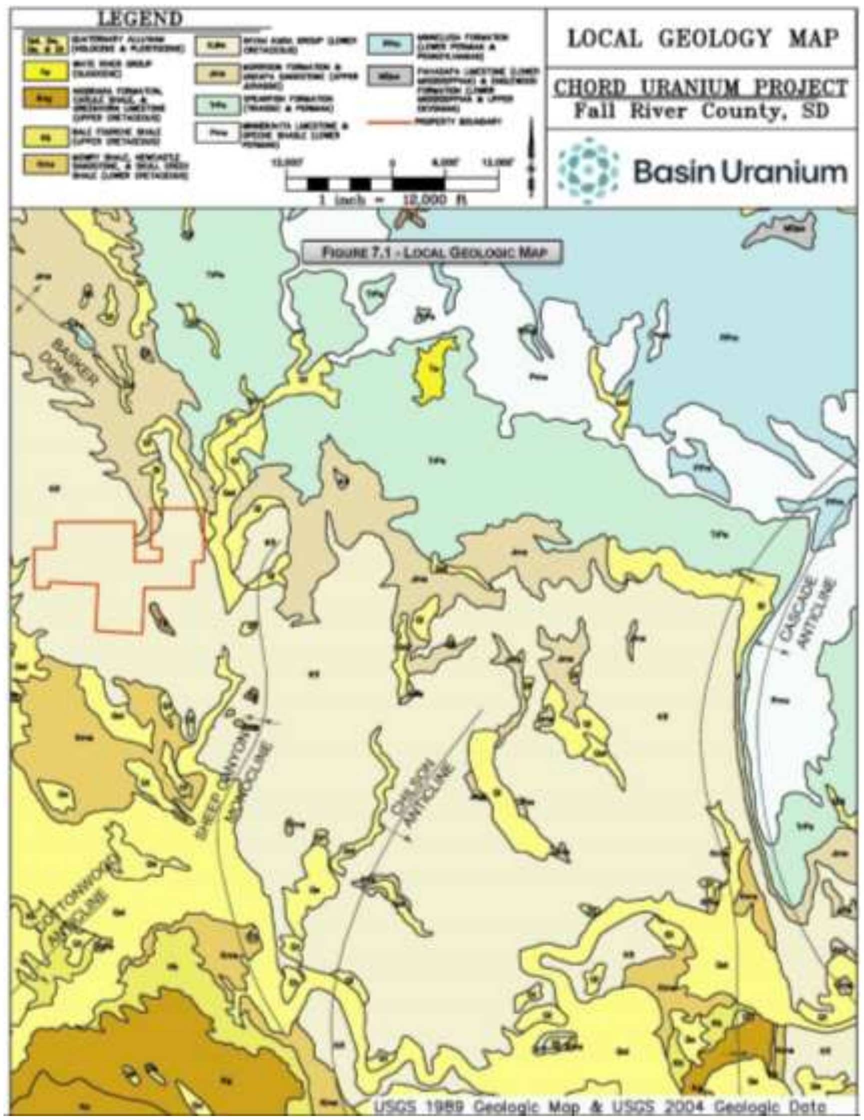

Figure 4. Project Area Geology

Drillholes to test for aquifer characteristics and indications of mineralization are planned to penetrate only the Inyan Kara Group, specifically targeting the Chilson Member of the Lakota Formation.

The Inyan Kara Group is known to be an aquifer throughout the Black Hills. However, at the project location, uranium mineralization is likely to influence water quality, and the aquifer is unlikely to be a suitable source of drinking water at the Project. Final drillhole closure requirements will prevent cross-aquifer contamination.

The vertical distance of the water table below the surface is not sufficiently defined, though the majority of drilling will occur above the water table. Data from two existing monitoring wells on site indicate the lower portion of the Chilson Member lies within a saturated aquifer [Cohan, 1984[1]].

No petroleum is present in the rocks and is not expected to be encountered on the property.

Access

No construction of new access roads or clearing of trees and other vegetation will be required. Drill sites have been sited to take advantage of gentle topography. The drill sites will require little or no surface modification to accommodate access for the drill rig, water truck, fresh water and recirculation tanks, as well as the potential sump installation for the settling and burial of particulates from drill water. Final closure and reclamation of the site are described in Section V(I). The choice of sites with gentle topography was also preferred to reduce reclamation complexity.

If topsoil can be selectively reclaimed within the drill sites, then the topsoil will be segregated and stockpiled for final closure as described in Section V(I). After completing the drill program and aquifer testing, this Plan proposes to recontour the drill sites and mulch and reseed these areas to improve the affected locations, as described in the following paragraphs and in Section V(I).

The proposed drill sites have been chosen based specifically on geologic potential and minimal operational impacts. The drill site locations along the existing access road will have minimal impact on forest resources and users. Visual impacts will be minimized by selecting drill sites that are not visible from paved roads or permanent structures, as discussed in Section V(D).

Drilling will occur during one or two shifts per day, 5 to 7 days per week. The entire drill program is anticipated to be completed within 1 month, followed by the aquifer testing and reclamation. If drilling is conducted after dark, two portable generator-powered light plants will be used to supply adequate lighting for the work site, as described in Section V5(D). Drilling operations would not occur on the following holidays (as well as weekend days

[1] **Cohan, W.T. 1984.** *Report on Water Sampling and Limited Aquifer Testing Chord Project*.

immediately following or proceeding said holiday) because of the potential for increased traffic and recreational usage: Memorial Day, Fourth of July, and Labor Day. During these pauses in drilling, equipment may remain at the drill sites and staging area.

Drilling Water Supply

Water required for core drilling will be sourced from municipal water supplies in Edgemont or Hot Springs or other readily permitted sources off USFS land. Water will be transported to and stored in a free-standing surface tank or bladder at or near drill sites and may be pumped or gravity-fed to the point of use. Water from distant sources, such as municipal wells, will be delivered by water truck to the storage tank.

Drill water will be stored and recirculated from a series of two to three free-standing holding tanks at the drill sites or a lined sump where drill solids will be separated by gravitational settling before reuse. Upon a drill site closure, the drill solids will be buried in a sump lined with a biodegradable liner or a plastic liner that will be removed, then mulched, and seeded, as described in Section V(C and H) below. Contractors will perform drilling and water haulage.

Aquifer Testing Program

This Plan includes installing four new cased groundwater monitoring wells (converted from new exploration holes) and conducting aquifer testing. The primary objective of the aquifer testing program is to determine the aquifer parameters (e.g., transmissivity, storativity, and heterogeneity). Two aquifer pumping tests are planned: a step rate test to determine the maximum pumping rate and a constant rate test. Each test will determine the aquifer parameters according to a theoretical analytical analysis (e.g., Theis).

The aquifer test will pump from one monitoring well and include observation at three monitoring wells, all to be completed within the Inyan Kara Aquifer. Wells will be drilled and logged to determine the proper screen interval. The wells will be screened from approximately 400 to 450 ft below the ground surface, though final screened intervals will be chosen based on results of geophysical logging data from the earliest wells drilled. The casing will then be installed and cemented. Pressure testing of the casing will precede the placement of the well screen.

The pump will be placed near the bottom of the pumped well to maximize the available head. The pumping rates will be controlled by varying the discharge at the surface as well as varying the pump speed. A preliminary review of historical data in the area suggests that a rate of 30 to 50 gallons per minute (gpm) can be sustained.

A temporary groundwater use/discharge permit will need to be obtained from the SD DANR before the aquifer test.

Discharge from the pumping well will be measured using instantaneous flow meters. Discharge would be measured and adjusted as needed. Water discharging from the pumped well would be collected in a lined sump or tank to ensure the pumped water does not return to the aquifer and influence the results. The estimated cumulative volume of water that may need to be discharged during the 3-day constant rate test at 30 gpm is approximately 130,000 gallons.

One or more water quality samples would be collected from the pumped well during the aquifer test, and water quality analysis would include a standard suite of anions, cations, and radionuclides.

Three drillholes will be used as monitoring wells. All holes will be completed within the Inyan Kara Aquifer, similarly to the pumped well. Before starting the aquifer test, the static water level will be measured in the pumped well and each observation monitoring well. Water-level measurements will be taken for at least 1 week before the aquifer test. These data will be compared to barometric readings for baseline assessment.

In general, the well will be pumped until the cone of depression has sufficiently developed. After the pump is shut off, recovery measurements will immediately commence and continue for approximately the same duration as the pumping test or until approximately 90 to 95 percent of the initial head is recovered. The aquifer might not recover as quickly as it drew down.

Pressure transducers with dataloggers will be used to measure water levels. Each transducer will be set to record at 30-second intervals throughout the pumping and recovery periods. The transducer in the pumping well will either be placed inside a 1-inch polyvinyl chloride (pvc) pipe to avoid tangling the transducer with cables and a drop pipe leading to the pump or tied off to the pump drop pipe, in which case the pump will need to be pulled out to remove the transducer from the pumping well. The pressure transducers will be vented and self-correcting for changes in atmospheric pressure.

The drawdown versus time data for the pumping and recovery phases of the test will be analyzed using appropriate methods with commercial test analysis software.

Clean Nuclear proposes that the four new monitoring wells remain in place, finished with appropriate surface casing and locking caps, for use in potential future water quality and water level monitoring by Clean Nuclear and the USFS. However, if requested, Clean Nuclear will properly plug and abandon the wells after completing the aquifer testing program.

Personnel

Personnel required at a drill site during each shift will include the following employees or contactors:

- Driller
- One to three drill helpers
- Geologist
- Water truck driver (part time, as required)
- Consultant to conduct geologic, engineering, or surveying studies on drillholes (as required)
- Drilling and Operator supervisor (occasional)

Plugging and Abandonment

Clean Nuclear commits to following all of the South Dakota laws and statutes concerning drillhole plugging and abandonment and would install a full cement grout where needed, such as in any instance where aquifer cross-contamination is possible. All of the exploration drillholes not converted to permanent monitoring wells will be plugged in accordance with the Administrative Rules of South Dakota (ARSD) 74:11:08 and South Dakota Codified Law (SDCL) 45-6D-33 through 45-6D-34. The drillholes are planned to penetrate the Inyan Kara Group rocks, which are water-bearing units or aquifers in some locations of the Black Hills. If an aquifer is penetrated, the completed exploration drillholes will be plugged from bottom to top using bentonite grout, which complies with the requirements of ARSD 74:11:08:05 and ARSD 74:11:08:05:01 (i.e., requirements for plugging exploration drillholes that penetrate single unconfined aquifers and confined or multiple aquifers). If a confined aquifer is penetrated, the weight of the bentonite grout column will either be sufficient to overcome formation pressure or the hole will be plugged using cement grout. The collar elevations of the planned holes are higher than the static water level to be encountered in the exploration holes; therefore, no natural artesian discharge from drillholes is anticipated.

Records regarding aquifers encountered during drilling and the plugging methods used will be recorded and retained for each exploration hole, and those records will be provided to the South Dakota Department of Agriculture and Natural Resources (DANR) at the end of exploration. All exploration drillholes not converted to USFS monitoring wells are planned to be plugged immediately upon completion while the drill rig is still on the site. If a drillhole temporarily needs to remain open, a temporary surface plug will be emplaced. If a hole needs to remain open for more than 30 days, Clean Nuclear will apply for an alternate plugging schedule to keep the hole open temporarily.

Based on site geology, no voids or karst are expected to be encountered.

No mining or processing of ore or storage of tailings is proposed under this plan.

D. Equipment and Vehicles.

The Project may require the following equipment during active operation:

Motorized:

- One core or reverse circulation drilling rig with auxiliary compressor
- Two or more pickup trucks
- One water truck
- One small dozer for repositioning the skid-mounted rig (if needed)
- One skid steer

Stationary:

- Portable toilet
- Drill steel
- Drill rod rack storage
- Water tank or bladder for water storage
- Two to three water recirculation tanks
- Water line and pumps
- Mud pump and tank for mixing drill mud, grout, and cement for drillhole reclamation
- Waste receptacles clearly labeled for trash and recyclables

Drilling Consumables:

- Diesel fuel used by the drilling rigs will be transported to the drill site in a fuel tank mounted on a pickup truck and transferred to the fuel tank on the drill rig on site. Pickup trucks may use either diesel fuel or gasoline, which will be stored in mounted tanks.
- Gasoline will be used to power water pumps and a generator at the drill site. Gasoline may be stored in portable containers.
- Drill mud bentonite will be used as a high-density additive to drill fluid, which increases the viscosity and density of the fluid for increased efficiency of the drilling process and improved recirculation of drill water.
- Grout will be used as a high-viscosity or cemented material to prevent drill water from penetrating the adjacent rock, fix the casing into the hole, or reclaim drillholes upon completion.
- Fuel stored at the drill rig will be placed on a flat platform with a raised berm around the perimeter and then lined with a geomembrane to mitigate a spill or leakage event. The containment area will be sufficiently sized to accommodate a 110 percent spill.

Spill absorbers will also be on site in case of petroleum spills, and equipment will be cleaned before arriving and departing the site, removing all soil, plant parts, seeds, vegetative matter, or other debris that could contain seeds to prevent the spread of noxious weeds into or out of the Project area.

Aquifer Test Equipment:

- PVC well casing

- Water line
- Variable speed pump
- Flow meter
- Pressure transducers with dataloggers and cable
- Generator
- Drop pipe
- Winch
- Water tanks/truck

E. Structures

No fixed structures are proposed under this plan.

V. ENVIRONMENTAL PROTECTION MEASURES (SEE 36 CFR 228.8)

A. Air Quality. ***Describe measures proposed to minimize impacts on air quality such as obtaining a burning permit for slash disposal or dust abatement on roads.***

The estimated average daily vehicle trips to and from the drill site are three per shift. Vehicles will be required to observe a speed limit of 25 miles per hour (mph) to minimize fugitive dust from vehicle travel on the project's primary and secondary USFS roads. Minimizing the number of trips to the project area will also lower dust generation. No open burning is proposed in this Plan.

All equipment, including vehicles, drill rig, generators, and pumps, will be operated according to the manufacturer’s operating specifications. No equipment modifications will be made to alter the emissions of equipment used on site.

The USFS may require dust abatement measures such as reduced speeds or water spraying if conditions warrant.

B. Water Quality. ***State how applicable state and federal water quality standards will be met. Describe measures or management practices to be used to minimize water quality impacts and meet applicable standards.***

1. State whether water is to be used in the operation, and describe the quantity, source, methods and design of diversions, storage, use, disposal, and treatment facilities. Include assumptions for sizing water conveyance or storage facilities.

Water will be used in drilling as a drill lubricant and coolant as well as to evacuate drill cuttings from the drill face. The amount of water to be used will be determined by the permeability of the geologic formations encountered in a drillhole. Water will be recirculated to the extent possible during drilling.

Water will be transported to the site from private or public sources depending on availability, from a local water well or public source off USFS lands. A water truck will transport water to the site and deposit the water into an on-site tank or bladder for storage. Water usage is estimated to range from 5,000 to 10,000 gallons per day; however, if circulation of drill water is lost, up to 1,000 gallons per hour may be required until circulation can be reestablished.

Water will be recirculated during drilling whenever possible and placed in either a lined sump or a series of two to three contained water settling tanks so that drill cuttings can be segregated by gravity from the liquid and the fluid can be reused.

During operations, a drill fluid mixture containing water, bentonite, and possibly non-hazardous polymers will be pumped into the drillhole.

Upon completion of each drillhole, the hole will be plugged in accordance with state standards as prescribed in Section V(I) to prevent cross-aquifer contamination.

This Project will require a temporary groundwater discharge permit from the SD DANR before the aquifer test. During the aquifer test, water will be pumped from a single well. Small quantities of water may also be used during setup and testing of the pump equipment. The tentative pumping rate is 30 gpm for 3 days. However, the test could be extended up to 3 days or until a measurable drawdown is observed at the other monitoring wells. Water from the aquifer test will be diverted to either a lined sump and allowed to evaporate or directly into holding tanks. No water will be discharged to surface water sources or drainages. The aquifer test plan is detailed in Section IV(C).

Surface water will be controlled to prevent erosion, as described in Section V(B)(2); the project Stormwater Pollution Prevention Plan (SWPPP) will be finalized before operations. No active or intermittent streams exist near any of the drill sites in which uncontrolled surface water can enter; however, in areas of gentle to moderate slopes near the drillholes, surface water will be contained, as described in Section V(B)(2).

Secondary containment shall accommodate 110 percent capacity to ensure any potential leak is contained and that there is adequate freeboard to accommodate a small precipitation event.

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2. Describe methods to control erosion and surface water runoff from all disturbed areas, including waste and tailings dumps.

The proposed monitoring well drill sites are located on relatively flat ground with permeable soils; therefore, erosion and surface water runoff are not anticipated. However, if erosion is observed at a site, erosion control logs will be placed up- or downgradient from the drill site to prevent onflow and runoff of surface water. As necessary, water diversion structures may alternatively be used to divert surface water away from the work site.

In the emergency event that excess drilling water or precipitation fills the lined sumps, an unlined sump downhill from the lined sump(s) would be constructed as approved by the District Ranger; this would allow for infiltration or evaporation in the unlined sump versus land application or overland flow.

Should it become evident that an erosion control component is not performing in the manner necessary to minimize erosion and runoff, drilling operations will be stopped, and corrective measures will be initiated to mitigate the situation.

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3. Describe proposed surface water and groundwater quality monitoring, if required, to demonstrate compliance with federal or state water quality standards.

No perennial streams or other water bodies are present at or near any of the drill sites; therefore, no surface water sampling is planned.

As part of the aquifer test, one or more water quality samples will be obtained from the pumping well during the aquifer test. The water will be analyzed for a suite of parameters, including cations, anions, and radionuclides. The results of the water quality analysis will be reported to the USFS and SD DANR. No additional groundwater monitoring is planned.

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4. Describe the measures to be used to minimize potential water quality impacts during seasonal closures or for a temporary cessation of operations.

This Project does not include seasonal closures or temporary cessation of operations. There is no surface water present near the work areas. However, temporary mitigation measures such as erosion control logs or diversion structures may be in place during drilling operations and aquifer testing as needed to minimize erosion. The final closure and reclamation of the drill sites are described in Section V(I).

5. If land application is proposed for wastewater disposal, the location and operation of the land application system must be described. Also describe how vegetation, soil, and surface and groundwater quality will be protected if land application is used.

No land application of wastewater is part of this Plan; however, recirculated water from the drillholes will be settled in tanks or a lined sump, as described in Section V(B)(1). The recirculated water will be reused in drilling after solids are separated by settling in holding tanks or recovered and recirculated if an SRU is used. A backhoe or small excavator will be maintained on site to ensure the excavation of the sump can be completed in a timely manner when needed.

During the aquifer tests, water will be contained within a lined sump or water tank so as not to reinfiltrate and impact the tests.

C. Solid Wastes. ***Describe the quantity and the physical and chemical characteristics of solid waste produced by the operation. Describe how the wastes will be disposed of including location and design of facilities or treated so as to minimize adverse impacts.***

All of the solid wastes generated on site will be transported, as needed, to approved solid waste facilities for disposal except for the drill cuttings recovered by gravity separation in settling tanks (i.e., sumps). These cuttings consist of crushed/pulverized rock from the drillhole with a consistency of mud or sand. After separated from the drill water by settling, these solids will reside in a lined sump at the site and will be buried, mulched, and seeded during final reclamation.

Human waste will be managed using portable toilets under contract with a commercial provider. The contractor will undertake the disposal of this waste at a licensed and permitted facility.

D. Scenic Values. ***Describe protection of scenic values such as screening, slash disposal, or timely reclamation.***

Proposed drill sites are located to avoid visibility from paved roads, permanent structures, dwellings, or developed campgrounds.

If drilling occurs during nighttime hours, then portable light plants will be required for work to proceed safely. To minimize stray light and light pollution, a maximum of two directional light plants will be used on a drill site. Directional lighting will generally minimize unnecessary glare by focusing the light downward on the worksite and away from populated areas to reduce stray light. Shielding of the sides and upward will reduce scattered light skyward and laterally.

The project area will be kept clear of trash and debris to reduce the negative visual impacts associated with the drill sites. At the end of the Project, all material not necessary for claim monumentation will be removed. The used area will be maintained to present a clean and orderly appearance. Reclamation will be completed in a timely manner.

E. Fish and Wildlife. ***Describe measures to maintain and protect fisheries and wildlife, and their habitat (includes threatened, endangered, and sensitive species) affected by the operations.***

No fisheries exist in the project vicinity, and no project activities are planned to occur within permanent waterbodies or watercourses. Erosion controls and mitigation of potential runoff into streams are addressed in Sections V(B)(2) and V(B)(4).

Wildlife species with the potential to occur in the project vicinity include small- and medium-sized mammals (e.g., squirrels, coyotes, and deer); large ungulates (e.g., elk); bats; migratory birds; raptors, and some insects. Information related to federally listed threatened, endangered, proposed, and candidate species with the potential to occur in the project vicinity was obtained through the U.S. Fish and Wildlife Service (USFWS) IPaC database [2023]. There are no critical habitats within or adjacent to the project area. Four USFWS-listed endangered species have the potential to occur in the southern Black Hills, including the Northern Long-eared Bat, Tricolored Bat, Red Knot, and Monarch Butterfly.

Any threatened or endangered (T&E) species, R2 sensitive species, or species of state concern located during project implementation would be appropriately managed through coordination with the USFS biologist.

No tree removal activities are planned, and no known bat hibernacula occur within 0.25 mile of a proposed drill site; however, if any bat roots or hibernacula are identified within the Project area, drilling activities would only occur between May 31 and October 1 or at the direction of the USFS. Any newly discovered cave or underground mine locations would be provided to the USFS for further revaluation as potential bat habitat.

No known raptor nests occur within the Project area. If any permitted activity results in the discovery of a raptor nest or defensive behavior by a raptor that suggests a nest may be nearby, Clean Nuclear will vacate the area immediately and notify the USFS biologist as soon as possible. A timing restriction will be placed if an active raptor nest is located.

Open sumps at drill locations would have a barrier around them sufficient to prevent cattle and big game from walking into the sump.

F. Cultural Resources. ***Describe measures for protecting known historical and archeological values, or new sites in the project area*.**

During the National Environmental Policy Act (NEPA) process, the USFS and State Historic Preservation Office (SHPO) will be consulted to identify an area of potential effect (APE) and determine what studies in the APE have been historically conducted and what archeological sites may have been identified by past work, if any. A Level 1 archeological records search will be completed by a third-party contractor and submitted to the SHPO and USFS.

Known sites will be located in the field, and project activities will follow the State and USFS recommendations regarding protection of historical and cultural resources. Clean Nuclear will avoid all archaeological sites that have been previously recorded during surveys of the Project vicinity. If Clean Nuclear encounters cultural resources (e.g., bones, artifacts, foundations, or other indications of past human occupation of the area) during operations, work in the vicinity of the discovery would cease immediately, and the District Ranger or Forest archeologist would be contacted within 24 hours.

The proposed exploration project is not located within the boundary of Craven Canyon and will not encroach upon, damage, or destroy any historic property within Craven Canyon. However, based on the proximity of exploration drilling and SHPO's existing concerns, an abbreviated case report will be required.

G. Hazardous Substances.

1. Identify the type and volume of all hazardous materials and toxic substances which will be used or generated in the operations including cyanide, solvents, petroleum products, mill, process and laboratory reagents.

Diesel, gasoline, and standard petroleum lubricants will be used in this operation. A limited amount of fuel will be contained in the fuel tanks of the equipment used on site. In addition, no more than a total of 5 gallons of petroleum product will be stored in gearboxes of equipment on site. The total estimated volume of fuel contained in the tanks and gearboxes of the equipment on site is outlined below and will be approximately 350 gallons:

- Excavator or backhoe – 40 gallons
- Forklift – 30 gallons
- Water truck – 90 gallons
- Water pump – 5 gallons
- Generator – 5 gallons
- Hydraulic fluid - 50 gallons
- Pickup truck – 30 gallons
- Drill truck – 90 gallons
- Motor oil (1 can) – 5 gallons
- Supplemental Fuel Cans (2) – 3 gallons each, 6 gallons total

2. For each material or substance, describe the methods, volume, and frequency of transport (include type of containers and vehicles), procedures for use of materials or substances, methods, volume, and containers for disposal of materials and substances, security (fencing), identification

(signing/labeling), or other special operations requirements necessary to conduct the proposed operations.

No fuel or lubricants will be stored on site. All fuel will be brought to the site in proper petroleum storage containers, via pickup truck. Fuel will most likely be brought to the site daily. The storage and transportation containers will be properly labeled, and the contents will be identified. Fueling will not occur in or immediately adjacent to water sources. Empty fuel containers will be disposed of properly.

3. Describe the measures to be taken for release of a reportable quantity of a hazardous material or the release of a toxic substance. This includes plans for spill prevention, containment, notification, and cleanup.

Fuel stored at the drill rig will be placed on a flat platform with a raised berm around the perimeter then lined with a geomembrane to mitigate a spill or leakage event. The containment area will be sufficiently sized to accommodate a 110 percent spill. Absorbent wipes for cleanup will be used for spill confinement. Small fluid leaks and spills from construction equipment would be promptly cleaned up, and any contaminated soil would be removed and disposed of offsite. Reportable spills would be reported to the USFS and SD DANR. Clean Nuclear will prepare a Health and Safety Plan, including spill control measures, that will be submitted to the USFS before operations commence.

H. Reclamation. ***Describe the annual and final reclamation standards based on the anticipated schedule for construction, operations, and project closure. Include such items as the removal of structures and facilities including bridges and culverts, a revegetation plan, permanent containment of mine tailings, waste, or sludges which pose a threat of a release into the environment, closing ponds and eliminating standing water, a final surface shaping plan, and post operations monitoring and maintenance plans*****.**

The proposed drill sites are located on lands that have been previously disturbed by wildfire and other activities. Final reclamation of the drill sites and staging area will include the following elements:

- Drillholes not converted to permanent monitoring wells will be sealed and reclaimed in accordance with ARSD 74:11:08 and SDCL 45-6D-33 through 45-6D-34.
- Drill sites will be recontoured to eliminate excessive rutting regardless of the pre-project condition.
- Drill fluids will be contained in recirculation tanks or a lined sump on the Drill Site to allow solids to settle. The solids will ultimately be disposed of in a buried lined sump before final reclamation.
- Clean Nuclear will initiate revegetation as soon as possible (i.e., not to exceed 6 months) after terminating ground-disturbing activities.

- Overly compacted areas at the drill sites that are not located on an active roadbed will be roughed either manually or mechanically to enhance seeding viability and minimize erosion.
- Areas to be enhanced by reseeding will initially be mulched with locally derived, stockpiled organic-rich amendments or with commercially available certified weed-free mulch. Seeding will be applied in accordance with USFS guidance. The proposed seed mix is provided in Table 2 and is compatible with existing habitat and Natural Resources Conservation Service (NRCS) recommendations. On areas needing immediate establishment of vegetation, non-native, non-aggressive annuals (e.g., wheat, oats, and rye) or sterile species may be used while native perennials are becoming established or when native species are not available (e.g., during drought years or years when wildfires burn large acreages in the United States).

Table 2. Reclamation Seed Mix Table: Recommended by NRCS

Species	Percent of Seed Mix
Sideoats grama	10
Western wheatgrass (*Pascopyrum smithii*)	50
Blue grama	5
Green needlegrass	15
Slender wheatgrass (*Elymus trachycaulus*)	10
Purple prairie clover	2
Little bluestem	8

Application Rate: 14 Pounds Live Seed/Acre

The seed would be tested for noxious weeds, and evidence would be provided to the USFS before the seed is used on National Forest Service (NFS) lands. If mulches are used, they are to be noxious weed free with certification provided to the USFS before use. Weed-free alfalfa seed may be used only when native legume seed is not available and only when there is extensive disturbance associated with road construction or mine reclamation where topsoil is no longer available (Forest Plan Standard 1110).

Clean Nuclear will monitor and assess the progress of reclamation activities, including revegetation and erosion control, for a minimum of 1 year. Depending on the success of the reclamation efforts, additional seeding, weed treatment, or installation of erosion control structures may be required by the Proponent.

Noxious weeds will be managed by Clean Nuclear in adherence with the USFS's current Noxious Weed Control Plan (NWCP). Clean Nuclear will prepare a plan that will include site inspections for noxious weeds and control measures as defined in the NWCP. This Plan will include spraying for weeds 1 year after final reclamation. All drill rigs, excavators, and equipment entering USFS lands would be washed before entry to reduce the potential for spread of noxious weeds onto USFS lands. Revegetation seed would be tested for noxious weeds. All straw wattles used on site to reduce soil erosion would be composed of certified weed-free straw and wrapped in biodegradable material (not plastic or photodegradable material). All natural fibers would be left on site.

I. Fire Prevention. ***Describe all procedures that will be followed throughout operations to prevent ignition and spread of fire including tools and prevention measures. Also describe (if any) the burning plan for slash that is not used in reclamation.***

Clean Nuclear will develop an emergency response plan for the Project as part of the site Health and Safety Plan (HASP). This plan will address a number of emergency situations (e.g., fire, injury). Protocols will be included in this plan to direct the on-site contractors' actions if they start a fire or if a fire starts on USFS land within the vicinity of the drill sites.

