SUPPLEMENT 1
EDGEMONT URANIUM MILL DECOMMISSIONING PLAN
ENVIRONMENTAL REPORT

Tennessee Valley Authority Responses
to
Nuclear Regulatory Commission Questions
on
Edgemont Uranium Mill Decommissioning Plan
Environmental Report

Questions Forwarded By
Letter From Ross A. Scarano To
L. M. Mills, Dated November 21, 1979

January 1980

ENCLOSURE 1

Comments Concerning Land Use, Soils, Air Quality, Cultural Resources, and Terrestrial Biota

Question: Section 2.1, p. 2.1-1

This section states that a minimum of 8 ha (20 acres) will be disturbed offsite for obtaining borrow material. What is the maximum size of offsite borrow areas likely to be? Where will the borrow areas be located?

Response

At present, options on the properties to be used for borrow material have not been finalized. When the options are obtained, the maximum amount of disturbance and the locations of the borrow areas can be determined and will be provided.

Question: Section 3.0, General

Please provide a discussion of the engineering design of the proposed tailings disposal area. Include appropriate figures.

Response

Information regarding the design of the disposal site is provided in Section 3.3, Disposal Site Preparation, of revised Chapter 3 of the Edgemont Uranium Mill Decommissioning Plan Environmental Report (ER).

Question: Section 3.2.2, p. 3.2-1

This section lists the dust-control measures to be used during transports of tailings and contaminated soils. Please provide details; i.e., how often or under what conditions will the haul roads be watered? At what speed will the vehicles travel? What constitutes "dry material"?

Response

Refer to Sections 3.4, Haul Road and Slurry Pipeline Construction and 3.5.2, Disposal of Tailings and Contaminated Materials of revised Chapter 3 of the ER for information regarding truck transports. Additional information regarding criteria for dust control will be provided in a later submittal.

The term "dry material" should be used to refer to material below a moisture content suitable for compaction. An exact water content cannot be provided because of the variability of the native soil types and also the variability of the mixture of sand and slimes. Generally, it could be stated that material with a water content of less than 12 to 20 percent, depending upon the material type, would be considered "dry material." More detail concerning the moisture content of the various material at the mill site will be obtained from the planned soil testing program.

Question: <u>Section 3.2.2.2, p. 3.2-1</u>

If the disposal site requires a clay liner, from where will the material be obtained? Give the quantity of clay that will be required and the size of the borrow area to be disturbed by this activity.

<u>Response</u>

At present a clay liner is not anticipated. However, if one is necessary, the above requested information will be provided. (Refer to Section 3.3, <u>Disposal Site Preparation</u>, of revised Chapter 3 of the ER.)

Question: <u>Section 3.2.2.2, p. 3.2-1</u>

What type of agreement does the applicant have with the State of South Dakota and the U.S. Government, BLM, to use portions of State and Federal land for tailings disposal? Please provide letters of agreement.

Response

Agreements have not yet been finalized with the State of South Dakota or the Bureau of Land Management. When agreements are finalized, they will be made available.

Question: Section 3.2.2.2, p. 3.2-1

How much land will be required for storage of topsoil and subsoil during preparation of the disposal site? Where will the materials be stored?

Response

Refer to Section 3.3, Disposal Site Preparation, of revised Chapter 3 of the ER for discussions on storage of topsoil and subsoil.

Question: Section 4.1.2.1, Table 4.1-10

Please provide the distances from the project area to all stations listed in Table 4.1-10.

Response

South Dakota	Distance from Project km (mi)
Hot Springs	32 (20)
Spearfish	129 (80)
Wyoming	
Douglas	142 (88)
Gillette	172 (107)
Irene Branch	98 (61)
Moorcroft	142 (88)
Stoddard Ranch	92 (57)
Torrington	138 (86)

Question: Section 4.1.2.2.2, Table 4.1-11

Please prepare a similar table listing the volumes of materials to be moved.

Response

This table will be provided in a revision to the ER in March 1980.

Question: <u>Section 4.1.2.2.3, p. 4.1-5</u>

With regard to emissions listed in Table 4.1-12, please cite the EPA citation and show how each source term was derived.

Response

The calculational methods and assumptions used to derive the source terms in the subject table will be provided as an appendix to the ER in March 1980.

Question: <u>Section 4.1.2.2.4, p. 4.1-6</u>

With regard to emission rates listed in Tables 4.1-14 and 4.1-15, please show how each source term was drived.