All vehicles, drill rigs, and other on-site equipment would be inspected as part of daily safety checks and would be equipped with a fire extinguisher, which would also be inspected routinely. Fire tools (e.g., shovels, buckets) shall also be maintained in each vehicle or staged appropriately on site.

Vehicles shall not sit idle for more than 5 minutes and shall not be over vegetation while doing so to reduce fire risk.

Burning: Excess slash and stockpiled brush will not be burned under this Plan.

J. Recreation. ***Describe any and all potential effects on recreation resources.***

Few recreation impacts would occur, primarily through minor project-related traffic, noise, and visual impacts. Impacts are expected to be minimal as there are no campgrounds, picnic areas, or non-motorized hiking trails within or adjacent to the October Jinx Project area.

Drilling equipment would use existing motorized trails during project drilling and reclamation. Traffic-related effects on recreation are anticipated to be minimal. Under the Proposed Action, traffic on local roads and trails would increase by approximately three vehicles per shift. Increased traffic congestion on Elbow Canyon Road and National Forest Service Road 318.3A associated with the Project would be minimal and have minimal impact on user access. The Project would have a minimal increase in road dust.

Increased traffic, drilling-related noise, and visual effects of large equipment may temporarily disrupt outdoor-based recreation activities in the Project vicinity, causing recreational users to either be inconvenienced, delay their activities, or temporarily find other locations for these activities. Though Project drilling is expected to take 2 months, drilling operations at an individual platform or specific drill site are temporary and are expected to take approximately one or two days of drilling per hole if there are no technical or weather delays.

Drilling operations would be prohibited on the following holidays (as well as weekend days immediately following or proceeding said holiday) because of the potential for higher traffic and recreational usage: Memorial Day, Fourth of July, and Labor Day. During these pauses in drilling, equipment may remain at the drill sites and staging area.

Hunting opportunities during the spring and fall turkey and fall deer and elk seasons may be impacted by noise and game displacement associated with the Project. Birding and photography may be reduced as drilling noise temporarily displaces wildlife.

Signs around the operating site will warn the public of any potential dangers within the Project area (i.e., open holes, hazardous material, and heavy equipment use).

K. Public Access, Safety, and Traffic Control. ***Describe how the proposed operations will not compromise public safety and access to open roads as assigned by the current District Travel Management Plan. Be sure to include traffic control measures if needed for equipment mobilization or haul routes.***

Public Access: The right of the public to lawfully use the land encompassed by the boundaries of the mining claims will not be restricted or denied by Clean Nuclear. The rights of the public do not include any activity that interferes with any mineral exploration-related activities without the claimant's consent. Clean Nuclear, in the exercise of this operating Plan, will require that its employees, subleases, contractors, subcontractors, or renters and their employees comply with all conditions of this Plan.

Safety: All operations will be conducted in a safe manner and in compliance with Occupational Safety and Health Administration (OSHA) and applicable local, state and federal requirements and guidelines. Clean Nuclear understands that failure to abide by these regulations will be grounds for termination of approval for the operating Plan by the Forest Service if the failure to comply presents a significant risk to the health, welfare, or safety of the public, agency staff, or operator’s staff.

A site security plan has been developed (see Appendix 3) and will be implemented by Clean Nuclear to maintain site safety and limit the risk of public interference.

Traffic Control: Before initiating the mobilization of equipment into the project area, Clean Nuclear will notify the Hell Canyon District Ranger or other Forest Service representative. Clean Nuclear’s sign plan is included in Appendix 2. Signage would be placed on any roads or trails adjacent to drill locations when drilling operations are underway. Safety signage regarding heavy equipment use on the road would be posted throughout the work area to ensure the public is aware of temporary site work.

L. Interim Shutdown Procedures. ***Describe the procedures that will be enacted if and/or when a shutdown period is required.***

No temporary or seasonal interim shutdown periods are anticipated.

M. Inspections.

The Forest Service and Clean Nuclear will agree on a schedule of inspections designed to ensure that the provisions of the operating Plan are followed. If there is uncertainty as to whether there should be an inspection before advancing in operations, the Operator will contact the Forest Service for clearance. It is understood that inspections will normally occur at the USFS's discretion and may include:

- After drill mobilization and before operation
- During operations to ensure all requirements, including fire tools and equipment, are met
- After removal of equipment
- After reseeding

Clean Nuclear and the USFS will monitor and assess the progress of reclamation activities, including revegetation and erosion control, for a minimum of 1 year. Depending on the success of the reclamation efforts, additional seeding, weed treatment, or installing erosion control structures may be required.

VI. FOREST SERVICE EVALUATION OF PLAN OF OPERATIONS

A. Required changes/modifications/special mitigation for plan of operations:

B. Bond. Reclamation of all disturbances connected with this plan of operations is covered by Reclamation Performance Bond No. ___, dated (mm/dd/yy) ___, signed by Todd Christensen (Principal) and ___ (Surety), for the penal sum of ___. This Reclamation Performance Bond is a guarantee of faithful performance with the terms and conditions listed below, and with the reclamation requirements agreed upon in the plan of operations. This Reclamation Performance Bond also extends to and includes any unauthorized activities conducted in connection with this operation.

The bond amount for this Reclamation Performance Bond was based on a bond calculation worksheet. The bond amount may be adjusted during the term of this proposed plan of operations in response to changes in the operations or to changes in the economy. Both the Reclamation Performance Bond and the bond calculation worksheet are attached to and made part of this plan of operations. Acceptable bond securities (subject to change) include:

1. *Negotiable Treasury bills and notes which are unconditionally guaranteed as to both principle and interest in an amount equal at their par value to the penal sum of the bond; or*

2. *Certified or cashier's check, bank draft, Post Office money order, cash, assigned certificate of deposit, assigned savings account, blanket bond, or an irrevocable letter of credit equal to the penal sum of the bond.*

VII. TERMS AND CONDITIONS

A. If a bond is required, it must be furnished before approval of the plan of operations.

B. Information provided with this plan marked confidential will be treated in accordance with the agency's laws, rules, and regulations.

C. Approval of this plan does not constitute certification of ownership to any person named herein and/or recognition of the validity of any mining claim named herein.

D. Approval of this plan does not relieve me of my responsibility to comply with other applicable state or federal laws, rules, or regulations.

E. If previously undiscovered cultural resources (historic or prehistoric objects, artifacts, or sites) are exposed as a result of operations, those operations will not proceed until notification is received from the Authorized Officer that provisions for mitigating unforeseen impacts as required by 36 CFR 228.4(e) and 36 CFR 800 have been complied with.

F. This plan of operations has been approved for a period of 5 years and 7 months or until *12/15/2029*. A new or revised plan must be submitted in accordance with 36 CFR part 228, subpart A, if operations are to be continued after that time period.

VIII. OPERATING PLAN ACCEPTANCE

I/We have reviewed and agreed to comply with all conditions in this plan of operations including the required changes, modifications, special mitigation, and reclamation requirements.

I/We understand that the bond will not be released until the Authorized Officer in charge gives written approval.

M. B[illegible] 06/10/2024

Signature of Operator or Authorized Representative | Date (mm/dd/yy)

IX. OPERATING PLAN APPROVAL

(Name)	(Title)
Signature of (Authorized Officer)	(Date) *(mm/dd/yy)*

Burden and Non-Discrimination Statement

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0022. The time required to complete this information collection is estimated to average 12 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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(Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call toll free (866) 632-9992 (voice). TDD users can contact USDA through local relay or the Federal relay at (800) 877-8339 (TDD) or (866) 377-8642 (relay voice). USDA is an equal opportunity provider and employer.

Appendix 1
Mineral Claims

October Jinx Project Mineral Claims (Page 1 0f 2)

Serial Number	Claim	Disposition	Township and Range	Section(s)
MT105284232	LONG-68 A	ACTIVE	7S2E	25
MT105284233	LONG-68 B	ACTIVE	7S2E	25, 36
MT105284234	LONG-68 C	ACTIVE	7S2E	25
MT105284235	LONG-68 D	ACTIVE	7S2E	25, 36
MT105284236	LONG-68 E	ACTIVE	7S2E	25
MT105284237	LONG-68 F	ACTIVE	7S2E	25, 36
MT105284238	LONG-68 G	ACTIVE	7S2E	25
MT105284239	LONG-68 H	ACTIVE	7S2E	25, 36
MT105284240	LONG-68 I	ACTIVE	7S2E	25
MT105284241	LONG-68 J	ACTIVE	7S2E	25, 36
MT105284242	LONG-69	ACTIVE	7S2E	25
MT105284243	LONG-70	ACTIVE	7S2E	25, 36
MT105284244	LONG-71	ACTIVE	7S2E	25
MT105284245	LONG-72	ACTIVE	7S2E	25, 36
MT105284246	LONG-73	ACTIVE	7S2E	25
MT105284247	LONG-74	ACTIVE	7S2E	25, 36
MT105284248	LONG-75	ACTIVE	7S2E	25, 26
MT105284249	LONG-76	ACTIVE	7S2E	25, 26, 36, 35
MT105284274	LONG-101	ACTIVE	7S2E	24, 25
MT105284275	LONG-102	ACTIVE	7S2E	25
MT105284276	LONG-103	ACTIVE	7S2E	24, 25
MT105284277	LONG-104	ACTIVE	7S2E	25
MT105284278	LONG-105	ACTIVE	7S2E	24, 25
MT105284279	LONG-106	ACTIVE	7S2E	25
MT105284280	LONG-107	ACTIVE	7S2E	24, 25
MT105284281	LONG-108	ACTIVE	7S2E	25
MT105284282	LONG-109	ACTIVE	7S2E	24, 25
MT105284283	LONG-110	ACTIVE	7S2E	25
MT105284284	LONG-111	ACTIVE	7S2E	24, 25
MT105284285	LONG-112	ACTIVE	7S2E	25
MT105284286	LONG-113	ACTIVE	7S2E	23, 24, 25, 26
MT105284287	LONG-114	ACTIVE	7S2E	25, 26

October Jinx Project Mineral Claims (Page 2 0f 2)

Serial Number	Claim	Disposition	Township and Range	Section(s)
MT105284197	LONG-32	ACTIVE	7S3E	19, 30
MT105284199	LONG-34	ACTIVE	7S3E	19, 30
MT105284203	LONG-38	ACTIVE	7S3E	19, 30
MT105284205	LONG-40	ACTIVE	7S3E	19, 30
MT105284208	LONG-43	ACTIVE	7S3E	29, 30
MT105284209	LONG-44	ACTIVE	7S3E	030
MT105284210	LONG-45	ACTIVE	7S3E	030
MT105284211	LONG-46	ACTIVE	7S3E	030
MT105284212	LONG-47	ACTIVE	7S3E	030
MT105284213	LONG-48	ACTIVE	7S3E	030
MT105284214	LONG-51	ACTIVE	7S3E	29, 30
MT105284215	LONG-52	ACTIVE	7S3E	29, 30
MT105284216	LONG-53	ACTIVE	7S3E	030
MT105284217	LONG-54	ACTIVE	7S3E	030
MT105284218	LONG-55	ACTIVE	7S3E	030
MT105284219	LONG-56	ACTIVE	7S3E	030
MT105284220	LONG-57	ACTIVE	7S3E	030
MT105284221	LONG-58	ACTIVE	7S3E	030
MT105284222	LONG-59	ACTIVE	7S3E	030
MT105284223	LONG-60	ACTIVE	7S3E	30, 31
MT105284224	LONG-61	ACTIVE	7S3E	030
MT105284225	LONG-62	ACTIVE	7S3E	30, 31
MT105284226	LONG-63	ACTIVE	7S3E	030
MT105284227	LONG-64	ACTIVE	7S3E	30, 31
MT105284228	LONG-65	ACTIVE	7S3E	030
MT105284229	LONG-66	ACTIVE	7S3E	30, 31
MT105284230	LONG-67	ACTIVE	7S3E	030
MT105284231	LONG-68	ACTIVE	7S3E	30, 31

Appendix 2
Signage Plan

Clean Nuclear Energy Corp's Traffic Control / Sign Plan

06/2024

DRILLING AND EXPLORATION OPERATIONS SIGNING PLAN

This traffic control sign plan is based on USFS logging and maintenance operations sign plan, modified as appropriate for drilling and exploration activities within the Black Hills National Forest.

All signs will be manufactured & installed as specified in the latest version of the Federal Highway Administration (FHWA) "**Manual on Uniform Traffic Control Devices**" (MUTCD) 2009 MUTCD with Revisions 1 and 2, May 2012 - Knowledge - FHWA MUTCD (dot.gov) and the FS publication "**Standards for Forest Service Signs & Posters**"(EM 7100-15) stelprd3810021.pdf (usda.gov) . Specific information regarding temporary traffic contol can be found in Chapter 4 of the EM 7100-15 or Part 6 of the MUTCD.

SIGN STANDARDS

SHAPE & COLOR: Generally, signs for drilling and exploration operations are considered temporary traffic control and are either diamond-shaped or rectangular. All signs will have a black legend and border on an orange retroreflective background unless shown otherwise. Hand-painted, homemade signs are not acceptable. Fluorescent paint is not reflectorized.

SUBSTRATE: Sign substrate material may be High Density Overlay (HDO) Plywood, Aluminum, Fiberglass

Reinforced Plastic, Corrugated Plastic or Roll-up Fabrics.

LEGEND: All lettering shall be minimum Series "C" alphabet, conforming to Standard Alphabets for Highway Signs. Letter size is also a function of speed - use letter size and word messages as specified in MUTCD and EM-7100-15.

SIGN PLACEMENT

Signs are to be installed in locations as agreed to in this document. All signs are to be removed, covered, or folded when operations are not in progress or the sign message is not applicable. Signs should generally be located on the right-hand side of the roadway. When special emphasis is needed, signs may be placed on both the left and right sides of the road. Sign message shall be clearly visible to road users, mounted on posts or portable sign stands.

SIGN LOCATION

Signs must be located 100-500 feet prior to the temporary traffic control activity based on speed, (both ends if a through road) to warn traffic and allow for adequate perception and reaction time of the driver as listed in Figure 1: Table 4A.1 (EM7100-15). These numbers are intended for guidance purposes only and should be applied with engineering judgement.

Table 4A.1—Recommended spacing of advance warning signs

Speed limit or prevailing approach speed (mph)	Distance from the TTC activity area to the first sign and between subsequent signs in a series (feet)
25 or less	100
30 to 45	350
45 to 50	500

Refer to the MUTCD, chapter 6C for State and county highways and speeds greater than 50 mph.

Figure 1: Table 4A.1 Recommended Spacing of Advance Warning Signs

SIGN SUPPORTS

POSTS: Signs are to be mounted on separate posts as shown in Figure 2. Supplemental signs such as Speed Advisory plates are to be mounted on the same post as the primary sign. ***Do not mount signs on trees or other signs.*** Posts may be wood, metal, carsonite or similar material and must meet breakaway standards if within the clear zone. Wood posts that are 4 inches by 4 inches or have a cross-sectional area of 24 square inches or smaller are considered to meet breakaway standards when installed in normal soil conditions.

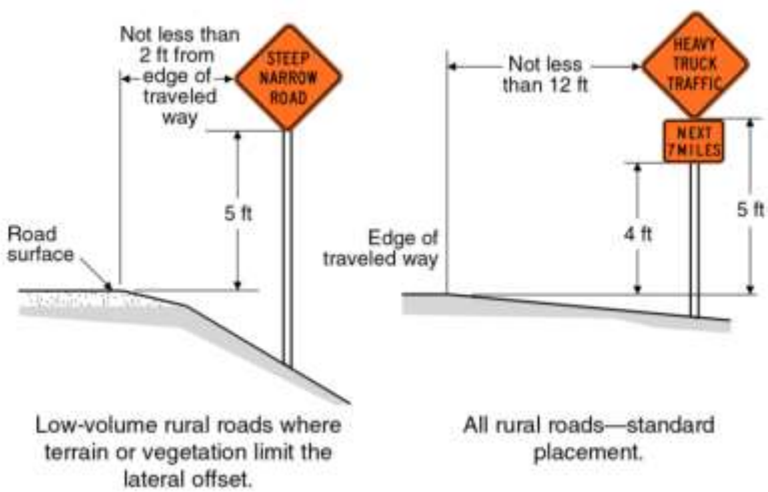

Figure 2. Sign Supports and Location

TEMPORARY/PORTABLE SUPPORTS: Portable supports may be used for short-term, short-duration, and mobile conditions, such as at drill platforms. All portable supports must meet MUTCD standards, including breakaway. These must be a minimum of 1 foot above the traveled way. Example temporary/portable signs and supports and shown in Figure 3.

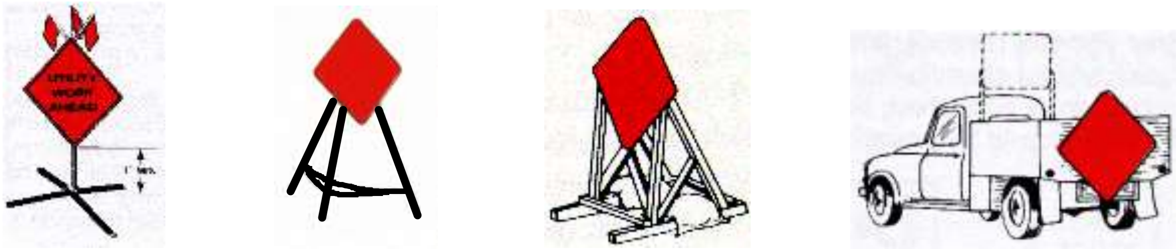

Figure 3: Examples of Temporary/Portable Supports

SIGN SIZES

Sign sizes are dependent on speed of the road and road type as shown in Figure 4 (Table 4-1 EM7100-15). Larger signs may be used whenever necessary for greater legibility or emphasis.

Table 4-1—Temporary Traffic Control sign sizes by road type

Message or Symbol	Sign code or series	Conventional road sign sizes (inches)	Low-volume roads Typical sign sizes (inches) = or >35 mph	Low-volume roads Minimum sign sizes (inches) <35 mph
REGULATORY				
TRAFFIC CONTROL POINT	EM-3	30 x 24	30 x 24	30 x 24
WARNING				
LOGGING OPERATIONS	FW11-10a	36 x 36	36 x 36	30 x 30
LOG TRUCKS	FW11-10b	36 x 36	36 x 36	30 x 30
LOG TRUCKS ENTERING ROAD	FW11-10c	36 x 36	36 x 36	30 x 30
HEAVY TRUCK TRAFFIC	FW11-10d	36 x 36	36 x 36	30 x 30

Figure 4: Table 4-1 Temporary Traffic Control Sign Sizes

TYPICAL SIGNS

The signs below in Figure 5 are not a complete listing of signs that may be needed or used. The decision to use a particular traffic control device at a specific location should be made by either an engineering study or application of engineering judgement. Sign numbers are from MUTCD. An ‘F’ before the sign number indicates a Forest Service sign and the last number indicates sign size, generally in the horizontal direction. The sign sizes in the signs below are for low- volume roads with a speed of less than 35 mph. Larger signs may be used whenever necessary for greater legibility or emphasis.

Additional signs will be placed at and near the drill platform during active operations, including site prepration, drilling, and reclamation (Figure 6).

Figure 5: Typical Road Signs

FW11-10d-30

W20-1-30

W21-3-30

W7-3a-24*

W13-1P-18**

W16-2P-24*

W21-1-30

W21-9-30

W20-3-30

R11-2R

Figure 6: Typical Drilling Area Signs

WARNING SIGN PLACEMENT

Project: October Jinx
Plan of Operations #: ____________

Unless otherwise agreed warning signs will be placed at the following locations.

A) *Where drilling and support equipment are using main motorized roads and trails open to the public, signs will be placed warning motorists of increased truck traffic. Signs will be placed at*
   a. *Elbow Canyon Road at the USFS Boundary*
   b. *Elbow Canyon Road at the north end of the October Jinx Project Area*

B) *Signs will be placed at the beginning of system roads and trails where active drilling operations are within 100 feet of roads or trails open to the public, per the current MVUM. If it is a through road or trail, both ends of the road or trail will be signed to the extent where active drilling operations are taking place. If signs required under paragraph A already cover these roads or trails, no additional signs will be needed.*

C) *Caution or Danger – Heavy Equipment Use Ahead or Drilling signs will be placed near active drill platforms and the staging area.*

D) *Any non-gate road closures (e.g., berms, boulders) that are removed as part of Project implementation would be replaced as soon as possible after project operations behind those closures are complete. Reflective signs and orange/white barriers across roads will be used to indicate the road is closed to motorized vehicles and is accessible by permit only.*

Modifications to the signage plan will be discussed with the USFS as work begins. Specific changes may be required based on the unique site and time of year.

Agreement: Clean Nuclear Energy Corp. shall furnish, install and maintain all temporary traffic controls as defined in this document.

____________________	M. Bl[signature] ____________________
FSR / ER Representative	**Clean Nuclear Energy Corp.**
____________________	06/10/2024 ____________________
Date	**Date**

Appendix 3
Site Security Plan

Drill Site Security Plan for Mineral Exploration Drilling

Objective: The primary objective of this Drill Site Security Plan is to ensure the safety and security of personnel, equipment, and assets involved in mineral exploration drilling operations.

1. Site Access Control:

- Access to the drill site will be restricted to authorized personnel only.
- All entry points will be clearly marked, and access will be controlled through designated entry gates or checkpoints.
- Visitors and contractors must be pre-approved and escorted while on-site.
- Any road gates that are normally locked should remain locked unless vehicles or equipment are actively passing through them. If a gate is locked upon entry, Clean Nuclear would be required to lock the gate behind them during operations to reduce public access and ensure public safety

2. Personal Identification:

- All personnel accessing the drill site must wear visible identification at all times.
- Identification may include the individual's name, role, and company affiliation.

3. Perimeter Security:

- The drill site perimeter may be secured with flagging to limit unauthorized entry.
- Clean Nuclear personnel will monitor the perimeter regularly to detect any breaches or suspicious activity.
- Surveillance cameras may be installed at strategic locations to enhance perimeter security if necessary.
- Particular attention will be given to drill sumps to prevent animals and birds as well as personnel from falling into one. Open sumps at drill locations would have a barrier around them (e.g., hurricane fencing or something similar) sufficient to prevent cattle and big game from walking into the sump. Open sumps should be covered to the maximum extent possible with material to discourage birds or bats from entering the sumps. This material should be something other than nylon or mesh netting to prevent birds and bats from becoming entangled in the covering

4. Equipment Security:

- All drilling equipment, vehicles, and machinery will be securely parked and immobilized when not in use.
- Locks and immobilization devices will be utilized to prevent unauthorized use or theft of equipment.
- Equipment serial numbers and identification tags will be recorded and monitored to facilitate tracking and recovery in case of theft.

5. Materials Control:

- Drilling materials, fuels, and chemicals will be stored in designated areas with appropriate signage and containment measures.
- Inventory logs will be maintained to track the movement and usage of materials, with regular audits conducted to ensure compliance.

6. Emergency Response Preparedness:

- Emergency response protocols will be established and communicated to all personnel.
- Emergency contact information, including local emergency services and medical facilities, will be posted prominently at the drill site.
- Regular drills and training exercises will be conducted to ensure all personnel are familiar with emergency procedures.

7. Communication Systems:

- Reliable communication systems, including two-way radios and satellite phones, will be provided to all personnel.
- Emergency communication channels will be established to facilitate rapid response in case of emergencies.

8. Environmental Protection Measures:

- Measures will be implemented to minimize the environmental impact of drilling operations, including spill prevention and waste management protocols.
- Environmental monitoring will be conducted regularly to ensure compliance with regulations and minimize ecological disturbances.

9. Reporting and Documentation:

- All security incidents, breaches, or suspicious activities will be reported immediately to designated personnel (Clean Nuclear's Project Manager or delegated representative) and documented for further investigation.
- Incident reports will include details of the event, actions taken, and recommendations for preventive measures.

10. Continuous Improvement:

- The effectiveness of the Drill Site Security Plan will be reviewed annually or as site conditions change and evaluated to identify areas for improvement.
- Feedback from personnel, security audits, and incident investigations will be utilized to refine security protocols and enhance overall security posture.

Conclusion: The implementation of this Drill Site Security Plan will ensure the safety, security, and integrity of mineral exploration drilling operations. By establishing robust security measures and fostering a culture of vigilance among personnel, we aim to mitigate risks and safeguard our assets, personnel, and the surrounding environment.

Geology of the Edgemont NE Quadrangle Fall River and Custer Counties, South Dakota

GEOLOGICAL SURVEY BULLETIN 1063-E

Prepared on behalf of the U.S. Atomic Energy Commission

Geology of the Edgemont NE Quadrangle Fall River and Custer Counties, South Dakota

By GARLAND B. GOTT *and* ROBERT W. SCHNABEL

GEOLOGY AND URANIUM DEPOSITS OF THE SOUTHERN BLACK HILLS

GEOLOGICAL SURVEY BULLETIN 1063-E

Prepared on behalf of the U.S. Atomic Energy Commission

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1963

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

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ILLUSTRATIONS

[Plates are in pocket]

TABLES

GEOLOGY OF THE EDGEMONT NE QUADRANGLE, FALL RIVER AND CUSTER COUNTIES, SOUTH DAKOTA

By Garland B. Gott and Robert W. Schnabel

ABSTRACT

The Edgemont NE quadrangle is in Fall River and Custer Counties, S. Dak., along the southwest side of the Black Hills uplift. Sedimentary rocks of Permian, Triassic, Jurassic, Cretaceous, Tertiary(?), and Quaternary age are exposed within the quadrangle.

The Permian and Triassic formations consist of a sequence of about 725 feet of largely red or maroon fine-grained clastic rocks with some limestone and several marine evaporite units. The formations are, in ascending order, the Opeche formation and Minnekahta limestone of Permian age, and the Spearfish formation of Permian and Triassic age.

The exposed rocks of Jurassic age are 400–500 feet thick and include marine sandstones and shales of the Sundance formation which are overlain by about 100 feet of soft, fine-grained nonmarine calcareous mudstones of the Morrison formation.

The Lower Cretaceous rocks include the nonmarine Inyan Kara group and the marine Skull Creek shale. The Inyan Kara group of rocks, about 325–650 feet thick, is composed of a sequence of rocks deposited in alternating fluvial and quiet water environments. The lithologic characteristics of these rocks change radically within short distances, depending on whether rocks of fluvial or of nonfluvial origin predominate in a given locality.

Tertiary(?) and Quaternary rocks are terrace and alluvial deposits of unconsolidated sand and gravel. The boundary between Tertiary and Quaternary deposits is based mainly on the altitudes of the several terrace levels.

The regional dip of about 3° SW is interrupted by several small anticlines and monoclines. Some of the folding occurred during pre-Fall River and post-Morrison time.

Subsidence structures are numerous in parts of the quadrangle. These structures are the result of the solution and removal of gypsum at depth.

Uranium deposits, which are restricted to the Inyan Kara rocks, constitute the most important economic mineral resource in the quadrangle. Most of the production has been from thick, fluviatile sandstone, but a significant proportion has been from nonfluviatile thin, tabular sandstone interbedded with carbonaceous siltstone. The thick fluviatile sandstones are channellike in shape, are approximately 1 to 5 miles in width, and are at least several tens of miles in length.

Carnotite, tyuyamunite, corvusite, rauvite, uraninite, coffinite, paramontroseite, and häggite are the principal ore minerals. They occur in and around carbonaceous material, around grains and nodules of iron sulfide, adjacent to the fine-grained facies of the sandstone, in association with calcium carbonate, and on structural irregularities, particularly on structural terraces adjacent to monoclinal axes.

Uranium and vanadium probably were transported largely in migrating ground water through the porous channel sandstones. Some deposits probably were precipitated as the result of the intermingling of alkaline and acid solutions, and other deposits evidently were concentrated as the result of the reducing environment surrounding organic debris.

Extensive gypsum and gravel deposits exist within the quadrangle and a small amount of oil has been produced from one small domal structure. Other small potential oil structures, formed during Early Cretaceous time, may exist. In those areas where the Cretaceous rocks have not been eroded these structures are not necessarily reflected by the surface rocks.

INTRODUCTION

This report describes the stratigraphy, structure, and economic resources of the Edgemont NE quadrangle. The quadrangle is bounded by longitudes 103°45′ and 103°52′30″ W. and latitudes 43°22′30″ and 43°30′ N. Most of the quadrangle is in the Black Hills National Forest in Fall River County, S. Dak., but a strip about 1½ miles wide along the north edge is in Custer County, S. Dak. (fig. 22). The area is in the foothills along the southwest edge of the Black Hills uplift.

The maximum relief within the quadrangle is about 900 feet. Much of the area is incised by canyons, as much as 400 feet deep, and walled by precipitous cliffs and steep, talus-covered slopes. The annual rainfall is between 13 and 15 inches, which is enough to support a thin growth of pine along the canyon walls, particularly in those areas that are underlain by the Inyan Kara group of rocks. The intercanyon divides and the valley bottoms support a sparse grass cover. The principal industries of the area are cattle raising and uranium mining.

The Black Hills uplift is in the shape of an elongate dome comprising an area about 125 miles long and about 60 miles wide. Precambrian igneous and metamorphic rocks are exposed in the central part of the uplift and outward dipping Paleozoic and Mesozoic rocks form cuestas and hogbacks around the elliptical mountainous area. The Edgemont NE quadrangle extends from the outermost hogback, composed of Lower Cretaceous Inyan Kara formations, northward across formations of Jurassic, Triassic, and Permian age.

The only previous comprehensive geologic maps of this area were made by Darton and Smith (1904) and published in U.S. Geological Survey Folio 108. Prior to the publication of this folio Darton (1901) had described the geology of the southern Black Hills. The present

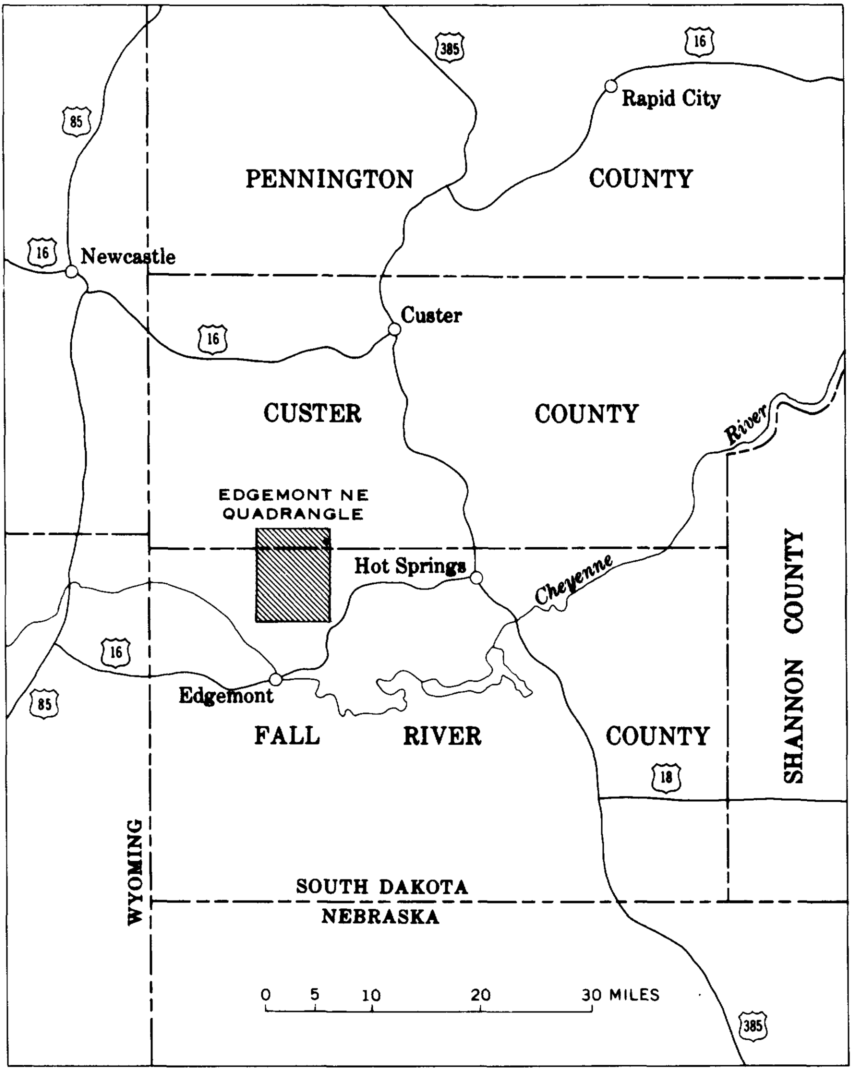

FIGURE 22.—Location of the Edgemont NE quadrangle, Fall River and Custer Counties, S. Dak.

nomenclature and much of the knowledge of the geology of this part of the Black Hills were largely established by these reports.

In 1951 uranium was discovered on Pictograph Mesa along the east side of Craven Canyon near the central part of the quadrangle. Subsequently, many small carnotite deposits were found in the surrounding area. These discoveries resulted in a program of detailed geologic investigations by the U.S. Geological Survey on behalf of

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the Division of Raw Materials of the U.S. Atomic Energy Commission to determine the relation of the deposits to their geochemical and geologic environments and to determine criteria that would be useful in the exploration for concealed deposits.

The uranium deposits of the southern Black Hills are restricted to rocks of the Inyan Kara group, a relatively complex series of fluviatile and lacustrine sedimentary rocks of Cretaceous age. Because of the economic significance and complexity of this group of rocks, they were mapped at a scale of 1:7,200 in an attempt to delineate the principal rock units, and to determine the significance of sedimentary and tectonic structures, lithology, and cementation in relation to the ore deposits. Manuscript copies of the original multiplex topographic maps were used as a base and the vertical control for the geology was carried largely with the use of altimeter and hand level. Drill-hole information made available to the writers by the U.S. Atomic Energy Commission and private companies has been utilized to determine the thickness and distribution of subsurface units. The geologic maps of the quadrangle have been published in preliminary form at a scale of 1:7,200 (Gott and Schnabel, 1956a–f). These maps, with little modification, have been reduced to a scale of 1:24,000 and are shown on plate 12.

STRATIGRAPHY

GENERAL FEATURES

The consolidated sedimentary rocks that underlie the Edgemont NE quadrangle range in age from Cambrian to Late Cretaceous. In aggregate thickness these rocks range from about 2,350 to about 3,600 feet (table 1). Of these rocks the Deadwood formation of Cambrian and Ordovician age, the Englewood and Pahasapa limestones of Mississippian age and the Minnelusa formation of Pennsylvanian age are not exposed within the quadrangle. Where they are exposed in the Fourmile quadrangle a few miles to the north, the Deadwood formation is composed of sandstone, glauconitic sandstone, and quartzite and is between 90 and 170 feet thick. The Englewood limestone is thin bedded, purplish red to lavender and highly fossiliferous. It ranges from 30 to 55 feet in thickness. The Pahasapa limestone is thick bedded and is cream to pale yellow-white. Its thickness varies because of solution and pre-Pennsylvanian erosion but probably ranges from 200 to 450 feet (Jack A. Redden, written communication, 1958).

The Minnelusa formation is composed of sandstone, limestone, cherty limestone, and shale. Results of studies of this formation indicate that large volumes of anhydrite or gypsum have been leached

TABLE 1.—*Estimated thickness of consolidated sedimentary rocks in the Edgemont NE quadrangle*

System	Formation		Thickness (ft) Minimum	Thickness (ft) Maximum
Cretaceous	Skull Creek shale		40	[1] 40
	Inyan Kara group	Fall River formation	125	150
		Lakota formation	200	500
Jurassic	Morrison formation		65	100
	Sundance formation		300	400
Triassic	Spearfish formation		525	590
Permian	Minnekahta limestone		45	50
	Opeche formation		60	115
Pennsylvanian	Minnelusa formation		650	1,000
Mississippian	Pahasapa limestone		200	450
	Englewood limestone		30	55
Cambrian and Ordovician	Deadwood formation		90	170
Precambrian				
	Total		2,330	3,620

[1] Upper part eroded in Edgemont NE quadrangle.

from the formation where it is exposed in the southern Black Hills area (C. G. Bowles, W. A. Braddock, and D. A. Brobst, oral communication, 1958). Because of this phenomenon and because of variations in the original thickness of the formation its present thickness is extremely variable (table 1).

The exposed consolidated rocks in the Edgemont NE quadrangle range in age from Permian to Late Cretaceous and include the Opeche, Minnekahta, Spearfish, Sundance, Morrison, Lakota, Fall River, and Skull Creek formations.

The depositional history, as represented by these formations, has been varied. It ranges from the marine environment of the Minnekahta and Sundance formations, to the highly saline waters in which the rocks of the Opeche and Spearfish formations were deposited; from a probable depositional environment of ponded fresh water during Morrison time, to a cyclic environment of ponded and fluvial waters of Lakota and Fall River time; and from a recurrence of marine conditions under which the Cretaceous shales were deposited, to a return to a period of intense erosion following the uplift of the Black Hills region.

PERMIAN ROCKS

OPECHE FORMATION

The Opeche formation of Permian age was named and defined by Darton (1901, p. 513). He assigned the name to that sequence of rocks around the Black Hills that are between the Minnelusa formation and the Minnekahta limestone. According to Darton the formation averages slightly less than 100 feet in thickness and is composed mainly of soft, red, thin-bedded, argillaceous sandstone. The upper part of the formation is composed of purple shale and the basal beds are generally composed of red slabby sandstone.

Within the Edgemont NE quadrangle the upper 20 feet of the formation is exposed only along the west side of Red Canyon near the northern boundary of the quadrangle. Here the upper part of the formation consists of red to purple silty shale which has been exposed where the Minnekahta limestone has been removed along the crest of a small domelike structure.

MINNEKAHTA LIMESTONE

The Minnekahta limestone of Permian age is exposed within a small area in the upper part of Red Canyon near the northeast corner of the quadrangle. It is finely crystalline to lithographic, reddish-gray, platy to massive limestone. It is about 40 feet thick and most commonly crops out as a reddish-gray ledge. The following partial section is representative of the Minnekahta limestone in this area:

Red Canyon in the SE¼SE¼ sec. 28, T. 6 S., R. 3 E.

Description	Thickness (feet)
1. Limestone, hard, gray to reddish-gray, predominantly lithographic. Weathers as a vertical cliff. Top eroded	11.5+
2. Limestone, lithographic, platy beds range from 1 to 6 in. in thickness; the overall color is grayish-red resulting from alternating light-gray and red bands with red predominating. These bands are about one-eighth in. thick except a few red bands that are about 1 in. thick. Differential weathering makes bedding conspicuous	5.5
3. Limestone, finely crystalline, sugary texture, very light gray with brown laminae (12 to the inch) on fresh surface, vuggy, bands of coarse secondary calcite crystals parallel to bedding. In places the bedding has been distorted into small right-angle folds. The base of the limestone is covered by alluvium	16.0
Total	33.0+

The Minnekahta limestone is characterized by an undulatory upper contact, breccia pipes, and small intraformational folds. The undulations form small elliptical and circular depressions and domes that range in size from a few tens to two or three hundred feet in diameter. Similar structures in the gypsum beds of the overlying Spearfish formation are smaller and do not everywhere appear to conform to the attitude of the Minnekahta limestone.

Where the Minnekahta limestone is well exposed along Red Canyon, breccia pipes occur in or near the base of the depressions (fig. 23). The breccia is a chaotic, rubbly mass in which much of the continuity of the bedding has been completely destroyed. The breccia pipes are inclined at steep angles and have been well cemented into a cohesive mass by secondary calcium carbonate.

FIGURE 23.—Edge of breccia pipe in the Minnekahta limestone.

The brecciation probably resulted from solution and removal of soluble rocks at depth. This is suggested by information derived from drill cores of parts of the Minnelusa formation taken in Hell Canyon (SW¼NW¼ sec. 3, T. 5 S., R. 2 E.) in the Jewel Cave quadrangle and near Pass Creek (NE¼NW¼ sec. 1, T. 6 S., R. 1 E.) in the Jewel Cave SW quadrangle.

This conclusion is further substantiated by the analyses of eight spring waters collected from the Newcastle, Wyo., and Hot Springs, S. Dak., areas (table 2). The calcium, magnesium, sulfate, and bicarbonate content of these waters indicates that appreciable volumes of anhydrite or gypsum and probably dolomite are being leached from the Minnelusa formation. The water from the Fall River formation (table 2, column 10) probably more nearly represents a water in which appreciable calcium salts have not been dissolved. The relatively high sulfate content of this water may be the result of oxidation of pyrite in the Fall River formation.

Another characteristic of the Minnekahta limestone is the occurrence of many small intraformational asymmetric folds, illustrated by figure 24. These folds normally have an amplitude of only 1 or 2 feet and are overlain and underlain by undeformed beds although there is no evidence of an intraformational disconformity. Most of the fold axes are oriented parallel to the strike in the immediate vicinity of the fold. The steep sides of the folds are generally to the south. They probably were formed by postconsolidation gravity sliding.

TABLE 2.—*Analyses of spring water from the Minnelusa formation, Weston County, Wyo., and Fall River County, S. Dak., compared to an analysis of water from the Fall River formation*

[Analyses, in parts per million, by U.S. Geological Survey, Denver, Colo.]

	Minnelusa formation [1]								Average (excluding sample 2211)	Fall River formation 2213
	2208	2209	2210	2211	2247	2248	2249	2250		
Silica	16	14	13	19	27	13	2.4	22	15	8
Aluminum	.2	.4	.1	.4	.1	.1	.3	.2	.2	.0
Iron	.00	.00	.04	.04	.00	.00	.03	.03	.014	.69
Manganese	.00	.00	.00	.00	.00	.00	.00	.00	.00	.07
Calcium	532	472	402	1,310	252	64	508	568	400	72
Magnesium	83	78	56	246	51	34	112	92	72	27
Sodium	5.4	5.5	3.8	16,500	86	9.8	21	54	26	200
Potassium	2.6	2.6	1.6	19	9.8	4	15	6.2	6	11
Lithium	.00	.00	.05	.00	.05	.05	.05	.00	.029	.00
Uranium	.012	.011	.0047	.017	.0075	.010	.0063	.0057	.008	.0001
Bicarbonate (HCO_3)	225	227	190	235	232	306	112	235	218	214
Carbonate (CO_3)	0	0	0	0	0	0	0	0	0	.0
Sulfate (SO_4)	1,420	1,260	1,040	3,680	639	51	1,610	1,540	1,080	525
Chloride (Cl)	4	5	1	25,000	112	8	13	62	29	18
Fluoride (F)	.4	.4	.2	.9	.8	.7	.2	.9	.5	.3
Nitrate (NO_3)	4.7	3.2	1.4	.0	1	1.7	.0	.6	1.8	.0
Phosphate (as PO_4)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.0
Boron (B)	.07	.11	.05	2	.24	.06	.19	.19	.44	.08
Ra (10^{-12} c/liter)	.4	.2	.1	.7	.4	.2	<.1	.9	.33	.0018
pH	7.6	7.7	7.5	7.2	7.0	8.0	7.4	7	7.5	7.6
Temperature (°F)	55	55	54	47	90	48	46	72	------	------
Date of sampling	October 1957	October 1957	October 1957	October 1957	November 1957	November 1957	November 1957	November 1957		October 1957

[1] Localities sampled:
2208: Spring, SE¼ sec. 31, T. 45 N., R. 60 W., Weston Co., Wyo.
2209: Spring, NE¼ sec. 31, T. 45 N., R. 60 W., Weston Co., Wyo.
2210: Spring, SW¼ sec. 17, T. 45 N., R. 60 W., Weston Co., Wyo.
2211: Spring, about 7 miles north of Newcastle, Wyo., T. 46 N., R. 61 W.
2247: Spring, Evans Plunge, Hot Springs, Fall River County, S. Dak.
2248: Spring, SW¼ sec. 10, T. 7 S., R. 6 E., Fall River County, S. Dak.
2249: Spring, NW¼ sec. 35, T. 7 S., R. 5 E., Fall River County, S. Dak.
2250: Spring, Cascade Springs, SW¼ sec. 20, T. 8 S., R. 5 E., Fall River County, S. Dak.
Unnumbered: Average analysis of spring waters except sample 2211.
2213: Artesian well, NE¼ sec. 9, T. 7 S., R. 1 E.

FIGURE 24.—Intraformational fold in the Minnekahta limestone.

PERMIAN AND TRIASSIC ROCKS

SPEARFISH FORMATION

The Spearfish formation is composed of alternating maroon to reddish-brown nonfossiliferous claystone, siltstone, sandy shale, sandstone, and gypsum. In a few places it is very slightly carbonaceous. It is dominantly composed of detrital quartz. Its characteristic color is imparted by ferric oxide that coats the quartz grains and fills the interstices between the grains. The upper part of the formation contains abundant veins and veinlets of gypsum. Within the Edgemont NE and adjacent quadrangles, two relatively thick gypsum beds are present in the lower part of the formation. In the northeastern part of the quadrangle, the lower gypsum bed averages about 30 feet in thickness and is from 75 to 100 feet above the base of the formation. The upper gypsum bed averages about 50 feet in thickness and is separated from the lower gypsum bed by about 40 feet of red siltstone. The sequence between the base of the formation and the top of the upper gypsum bed is, therefore, approximately 220 feet. The red-bed sequence between the top of the upper gypsum bed and the top of the formation is about 300 feet thick giving a total thickness of approximately 520 feet where the formation crops out in the northeastern part of the quadrangle. A more reliable measurement, however, is in the Helms-Coffin oil well in the E½ sec. 34, T. 6 S., R. 2 E., where the total thickness is 588 feet.

The extensive gypsum beds in the Spearfish formation are not associated with other evaporitic salts except that dolomite beds a few inches thick, and probably of evaporitic origin, have been observed in a few places. In several places within the quadrangle the thickest gypsum beds have been deformed into an undulating attitude caused either by subsidence resulting from removal of soluble rock at depth or by deformation resulting from the increase in volume accompanying the change from anhydrite to gypsum. This type of deformation is illustrated in figure 25.

The Spearfish formation is best exposed in the northeastern part of the quadrangle where it forms a gently rolling grass-covered surface. The relative lack of resistance to erosion offered by these rocks compared with the more resistant younger and older formations has resulted in the erosion of a wide, rolling valley that conforms to the strike of the beds and that, with few interruptions, encircles the entire Black Hills uplift. This valley has been known locally as Red Valley and was referred to by Darton (1901, p. 516) as the race course, a name given to it by Indians in the northern hills.

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FIGURE 25.—Gypsum beds in the Spearfish formation.

Darton (1901) defined the Spearfish formation as the red-bed sequence between the Minnekahta limestone of Permian age and the Sundance formation of Jurassic age. He considered the formation to be of probable Triassic age. More recent studies in areas adjacent to the Black Hills have resulted in a controversy regarding the Permian and Triassic boundary. According to Love (1957) and Lewis and Hadley (1957) the systemic boundary has been drawn at several stratigraphic positions: the top of the Minnekahta limestone, the top or bottom of the evaporite sequence, or in the unit above the evaporite sequence. In this report the top of the second gypsum bed is considered as the boundary between the two systems.

JURASSIC ROCKS

SUNDANCE FORMATION

The Sundance formation of Jurassic age was described by Darton (1901, p. 520–524) as a unit of marine rocks composed of shales and sandstones. Later, Imlay (1947) subdivided the formation into five members and named them, in ascending order, the Canyon Springs sandstone member, the Stockade Beaver shale member, the Hulett sandstone member, the Lak member, and the Redwater shale member. As a result of his studies, Imlay tentatively concluded that the Nugget sandstone of Jurassic age is represented by a nonfossiliferous cross-bedded sandstone that lies between the Spearfish formation and the Canyon Springs member of the Sundance formation in an area partly encompassed by the Edgemont NE quadrangle. As described by Imlay, the Nugget sandstone is in the part of the nearly vertical sandstone cliff in the NE¼ sec. 7, T. 7 S., R. 3 E., that shows eolian-type crossbedding. Because this type of crossbedding is not persistent in this area the bedding cannot be used as a criterion for mapping a separate unit. The writers have, therefore, included the crossbedded sandstone in the Canyon Springs sandstone member of the Sundance formation. With this exception, the members of the Sundance formation have been mapped as described by Imlay.

With the exception of the Canyon Springs and Hulett sandstone members, the Sundance formation is normally very poorly exposed. Along steep slopes the formation is usually covered by landslides and talus debris from younger formations. Where the formation forms a rolling topography, the softer strata usually weather to a deep soil zone.

CANYON SPRINGS SANDSTONE MEMBER

The Canyon Springs sandstone member unconformably overlies the Spearfish formation and conformably underlies the Stockade Beaver shale member. The Canyon Springs is predominantly composed of a homogeneous, very fine grained quartz sandstone but in places near the middle part the unit contains a facies of gray massive or laminated siltstone. It is colored in bands of red, reddish brown, orange, salmon, yellow, yellowish gray, or white. The lightest colors are generally at or near the base and at the top of the unit. Almost invariably a white zone about 1 foot thick occurs at the base in contact with the Spearfish formation. A similar zone, about 20 feet thick, is widespread at the top.

The Canyon Springs member reaches a maximum thickness of 92 feet in the NE¼ sec. 7, T. 7 S., R. 3 E., thins northward to zero near the center of sec. 6, T. 7 S., R. 3 E., and thins southeastward to about 60 feet in secs. 15, 16, and 22, T. 7 S., R. 3 E. In the Helms-Coffin oil well in the E½ sec. 34, T. 6 S., R. 2 E., the sandstone is fine grained, orange red, calcareous and is 32 feet thick. In sec. 16, T. 7 S., R. 3 E., and southward to a point where the Canyon Springs member is buried by younger rocks, a gray siltstone, in part laminated, occupies a position in the middle part of the sandstone. The siltstone appears to be in the form of a wedge that increases in thickness to the south and attains a maximum exposed thickness of about 35 feet within the Edgemont NE quadrangle.

Commonly the bottom of the Canyon Springs member fills shallow, erosional irregularities cut 1 or 2 feet into the Spearfish formation and the lower 6 inches to 3 feet contains disseminated, rounded and polished chert pebbles as much as 1 inch in diameter. Generally these chert pebbles are most abundant in the basal 2 or 3 inches.

The following section, measured on the nearly vertical cliff in the NE¼ sec. 7, T. 7 S., R. 3 E., is an example of the Canyon Springs sandstone member where the unit is composed chiefly of sandstone

Description	*Thickness (feet)*
Sundance formation:	
Stockade Beaver shale member:	
1. Shale, platy, medium gray with a few reddish streaks near top	44
Total thickness of Stockade Beaver shale member	44
Canyon Springs sandstone member:	
2. Sandstone, very fine grained, white, mottled with yellow and red. Weathers into rolling, rounded shapes. Horizontally bedded	18
3. Sandstone, very fine grained, red. Lower 15 ft. crossbedded, upper 58 ft. horizontally bedded. Contact with the white sandstone above is irregular and gradational	73
4. Sandstone, similar to sandstone above except for color change, white. Few chert pebbles and black grains along basal contact	1
Total thickness of Canyon Springs sandstone member	92
Spearfish formation:	
5. Siltstone, red, micaceous. Weathers in blocky ledges 1 to 2 ft. thick. Unconformable with Canyon Springs sandstone member	10

The Canyon Springs member appears to be conformable with the overlying Stockade Beaver member. The variable thickness of the Canyon Springs, therefore, indicates that it was deposited over an irregular surface. The irregularity of the pre-Canyon Springs surface is best illustrated in the NE¼ sec. 7, T. 7 S., R. 3 E., where the Canyon Springs member is about 90 feet thick and thins northward to zero near the center of sec. 6, T. 7 S., R. 3 E., where the Stockade Beaver rests directly on the Spearfish formation.

One of the interesting features of the Canyon Springs member is the crossbedding that is present in a few places. This crossbedding is best shown in the nearly vertical cliff in the NE¼ sec. 7, T. 7 S., R. 3 E. The crossbedding appears to be of eolian origin. In view of the obviously water laid, laminated siltstone wedge that is included within this sandstone a short distance to the south, it seems probable that the crossbedded sandstone is a beach deposit marginal to the Canyon Springs shoreline.

STOCKADE BEAVER SHALE MEMBER

The Stockade Beaver shale member of the Sundance formation consistently ranges from 40 to 50 feet in thickness where it is exposed in the Edgemont NE quadrangle. It is a dark-gray highly argillaceous shale with poor fissility. On a dry weathered surface it is light gray but where slightly moist it is dark gray. Locally the unit contains 1- to 2-inch-thick beds of fossiliferous limestone. The shale is conformable with the underlying Canyon Springs member but is disconformable with the Spearfish formation in those areas where the Canyon Springs member is not present. It is gradational with the overlying Hulett member. Throughout most of the mapped area it forms a gentle grass-covered slope with few good exposures.

HULETT SANDSTONE MEMBER

The Hulett sandstone member is gradational with the underlying and overlying units. The sandstone ranges from 35 to 45 feet in thickness. It is flaggy, light gray, fine grained, glauconitic, intermittently ripple marked, and locally fossiliferous. Although predominantly sandstone, it contains many streaks of light-gray shale similar to the Stockade Beaver shale member. The Hulett is characterized by its flagginess with the thickness of the individual beds ranging from less than 1 inch to 4 or 5 feet. Generally each sandstone bed is enclosed by thin shale beds of Stockade Beaver type. In some zones of very thin bedded alternating sandstone and shale, there is nearly as much shale as sandstone. Throughout most of the area the Hulett crops out as a narrow prominent ledge.

LAK MEMBER

The Lak member is characterized by its distinctive salmon and reddish-brown colors. It is about 70 feet thick and is composed of salmon-colored, poorly bedded to massive, very fine grained sandstone and reddish-brown siltstone. Normally the sandstone forms ledges; and the siltstone forms gentle slopes between the sandstone. In general, the Lak does not effectively resist erosion. Its red color is generally imparted to the soil except where it is well buried under talus blocks and landslides. Because the least resistant beds are at the top and bottom of the member, its contact with the underlying Hulett member and the overlying Redwater member are generally not well exposed. In those places where its upper and lower limits have been observed, the Lak is conformable with both the Redwater and the Hulett.

The following section is representative of the Lak member in the Edgemont NE quadrangle. It was measured in the SW¼ sec. 27, T. 7 S., R. 3 E., near the east boundary of the Edgemont NE quadrangle.

Description	Thickness (feet)
Sundance formation:	
Lak member:	
1. Sandstone and siltstone, the basal 2 ft. is composed of thin fine-grained sandstone beds each less than 1 in. thick. The remainder of the section is composed of brown homogeneous siltstone with poor to no bedding and a few thin beds of massive, salmon-colored, fine-grained sandstone. The contact with the Redwater member is delineated by a distinct color change from the salmon and reddish browns of the Lak to a neutral gray of the Redwater	14.0
2. Sandstone, very fine grained, salmon color; no apparent bedding except in the top 2 ft. Weathers in a smooth, rounded sloping ledge similar to much of the Canyon Springs	19.0
3. Siltstone, reddish-brown, contains two fine-grained massive sandstone ledges, each about 2 ft. thick. In general appearance this unit resembles the siltstones of the Spearfish, particularly in its obscure bedding and color	14.0
4. Predominantly siltstone in poorly exposed gentle slope. Lower part platy; upper part, massive	8.0
5. Sandstone, very fine grained, well-sorted, homogeneous, glauconitic, salmon-colored. Forms ledge	3.0
6. Siltstone, platy, salmon-colored, mottled with greenish-gray to white spots	3.5
7. Sandstone, very fine grained, well-sorted, homogeneous, glauconitic, salmon-colored, forms ledge	2.0
8. Covered, probably basal Lak	5.5
Total	69.0

REDWATER SHALE MEMBER

The Redwater shale member is normally very poorly exposed. On steep slopes it is covered by landslides, talus blocks, and in areas of gently rolling topography, it is effectively concealed by a grass- and soil-covered surface. Its total thickness is, therefore, rarely exposed and is subject to question throughout most of the Edgemont NE quadrangle. Along the east quadrangle boundary in the northern part of sec. 34, T. 7 S., R. 3 E., the total thickness is 179 feet. About 10 miles to the northwest in the Jewel Cave SW quadrangle, the Redwater is 150 feet thick (W. A. Braddock, oral communication, 1958), and to the southeast in the NE¼ sec. 9, T. 8 S., R 4 E., in the Flint Hill quadrangle it has an average thickness of about 130 feet (Henry Bell 3d, oral communication, 1958).

The Redwater member is composed of gray, thin-bedded, platy, or laminated glauconitic siltstones interbedded with thin sandy claystones, and a few very thin fossiliferous limestones. A white fine-grained homogeneous calcareous sandstone that is normally 10 to 15 feet thick marks the top of the Redwater in this area. In those places where the top and bottom of the member have been observed, it appears to be conformable with both the overlying Morrison formation and the underlying Lak member.

In the Edgemont NE quadrangle, the Redwater shale member is most completely exposed in the north part of sec. 34, T. 7 S., R. 3 E., along the east quadrangle boundary and extending into the Minnekahta quadrangle.

Measured section at sec. 34, T. 7 S., R. 3 E.

Description	Thickness (ft.)
Sundance formation:	
Redwater shale member:	
1. Sandstone, fine-grained, homogeneous, calcareous. In most places this sandstone is from 10 to 15 ft. thick and is present consistently within the boundaries of this quadrangle. Its top marks the contact between the Redwater shale member and the Morrison formation	5.0
2. Siltstone and clay, thin bands of light-gray siltstone alternating with dark-gray clay giving a laminated effect	11.5
3. Siltstone, laminated, maroon	2.0
4. Siltstone, light-gray, beds are 1 to 2 in. thick and are separated by dark-gray clay partings	16.5
5. Sandstone, glauconitic, light greenish-gray finely crossbedded within tabular beds half a foot to one foot thick	5.5
6. Siltstone, light-gray, glauconitic. Micaceous bands a quarter of an inch or less in thickness alternate with dark-gray clay partings giving a laminated effect	6.5
7. Shale, argillaceous, medium- to dark-gray, platy, noncalcareous except for sporadic calcareous concretions, belemnites abundant on weathered slope	69.5
8. Covered slope	22.5
9. Siltstone, light-gray, calcareous, glauconitic. The beds are from 1 in. to 1 ft. thick with shale partings from 2 to 3 in. thick. Oscillation ripple marks; indistinct crossbedding	12.5
10. Shale, medium-gray, calcareous, platy. Composed of both siltstone and claystone	27.5
Total	179.0
Lak member.	