Response

The calculational methods and assumptions used to derive the source terms in the subject tables will be provided as an appendix to the ER in March 1980.

Question: <u>Section 4.1.2.2.4, p. 4.1-6 and 4.1-7</u>

Statements are made in this section that the maximum 24-hour average and annual average particulate concentrations produced by decommissioning activities when added to background are expected to be less than the most stringent State and Federal ambient standards. Please discuss your rationale for these statements in light of the fact that no background air quality data exist for the Edgemont area (p. 4.1-4). Also, please calculate the expected maximum 24-hour and annual average ground-level concentrations of suspended particulate matter in Cottonwood and Edgemont Communities. For each calculated concentration, state the direction and distance from the source, the source term, and all meteorological assumptions.

Response

Information in response to this request will be provided in a revision to the ER in March 1980 which will include an appendix showing the calculational methods and assumptions used to derive the concentrations.

Question: Section 4.1.2.3, p. 4.1-8

This section states the methods proposed to control dust. Further, "if these measures prove to be insufficient to control the dust, other mitigative measures will be implemented." Define the criteria for determining if the proposed measures are ineffective. How will you determine if these criteria are being met? Section 5.1.1, p. 5.1-1, states that particulate monitoring will not be conducted unless the State of South Dakota requires such a monitoring program.

Response

Information regarding the criteria that will be used to determine the effectiveness of measures to control dust and methods to be used to determine if the criteria are being met will be provided in a revision to the ER in March 1980. Discussion regarding necessary monitoring will also be provided.

Question: Section 4.2.2.1.3, p. 4.2-14

Please provide a discussion with figures regarding the system of dikes, trenches, ponds, or other appropriate measures proposed to prevent erosion and discharge of contaminated and uncontaminated runoff water.

Response

Refer to the following sections of revised Chapter 3 of the ER:

- 3.3, Disposal Site Preparation
- 3.4, Haul Road and Slurry Pipeline Construction
- 3.5, Mill Site Cleanup

Question: Section 4.2.2.1.3, p. 4.2-14

Locate on a map all areas to be designated for the storage of fuel, oil, and other hazardous or toxic materials.

Response

Any fuel oil to be stored will be located near the mill building (refer to Revised ER Figure 2.2-1 and Section 3.6.1, Equipment and Manpower Requirements of revised Chapter 3). Other hazardous or toxic materials which may be used for decommissioning are presently unknown. However, if such is needed, they will be properly contained.

Ore piles will be removed to a suitable ore storage area. A study has been proposed to determine the quantity of residual values of uranium and vanadium remaining in the tailings and if it would be economically practicable to recover these values.

Question: Section 4.2.2.2.2, p. 4.2-16

This section states: "During the decommissioning operation, all tailings and soils contaminated with significant quantities of nonradiological pollutants will be excavated and removed from the mill site, thus eliminating any future contaminations of the alluvial aquifer beneath the mill site." Please discuss more fully; what constitutes contamination? What is meant by significant quantities? How much material is expected to be moved?

Response

"Contamination" results in degrading water quality and to the extent the water becomes unfit for use for beneficial purposes, such contamination is environmentally significant. The objective of the decommissioning operation relative to water quality protection is to remove all sources of tailings, contaminated soils, and other materials that could degrade water quality below that level necessary for use for designated or otherwise appropriate beneficial purposes.

The State of South Dakota has classified the major surface streams and determined their appropriate beneficial uses. The Cheyenne River at Edgemont has been designated as suitable for the following uses: (1) warm water semipermanent fish life propagation; (2) limited contact recreation; (3) wildlife propagation and stock watering; and (4) irrigation. Cottonwood Creek is a minor stream and has not specifically been classified for any use; however, all streams in the State are generically assigned the beneficial uses of irrigation and wildlife propagation and stock watering. Specific standards have been established for each beneficial use. Ground waters are not specifically classified by the State; however, the alluvial aquifer system in the Edgemont area is generally suitable for irrigation and stock watering.

TVA's goal will be to remove all contaminated tailings and soils so that the surface waters (Cheyenne River and Cottonwood Creek) and ground water (alluvial aquifer) are not impacted by residual contaminated tailings and soils to the extent they would be unsuitable for the above beneficial uses. After removal of the radiologically contaminated strata, our plans are to obtain representative samples of (1) the strata below each tailing pond; (2) the streambed of Cottonwood Creek; (3) known seepage areas; (4) any other probable contaminated area that may be detected during decommissioning; and (5) control samples (uncontaminated strata) of each type strata believed to be contaminated. Samples will be analyzed for major cations associated with the tailings' liquors and if concentrations of any of the major cations (excluding non-problem cations such as calcium, magnesium, and potassium) in any suspect sample exceeds the average concentration plus the standard deviation of the control samples (for the same type of strata) by more than approximately 100-200 percent (the actual value will be coordinated with the State and NRC), the suspect sample will be considered to be significantly contaminated and the area will be excavated as deep as necessary to remove the contaminated strata.