MORRISON FORMATION

Within the Edgemont NE quadrangle, the Morrison formation of Jurassic age appears to conformably overlie the Redwater shale member of the Sundance formation. The Morrison formation is composed of greenish-gray to gray, waxy, unctuous, calcareous, noncarbonaceous, massive clay with numerous fine-grained to lithographic and argillaceous limestones, and a few very thin fine-grained sandstones. Throughout most of this area the formation is from 90 to 100 feet thick, but, along the section line between secs. 21 and 22 and in the NE¼NE¼ sec. 33, T. 7 S., R. 3 E., it is between 65 and 75 feet thick and 3 miles farther southeast in the Minnekahta quadrangle, it is less than 10 feet thick.

Because of the high clay content of the Morrison formation, segments of the overlying resistant sandstones of the Inyan Kara group have had a strong tendency to slide completely over the Morrison formation and down onto the underlying Redwater shale member. As a consequence, the Morrison formation is almost everywhere covered with landslides and talus blocks derived from the overlying rocks. Even in many places where the rocks of Morrison age are exposed there can be no certainty that they have not been involved with the sliding sandstones of the Lakota and thus may be many tens of feet below their true stratigraphic position. The many collapse blocks in this area further complicate the interpretation of the stratigraphy beneath the landslides and surficial debris. The thickness and the structural attitude of most of the Morrison formation are therefore highly questionable.

CRETACEOUS ROCKS

INYAN KARA GROUP

GENERAL FEATURES

The formations of the Inyan Kara group were originally defined and named by Darton (1901). In ascending order he assigned the formational names Lakota sandstone, Minnewaste limestone, Fuson shale, and Dakota sandstone to that group of rocks between the Morrison formation and the base of the marine Cretaceous shales. Later Russell (1928) substituted the name Fall River sandstone for the Dakota sandstone of Darton because he found that the flora in the Dakota sandstone of the Black Hills are older than are those of the type section. Still later Rubey (1931) introduced the term Inyan Kara group within which he included the Lakota, Fuson, and Fall River formations (the Minnewaste limestone is absent in that part of the Black Hills). Recently Waagé (1959) redefined the Lakota formation and included within it, as members, the Fuson shale and Minnewaste limestone of Darton.

In this report the Inyan Kara group is divided into the Lakota and Fall River formations. The Lakota formation in ascending order is divided into the Chilson member (Post and Bell, 1961), the Minnewaste limestone member, and the Fuson member. The Fall River formation is subdivided into lower, middle and upper units. As a result of detailed mapping of parts of the southern and northwestern Black Hills several of the most prominent sandstones have been given number designations (Mapel and Gott, 1959). Sandstones, Nos. 1, 2, and 4 in the Lakota formation, and the No. 5 in the Fall River formation crop out in the Edgemont NE quadrangle.

The thickness of the Inyan Kara group of rocks ranges from about 325 to about 650 feet. Most of this variation was caused by early Inyan Kara structural deformation resulting in the deposition of a relatively thick sequence of rocks in the structural troughs during Lakota time. As shown by figures 28–36 the axial lines of most of the units in the Lakota formation and one unit in the Fall River formation are oriented northwest across the quadrangle parallel to the axes of the Black Hills uplift and probably parallel to the structural grain established by the early deformation. It is probable, therefore, that the distribution of many of the Inyan Kara stratigraphic units has been controlled by this period of folding.

The folding during early Inyan Kara time may have been part of the structural deformation accompanying the beginning of the Black Hills uplift. The post-Inyan Kara marine invasion of the Black Hills area, however, suggests that uplift, in any event, was not continuous during Late Cretaceous time.

LAKOTA FORMATION

The rocks in the Lakota formation are composed of a complex sequence of generally very fine to medium-grained clastic rocks. Fine- to medium-grained sandstone predominates volumetrically, but siltstone and clay are also quantitatively significant. These rocks were deposited under varied conditions in fluvial, lacustrine, and swampy environments. The stratigraphic relations of the various lithologic units are shown on the block diagram of part of the Edgemont NE quadrangle (pl. 13).

The changes in depositional environment evidently accompanied periods of mild structural deformation, particularly during early Lakota time. The structural irregularities formed at this time are graphically illustrated by the cross section referred to several datums on plate 14. The illustration indicates that a structural and deposi-

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tional basin was formed in the eastern part of the quadrangle and was persistently accentuated during Lakota time. Evidently during its formation, changes in the temporary base level of the drainage system resulted in a crudely cyclic sequence of stream, swamp, and lake deposits. The various lithologies of these rocks are, in places, delineated by abrupt and distinct boundaries, but, in most places, they are characterized by vertical and lateral gradations that give them obscure and often irregular shapes. Locally, many of the lithologic units have been deposited in an orderly and systematic arrangement, but, within an area of several square miles, such as the southern two-thirds of the Edgemont NE quadrangle, the various units can be seen to interfinger, intergrade, truncate, or be truncated. Drill-hole information, therefore, is required to determine the distribution of the intraformational units in areas where the rocks are poorly exposed.

In the Edgemont NE quadrangle the Lakota formation ranges from less than 200 to 500 feet in thickness (fig. 26) as determined from drill-hole data (fig. 27) and outcrop measurements. The formation is composed of fluviatile and nonfluviatile sandstone, shale, mudstone, and siltstone. The composition and probable depositional environments of the units within the formation are summarized in table 3. The principal fluviatile deposits, in ascending order, are the Nos. 1, 2, and 4 sandstones. The No. 3 sandstone is not present in the quadrangle. The No. 1 sandstone is underlain by a sequence of black fissile shale interlayered with carbonaceous mudstone, siltstone, and fine-grained sandstone of variable thickness. Within the Edgemont NE quadrangle the Nos. 1 and 2 sandstones are separated by a sequence of thin alternating beds of tabular sandstone, siltstone, and mudstone, probably largely of flood-plain origin. The Minnewaste member directly overlies the No. 2 sandstone but occurs only as isolated patches. The Fuson member overlies the Minnewaste limestone or where the Minnewaste is absent the Fuson lies on the Chilson member of the Lakota formation. It is composed of variegated mudstone, siltstone, or sandstone. A characteristic white massive sandstone is normally present near the base. The thickness of the Fuson member is extremely variable, principally because of erosion before deposition of No. 4 sandstone. In areas of deepest dissection the entire Fuson member has been removed. Its depositional environment is obscure. The No. 4 sandstone is locally present at the top of the Fuson member. This sandstone occupies deep-cut sinuous channels that in general are elongated northwesterward.

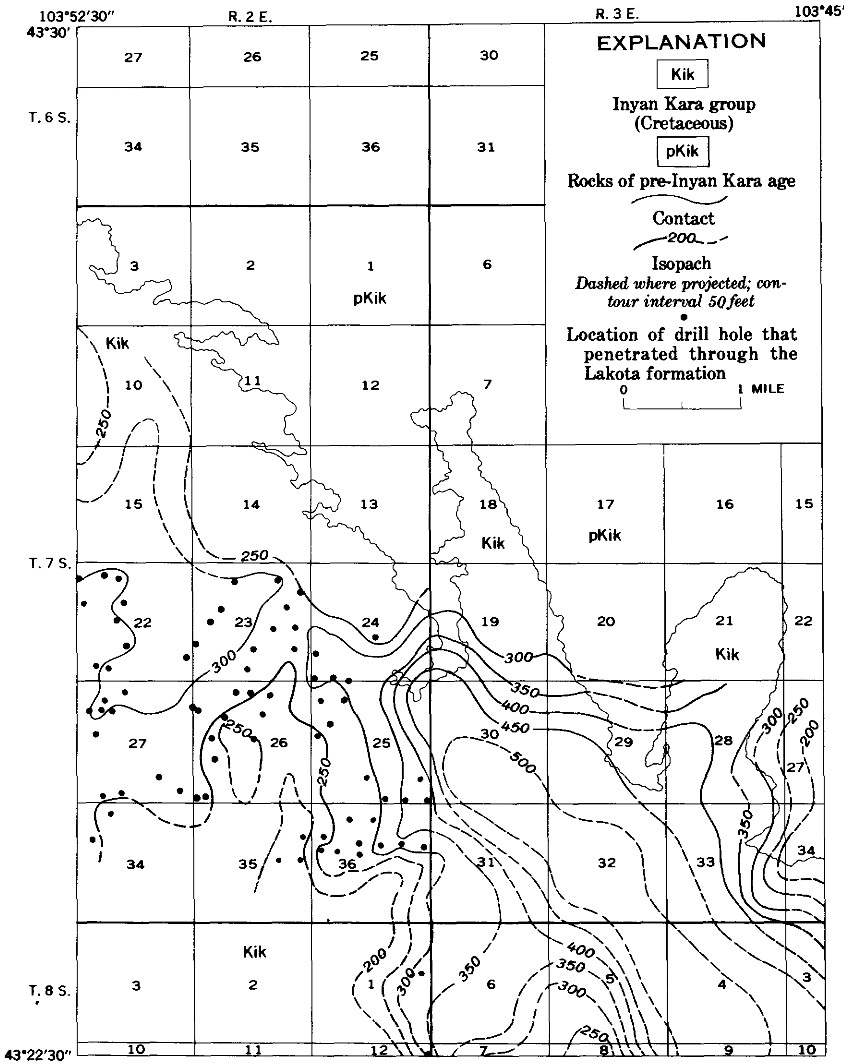

FIGURE 26.—Isopach map of the Lakota formation, Edgemont NE quadrangle.

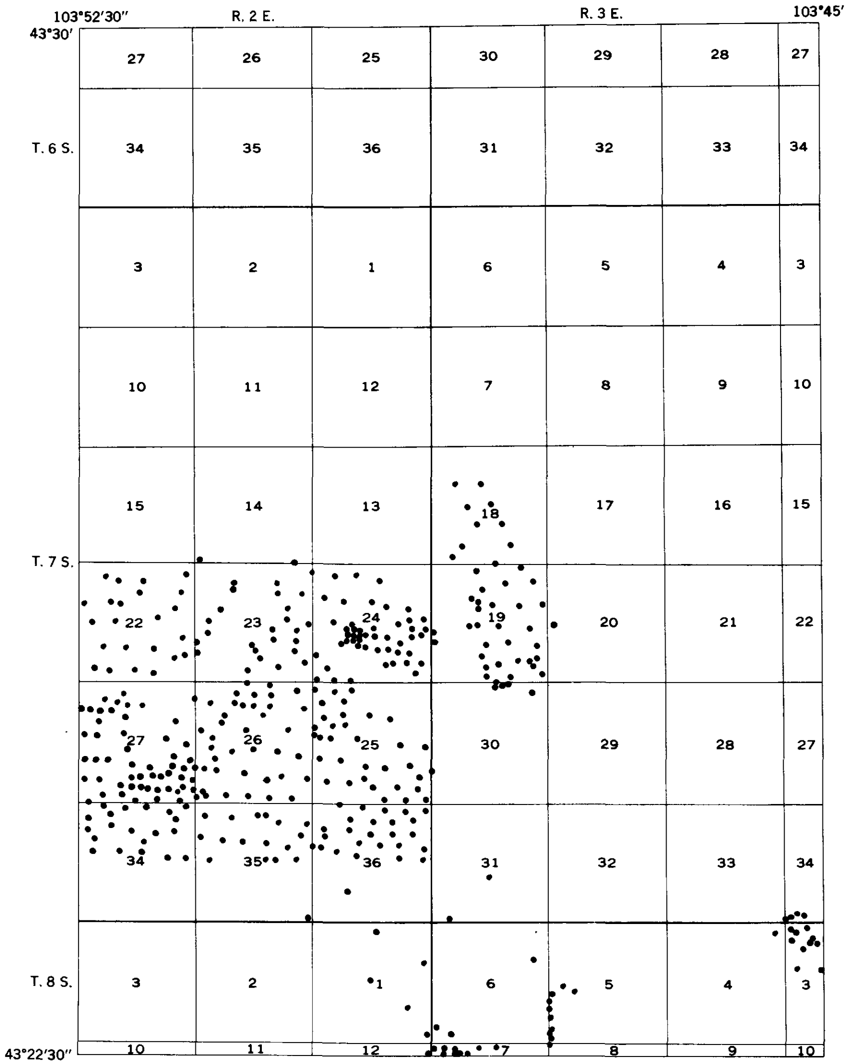

FIGURE 27.—Location of drill holes for which stratigraphic information has been made available by the Atomic Energy Commission and private companies.

TABLE 3.—*Lithology and depositional environment of the Lakota formation, Edgemont NE quadrangle*

Lithologic unit	*Depositional environment*
Fuson member	
Sandstone No. 4. Gray, medium-grained channel-fill sandstone. It ranges from 0 to 150 ft in thickness. The variegated mudstone above the No. 4 sandstone probably represents reworked mudstone of the Fuson member and is, therefore, part of the channel fill.	Fluvial.
Variegated mudstone. Red, green, and gray variegated mudstone. It ranges from 0 to 100 ft in thickness. The manner in which it was deposited is unknown.	
Sandstone. A white massive, structureless sandstone near the base of the variegated mudstone occurs over most of the area. It grades laterally and vertically into the variegated mudstones and is largely contained within the variegated mudstone. It ranges from 0 to about 100 ft in thickness. The sandstone was deposited slightly later than the Minnewaste.	Lacustrine(?).
Minnewaste limestone member, locally present in isolated patches; is composed of lithographic to sandy limestone that ranges in thickness from 0 to 20 ft	Lacustrine.
Chilson member	
Sandstone No. 2, white to gray, fine-grained, cross-laminated: it has a maximum thickness of about 75 ft in the eastern part of the quadrangle and is not present in the western part.	Fluvial.
A sequence of alternating beds of sandstone, siltstone, and mudstone. The beds are generally less than 2 ft thick but locally some of the sandstones are 10 to 15 ft thick. Many of the mudstones contain ostracodes. The sandstone and siltstone beds are sparsely carbonaceous. The unit is about 175 ft thick near the south end of Long Mountain but is absent in most of the area west of Craven Canyon.	Flood plain; in large part the unit is a fine-grained equivalent of the No. 1 sandstone.
Sandstone No. 1, light-gray, fine grained to very fine grained; contains disseminated carbonaceous debris and many siltstone and mudstone lenses; it is a cliff former and ranges from 0 to about 250 ft in thickness.	Fluvial.
Basal shales, a sequence of thin alternating and tabular beds of very fine grained sandstone, carbonaceous siltstone, fissile carbonaceous shale, and mudstone; the unit ranges from 0 to 75 ft in thickness.	Swampy, flood plain, or lacustrine.

Although the boundary between the Morrison and Lakota formations is evidently gradational in many places, particularly in the northern Black Hills, little difficulty has been met in delineating the two formations where they are exposed in the Edgemont NE quadrangle. In general, however, the lack of exposures of the contact between these formations is a handicap in a study of their relations. In most places, the Lakota formation is composed of a high proportion of relatively thick sandstones. Most of these sandstones are cliff formers, and they have a tendency to break away from the cliff face along joint planes and to slide over the highly argillaceous Morrison formation. The Morrison-Lakota contact, therefore, is rarely exposed. Where it is exposed a strong contrast is apparent between the waxy, unctuous, greenish-gray, claystone of the Morrison and the carbonaceous mudstone, siltstone, or sandstone of the Lakota formation. The most reliable criterion that can be used in differentiating the two formations in this area is the abundance of silt and larger size clastic and carbonaceous material in the Lakota formation and the scarcity or lack of these materials in the Morrison formation.

Normally, the top of the Lakota formation can be recognized by a change from the highly argillaceous, noncarbonaceous and variegated mudstone of the Fuson member to the thin-bedded or laminated carbonaceous siltstone that alternates with equally thin bedded, fine grained sandstone of the Fall River formation. In many places, however, two channel sandstones cause confusion in recognizing the formational contact. The oldest of these units is the No. 4 sandstone, which was deposited in those places where mudstone of the Fuson is dissected by pre-Fall River erosion. The other unit that is intermittently present at this contact is the No. 5 sandstone in the Fall River formation. In places the basal Fall River rocks were completely or partly eroded during Fall River time. These scours were then refilled with the No. 5 sandstone. In such places, the sandstone unconformably overlies all of the rocks between the middle part of the Fall River formation and the No. 4 sandstone or the Fuson in the Lakota formation.

CHILSON MEMBER

General features

The Chilson member is underlain by the Morrison formation and is overlain either by the Minnewaste member or Fuson member. The Chilson includes principally the Nos. 1 and 2 sandstones and their fine-grained equivalents. The No. 2 sandstone is present only in the eastern part of the quadrangle. A unit of interbedded sandstone and mudstone, representing the fine-grained equivalent of the No. 1 sandstone, occurs between the two major sandstone units. A carbonaceous shale unit unconformably underlies the No. 1 sandstone in most places.

Basal shale

The basal part of the Lakota formation is composed of a thin-bedded sequence of dark fissile shale, mudstone, siltstone, and fine-grained sandstone. The sequence ranges from 0 to 100 feet in thickness. In most places the unit is very carbonaceous. Plant fragments contribute much of the carbon in the sandstone and siltstone facies. Some of the sandstone and siltstone is crossbedded on a miniature scale and ripple marks are numerous.

Dark fissile shale is the predominant rock type within this unit east of Craven Canyon and in drill holes near the southern boundary of the quadrangle. Northwest of Craven Canyon, along the northern margin of the Lakota outcrop, the unit is poorly exposed but appears to be made up of thin alternating beds of mudstone, siltstone, fine-grained sandstone, and minor amounts of fissile shale. The shale is well exposed in several places near the eastern quadrangle boundary. In that area it is composed of dark-gray fissile to platy, carbonaceous shale interbedded with dark-gray carbonaceous siltstone and a few relatively thin horizontally bedded, fine-grained sandstones.

The thickness and distribution of the basal shale unit, as interpreted from drill-hole data as well as surface mapping, are shown on figure 28. Its relation with the overlying sandstone is also graphically illustrated by plates 13 and 14. The pronounced northwest linear pattern reflecting the variation in its thickness indicates that part of the unit was removed by the stream action which scoured the channel system in which the overlying No. 1 sandstone was deposited.

The basal Lakota unit probably was laid down as an extensive blanket-type deposit. Its carbon content, texture, and sedimentary structures suggest that it was deposited in a swampy or lacustrine environment but in part it may also represent a fine-grained equivalent of the No. 1 sandstone.

No. 1 sandstone

The No. 1 sandstone is a unit that is composed chiefly of sandstone but also includes variable amounts of mudstone, siltstone, carbonaceous shale, and organic debris. It is of fluviatile origin, variable in thickness, and, except for the lenses of fine-grained material contained within it, is remarkably uniform in composition. Many small uranium mines have been developed in the sandstone of this unit in the southeastern quarter of the quadrangle.

The sandstone ranges in thickness from 0 to about 250 feet (fig. 29) and is one of the thickest and most extensive sandstone units in the Lakota formation within the quadrangle. This unit is generally well exposed, and where it is thickest, as in parts of Craven Canyon, it forms vertical cliffs 70 to 100 feet high. Although the unit is composed chiefly of sandstone it also contains discontinuous

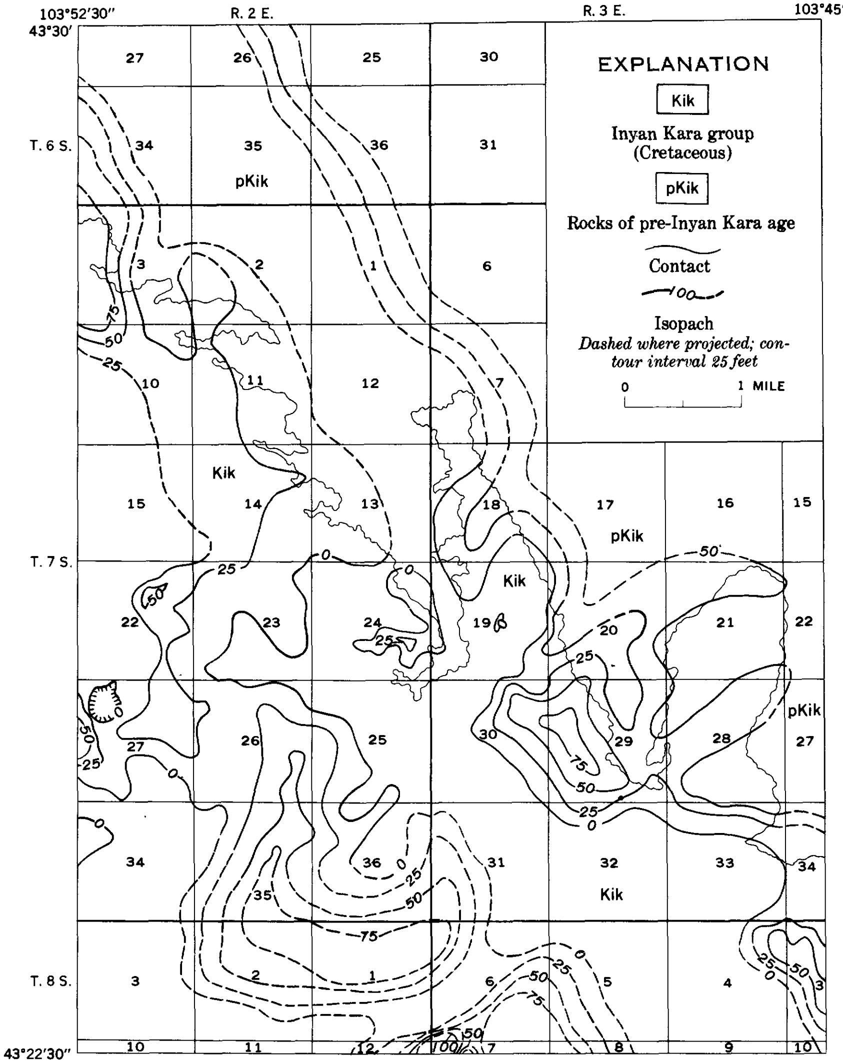

FIGURE 28.—Isopach map of the basal shale of the Chilson member of the Lakota formation, Edgemont NE quadrangle.

lenses of finer grained material that locally divide the unit into two or more sandstone beds.

Normally, the sandstone is a light brownish gray. It is generally fine to very fine grained but locally it is medium to coarse grained. The sandstone is composed predominantly of fine, subrounded quartz grains. Chert grains normally constitute less than 5 percent of the rock but locally constitute as much as 40 percent. White clay grains are common in the sandstone and may form as much as 5 percent of

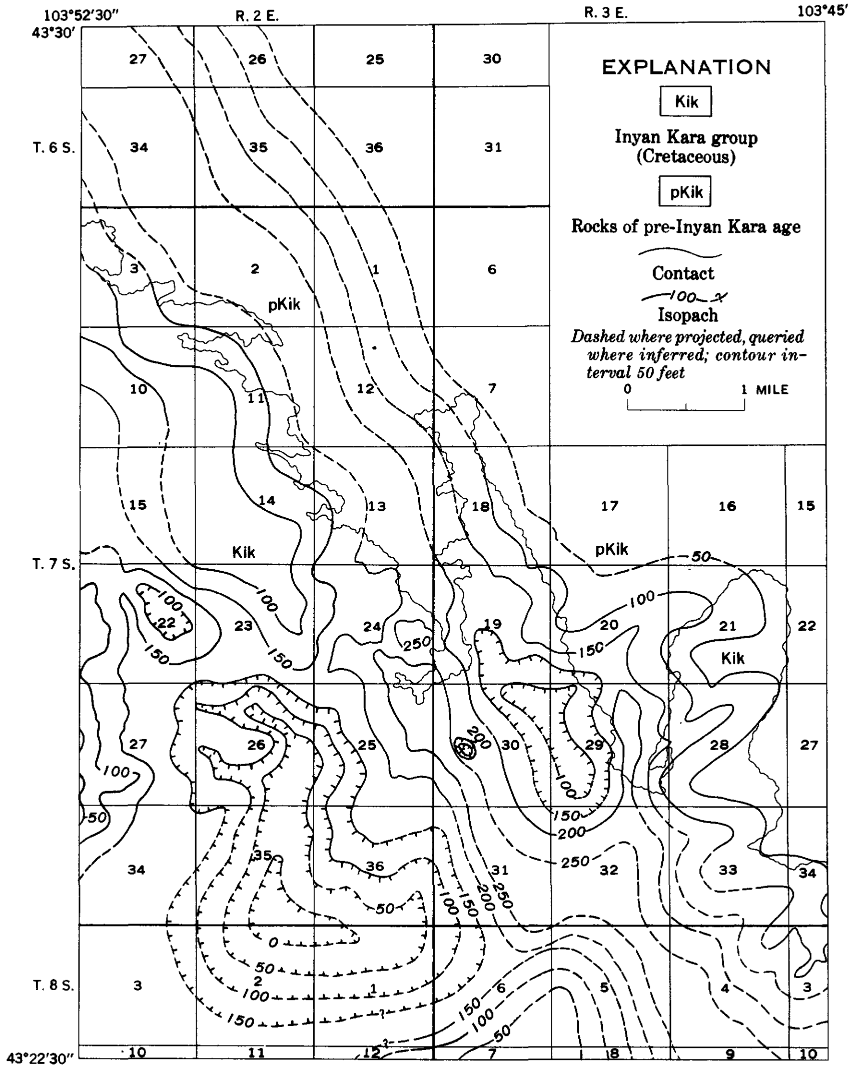

FIGURE 29.—Isopach map of the No. 1 sandstone of the Chilson member of the Lakota formation, Edgemont NE quadrangle.

the rock. The sandstone usually contains less than 1 percent of heavy minerals. Carbonized plant debris is distributed erratically through the sandstone.

The sandstone is cross-stratified throughout the area in which it is exposed, relatively long tangential foreset beds being most abundant. The orientation of the cross-stratification is extremely variable although in general the crossbeds dip in a northwesterly direction. The internal structure of the sandstone is complicated by numerous scours and fills that form no obvious drainage pattern.

Locally the sandstone is tightly cemented by calcium carbonate. This type of cementation is most abundant in the SE¼ sec. 21, T. 7 S., R. 3 E., where the sandstone is cemented in nodular, concretionary, and lenticular masses. Much of the calcium carbonate contains iron and manganese that, upon weathering, color the rock dark gray to black.

In a few places the sandstone is partly cemented by silica and iron. Most of the sand grains in the sandstone show secondary quartz overgrowths, but the secondary silica is rarely abundant enough to fill the interstices between the sand grains. Iron oxides locally cement the sand grains but normally are present only as a stain that imparts tones of yellow, brown, and red to the sandstone. One of the more interesting iron oxide stains is a characteristic purplish-pink that impregnates the sandstone adjacent to many of the uranium deposits. Its association with the ore deposits is so consistent that it can be used as a guide to ore.

The lenses of fine-grained material contained within the sandstone unit are made up variously of gray massive mudstone, very fine grained sandstone, carbonaceous siltstone, and finely laminated carbonaceous shale. These fine-grained lenses are made up of either a single rock type or of an alternating sequence of thin beds of mudstone, siltstone, and very fine grained sandstone. One of the thickest sequences of the fine-grained facies is in the Coal Canyon area where 50 to 75 feet of black papery shale interlayered with dark-gray platy shale, gray mudstone, carbonaceous siltstone, and fine-grained sandstone occurs within the No. 1 sandstone unit. Most of the fine-grained lenses are less than 10 feet in thickness and many are from a few inches to a foot thick.

In general outline the No. 1 sandstone has the shape and character of a broad channel-fill sandstone. Its approximate distribution and thickness are shown on figure 29. The isopachs on this map show that the thickest part of the sandstone occupies a band 1 to 3 miles wide trending northwestward through the quadrangle. The band conforms remarkably well to a similar area within which the basal shale is either abnormally thin or absent (fig. 28). This relation suggests that the basal shale has been partly removed by erosion and that the deepest topographic irregularities were then filled with the No. 1 sandstone.

The relations between the various units of the Lakota formation shown on plate 14 suggest that the dissection of the basal shale began before folding of the No. 1 sandstone.

Interbedded sandstone and mudstone

A heterogeneous unit composed of alternating tabular beds of sandstone, siltstone, and mudstone overlies the No. 1 sandstone and underlies the No. 2 sandstone. The unit is gradational and interfingers with the No. 1 sandstone. In general outline the unit is a northwest-elongated lens and ranges in thickness from 0 to 150 feet (fig. 30). The individual beds normally range in thickness from less than 1 to about 10 feet. Because of the lack of thick resistant beds these rocks are not as well exposed as the overlying and underlying sandstones. One of the best exposures of this unit is on the west side of Red Canyon and just north of the junction of Red and Craven Canyons.

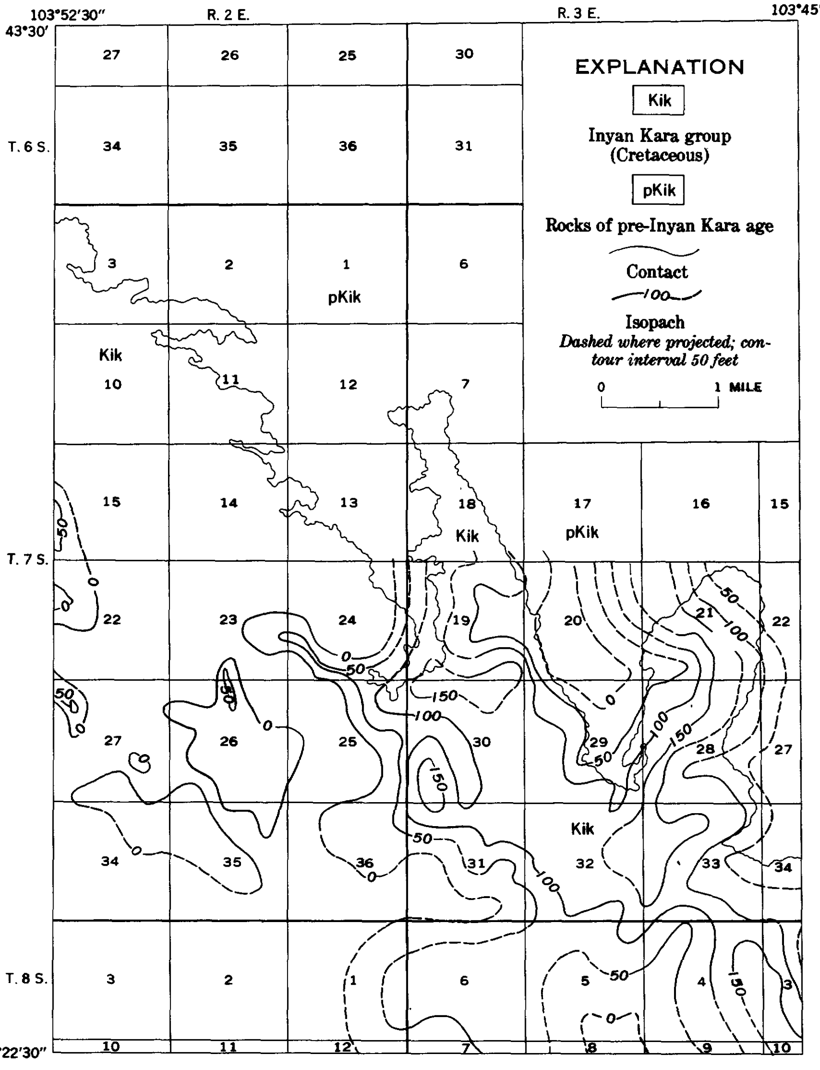

FIGURE 30.—Isopach map of interbedded sandstone and mudstone in the Chilson member of the Lakota formation, Edgemont NE quadrangle.

A measured section at this locality is in the NE¼NW¼NE¼ sec. 5, T. 8 S., R. 3 E.

	Description	Thickness (feet)
	Overlain by No. 2 sandstone not measured; very fine grained, massive, mottled with streaks and spots of red, maroon, green, and white.	
	Interbedded sandstone and mudstone unit:	
1.	Siltstone, sandy, hard, brittle. Prominent maroon band one inch thick at top	1.0
2.	Siltstone and claystone, green, gray, and maroon	5.0
3.	Mudstone, gray, slightly silty	11.0
4.	Limestone, medium-gray, dense. Conchoidal fracture. Overlain by 1-in.-thick bed of fibrous gypsum	.5
5.	Mudstone, gray, silty	3.0
6.	Limestone, light-gray, lumpy, gypsiferous	.5
7.	Mudstone, gray, silty	2.5
8.	Sandstone, fine-grained, spotted with yellowish-brown iron oxide stain	1.0
9.	Alternating beds of fine-grained sandstone and brown to dark-gray papery shale	2.5
10.	Shale, fissile, brownish-gray	.5
11.	Sandstone, yellowish-gray, fine-grained	.5
12.	Siltstone, dark-gray, platy in part	1.5
13.	Sandstone, fine-grained, light-gray with brownish-yellow iron oxide stained bands	.5
14.	Mudstone	1.5
15.	Sandstone, very fine grained, sparse carbonaceous specks	1.0
16.	Sandstone, fine-grained, calcareous, gypsiferous. Contains tiny dark granules concentrated along bedding planes	1.5
17.	Siltstone, coarse, stained with iron oxide	1.0
18.	Mudstone, gray, silty. Contains two resistant siltstone layers	3.0
19.	Sandstone, fine-grained, very calcareous, carbonaceous specks	2.0
20.	Covered	10.0
21.	Sandstone, medium-grained, slight brown iron oxide stain, many black accessory minerals, few white clay grains	3.0
22.	Mudstone	.5
23.	Covered	8.0
24.	Mudstone	.5
25.	Sandstone, fine-grained, little iron oxide stain	.5
26.	Mudstone, dark-gray, silty, some yellow iron oxide stain	1.0
27.	Sandstone, fine-grained, argillaceous, irregularly stained with iron oxide, carbonaceous	3.0
28.	Shale, dark-gray, laminated	2.0
29.	Alternating beds of siltstone and claystone	6.5
30.	Sandstone, very fine grained	1.0
31.	Shale, dark-gray, laminated	5.0
32.	Siltstone, grayish-yellow	4.0
33.	Sandstone, very fine grained, irregularly stained with iron oxide. Contains two thin mudstone beds	4.0
34.	Alternating beds of siltstone and mudstone	6.5
	Total	95.5

No. 1 sandstone

The interbedded sandstone and mudstone unit is almost entirely restricted to the eastern half of the quadrangle, although cores from drill holes in the western part indicate that the unit is present as isolated patches in that area. In the area west of Craven Canyon, the Fuson member or that Minnewaste limestone member lies on the No. 1 sandstone (pl. 14).

Fish remains and fresh-water ostracodes and gastropods have been found in the rocks of this unit at a few localities. The gastropods and ostracodes seem to indicate a lacustrine environment as do the laminated carbonaceous shale, thin horizontally bedded carbonaceous siltstone, limestone and tabular sandstone. The interfingering relations of the unit with the No. 1 sandstone, however, indicate that it largely was deposited on a flood plain contemporaneously with the sandstone.

No. 2 sandstone

The No. 2 sandstone is most prominently exposed a few miles east of the quadrangle. At Flagpole Mountain near Cascadė Springs the sandstone is about 435 feet thick and is immediately below the Minnewaste member. The No. 2 sandstone cannot, with certainty, be traced from the area where it is best exposed into the Edgemont NE quadrangle because of lack of exposures. A prominent sandstone in the southeastern part of the Edgemont NE quadrangle, however, has been correlated with the No. 2 sandstone on the basis of similarity of stratigraphic position and physical characteristics. Where it is best exposed in the Edgemont NE quadrangle it is the first prominent sandstone above the No. 1 sandstone and is subjacent to a white massive sandstone in the basal part of the Fuson member (pl. 14).

The No. 2 sandstone is of fluviatile origin but is in gradational contact with overlying rocks that have predominantly nonfluvial characteristics. It is best developed in the southeastern part of the quadrangle where it has a maximum thickness of about 75 feet. From this area it thins westward and apparently is absent on the west side of Craven Canyon beyond the center of sec. 36, T. 7 S., R. 2 E. (fig. 31).

The sandstone is light gray to white, well sorted, and is predominantly fine grained, but locally it is coarser textured. It is variously crossbedded, horizontally bedded, and massive. The crossbedding is erratic but generally dips in an easterly direction. Locally nodular-like calcium carbonate cement is abundant, resulting in the sandstone having a rough, warty appearance on a weathered surface. Angular white grains of clay concentrated along the bedding planes are common. Streaks and spots of red, pink, yellow, and brown stains are abundant. These stains, together with varicolored lenses of mudstone within the sandstone and much red, green, and pink interstitial clay

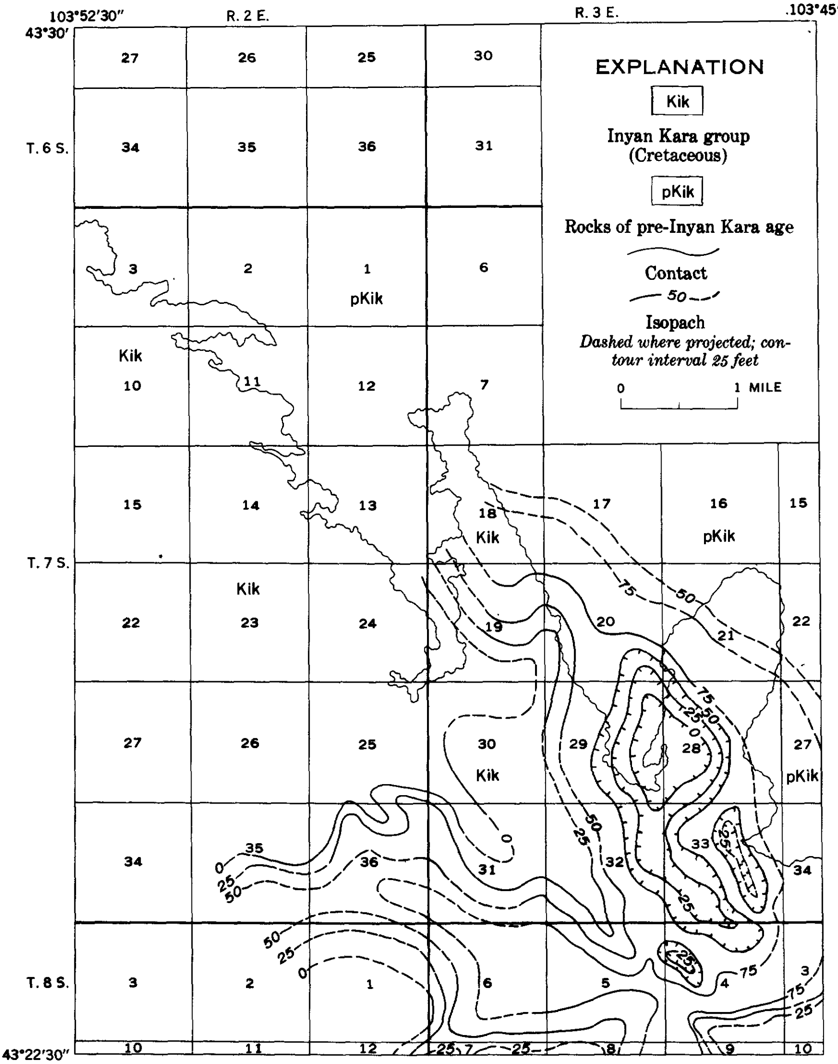

FIGURE 31.—Isopach map of the No. 2 sandstone of the Chilson member of the Lakota formation, Edgemont NE quadrangle.

impart to it, in places, a subdued varicolored appearance. Carbonaceous material is very sparsely present in a few places.

MINNEWASTE LIMESTONE MEMBER

The Minnewaste member is apparently restricted to the southern part of the Black Hills. It was described by Darton as "* * * a nearly pure light gray limestone presenting a uniform character throughout" (Darton, 1901, p. 529). This limestone is present in secs. 3 and 10, T. 7 S., R. 2 E., and has been observed in drill core in the vicinity of secs. 6 and 7, T. 8 S., R. 3 E., but elsewhere within the quadrangle it is either absent or is unrecognizable (fig. 32). In sec. 10, it attains a maximum thickness of about 20 feet and thins rapidly toward the southeast. Locally it is a lithographic limestone, but in most places it is a sandy limestone or even a calcite-cemented sandstone. A few fresh-water sponge spicules have been found in the limestone.

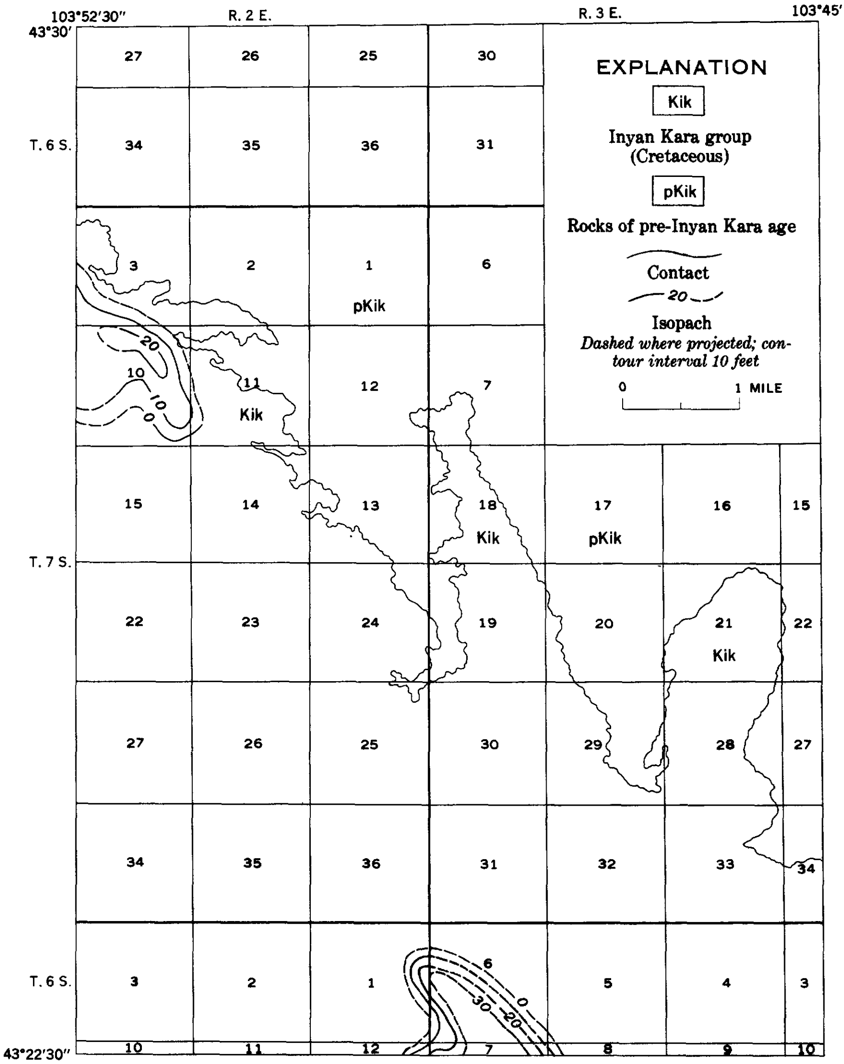

FIGURE 32.—Isopach map of the Minnewaste limestone member of the Lakota formation, Edgemont NE quadrangle.

Where the No. 2 sandstone and the underlying interbedded sandstone and mudstone are absent, the Minnewaste member rests directly on the No. 1 sandstone and in some places it appears to intertongue with variegated mudstone. It underlies a prominent white massive sandstone in the basal part of the Fuson member in the only place that the age relation of these two units could be observed. The lenticular nature of the limestone and the presence of fresh-water sponge spicules indicate that the limestone is lacustrine in origin.

FUSON MEMBER

General features

The Fuson member is a tabular body composed of clay, silt, and sand. In the Edgemont NE quadrangle the unit is characterized by variegated clay and silt, by a white massive structureless sandstone that is normally present near the base of the member, and by a medium- to coarse-grained channel sandstone locally present at the top. Where present the top of the Minnewaste member defines the base of the Fuson. This limestone, however, is restricted to a relatively small area in the southern Black Hills and in the Edgemont NE quadrangle is present only in isolated patches. Beyond the limits of the Minnewaste member the Fuson member is underlain by the No. 2 sandstone, the interbedded sandstone and mudstone, and by the No. 1 sandstone (pl. 13). The top of the member is limited by the base of the carbonaceous sandstone and siltstone unit or the No. 5 sandstone, both of the Fall River formation. Except for the channel sandstone at its top the thickness and distribution of the member are shown on figure 33.

White massive sandstone

The white massive sandstone near the base of the Fuson member was probably deposited contemporaneously with parts of the variegated mudstone in the upper part, but because the sandstone is one of the most easily recognized units in the Inyan Kara group, it has been mapped as a separate unit. Its spatial relation with the adjacent units is graphically represented on plate 14 and its thickness and distribution are shown on figure 34.

The sandstone is white, sugary textured, and contains little or no bedding. Because of the lack of bedding, it weathers to large mammillary masses. This type of weathering and its strikingly light color make it a conspicuous sandstone, particularly in the area between Red Canyon and Coal Canyon where it is thickest.

The sandstone ranges from 0 to about 100 feet in thickness with the thickest part forming a narrow band parallel to its northeast edge. It forms a lens elongate to the northwest from near the southeast corner of the quadrangle to the middle part of the western boundary.

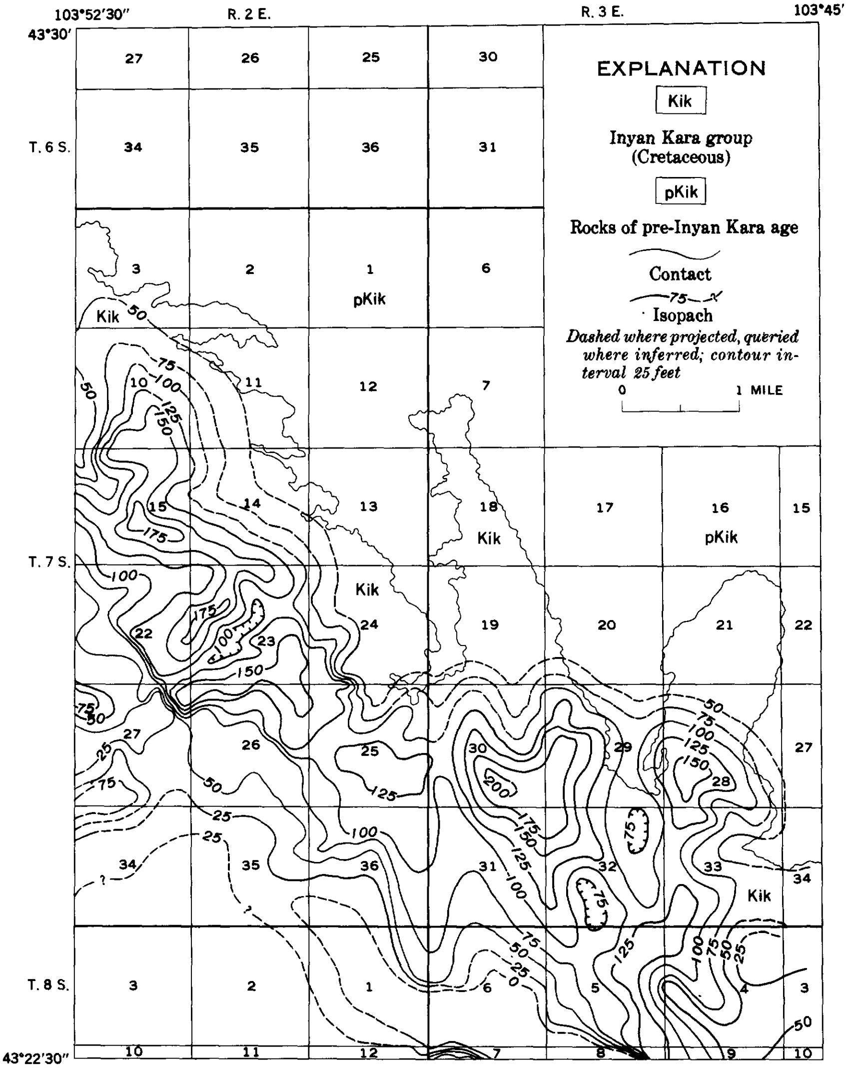

FIGURE 33.—Isopach map of the Fuson member, exclusive of the No. 4 sandstone, of the Lakota formation, Edgemont NE quadrangle.

Detailed mapping in the Flint Hill quadrangle to the southeast indicates that the sandstone is not consistently present beyond the limits of the Edgemont NE quadrangle. It does, however, continue westward across the Burdock quadrangle to where it is buried by younger rocks.

The sandstone is fine to very fine grained, well sorted to argillaceous, homogeneous, nearly structureless, noncarbonaceous, and in many

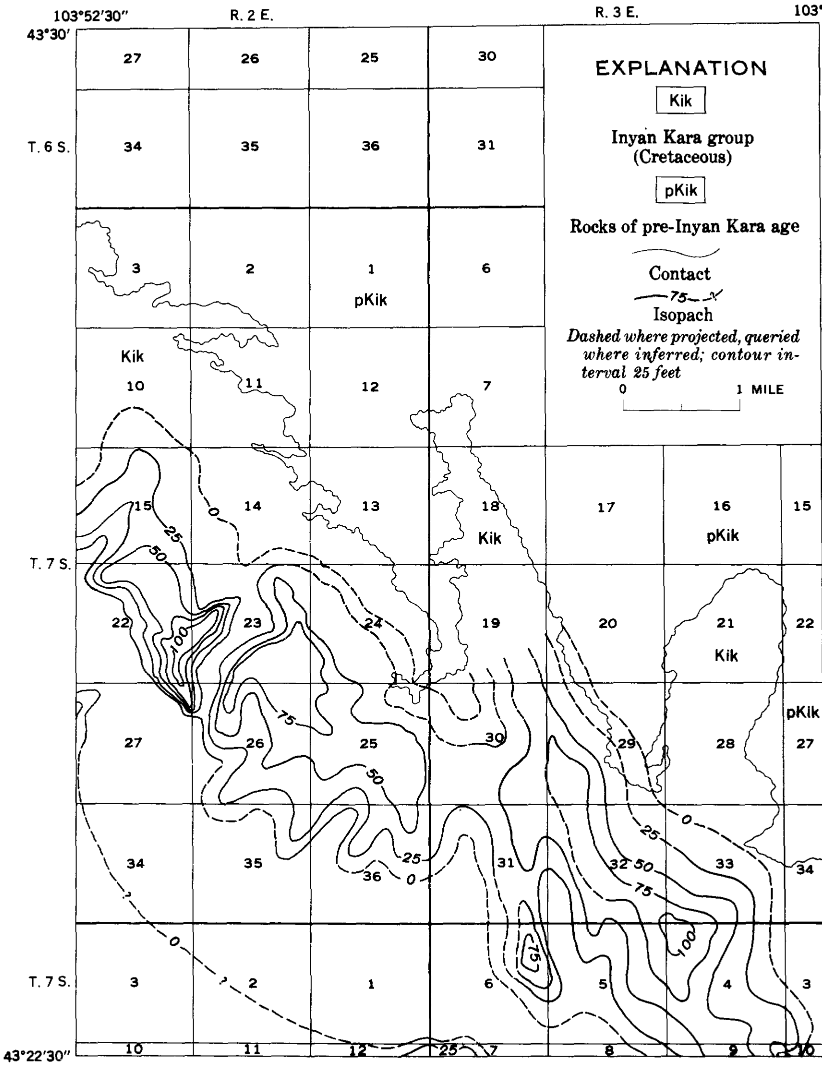

FIGURE 34.—Isopach map of a white massive sandstone in the Fuson member of the Lakota formation, Edgemont NE quadrangle.

places is mottled and streaked with red, pink, and yellow iron oxide stains.

Normally the sandstone is overlain by variegated mudstone and claystone. In places, however, both the variegated mudstone and the sandstone are truncated by the No. 4 channel sandstone. This truncation can best be seen along the west quadrangle boundary where the rocks are well exposed just north of the quarter corner between secs.

21 and 22, T. 7 S., R. 2 E. Another locality at which this relation can be seen is near the south quadrangle boundary along the west side of Red Canyon in the NW¼NE¼ sec. 8., T. 8 S., R. 3 E.

From Craven and Red Canyons east to the quadrangle boundary the basal white massive sandstone, where present, is underlain by the No. 2 sandstone; a red or maroon mudstone locally separates the two units. In the Coal Canyon area the No. 2 sandstone is not present, and the white massive sandstone is underlain by a sequence of variegated but predominantly greenish gray siltstone interbedded with thin white fine-grained sandstone. The sandstones are generally not more than 2 or 3 feet thick and have the reddish mottling and massive characteristics of the white massive sandstone. These beds are collectively about 50 feet thick and seem to have been deposited under conditions similar to those under which the white massive sandstone was deposited.

The high degree of sorting of the sand grains, and the scarcity of bedding, particularly of crossbedding, suggest that the sandstone is of nonfluviatile origin, and perhaps represents a lacustrine deposit. The underlying sequence of siltstone and thin sandstone in the Coal Canyon area, as well as the underlying red and maroon mudstone, is probably a facies of the white massive sandstone.

Variegated mudstone

The variegated mudstone varies in thickness but a large part of this variation is the result of erosion after mudstone deposition and before the No. 4 sandstone was deposited. It is consistently present except in those areas where it has been completely truncated by the overlying channel sandstone. It ranges from 0 to about 100 feet in thickness and is predominantly composed of red, maroon, and gray claystone; but in places light-green or greenish-gray siltstone and white, very fine grained sandstone are present. Its approximate thickness and distribution combined with those of the white massive sandstone are shown in figure 33. The few exposures that exist in this area indicate that the mudstone is predominantly massive but locally it is horizontally bedded. It is noncarbonaceous although silicified tree trunks, some as large as 3 feet in diameter, have been found in this unit.

Highly polished rounded chert pebbles as much as 3 inches in diameter occur sporadically in the mudstone and on its weathered surface. Similar pebbles have been observed in other places on the mudstone slopes of the Fuson in the southern Black Hills.

Small spherulitically shaped, brown or yellowish-brown grains generally occur in the upper 5 feet of the mudstone where it is directly overlain by the Fall River formation. Waagé (1959) has identified these grains as manganosiderite and concluded that they were formed as a result of weathering on the pre-Fall River surface.

The homogeneity and high degree of sorting of the mudstone of the Fuson suggest that it may have been deposited as a loess or under quiet water, perhaps lacustrine, conditions. Lakes, however, ordinarily support an abundance of aquatic organisms that would result in the deposition of enough organic material to reduce the iron oxide and, thus, eliminate the red and maroon colors. In any event the area returned to a subaerial, and, therefore, an oxidizing environment during the period of extensive channeling immediately following the deposition of the mudstone. It is possible, therefore, that partial oxidation of the iron occurred after deposition of the mudstone.

No. 4 sandstone

The No. 4 sandstone, at the top of the Fuson member, fills a northwestward-trending scour that is buried beneath younger rocks to the southeast of the quadrangle and has been removed by erosion to the northwest. It is intermittently exposed within a narrow sinuous band extending from the Cheyenne River in the southern part of the Flint Hill quadrangle to beyond Pilger Mountain in the southeastern part of the Jewel Cave SW quadrangle.

The No. 4 sandstone is a fine- to medium-grained, locally conglomeratic, light yellowish-gray, noncarbonaceous sandstone that was deposited in a channel cut into the underlying mudstone and sandstone of the Fuson. A mudstone facies of the sandstone is locally present at the top of the unit. The unit is overlain by interbedded siltstone and sandstone unit, or by the No. 5 sandstone both of Fall River age.

The overlying varicolored mudstone is poorly exposed nearly everywhere, but it appears to be similar in appearance and composition to the variegated mudstone of the Fuson member within which the No. 4 sandstone is entrenched. The upper mudstone probably represents a reworked part of the mudstone of the Fuson member and, therefore, probably is part of the channel fill.

The No. 4 sandstone fills an elongate trough trending northwestward from the southeast corner of the quadrangle to about the middle of the west quadrangle boundary (fig. 35). The sandstone reaches a maximum thickness of about 150 feet in the deepest part of the channel and thins rapidly toward the northeast and southwest margins. The base of the sandstone rests unconformably on the underlying rocks (pl. 13). The downcutting relation between the sandstone and the older rocks can best be seen along the west quadrangle boundary where the rocks are well exposed just north of the quarter section corner between secs. 21 and 22, T. 7 S., R. 2 E. Truncation of older rocks by the sandstone can also be seen just north of the south quadrangle boundary on the west side of Red Canyon.

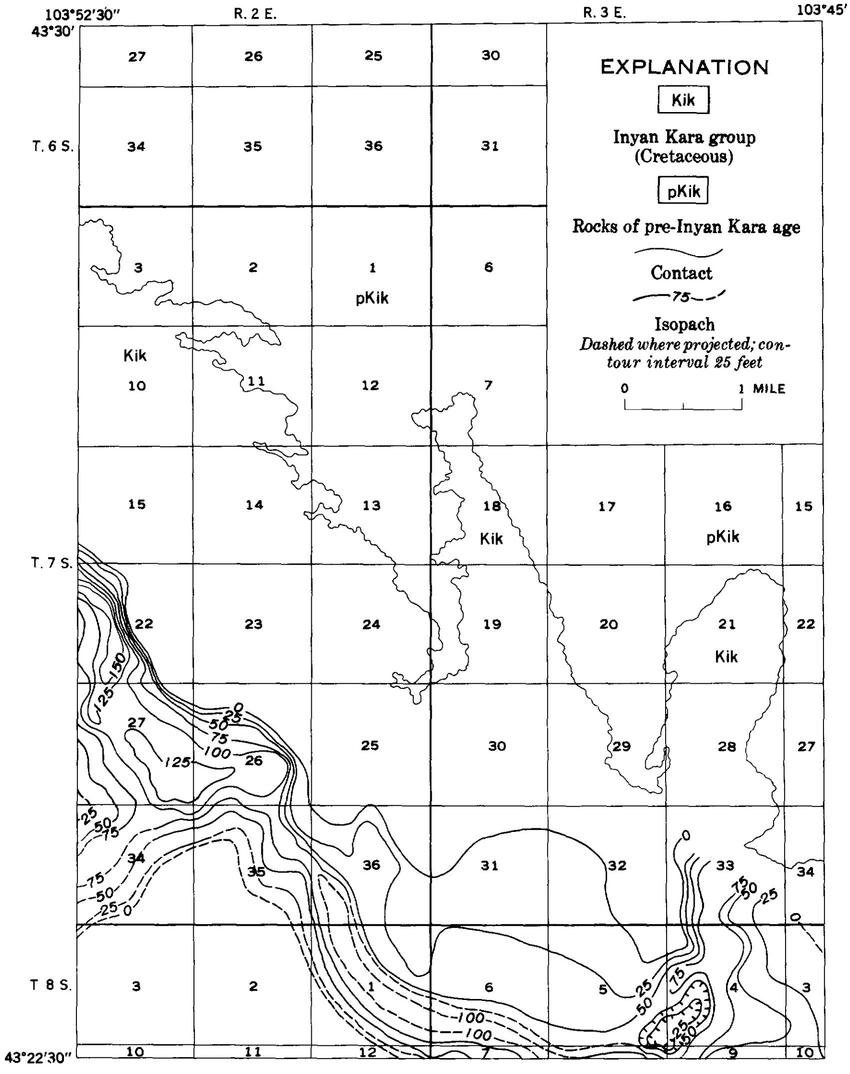

FIGURE 35.—Isopach map of the No. 4 sandstone, Fuson member, Edgemont NE quadrangle.

The No. 4 sandstone is characterized nearly everywhere by cross-lamination in the form of parallel sets of foreset beds separated by thin horizontal beds. The individual sets range from about 8 to about 36 inches in thickness and average about 18 inches. The foreset strata dip generally toward the northwest and always in a direction parallel to the trend of the thickest part of the channel. In some places the cross-laminations in the upper part of a set of crossbeds are overturned to form a V pointing in the upstream direction. This phenomenon has been attributed to intraformational sliding.

In places, particularly along the west side of the quadrangle near the junction of Coal and Driftwood Canyons and in the subsurface along the southern part of the quadrangle, the sandstone is heavily cemented with calcium carbonate. Locally the carbonate impregnates the whole sandstone mass and commonly forms rounded nodules which range in diameter from about one-sixteenth of an inch to as much as 4 inches. The nodules weather as rounded forms giving the surface of the rock a knobby appearance.

FALL RIVER FORMATION

GENERAL FEATURES

The Fall River formation averages about 135 feet in thickness. It is composed of carbonaceous interbedded siltstone and sandstone, channel-filled sandstones, and a sequence of interbedded sandstone and mudstone.

The base of the Fall River formation rests on a surface that appears to have beveled the No. 4 sandstone and the variegated mudstones of the Fuson member. This beveling, if considered on a regional scale, suggests that the pre-Fall River surface had been reduced nearly to base level (pl. 14). It also suggests that the volume of older rocks removed during this period of beveling was greatest on the pre-Fall River anticlinal folds. Throughout most of the Edgemont NE quadrangle and the southern Black Hills the base of the formation is easily recognized. For this reason it is one of the most reliable reference lines in the Inyan Kara group.

The top of the formation is poorly exposed, but appears to be gradational with the overlying Skull Creek shale. The boundary between these two formations has been drawn so that the predominantly silt- and sand-size clastic material is included in the Fall River formation and the clay-sized particles are included in the Skull Creek shale.

CARBONACEOUS INTERBEDDED SILTSTONE AND SANDSTONE

The oldest unit in the Fall River formation in the Edgemont NE quadrangle is composed of interbedded carbonaceous siltstone and sandstone. Except for those places where it was removed by erosion before deposition of the No. 5 sandstone the unit is apparently continuous over several hundred square miles in the southern part of the Black Hills.

The unit consists of dark, carbonaceous siltstone interbedded with fine-grained, light yellowish-brown sandstone. It is generally 20 to 50 feet thick except where it is truncated by the No. 5 sandstone. The sandstones within the unit average less than 5 feet in thickness.

The top of the unit is locally difficult to distinguish from the overlying mudstone and sandstone that is a fine-grained equivalent of the No. 5 sandstone. The result is that the thickness of the siltstone and sandstone appears to be variable over a short distance. For this reason the top contact as shown on plate 12 should be considered as an approximation.

The characteristically tabular beds, and the high content of fossil plant material of these rocks suggest that they were probably deposited in a marshy or swampy environment.

Several uranium deposits have been mined from this unit, particularly in and adjacent to sec. 26, T. 7 S., R. 2 E.

NO. 5 SANDSTONE AND ITS FINE-GRAINED FACIES

Before deposition of younger beds the basal siltstones and sandstones were partly dissected. The erosional irregularities were then filled by fluvial sandstone. This sandstone represents the oldest part of the No. 5 sandstone complex. After the erosional irregularities were filled the streams continued to flow northwestward across the area and additional sand was deposited. At the same time a lateral facies of the No. 5 sandstone was deposited over the basal siltstone and sandstone sequence. This facies is composed of alternating thin beds of sandstone and mudstone with a minor amount of sandstone and siltstone and represents the flood-plain deposits marginal to the principal streams.

The No. 5 sandstone is a thick cliff-forming sandstone complex. It ranges in thickness from 0 to a little more than 100 feet. The general distribution of the sandstone is shown on figure 36. As illustrated by the isopachs in the southern part of the quadrangle the sandstone appears to occupy two confluent channels. Cross-laminations in the sandstone suggest that the streams were flowing predominantly in a northwesterly direction.

Generally the No. 5 sandstone is fine grained to medium grained, is light-yellowish gray, and weathers to intermediate shades of yellow and brown. It contains abundant mica and numerous iron-manganese concretions. Locally the sandstone is heavily stained with red or yellow iron oxides and in general is darker than the Lakota sandstones. In places the sandstone is cemented with calcium carbonate forming concretions as much as 15 feet in diameter.

The lateral facies of the No. 5 sandstone constitute a variable sequence consisting principally of thin beds of light-gray, sparsely carbonaceous mudstone interlayered with thin, platy, light brownish-gray sandstone. The sandstones interfinger with the No. 5 sandstone, are normally tabular in appearance, on the average are less than 5 feet

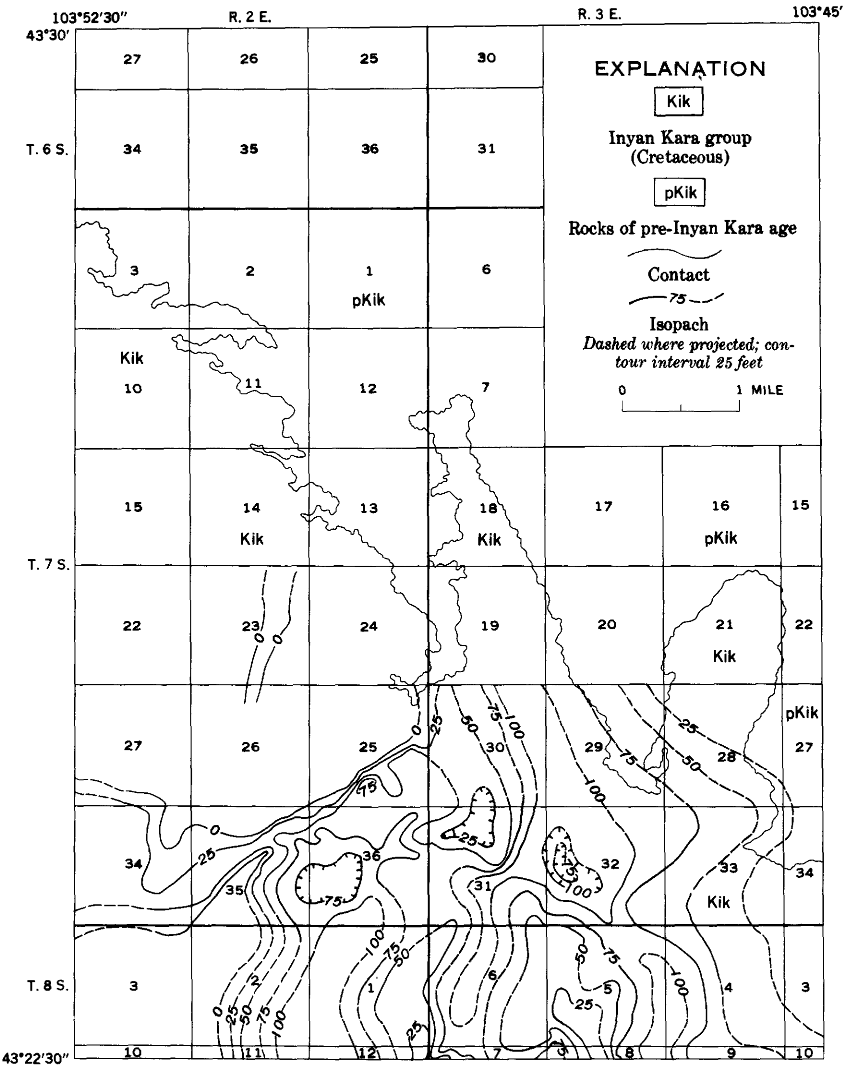

FIGURE 36.—Isopach map of the No. 5 sandstone, Fall River formation, Edgemont NE quadrangle.

thick, and are light yellowish brown and fine to medium grained. Mica is conspicuously abundant and in many places the sandstones are heavily cemented with iron oxides.

VARIEGATED MUDSTONE

The variegated mudstone overlies the No. 5 sandstone and the fine-grained flood-plain facies. It underlies a sequence of interbedded sandstone and mudstone that in general appearance resembles the fine-grained facies of the No. 5 sandstone. In the Edgemont NE quadrangle the variegated mudstone is highly argillaceous and ranges from predominantly red to predominantly gray but generally it is red and gray mottled. The mudstone ranges in thickness from about 10 to about 30 feet except in a few places where it has been truncated by a sandstone in the overlying unit. Where it can be recognized it serves as a useful marker bed.

The physical characteristics of the mudstone resemble those of the variegated mudstone of the Fuson member. Its color and degree of oxidation suggest either a change in the depositional environment or a period of quiescence during which time the surface rocks were oxidized.

INTERBEDDED SANDSTONE AND MUDSTONE

That part of the Fall River formation between the variegated mudstone and the base of the Skull Creek shale is a succession of thin sandstone, siltstone, and mudstone beds. In general appearance the unit is similar to the fine-grained facies of the No. 5 sandstone. The thinly tabular nature of the alternating sandstone and mudstone unit results in a uniform resistance to weathering and erosional processes. The unit, therefore, forms a gently sloping, grass-covered surface virtually parallel to the dip. The thickness is difficult to measure but probably ranges from 20 to 40 feet within the outcrop area.

The ratio of sand-, silt-, and clay-sized material varies greatly. In some places the unit is composed chiefly of sandstone containing very thin laminae of mudstone or siltstone separating the individual beds. In other places it is composed chiefly of mudstone and siltstone separated by thin sandstone beds. Locally a sandstone in the upper part of the unit truncates the underlying beds down to the No. 5 sandstone.

SKULL CREEK SHALE

The Skull Creek shale of Early Cretaceous age has been eroded from within the boundaries of the quadrangle except for a few patches in the southern and southwestern part. A maximum of 40 feet of the shale is exposed within this area. It is a black fissile shale, apparently of marine origin, that contains abundant secondary gypsum near its base. A thin lenticular sandstone about 30 feet above the base shows well-developed cone-in-cone structure.

TERTIARY ROCKS

WHITE RIVER(?) FORMATION

Unconsolidated gravel deposits, designated by Darton and Smith (1904) as the basal White River formation of Oligocene(?) age, rest in part on the Skull Creek shale and in part on the Fall River formation along the west side of Craven Canyon. Limestone fragments constitute 75 to 80 percent of the gravel with the remainder being largely made up by chert and sandstone fragments. Feldspar and quartz are also sparsely present. The gravel contains large angular blocks of sandstone that have been derived from the Fall River formation. A few of the reworked Fall River sandstone fragments contain secondary yellow uranium minerals. The composition of the gravel is similar to deposits elsewhere within the quadrangle that have been mapped as Quaternary in age.

QUATERNARY ROCKS

TERRACE GRAVELS

Over much of the Edgemont NE quadrangle topographic prominences are covered with comparatively thick gravel deposits. Gravel terraces are also present along many of the stream valleys, although in many places these terraces are poorly developed or have been largely removed by erosion.

The terrace gravels are composed chiefly of material derived from the Paleozoic and Precambrian formations exposed to the north. Limestone is the predominant rock type but a few percent of Precambrian igneous and metamorphic fragments are also present (table 6).

ALLUVIUM

Alluvial terraces occur along many of the streams in the Edgemont NE quadrangle but they are particularly conspicuous along Red Canyon where four sets have been developed. The lower terrace is 5 to 10 feet above the flood plain, and the other three are from 10 to 20 feet high. The flood-plain alluvium is generally very fine grained, although locally comparatively large fragments of rock form the bulk of the deposit. The alluvium usually reflects the composition of the rocks that are exposed slightly upstream from where it is being deposited. The thickness of the alluvial fill has not been determined except near the mouth of Coal Canyon where a drill hole penetrated about 40 feet of this material.

TALUS AND LANDSLIDE

Most of the steep slopes along the valleys in the Edgemont NE quadrangle are covered with thick deposits of talus and many show evidence of landslides of varying sizes. A large proportion of the talus and landslide debris has been derived from the Nos. 1 and 5 sandstones so that much of the soft mudstone under these units is concealed.

STRUCTURE

The Edgemont NE quadrangle is along the slightly deformed southwest margin of the Black Hills uplift. The structural deformation of the rocks within the quadrangle is illustrated on plate 12. The regional dip is about 3° SW., but on the westward-dipping monocline in the southeastern part of the quadrangle the maximum dips are about 20°. Small anticlinal folds occur in the northwestern and northeastern parts of the quadrangle. Elsewhere the structural irregularities consist of a steplike series of terraces and monoclines of low relief. Several small faults exist, all have a displacement of less than 100 feet, and many have a displacement ranging from 10 to 25 feet. One nearly vertical joint system striking N. 20° W. predominates within the quadrangle. One and perhaps two minor nearly vertical joint systems strike in a northeasterly direction (fig. 37).

Most of the folding occurred during post-Fall River time and as a result of the Black Hills uplift. Discordance of the attitude of the base of the Fall River formation with all the major units of the Lakota formation, however, indicates that some of the folding had occurred before the end of Lakota time. For purposes of illustrating the probable time and degree of the pre-Fall River folding a series of cross sections has been drawn using the top of each major lithologic unit in the Lakota formation as a reference plane (pl. 14). It is evident from these cross sections that a significant amount of folding had occurred before the end of Lakota time. One drill hole located on the anticline near the west end of the cross sections penetrated the Morrison formation and the underlying Redwater shale member of the Sundance formation. At that point the Morrison formation is 100 feet thick, an average thickness for the formation within the area of this quadrangle. This thickness indicates that there was little, if any, post-Morrison and pre-Lakota erosion and, therefore, little, if any, folding prior to the beginning of Lakota time. Folding evidently continued through Lakota time resulting in a pronounced depositional and structural trough in the eastern part of the quadrangle. After deposition of the Fall River formation, presumably at the end of Cretaceous time, the Black Hills area was uplifted and the folding accompanying the uplift was superimposed on the pre-Fall River structure.

Folding in Lakota time probably influenced the major drainage and, as a consequence, influenced the distribution of the subunits of the Lakota formation. Figures 28–36 show that the axial lines of all the subunits of the Lakota formation are oriented northwestward, and this suggests that the Lakota deformation resulted in a structural pattern that was similarly oriented. As the inferred orientation of the Lakota folds is parallel to the present axis of the Black Hills uplift

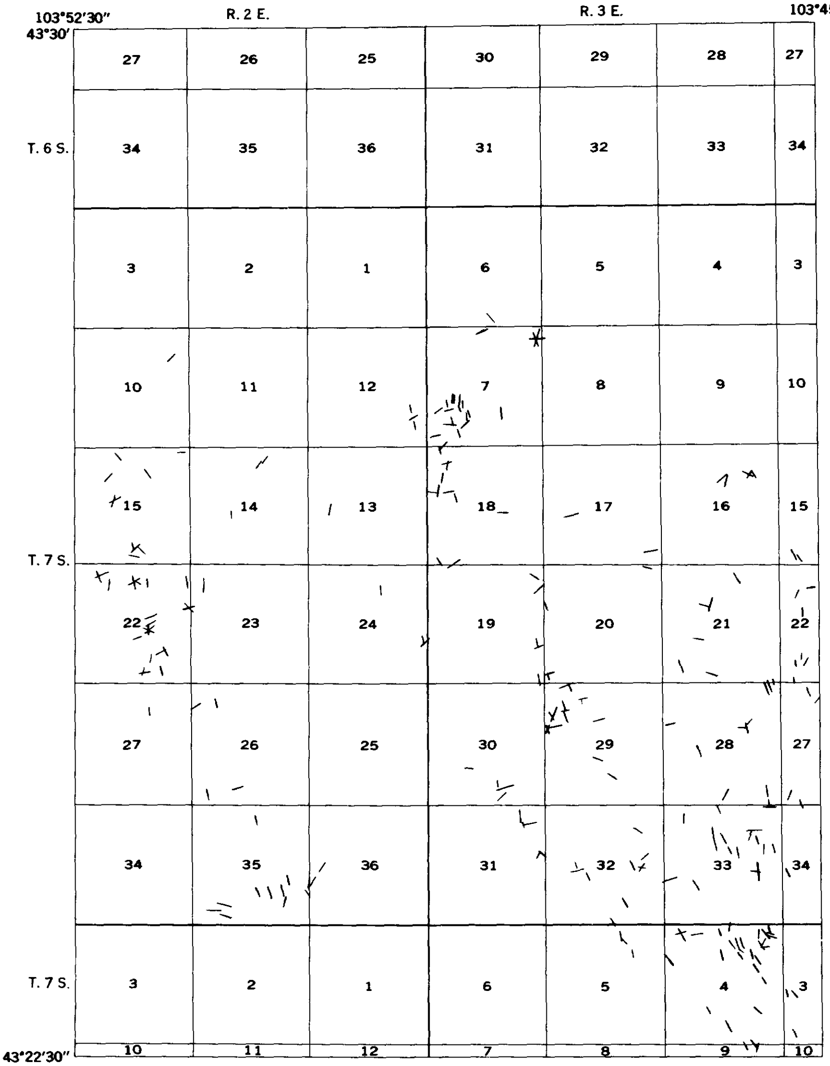

FIGURE 37.—Joint pattern, Edgemont NE quadrangle. (Ninety percent or more of the joints dip from 85° to 90°. Each symbol represents the orientation of a set of joints.)

it is probable that uplift of the Black Hills area started as early as Lakota time.

In areas adjacent to the Edgemont NE quadrangle approximately the upper 250 feet of the Minnelusa formation consists of a coarse sheet breccia and numerous breccia pipes (C. G. Bowles, oral communication, 1958). The brecciation was caused by the solution and removal of extensive anhydrite or gypsum beds in the upper part of the Minnelusa formation. The removal of these beds resulted in subsidence accompanied by brecciation of overlying and associated rocks. The breccia pipes are relatively small cylindrical-shaped structures formed by the subsidence of overlying rocks into the sheet breccia.

Several structures that are similar to the breccia pipes in the Minnelusa formation are exposed in the Edgemont NE quadrangle. They are best exposed in secs. 7, 8, 15, and 16, T. 7 S., R. 3 E., where slightly brecciated calcareous masses of Canyon Springs sandstone are embedded in the Spearfish formation as much as 100 feet below their normal stratigraphic position.

It is probable that many faults of small displacement and short extent are also the result of subsidence following solution of the underlying rocks. Particularly, many of the faults that are shown on plate 12 in secs. 7, 17, and 18, T. 7 S., R. 3 E., probably originated in that manner.

ECONOMIC GEOLOGY

URANIUM DEPOSITS

The first discovery of a commercial uranium deposit in the southern Black Hills was in 1951 in Craven Canyon (NW¼ sec. 30, T. 7 S., R. 3 E.) (Page and Redden, 1952). Since 1951 many deposits ranging from a few tons to more than 50 thousand tons have been discovered within an area of about 50 square miles (pl. 15). The area has become known as the Edgemont mining district.

Soon after the beginning of mining activities the U.S. Geological Survey started a program to study the geology and uranium deposits of the district. The ore deposits were studied by various members of the Geological Survey, principally L. R. Page, W. A. Braddock, N. P. Cuppels, V. R. Wilmarth, and F. R. Shawe. This report will include only such information relative to the ore deposits as has been obtained by the writers during the process of mapping the geology of the Edgemont NE quadrangle.

MINERALOGY AND OCCURRENCE OF THE DEPOSITS

The ore deposits are composed of tabular-shaped bodies of sandstone that have been partly impregnated with uranium and vanadium minerals. The ore minerals contain variable amounts of vanadium with respect to uranium (table 4). This variation in the relative abundance of vanadium has apparently controlled the mineralogy of the oxidized and partly oxidized deposits. The deposits that contain the highest vanadium/uranium ratios contain abundant purplish-black and reddish-brown uranium and vanadium minerals whereas those deposits that have low vanadium/uranium ratios contain only the yellow uranyl vanadates as important ore mineral constituents. Because of the color variations of the ore minerals it is convenient to classify the deposits as yellow, purplish-black, and black ores. Inasmuch as the color of the ore minerals is largely dependent on their oxidation state the deposits can be considered respectively as oxidized, partly oxidized, and unoxidized.

TABLE 4.—*Uranium and vanadium minerals known to occur in the ore deposits of the Edgemont NE quadrangle*

Mineral	*Chemical composition*
Carnotite	$K_2(UO_2)_2V_2O_8 \cdot 1\text{–}3H_2O$
Coffinite	$U(SiO_4)_{1-x}(OH)_{4x}$
Corvusite	$V_2O_4 \cdot 6V_2O_5 \cdot nH_2O$
Häggite	$V_2O_3 \cdot V_2O_4 \cdot 3H_2O$
Hewettite	$CaV_6O_{16} \cdot 9H_2O$
Metahewettite	$CaV_6O_{16} \cdot 3H_2O$
Hummerite	$K_2Mg_2V_{10}O_{28} \cdot 16H_2O$
Metatyuyamunite	$Ca(UO_2)V_2O_8 \cdot 3\text{–}5H_2O$
Paramontroseite	VO_2
Rauvite	$CaO \cdot 2UO_3 \cdot 5V_2O_5 \cdot 16H_2O$
Tyuyamunite	$Ca(UO_2)V_2O_8 \cdot 5\text{–}8H_2O$
Uraninite	UO_{2+}
Uranophane	$Ca(H_3O)_2(UO_2)_2(SiO_4)_2 \cdot 3H_2O$

The predominant minerals in the yellow ores are carnotite, tyuyamunite, and metatyuyamunite but autunite and uranophane have been found in small quantities. The mineralogy of the purplish-black ores is somewhat more complex than is the mineralogy of the yellow ores. The purplish-black ores also contain carnotite and tyuyamunite but in addition they contain enough corvusite and rauvite, along with small amounts of hewettite, to give the ores a purplish-black or reddish-brown color. The black ore minerals are uraninite, coffinite, häggite and paramontroseite. They represent the mineral suite from which the purplish-black and yellow ore minerals have been derived by oxidation.

The ore deposits in the Edgemont NE quadrangle are restricted to four stratigraphic units. These units are the basal carbonaceous sandstone and siltstone of the Fall River formation, Nos. 1 and 4 sandstones of the Lakota formation, and No. 5 sandstone of the Fall River formation. The oxidized yellow ores occur in the No. 1 sandstone; the partly oxidized purplish-black ores occur in the interbedded sandstone and siltstone in the basal part of the Fall River formation; and the one known unoxidized black ore deposit within the quadrangle occurs within the No. 4 and No. 5 sandstones. All the ore-bearing units continue with no discernible lithologic change beyond the boundaries of the quadrangle.

YELLOW ORES

The yellow ores are characterized by an abundance of the yellow ore minerals carnotite, tyuyamunite, and metatyuyamunite; and by the absence or scarcity of the purplish-black minerals corvusite, rauvite, and hewettite. The yellow minerals occur with variable amounts and proportions of calcite, iron oxide, carbonaceous material, and clay minerals interstitial to the quartz grains that make up the bulk of the rock. In thin section the yellow uranyl vanadates, calcite, and iron minerals are mutually embayed and corrode the detrital quartz grains.

The ore deposits of this type that have been mined in the Edgemont NE quadrangle are restricted to the No. 1 sandstone. They are particularly abundant in the upper Craven Canyon-northern Long Mountain-Red Canyon area, and near the eastern quadrangle boundary in secs. 28, 33, and 34, T. 7 S., R. 3 E. Carnotite-type ore has been produced from about 25 small mines in this area although occurrences have been observed at about 60 localities.

The yellow ore that has been mined from the Edgemont NE quadrangle is unusually low in vanadium. It has a vanadium-uranium ratio that ranges from 0.25 to 0.68 and averages about 0.4 (table 5). This ratio exceeds the vanadium-uranium ratio in carnotite and tyuyamunite only by a factor of about 2.

TABLE 5.—*Vanadium-uranium ratios of the yellow and purplish-black ores, Edgemont NE quadrangle*

[Locations of deposits shown on MF 39, by Braddock (1955)]

Yellow ores (restricted to No. 1 sandstone)		Purplish-black ores (except as noted these deposits are restricted to the basal part of Fall River formation)	
Mine	V:U	Mine	V:U
B and H No. 2	0. 64	Coal Canyon lode	3. 59
		Coal Canyon No. 1	1. 23
B and H No. 6	. 47	Coal Canyon No. 14	4. 54
Clarabell No. 1	. 40	Dakota Flats	. 85
Clarabell No. 2	. 68	Get Me Rich No. 1	2. 10
Clarabell No. 5	. 48	Get Me Rich Quick	2. 18
Flora	. 34	King	1. 05
Green Acre No. 3	. 61	Lucky No. 1	2. 42
Green Acre No. 4	. 50	Lucky Strike	1. 08
Gertrude	. 35	Pennywitt	1. 75
		Ridge Runner No. 3	2. 8
Hay and Fay	. 38	Ridge Runner No. 4	3. 28
Hot Point No. 1	. 44	Road Hog 1A	1. 84
Hot Point No. 2	. 34	Road Hog 3A	1. 71
Hot Point No. 3	. 39	South View No. 3	1. 43
Little Annie	. 29	South View	1. 30
Lucky Toss	. 33	Taylor	1. 31
Ophelia	. 25	Trail Fraction	1. 40
Pictograph	. 31	Verde	1. 80
Tess	. 54	Virginia C	1. 95
Helen	. 56	Wakan	1. 90
Too Late	. 56	Holdup No. 15—Kados No. 3 (in No. 1 sandstone)	1. 39
Western Edge	. 31		
Lakota No. 11	. 54		

The No. 1 sandstone, in which the oxidized yellow ore occurs, is composed of a complex series of irregularly shaped, crossbedded fine- to medium-grained fluviatile sandstone lenses and variable amounts of clay and silt. Mudstone and alternating beds of mudstone, siltstone, and fine-grained sandstone separate many of the lenses. The sandstone unit has a maximum thickness of about 250 feet and appears to fill a wide, shallow northwestward-trending channel that is 2 to 4 miles wide (fig. 29). Its length is unknown but appears to be at least in the order of tens of miles. Normally it directly overlies the relatively impermeable Morrison formation, but along the margins of the channel it overlies a heterogeneous sequence of carbonaceous shale, mudstone, siltstone, and fine-grained sandstone. The carnotite deposits occur both in the thick central part and along the thin east margin of the sandstone unit.

The No. 1 sandstone contains a large amount of erratically and sparsely distributed carbonaceous material. In some places the uranium minerals are selectively concentrated around carbonized wood fragments and macerated plant remains, but in other places this relation does not exist. Although the association of uranium compounds with carbonaceous material is too frequent to be attributed to a fortuitous set of circumstances, the field relations indicate that factors other than the presence of carbonaceous material are also effective in the localization of the deposits.

Calcium carbonate coats and cements the sand grains in some areas, and is widespread in the No. 1 sandstone in low concentrations. In the yellow uranium ores that have been mined the calcium carbonate content ranges from about 0.1 to about 4 percent and averages less than 1 percent. Locally the ore minerals are concentrated around lenses, pods, and concretions of calcium carbonate-cemented sandstone.

The yellow ores are partly enveloped by an irregularly shaped purplish-pink halo that reflects a hematite stain that impregnates the interstitial clay and coats the individual sand grains. The purplish-pink stained rocks are normally barren, and the characteristic color terminates abruptly against visibly mineralized rock. The stain is so distinctive and so persistently associated with the deposits that it can be used as a prospecting guide.

PURPLISH-BLACK ORES

The most important ore minerals of the purplish-black ores are corvusite, rauvite, and variable proportions of carnotite and tyuyamunite. The uranium and vanadium minerals occur interstitial to the quartz grains of the sandstones. Secondary rims of quartz overgrowth on detrital quartz grains are common, and in the ore deposits of this type the secondary rims and the detrital quartz are normally corroded and embayed by the uranium-vanadium minerals.

The relative abundance of the vanadium minerals, corvusite and rauvite, in the purplish-black deposits is reflected by the relative proportions of vanadium and uranium. The vanadium/uranium ratio in these deposits averages about 2 as compared to an average ratio of about 0.4 in the yellow ore deposits (table 5).

The purplish-black ore deposits contain small amounts of calcium carbonate and pyrite. The acid-soluble minerals, mostly calcium carbonate, range from about 0.1 to 2.5 percent in the ore that has been shipped to the Edgemont buying station. Analyses have not been made to determine whether the country rock contains a similar amount, but none is obvious on the outcrop. Most of the original pyrite has been oxidized but remnants remain in the least oxidized parts of several mines. It is probable that acid solutions resulting from the oxidation of pyrite has dissolved some of the calcite cement. As in the yellow ore deposits, a purplish-pink hematite stain impregnates the country rock adjacent to the ore deposits and terminates abruptly against rock that contains visible uranium and vanadium minerals.

The purplish-black deposits occur in a sequence of alternating fine-grained sandstone and laminated carbonaceous siltstone in the basal 20 to 30 feet of the Fall River formation. The greatest concentrations of ore minerals are in sandstone that is generally less than 5 feet thick. Few deposits of this type have produced more than 5,000 tons of ore.

The ore-bearing unit is a blanketlike sequence that was deposited over the southern part of the Black Hills. Subsequent to its deposition extensive deep-cut channels were formed. These channels were then filled by the No. 5 sandstone complex. All of the partly oxidized uranium and vanadium deposits in the basal part of the Fall River formation are near the margins of the No. 5 sandstone. The location of the deposits suggests that the mineralizing solutions may have migrated from the No. 5 sandstone into the reducing environment of the basal sandstone and carbonaceous siltstone of the Fall River formation.

BLACK ORES

The Runge deposit is the only black ore deposit that had been developed in the Edgemont NE quadrangle by the end of 1958. The principal ore minerals are uraninite, coffinite, paramontroseite, and häggite. These minerals impregnate the interstices of the sandstone and are intimately associated with calcite, pyrite, marcasite, and in some parts of the mine with a molybdenum mineral thought to be "jordisite." The ore has a vanadium/uranium ratio of approximately 1.5.

The deposit occurs in the basal part of the No. 5 sandstone and upper part of the No. 4 sandstone. According to V. R. Wilmarth (oral communication, 1958) the epigenetic minerals in the deposit are arranged in a lower carbonate zone and an upper sulfide zone. The most abundant introduced mineral in the lower carbonate zone is calcium carbonate. In some places this mineral completely impregnates the interstices of the sandstone and in other places forms nodules, concretions, and layers of calcite-cemented sandstone. Most of the ore has been mined from the partly cemented part of the carbonate zone. The most abundant minerals in the overlying zone are the iron sulfides or their oxidation product iron oxide. The iron sulfides and iron oxides are concentrated mostly in the lower part of this zone where they constitute as much as 30 percent of the rock and average about 10 percent. The iron minerals decrease upward to an average of about 2.5 percent in the upper part of the zone. Uranium and vanadium occur throughout the sulfide zone but only average about 0.05 percent. Molybdenum and arsenic are present in the upper part of the zone where molybdenum averages nearly 0.1 percent and arsenic about 0.06 percent.

The uranium, vanadium, and iron minerals occur principally as banded nodules, pods, lenses, or fracture fillings in the sandstone. Characteristically these features contain either a core of pyrite or a core of hematite surrounded by a band of pyrite. The pyrite is surrounded by a mixture of vanadium and uranium minerals.

In general, the uranium and vanadium minerals are younger than the gangue minerals although small amounts of late quartz, calcite, pyrite, and marcasite are present. According to F. R. Shawe (oral communication, 1958) there is a paragenetic sequence of quartz, calcite, pyrite, pyrite and marcasite, clay and first-stage uraninite, häggite, and second-stage uraninite. As paramontroseite has been identified only by X-ray analyses its position in the paragenetic sequence has not been determined. Evans (1959, p. 94), however, has concluded that paramontroseite can form only by solid-state oxidation of montroseite. As montroseite is probably one of the chief primary vanadium minerals (Evans, 1959, p. 95) it is probable that this mineral was formed at about the same time as häggite.

The first-stage uraninite is a hard variety that is highly reflective in polished sections. The second stage is a sooty black variety that fills the pore spaces between all the preexisting minerals. Microchemical tests show the presence of iron in both varieties, but the earlier uraninite gives a stronger test.

The early pyrite is in cubes and irregular masses, the intermediate pyrite and marcasite are intergrown, the late pyrite is principally in the form of pyritohedrons and octahedrons, and the late marcasite forms drusy linings in pore spaces. Analyses of 6 samples show the presence of as much as 0.17 percent arsenic in the iron sulfides.

LOCALIZATION OF THE DEPOSITS

In recent years an unprecedented effort by many workers has been expended on studies of uranium ores throughout the world. As a result of these studies, divergent views regarding the source of the metal have evolved. These views are represented by hypotheses that postulate that the uranium has been redistributed and reconcentrated from the rocks in which the deposits now occur; that it was introduced into the host rocks from downward migrating meteoric solutions that had leached uranium from overlying perhaps tuffaceous rocks; or that the uranium was introduced into the host rocks by thermal solutions of several possible origins. Results of recent geochemical studies of uranium deposits indicate that uranium is probably transported in the U (VI) valence state and that in a reducing environment it is precipitated in the form of uraninite or coffinite (Garrels, 1955). When these minerals are brought into the zone of oxidation, the uranium is again oxidized and will be dispersed in solution unless either vanadium, phosphorus, arsenic, molybdenum, or chemically active silica is present to fix it in stable compounds. Under the proper geochemical conditions the uranium remobilized as uranyl ions will result in the formation of new deposits below the zone of oxidation. The important processes involved in the localization of the deposits, therefore, appear to be the transportation, reduction, precipitation, and oxidation of the metals.

Regardless of the source of the metals, the formation of ore deposits from the mineralizing solutions was dependent on the movement of the solution into a geochemical environment that caused the precipitation of uranium and vanadium minerals. The nature of the mineralizing solution and of the chemical environment that causes precipitation of these minerals is not completely understood.

The distribution of the ore deposits in sandstones of both the Lakota and Fall River formations indicates that the Nos. 1, 4, and 5 sandstones have been the principal supply lines through which the uranium and vanadium minerals have been distributed. Numerous chemical experiments, principally relating to Colorado Plateau ores, have been made to determine whether the transporting media were most probably acid, neutral, or alkaline. Garrels (1957, p. 121), Gruner (1956) and others, on the basis of extensive chemical experiments and geologic observations, have concluded that near-neutral to highly alkaline carbonate solutions are effective carriers of uranyl ions. There is no direct evidence to indicate the degree of concentration of the metallic ions in the mineralizing solutions, however. Whether the ore deposits could have formed from ground waters with a few parts per billion of uranium, or whether they were formed from more concentrated solutions, possibly in the order of hundreds of parts per million has not been demonstrated.

The ore deposits are in sandstone through which a large volume of ground water has migrated. This relation between distribution of ore deposits and ground-water movement suggests that the uranium, vanadium, and iron may have been carried by these solutions in low concentrations. If the deposits were formed from weakly mineralizing solutions the source of the uranium and other metals may be of less importance than their transportation and the cause of their precipitation.

The point at which uranium is deposited from migrating solutions in the porous sandstone is evidently determined by the presence of reducing agents that result in the reduction of the hexavalent uranium ion. Uranium exists in the hexavalent state as a complex uranyl ion, which, when reduced to the uranous ion U^{+4}, forms uraninite or coffinite. Some of the specific agents that caused the reduction in valence seem to have been transitory, for in many deposits no evidence can be seen of their former existence. It is well known that organic material in some forms reduces metallic ions, resulting in the precipitation of many of their compounds from solution. This is an effective mechanism in the precipitation of uranium which is almost invariably associated with carbonized plant fragments in the No. 1 sandstone and in the basal Fall River carbonaceous sandstone and siltstone sequence. Some of the larger deposits, however, contain no carbonaceous material and the study of such deposits indicates that carbon had little or no direct influence on the precipitation of the ore minerals. An example of such a deposit can be seen in the Runge mine (SE¼SE¼NE¼ sec. 1, T. 8 S., R. 2 E.) where the ore minerals, uraninite, coffinite, and häggite are intimately associated with calcite, pyrite, and marcasite. Mineralogical studies of the ore in this mine indicate a general paragenetic sequence of calcite, pyrite, marcasite, and the ore minerals. Only a small amount of organic material has been observed.

The ore deposit is localized along the erosional contact between the No. 4 and No. 5 sandstones (pl. 16). The general trend of the No. 4 sandstone is northwest, but the trend of the No. 5 sandstone is northeast. In the area of intersection the No. 5 sandstone has scoured below the top surface of the underlying No. 4 sandstone. The contiguity of these sandstones may have been at least one of the influencing factors in the precipitation of the secondary minerals; for the concentration and assemblage of interstitial minerals changes markedly in this area. Outside the area of intersection the No. 4 sandstone is intensely cemented with calcium carbonate. Within this area, however, the calcium carbonate cement seems to be, in general, restricted to relatively thin pods and lenses near the top of the No. 4 sandstone. It is also similarly present in the basal part of the No. 5 sandstone but only where the two sandstones are contiguous. Uraninite, coffinite, vanadium oxide, and pyrite are marginal to the carbonate pods and lenses in both sandstones. On the basis of incomplete drilling, the area within which the sandstones contain these minerals is about 1 mile long and 0.2 mile wide. The concentration of uranium within this area ranges from 0.01 percent to as much as 5 percent.

The mineralogical evidence, therefore, indicates that the mineralizing solutions were enriched in carbonate, bicarbonate, calcium, iron, vanadium, and uranium. It also indicates that the epigenetic minerals were not precipitated in a carbonaceous environment. Considering the relation of the uranium deposits with the intersection of the two channel sandstones diagrammatically illustrated on plate 16, it seems most probable that the precipitation of the minerals was a result of uranyl carbonate- or bicarbonate- and ferrous iron-bearing solutions in the No. 4 sandstone coming in contact with organic acid- or hydrogen sulfide-bearing ground water in the No. 5 sandstone. Under these conditions the carbonate solutions would have migrated through the No. 4 sandstone as is indicated by the cementation of that sandstone by calcium carbonate. Hydrogen sulfide and organic acids in the No. 5 sandstone should have been generated by the decay of organic material in the basal Fall River carbonaceous sandstone and siltstone. As the No. 5 sandstone is embedded in this carbonaceous sandstone and siltstone, entry into it of hydrogen sulfide and organic acids thus evolved would be expected. Intermingling of the carbonate and acid solutions would have resulted in the precipitation of uranium oxide and iron sulfide at the intersection of the two channel sandstones where the two solutions came in contact.

In the zone of oxidation the black vanadiferous uranium ores are oxidized to the relatively insoluble minerals carnotite and tyuyamunite. Excess vanadium is evidently fixed in the clays and in such minerals as corvusite, hewettite, hummerite, and rauvite. Uranium is probably lost in solution from those ores that do not contain enough vanadium for all of the uranium to be fixed in stable compounds. As is shown by table 5, the vanadium-uranium ratio of the oxidized deposits ranges from an average of about 0.4 for the deposits in the No. 1 sandstone to an average of about 2 for the deposits in the basal Fall River carbonaceous sandstone and siltstone sequence.

The reduction of metallic ions by hydrogen sulfide or other migrant reducing agents may also have influenced the localization of some deposits in the Nos. 1, 4, and 5 sandstones where these sandstones intersect structural irregularities. This possibility is suggested by the greater number of deposits along the monoclinal axis and on the structural terrace shown on the east half of plate 15. The concordance of deposits with the intersection of both tectonic and sedimentary structures may have resulted in part from the accumulation of gaseous reducing agents against permeability barriers in areas of low dips or in areas of abrupt changes in the dip.

If uranium is lost from low-vanadium ores during the process of oxidation, it is probable that the highly oxidized carnotite ores in the No. 1 sandstone were more affected than were the other ores in the Edgemont NE quadrangle. The mineralogy of these deposits indicates that vanadium is the only element present that is capable of fixing the uranium in stable compounds. The vanadium in the highly oxidized deposits is largely confined to the carnotite-tyuyamunite minerals and to the clays. As the vanadium in the clays would not have been available for the formation of stable uranium-vanadium minerals during the process of oxidation any uranium in excess of that now present would have been lost in solution. If one or more large unoxidized deposits is postulated as the source from which the small carnotite deposits in the Craven Canyon-Long Mountain-Red Canyon area were derived, then a considerable amount of uranium may have been carried away by ground water and deposited elsewhere below the zone of oxidation. Solutions moving through this area would probably have migrated downdip into the No. 1 sandstone (fig. 29). This sandstone evidently fills a scour in the underlying Lakota mudstone and shale (fig. 28). Solutions, therefore, probably would have moved along the bottom or sides of the channel and if they reached effective precipitating agents such as carbonaceous material or hydrogen sulfide, economically significant uranium deposits may have formed.

PROSPECTING

Most of the exposed and near-surface deposits in the Edgemont NE quadrangle probably have already been discovered. It should be expected, however, that concealed deposits can be found by the use of exploratory techniques involving drill holes distributed on the basis of geologic considerations. The ore that had been produced from this area to the end of 1957 was mined from the Nos. 1, 4, and 5 sandstones and from the sequence of interbedded sandstone and siltstone in the basal part of the Fall River formation. As these rocks were hospitable for the formation of ore deposits, exploration for the purpose of discovering concealed deposits should be concentrated on them; particularly in those areas where these rocks are buried below the zone of oxidation.

NO. 1 SANDSTONE

As previously discussed the possibility exists that the relatively low vanadium content of the ores that have been mined from the No. 1 sandstone in the Long Mountain area has permitted remobilization of the uranium during oxidation of the black ores. Under such conditions downdip migration of the mobilized uranium probably would have resulted in its reprecipitation below the zone of oxidation, possibly adjacent to the underlying carbonaceous shale. As shown in figure 28 the basal shale of the Lakota has been removed by erosion during Lakota time below the thickest part of the No. 1 sandstone, but erosional remnants seem to be scattered along the sides of the former channel. Drill holes through the No. 1 sandstone in the areas where it is underlain by the basal shales would determine whether the carbonaceous environment of these shales, particularly near the water table, has influenced the localization of uranium.

NOS. 4 AND 5 SANDSTONES

Evidence suggests that the ore minerals at the Runge mine were deposited as a result of reactions between carbonate- uranium- vanadium-bearing solutions in the No. 4 sandstone and hydrogen sulfide-bearing solutions in the No. 5 sandstone. Duplication of these conditions may exist at any point where the No. 5 sandstone truncates the No. 4 sandstone. The distribution and thickness of these sandstones are shown in figures 35 and 36. By comparing these illustrations it can be seen that there is a high probability of these sandstones being in direct contact in part of secs. 35 and 36, T. 7 S., R. 2 E.; sec. 1, T. 8 S., R. 2 E.; and secs. 5 and 6, T. 8 S., R. 3 E.

CARBONACEOUS INTERBEDDED SANDSTONE AND SILTSTONE IN THE BASAL PART OF THE FALL RIVER FORMATION

As of July 1955 ore from this sequence had been mined from about 20 small mines in and adjacent to sec. 26, T. 7 S., R. 2 E. According to statistics compiled by the U.S. Atomic Energy Commission the ore produced from this group of mines ranged from 25 to 3,000 tons per mine.

Many of the deposits that have been found in the basal sandstone and siltstone of the Fall River are marginal to a series of en echelon faults of small displacement. They are also near the western margin of the No. 5 sandstone where that sandstone has truncated both the basal sandstone and siltstone and the No. 4 sandstone. This relation is somewhat similar to the occurrence of ore at the intersection of the Nos. 4 and 5 sandstones in the Runge mine, and suggests the possibility that uranium and vanadium were transported by high-carbonate solutions that migrated through the No. 4 sandstone to a point where these solutions could escape to the highly reducing environment of the basal sandstone and siltstone. Such escape channels are provided by the faults and by the No. 5 sandstone.

Exploration in other areas where similar relations exist might result in the discovery of other ore deposits in the basal sandstone and siltstone of the Fall River. On the basis of past production, however, it would be expected that deposits of this type that may be discovered in the future will be relatively small.

GYPSUM DEPOSITS

Over much of the northeastern part of the Edgemont NE quadrangle two relatively thick gypsum beds are exposed in the Spearfish formation. The lower gypsum bed averages about 30 feet and the upper bed about 50 feet in thickness. A huge quantity of gypsum is, therefore, present in this area, but its exploitation is dependent on transportation and other economic factors.

Analyses of two grab samples from the upper and lower gypsum beds are given below. Both samples were collected from exposures in the SE¼NW¼ sec. 34, T. 6 S., R. 3 E. Clay and silt probably constitute the impurities not reported from the lower bed.

Analyses of two grab samples from the upper and lower gypsum beds

	Upper bed (percent)	*Lower bed (percent)*
CaO	32.78	32.26
SO_3	45.62	40.80
Total H_2O	20.59	18.35

GRAVEL DEPOSITS

Extensive Quaternary and Tertiary (?) gravel deposits exist within the quadrangle (fig. 38). Limestone is the predominant rock type in all the deposits, chert ranges from 2 to 13 percent, and igneous and metamorphic rocks range from 0 to 28 percent (table 6). The gravel has been derived from older rocks in the Black Hills. The igneous and metamorphic rocks were derived from the Precambrian core of the uplift, and the limestone and chert were derived from the Paleozoic formations surrounding the uplift.

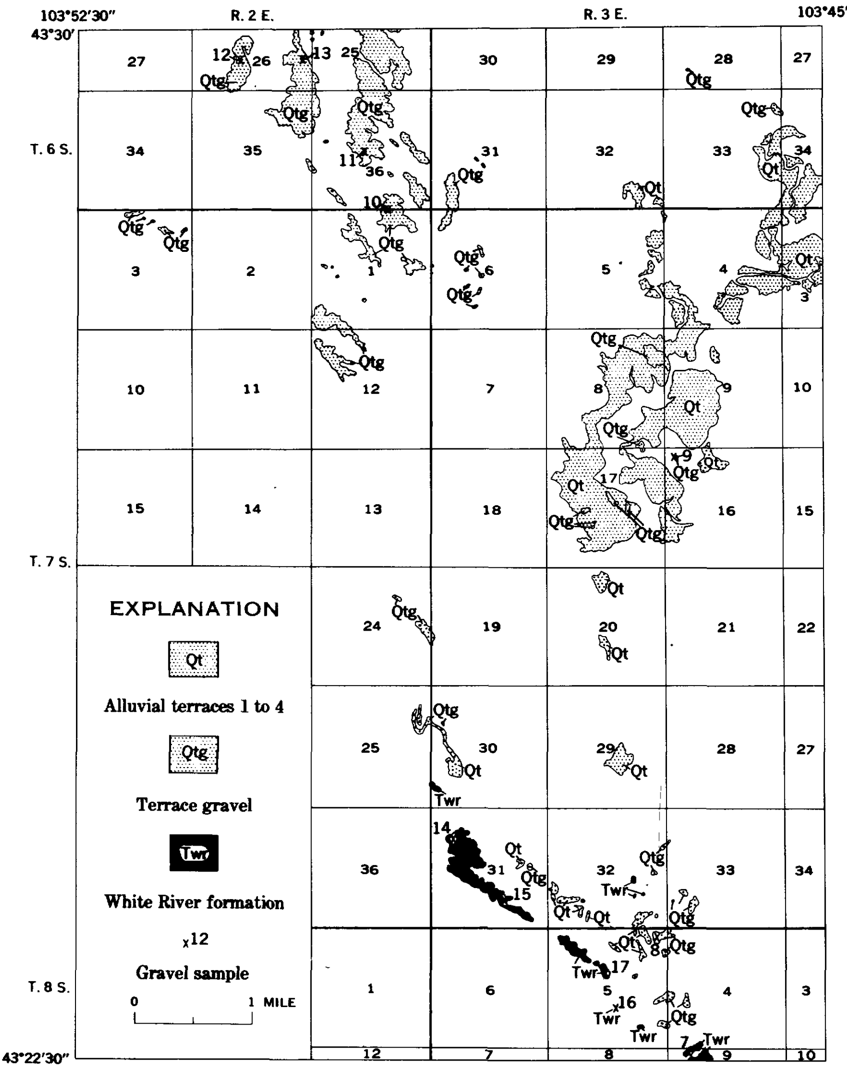

FIGURE 38.—Distribution of gravel deposits in the Edgemont NE quadrangle.

TABLE 6.—*Composition of the 9.42mm to 13.33 mm part of the gravel deposits, Edgemont NE quadrangle*

Sample	Sample with grains between 9.42 and 13.33 mm in diameter (percent)	Number of pebbles counted	Quartz (percent)	Feldspar (percent)	Metamorphic rocks (percent)	Chert (percent)	Chalcedony (percent)	Limestone (percent)	Sandstone and siltstone (percent)	Gypsum (percent)
8	10.6	226	13	7	0	8	0	55	16	1
9	4.4	308	16	3	5	13	0	54	9	0
10	6.4	190	9	2	0	5	0	71	11	2
11	9.9	159	1	0	0	2	0	88	9	0
12	8.7	195	0	0	0	8	0	88	4	0
13	9.0	273	0	0	0	7	0	87	6	0
14	11.4	183	0	0	0	6	0	87	6	1
15	12.2	216	0	0	0	8	1	79	12	0
16	6.2	172	1	0	0	9	0	80	10	0
17	8.0	268	1	1	0	7	0	81	10	0
7	6.1	403	20	4	4	13	0	51	8	0

OIL AND GAS

A small amount of oil has been produced from the Barker dome (pl. 12) in the northwestern part of the quadrangle. All the production on this structure has been from sandstone in the Minnelusa formation. It has been reported that natural gas also has been found in some of the drill holes, but presumably because of the small volume it has not been commercially exploited.

Possibly structure similar to the Barker dome exists in the northeastern part of the quadrangle and the southeastern part of the quadrangle adjoining on the north (pl. 12). It has not been determined, however, that there is closure on this structure to the north of the Edgemont NE quadrangle.

According to logs of drill holes made by geologists of the U.S. Atomic Energy Commission there is a small dome in the Morrison formation in sec. 26, T. 7 S., R. 2 E. Doming in this area occurred principally during pre-Fall River time, and this suggests that similar hidden structures may exist in any of the area covered by Fall River and younger rocks. In such areas the sandstone in the Minnelusa formation is a potential oil producer.

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Robert Nelson
Mayor
hsmayor@hs-sd.org

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MAY 2 1 2025
MINERALS & MINING PROGRAM

May 13, 2025

Minerals, Mining, and Superfund Program
523 East Capitol Avenue
Pierre, South Dakota 57501-3182

Subject: Strong Opposition to Uranium Exploration near Craven Canyon, Fall River County, SD – Concerns Regarding Large-Scale Disturbance and Water Contamination

Dear Members of the Minerals, Mining, and Superfund Program,

The City of Hot Springs is writing to express its strong and urgent opposition to the proposed uranium exploration project near Craven Canyon in Fall River County, South Dakota. The public notice regarding Clean Nuclear Energy Corp. (CNEC), a subsidiary of Basin Uranium, has raised significant concerns within the community due to the project's scale, its proximity to culturally sensitive lands, and the serious environmental risks it poses—particularly to vital water resources.

It has come to attention that the proposal includes 50 drill platforms with depths of up to 700 feet, with each borehole potentially taking two weeks to complete. This would result in sustained disruptive activity within an environmentally and culturally sensitive area. Although classified as "exploration," the scale and intensity of the project strongly suggest the likelihood of future large-scale uranium mining operations, with all the associated consequences that the region has historically experienced.

The primary concern is the potential for water contamination. The history of uranium mining in the Black Hills provides a clear record of environmental degradation. Uranium extraction in previous years has led to significant land disturbance. Even the exploratory drilling phase exposes large surface areas, which significantly heightens the risk of contaminated runoff, potentially carrying radioactive materials, heavy metals, and other hazardous substances into local waterways.

This risk is further amplified by the region's precipitation patterns, topography, and the proximity of Craven Canyon to critical water sources. A train derailment near Dewey, SD, though unrelated to mining, demonstrated how easily materials can spread via runoff. Uranium exploration, however, would introduce substances that present much greater and more lasting environmental and public health threats.

In addition to the environmental risks, uranium mining presents significant health hazards. Exposure to uranium and its decay products can lead to serious health issues, including lung cancer, kidney damage, and respiratory problems, especially in communities living near mining sites or downstream of contaminated runoff. The radioactive materials released during mining can contaminate air, water, and soil, and the long-term health impacts can persist for generations. For these reasons, any exploration or mining activities in areas like Craven Canyon pose a direct threat not only to the environment but also to the health and safety of local residents and future generations.

Past uranium operations in the Black Hills produced more than 10,000 tons of ore, illustrating the scale of operations that may follow should the exploration phase be successful. Any future mining operations in Craven Canyon would result in extensive excavation, irreversible landscape changes, and a significantly increased risk of toxic runoff affecting nearby water systems.

In addition to environmental concerns, Craven Canyon contains significant cultural and archaeological resources, including rock art and artifacts dating back over 7,000 years. The proposed drilling and potential mining activities would put these irreplaceable sites at risk, both through physical disruption and chemical contamination from runoff.

The City of Hot Springs feels that it is imperative that the Minerals, Mining, and Superfund Program take immediate action to reject this exploration proposal. The potential for long-lasting damage to water quality, environmental health, and cultural heritage is far too great. This project does not align with the principles of responsible land stewardship, public safety, or the overall wellbeing of the community.

The City of Hot Springs urges your agency to prioritize the protection of the environment and the preservation of South Dakota's cultural heritage by denying this exploration request.

Sincerely,

Robert Nelson
Mayor, City of Hot Springs

EXHIBIT
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Basin Uranium Provides Chord Permitting Update

Permitting (/mining-topics/topic/permitting.html) Uranium (/mining-topics/topic/uranium.html) South Dakota (/mining-topics/topic/south-dakota.html)

Last Trade: 0 0.00 (0.00%)

Vancouver, British Columbia--(Newsfile Corp. - September 16, 2024) - **BASIN URANIUM CORP. (CSE: NCLR) (CNSX: NCLR.CN)** ("**Basin Uranium**", "**Basin**" or the "**Company**") is pleased to provide an update on permitting for the Company's flagship Chord uranium project in South Dakota. The Company has completed its summer field work and associated reporting. In all, six (6) surveys were completed including: wildlife/raptor, vegetation and cultural resource surveys on both State Section 36 and the adjacent USFS lands that are located within our future proposed exploration and development area.

"Completing six important surveys over the past couple months on time and on budget allowed us to significantly advance our permitting plans in South Dakota. We remain committed to environmentally safe and conscious exploration that meets or exceeds the standards currently used across the industry," commented Mike Blady, CEO of Basin Uranium. "We are looking forward to continuing to advance our Chord permitting in a professional and timely manner."

Next steps for the state section include hosting an onsite meeting for interested Tribes and Tribal members (within the next two weeks) to discuss and finalize the cultural resource surveys before submittal to the State Historic Preservation Office (SHPO). The SHPO review of the report and subsequent signoff is expected by the end of October. Upon receiving final signoff from SHPO, the Department of Agriculture and Natural Resources (DANR) will have 30 days to determine the completeness of our report and conduct a site visit. With the p mi ns ari ota Board of Minerals, and the paying of an assurance bond. These steps are expected to be completed between Q4/2024 to Q1/2025. The Company continues to work collaboratively with the various administrative and government agencies to achieve the most expedient timeline possible.

About Basin Uranium Corp.

Basin Uranium is a Canadian junior exploration company focused on mineral exploration and development in the green energy sector. The company has five advanced-stage uranium projects located in the United States, namely the Chord and Wolf Canyon projects in South Dakota, the South Pass and Great Divide Basin projects in Wyoming, and the Wray Mesa project in Utah. All five projects have seen extensive historical exploration and located in prospective development areas. The Company also has the Mann Lake uranium project, located in the world-class Athabasca basin of Northern Saskatchewan, Canada, in addition to the CHG gold project in south-central British Columbia.

For further information, please contact Mr. Mike Blady or view the Company's filings at www.sedarplus.ca (https://api.newsfilecorp.com/redirect/R74PJhx8gj).

On Behalf of the Board of Directors
Mike Blady
Chief Executive Officer
info@basinuranium.ca (mailto:info@basinuranium.ca)
604-722-9842

Neither the Canadian Securities Exchange nor its regulation services provider accepts responsibility for tl adequacy or accuracy of this news release.

FORWARD-LOOKING STATEMENTS:

Cautionary Note Regarding Forward-Looking Statements: This news release includes certain statements and information that may constitute forward-looking information within the meaning of applicable Canadian securities laws. All statements in this news release, other than statements of historical facts, including statements regarding future estimates, plans, objectives, timing, assumptions or expectations of future performance are forward-looking statements and contain forward-looking information. Generally, forward-looking statements and information can be identified by the use of forward-looking terminology such as "intends" or "anticipates", or variations of such words and phrases or statements that certain actions, events or results "may", "could", "should", "would" or "occur". Forward-looking statements are based on certain material assumptions and analysis made by the Company and the opinions and estimates of management as of the date of this news release. These forward-looking statements are subject to known and unknown risks, uncertainties and other factors that may cause the actual results, level of activity, performance or achievements of the Company to be materially different from those expressed or implied by such forward-looking statements or forward-looking information. Important factors that may cause actual results to vary include, without limitation, uncertainties affecting the expected use of proceeds. Although management of the Company has attempted to identify important factors that could cause actual results to differ materially from thos d-l or f m other factors th b im ier ce that *such statements will prove to be accurate, as actual results and future events could differ materially from those anticipated in such statements. Accordingly, readers should not place undue reliance on forward-looking statements and forward-looking information. Readers are cautioned that reliance on such information may not be appropriate for other purposes. The Company does not undertake to update any forward-looking statement, forward-looking information or financial out-look that are incorporated by reference herein, except in accordance with applicable securities laws.*

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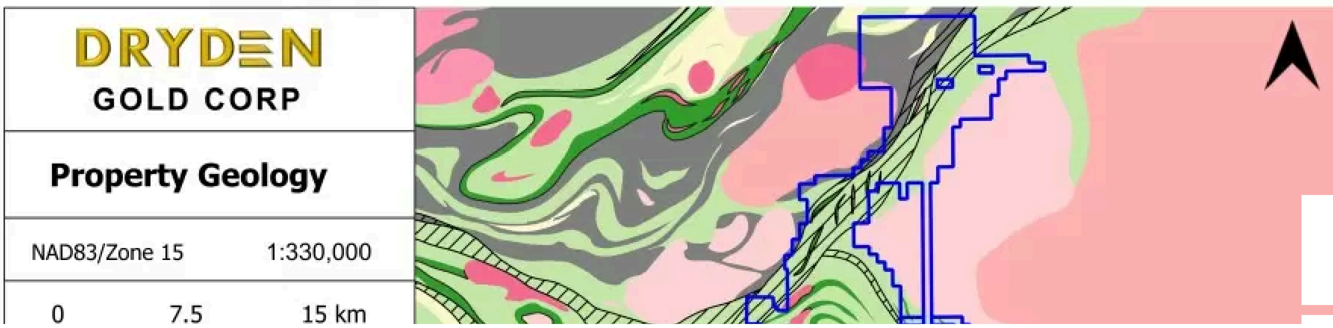

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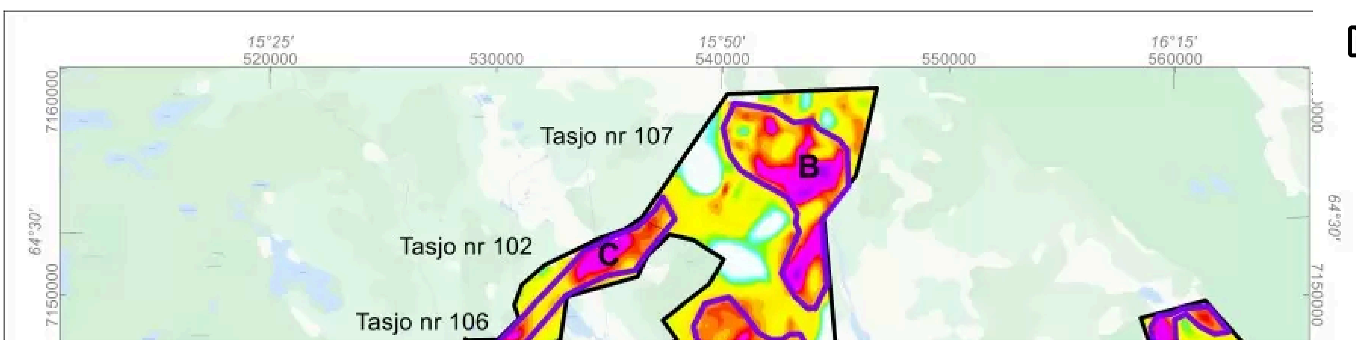

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News

Nexus Uranium And Basin Uranium Anno Create North American-Focused Uraniur Company

Vancouver, British Columbia – June 25, 2025 – Nexus Uranium Corp, (CSE: NEXU; OTCQB: GIDMF; FRA: 3 NCLR; CNSX: NCLR.CN) ("**Basin**") are pleased to announce that they have entered into a definitive arrange dated June 25, 2025, providing for, among other matters, the acquisition by Nexus of 100% of the outstar under a statutory plan of arrangement, (the "**Arrangement**"). Pursuant to the Arrangement, Nexus will issu shares ("**Nexus Shares**") to Basin shareholders representing approximately 1.1 of a Nexus share for each issued and outstanding as at the date of this news release. In addition, as part of the Arrangement, Basin common shares ("**SpinCo Shares**") of a subsidiary of Basin, ("**Basin SpinCo**"), on the basis of approximat held. The transaction represents total consideration for Basin shareholders of $3.6 million or $0.137 per I $0.115/sh) plus SpinCo Shares (attributable pre-money valuation of $0.022/sh), or an approximate 10% p announcement.

Strategic Rationale of the Transaction

- **North American Focused Exploration & Development Company** with a portfolio of six uranium project located in the high-grade Athabasca Basin of Saskatchewan, and four potentially ISR-amenable US projec uranium project in South Dakota (the "**Chord Project**").
- **Improved Access to Capital, Stronger Balance Sheet and improved liquidity** with a more diversified sh capitalization.
- **Benefits from recent North American (N.A.) Uranium Market Developments** including US Federal Gov production, increased SMR certifications and deployments, and power demand which has corresponded term uranium spot prices.

Benefits for Shareholders

For Nexus shareholders, the transaction provides for exposure to a resource stage US project portfolio w plus a potential Exploration Target of 1.42 to 4.23 Mlb U3O8. The inferred mineral resource was defined ir COUNTY, SOUTH DAKOTA, USA Mineral Resource NI 43-101 Technical Report" prepared by: Carl D. Warrer **Technical Report**"). Additionally, the Chord Technical Report contains additional information on the Explo accessed on Basin's SEDAR+ profile.

the McArthur River and Key Lake mines, and the Millenium and Phoenix deposits. It also provides for dive
Chord Project. Lastly, it provides gold exposure through the gold-focused Basin SpinCo comprised of the
Gold project (7,998 hectares) and the CHG project (4,072 hectares).

Jeremy Poirier, CEO of Nexus Uranium, commented "This transaction brings together complementary ass
North America that bolsters the company's position as a premier uranium exploration company. It provide
100% uranium focus which would benefit from improving US & Canadian market fundamentals."

Mike Blady, CEO of Basin Uranium, further added "This transaction also provides an added benefit for Bas
the Chord Project, improving access to capital given NEXUS' demonstrated history of capital raising and l
gold-focused Basin SpinCo with gold trading near all-time highs."

Chord Project (South Dakota) Update

Since acquiring the Chord Project in 2023 Basin has been actively moving the project forward by aggress
and engineering data. This data was used to complete a maiden resource on the Chord Project in 2024 o
reside below the water table. It also outlined a significant Exploration Target that Basin has been working
United States Forest Service ("**USFS**") ground held by Basin. Permitting commenced in late 2023 and is ir
which hosts the bulk of the Exploration Target. A memorandum of understanding is in the final stages of
which once finalized would move the Chord Project on USFS ground into the final stage of permitting. Dur
numerous baseline studies including archeological, biological (vegetation and wildlife) and water samplir
operators. These studies commissioned by independent third parties have demonstrated that exploratior
represents a low risk to the environment, community and any archeological sites. In total, over 60,000 fee
drilling is being permitted for which will be focused on increasing the resource at the Chord Project and b
other pertinent factors of the deposit.

Arrangement Terms

Pursuant to the Arrangement Agreement, Nexus will acquire all the issued and outstanding Basin Shares
the Business Corporations Act (British Columbia). Under the terms of the Arrangement, Nexus will issue a
shareholders. The exchange ratio per share (the "**Exchange Ratio**") will be calculated based on the 30,000
Arrangement divided by the number of Basin Shares issued and outstanding immediately prior to the effe
the Arrangement, all of Basin's convertible securities will cease to represent a right to acquire Basin Share
Nexus Shares using the Exchange Ratio. Assuming no further issuances of Nexus Shares prior to closing
former Basin shareholders will own approximately 40% of the then issued and outstanding Nexus Shares

Prior to the Arrangement, Nexus will transfer its: (i) Napoleon gold project, comprised on 1,281 hectares i

British Columbia, to Basin SpinCo. In consideration for the CHG Project, Basin SpinCo will issue 3,000,000 distributed under the Arrangement to Basin shareholders on the basis of approximately 0.11 of a SpinCo

On completion of the Arrangement, Basin SpinCo intends to list on a recognized stock exchange Canada Columbia, Alberta and Ontario. The management of Basin SpinCo is expected to be comprised of Mike Bl comprised of Mike Blady, Desmond Balakrishnan, and Jonathan Hamway.

Closing of the Arrangement is subject to approval of the Basin shareholders, approval of the Supreme Co Securities Exchange (the "**CSE**"), standard closing deliverables, and other customary conditions typical fo completion of the Arrangement, Mike Blady, the Chief Executive Officer of Basin, will be appointed to the b members of the board of directors of Basin will resign. Nexus will continue to be managed by the current addition of Mr. Blady. Basin will be delisted from the CSE following the Arrangement.

Basin Special Meeting and Fairness Opinion

A special meeting of Basin shareholders to approve the Arrangement is expected to take place in August Arrangement will be described in further detail in a Management Information Circular of Basin to be maile Meeting (the "**Circular**"). All directors and officers of Basin, as well as certain Basin shareholders, have or Nexus prior to the Meeting pursuant to which they have agreed or will agree to vote their Basin Shares in

A special committee comprised of independent directors of Basin (the "**Special Committee**"), establishec financial advisor, Evans & Evans Inc. ("**Evans & Evans**"), to provide a fairness opinion in connection with th Fairness Opinion is expected to state that the Arrangement is fair, from a financial point of view, to the sh condition to closing the Arrangement. A copy of the Fairness Opinion, as well as additional details regard and the rationale for the recommendations made by the Special Committee and the Basin board will be s shareholders in connection with the Meeting and filed by Basin on its profile on SEDAR+.

Basin securityholders and other interested parties are advised to read the materials relating to the Arrang securities regulatory authorities in Canada when they become available. Anyone can obtain copies of the Basin's SEDAR+ profile at www.sedarplus.ca.

None of the securities to be issued pursuant to the Arrangement have been or will be registered under the (the "**U.S. Securities Act**"), or any state securities laws, and any securities issuable in the Transaction are exemptions from such registration requirements pursuant to Section 3(a)(10) of the U.S. Securities Act a laws. This press release does not constitute an offer to sell or the solicitation of an offer to buy any secur

The technical contents of this news release were reviewed and approved by Carl D. Warrant, P.E., P.G., geo

Nexus Uranium Corp. is a multi-commodity development company focused on advancing the Cree East u
to its precious metals portfolio that includes the Napoleon gold project in British Columbia and a packag
project is one of the largest projects within the Athabasca Basin of Saskatchewan spanning 57,752 hecta
in exploration to date. The Napoleon project comprises over 1,280 hectares and prospective for multiple
the area dating back to the 1970s with the discovery of high-grade gold. The Yukon gold projects are com
prospective for high-grade gold mineralization. Additional information on Nexus can be found on its webs
profile at www.sedarplus.ca.

About Basin Uranium Corp.

Basin is a Canadian junior exploration company focused on mineral exploration and development in the g
advanced-stage uranium projects located in the United States, namely the Chord and Wolf Canyon projec
Divide Basin projects in Wyoming, and the Wray Mesa project in Utah. All five projects have seen extensiv
development areas. The Company also has the Mann Lake uranium project, located in the world-class At
in addition to the CHG gold project in south-central British Columbia. Additional information on Basin can
and on its SEDAR+ profile at www.sedarplus.ca.

On Behalf of the Nexus Board

Jeremy Poirier
Chief Executive Officer
info@nexusuranium.com

On Behalf of the Basin Board

Mike Blady
Chief Executive Officer
info@basinuranium.ca

Neither the Canadian Securities Exchange nor its regulation services provider accepts responsibility for the adequacy or accura

Forward Looking Information

*This news release includes certain statements and information that may constitute "forward-looking information" within the mea
forward-looking statements and information can be identified by the use of forward-looking terminology such as "intends" or "ant
statements that certain actions, events or results "may", "could", "should", "would" or "occur". All statements in this news release,
statements regarding future estimates, plans, objectives, timing, assumptions or expectations of future performance are forward*

completion of the Arrangement; the anticipated timing of the Meeting; the composition of the Nexus board following the Arrange
shareholders entering into voting and support agreements with Nexus prior to the Meeting; and the delisting of Basin Shares follo
involves known and unknown risks and uncertainties and other factors, which may cause actual events or results in future period
results expressed or implied by such forward-looking information or statements, including, among others: the failure to obtain sh
with the Arrangement, failure to complete the Arrangement, failure to realize the anticipated benefits of the Arrangement or imple
operating cash flow and dependence on third party financing, uncertainty of additional financing, no known current mineral reserv
personnel, potential downturns in economic conditions, actual results of exploration activities being different than anticipated, ch
generally associated with the mineral exploration industry, environmental risks, changes in laws and regulations, community relat
and the risk factors with respect to Nexus and with respect to Basin set out in the companies' most recent annual management c
with the Canadian securities regulators and available under Nexus' and Basin's respective profiles on SEDAR+ at www.sedarplus.c

Although Nexus and Basin have attempted to identify important factors that could cause actual results to differ materially from th
by forward-looking information, there may be other factors that cause results not to be as anticipated, estimated or intended. The
statements will prove to be accurate, as actual results and future events could differ materially from those anticipated, estimated
reliance on forward-looking statements or information. Nexus and Basin undertake no obligation to update or reissue forward-loc
except as required by applicable securities laws.

Nexus Uranium And Basin Uranium Announce Merger

Basin Uranium Receives South Pass Project Approval

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Basin Uranium Corp.

503-905 West Pender St.
Vancouver, BC, V6C 1L6

EXHIBIT
Ellison 7

Chord

Project Phase:

NI 43-101 Resource
View Technical Report

Commodity:

Uranium

Size:

3,640 acres

Location:

Fall River County, South Dakota

Project Overview

The Chord property is comprised of 147 contiguous lode mining claims (~ 3,037 acres) located in Edgemont, South Dakota approximately 3 miles southwest of encore Energy Corp.'s (NYSEAM:EU) Dewey-Burdock development project which is targeting initial production in 2025.[1] Mineralization at Chord is hosted within typical roll front deposits in the Cretaceous age Fall River and Lakota formations, in particular the Chilson member which is the same host for mineralization at Dewey-Burdock. The property has been the subject of extensive exploration since the 1970's with over 1,000 holes drilled by Union Carbide Corp. ("**UC**") which led to the tabling of an internal resource and feasibility study.

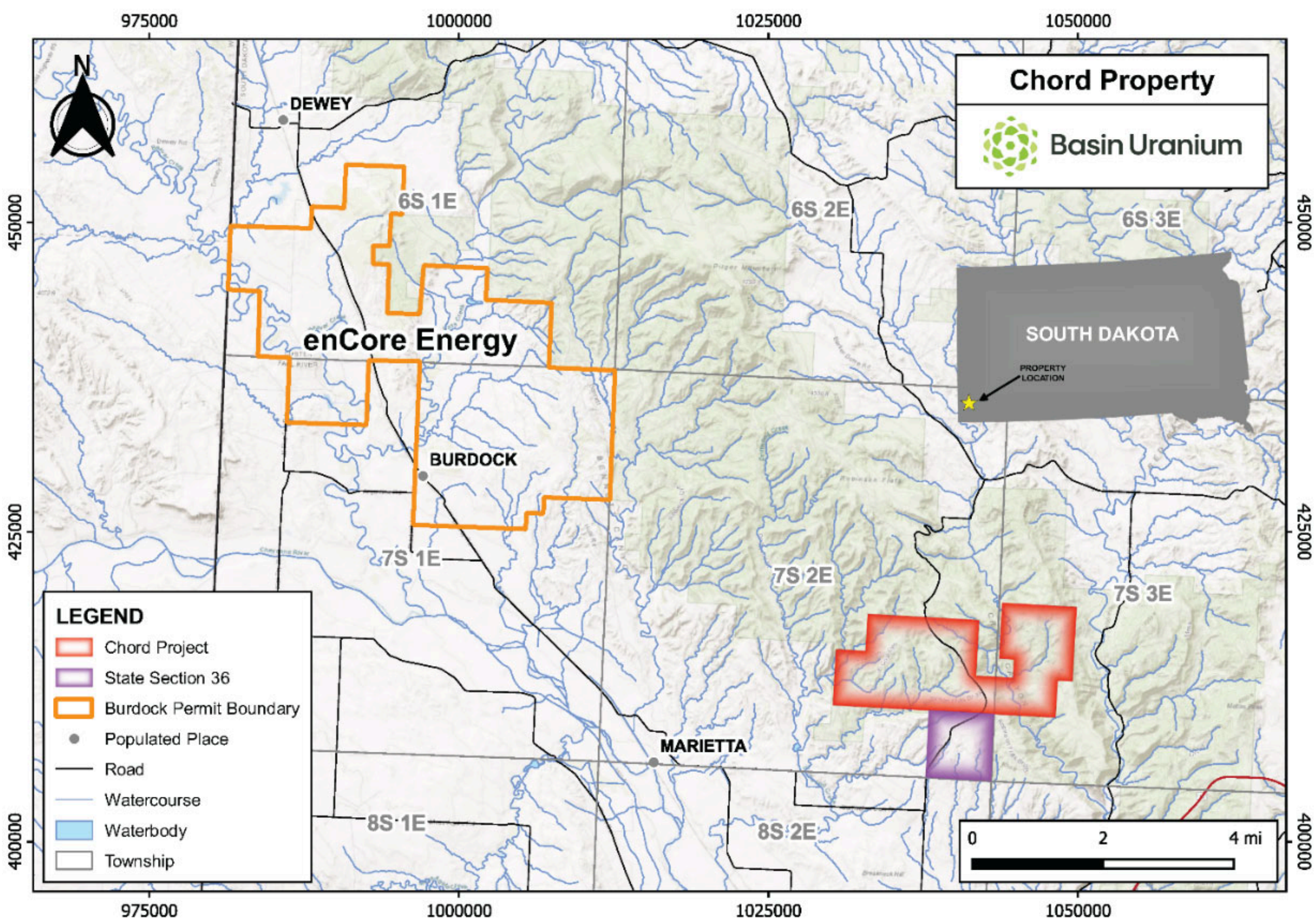
enCore Energy's adjacent Dewey-Burdock project is host to a M&I resource of 17.1 Mlbs U_3O_8

Dewey-Burdock project also has received its Radioactive Materials License (RML) from the U.S. Nuclear Regulatory Commission (NRC) and is currently navigating the State Licensing process.

Basin is acquiring a up to a 90%-interest for a total of US$50K in cash, US$950K in stock, and US$1.2M in exploration with the timing dependent on the receipt of permits from applicable regulatory authorities in accordance with the terms of the Option Agreement (see March 3rd, 2023 Press Release).

1 enCore Energy February 2023 Corporate Presentation "enCore: production pipeline"

2 Azarga Uranium NI 43-101 PEA dated December 22, 2020



Mineralization on the Chord property is hosted within typical roll front deposits in the Cretaceous age Fall River and Lakota formations, in particular the Chilson member. The Chilson member is also the same host for mineralization at the adjacent Dewey-Burdock project by enCore Energy. The historical exploration and drilling was evaluating potentially economic uranium mineralization from an open pit or underground mining scenario and *never evaluated for their ISR potential*. Specifically, the October Jinx and Viking areas vary from depths of 350 to 500 feet deep and, based on historic depth-to-groundwater measurements,[3] are believed to, at least in part, lie below the water table which could potentially allow for ISR extraction.

3. W.T. Cohan, 1984, Report on Water Sampling and Limited Aquifer Testing, Chord Project

NI 43-101 Resources

Uranium Inferred Mineral Resource Area	**GT Cutoff (ft%)**	**AVG. Thickness (ft)**	**AVG. Grade (%eU_3O_8)**	**Tons (Millions)**	**Pounds (e U_3O_8) (Millions)**
October-Jinx	0.25	8.8	0.081	1.584	2.569
Viking	0.25	6.0	0.082	.050	.082
Ridge Runner	0.25	5.9	0.069	.075	.103
Total Inferred Mineral Resource	**0.25**	**8.5**	**.081**	**1.709**	**2.754**

Pounds and tons as reported are rounded to the nearest 1,000. Mineral resources are not mineral reserves and do not have demonstrated economic viability.

Notes To The NI 43-101

1. The MRE has an Effective Date of May 7, 2024.
2. The Qualified Person for the MRE is Mr. Carl Warren, P.E., P.G., whom is a Senior Engineer for BRS Engineering in Riverton, Wyoming.
3. Mineral resources are reported using the 2014 CIM Definition Standards and were estimated in accordance with the CIM 2019 Best Practices Guidelines, as required by NI 43-101

ever be converted into Mineral Reserves

5. All data used in the MRE consists of original drill hole maps and geophysical logs and was sourced from a combination of the South Dakota Geological Survey and private parties.
6. The MRE was performed using the Grade time Thickness (GT) contour modeling method.
7. The available original data was evaluated for authenticity and the equivalent uranium oxide (eU_3O_8) grades recalculated from the original gamma curves using K factor, deadtime, water and air factors clearly stated on each original geophysical log.
8. A disequilibrium factor of 1 was applied to the resulting eU_3O_8 intercept dataset.
9. An intercept grade cutoff of 0.02% eU_3O_8 was applied to the grade data to screen for intercepts which are not economically extractable by conventional heap or milling methods.
10. Intercept data meeting the grade cutoff criteria were split into mineral horizons based on 3-dimensional interpretation of geological units and were composited and modeled within each horizon using a minimum 0.1 GT cutoff, a maximum vertical distance of 10 feet between intercepts, and a maximum radius of influence of 200 feet between drill holes.
11. Three Mineralized Horizons were Identified by 3-dimensional interpretation and modeled: Horizon A being the highest in elevation, C being the lowest in elevation and B residing between A and C.
12. These mineral horizons are variably present within the three project areas: October-Jinx, Viking, and Ridge Runner.
13. A bulk density of 14 ft^3/ton (2.288 tonne/m^3) was applied for the MRE in mineral horizons B and C. For mineral resource estimations in the Fall River sandstone, Horizon A, a bulk density of 15.5 ft^3/ton (2.067 tonne/m^3) was used.
14. A marginal economic GT cut off of 0.25 was further applied to the GT model, based on US$70 per ton average conventional underground mining costs and US$90 per pound U_3O_8 assumptions for reasonable eventual economic extraction.
15. Moreover, isolated, and small pods of mineralization were removed from the MRE due to lack of reasonable eventual economic extraction.
16. Figures are rounded to reflect the relative accuracy of the estimate and may not sum due to rounding.
17. Resources are presented as undiluted and in-situ, are constrained by the GT contour model for each mineral horizon, and
18. The Qualified Person is not aware of environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues that could materially affect the potential development of the Mineral Resources.

Exploration Target

Exploration Target Trend	**Trend Length (ft)**	**Trend Width (ft)**	**AVG. Thickness Range (ft)**	**AVG. Grade Range (%eU_3O_8)**	**Tons Range (Millions)**	**Pounds (e U_3O_8) Range (Millions)**
Viking-Runner	7,650	400	3.6 – 7.3	0.056 – 0.074	0.730 – 1.635	0.813 – 2.419
Jinx Ridge	2,480	400	3.6 – 7.3	0.056 – 0.074	0.249 – 0.559	0.278 – 0.826
October South	1,860	600	3.6 – 7.3	0.056 – 0.074	0.298 – 0.668	0.332 – 0.989
Total	**11,990**		**3.6 – 7.3**	**0.056 – 0.074**	**1.278 – 2.862**	**1.422 – 4.234**

The potential quantity and grade disclosed above are conceptual in nature and there has been insufficient exploration to define a mineral resource at these targets. Further exploration is needed to test them for mineralization. No guarantee is made that any future resource will be delineated by future exploration.

Adjacent Projects

- Dewey-Burdock Project located 3 miles SW of Chord is owned by enCore Energy Corp (NYSEAM:EU)
- Project is host to a M&I resource of 17.1 Mlb U_3O_8 grading 0.116% U_3O_8 and Inferred resource of 0.7 Mlb grading 0.055% U_3O_8.[4]
- A December 2020 PEA[5] outlined life-of-mine (LOM) production of 14.3 Mlb

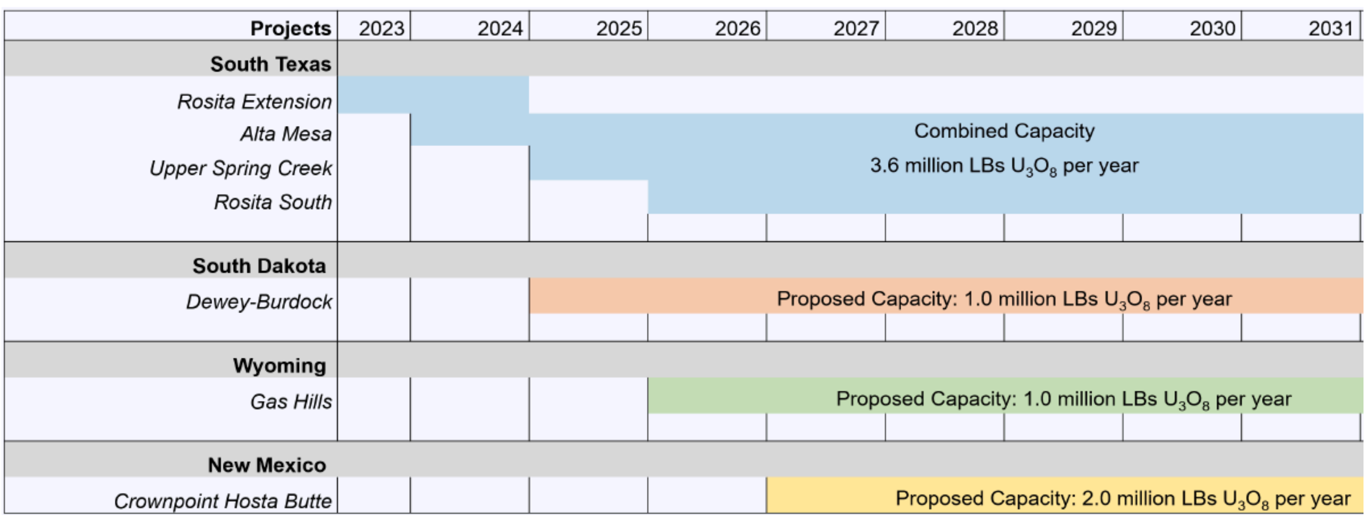
LOM), the project generated an after-tax NPV8% of US$147.5M and IRR of 50%.

Production	
LOM Uranium Prod. ('000 lb U_3O_8)	14,268
Mine Life (yrs)	16.0
Avg Annual Prod ('000 lb U_3O_8)	1,000
Cash Cost ($/lb U_3O_8)	10.46
All-in Cost ($/lb U_3O_8)	32.27

Financial	US$'000
Uranium Price ($/lb U_3O_8)	55.00
CAPEX (initial)	31,672
CAPEX (LOM)	189,354
After-Tax NPV(8%)	147,485
After-Tax IRR	50.0%

4,5. Azarga Uranium NI 43-101 PEA dated December 22, 2020

- enCore has publicly stated initial production targeted for 2025.[6]



- The project has received its Radioactive Materials License (RML) from the U.S. Nuclear Regulatory Commission (NRC) and is currently navigating the State Licensing process.

Note: There is local opposition in Fall River County as a November 2022 referendum to consider if uranium mining should be considered a 'nuisance' and thus in violation of county ordinance: 56% of the votes (3,531 votes) were against uranium mining. According to enCore Chairman Bill Sheriff:[7] "The nuisance declaration would give residents legal standing to file a lawsuit, albeit an illegitimate one, as enCore energy owns the mineral rights which authorizes extraction of those resources in accordance with state and federal law. At the end of the day, enCore doesn't feel that a nuisance declaration by the county would have any significant legal standing that would deter uranium extraction." The presence of uranium mineralization on Dewey-Burdock is not necessarily indicative of similar mineralization at Chord. The Company has not verified the Dewey-Burdock exploration information.

7.https://frcheraldstar.com/news/3940-fifty-six-percent-of-voters-say-uranium-mining-is-nuisance

Tim Henneberry, P.Geo, consultant to for Basin Uranium is the Qualified Person as defined by National Instrument 43-101 and has approved the technical information on this website.

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