Sampling will be keyed to substrates with relatively high clay content since clays would be the only material expected to significantly absorb cations from the leachate. Other type substrates will also be sampled, however, since changes in geochemistry might result in precipitation of contaminants.

The extent of the material that is contaminated can only be determined by actual sampling; however, clays normally exhibit a high cation absorption capacity and contamination is expected to be limited to a few feet at most. The extent of nonradiological contamination of the substrata will probably be within the same order of magnitude as that of the radiological contamination.

Question: Section 4.3 and Section 4.5, General

The U.S. Soil Conservation Service should review all areas likely to be disturbed for the presence of prime farmlands. Provide a letter from the state soil conservationist indicating if any prime farmland or additional land of statewide or local importance will be affected by the project.

Response

This information has been requested from the U.S. Soil Conservation Service at Hot Springs, South Dakota, and will be provided when it is received.

Question: Section 4.3.1, General

Will all of the reclaimed area have unrestricted use? If not, discuss the approved uses of the restricted areas and how these areas will be identified to ensure compliance.

Response

All of the reclaimed areas once reclamation is complete can be for unrestricted use except for that area designated for the disposal site [approximately 44.5 ha (110 acres)]. However, the use of alluvial ground water on the mill site should be restricted by the appropriate regulatory agency. TVA is proposing to reclaim the disposal site to its orignal use which was grazing. Lease agreements for such grazing should include provisions for an annual range survey and livestock reduction dur:ng years of drought or evidence of over-utilization.

Question: Section 4.3.2.2.2, p. 4.3-3

Please provide a letter from the State Historic and Preservation Office to document your statement that "No sites of historic significance on or adjacent to the proposed activities will be impacted."

Response

A copy of the October 17, 1979, letter from John J. Little, South Dakota State Historic Preservation Officer to Max Ramsey, Tennessee Valley Authority, providing concurrence with our findings is provided in Attachment 1.

Question: Section 4.3.2.3.3, p. 4.3-5

Archeological survey of disposal site: with ground visibility at 20 to 30 percent and being further reduced by 30 to 90 percent due to snow, the percentage of area that could have been observed during a visual survey at this time of year was 21 percent at a maximum or as low as 2 percent. Do you consider this to be an adequate survey? Was the area which contained the biface frag[illegible] resurveyed when ground visibility was greater? If so, what were the results?

Response

The survey was adequate and the State Historical Preservation Officer has concurred with TVA's findings. For example, numerous instances of sites where surface visibility ranged from 5 to 20 percent are reported in Haug 1978.[1] Archeology sites are seldom defined on the basis of a solitary artifact. It is rather the occurrence of evidence of repeated activities which are important. The area surrounding the biface locus was thoroughly recorded for any additional remains which resulted in none being found. It was therefore concluded that there were no other cultural remains in the vicinity. The area which contained the biface fragment was not resurveyed when ground visibility was greater.

Question: Section 4.3.2.3.4, p. 4.3-5

Please provide a letter from the state archaeologist verifying that no archaeological remains will be destroyed or made unrecoverable by decommissioning activities. The statement that "work should be halted" and "the South Dakota State Archeologist should be notified" in the event that any additional archaeological materials are encountered during decommissioning activities should be stated as commitments rather than what should be done.

Response

The State Historic Preservation Officer (SHPO) has the responsibility under the National Historic Preservation Act (Act) for ensuring compliance with the Act for projects involving Federal agencies. Consideration of impacts on archaeological resources was made as a part of the SHPO's review of the project. A letter from the SHPO assuring such compliance has been received and is provided in the response to question on Section 4.3.2.2.2, p. 4.3-3, above. Therefore, no further correspondence from the State is required to ensure TVA's compliance with laws concerning the protection of archaeological resources.

Question: Section 4.5.3, p. 4.5-3

Please provide a detailed discussion of your reclamation plans, including soil nutrient analysis, proposed species, mulching and irrigation requirements, time of planting, method of planting, etc. Also, describe your methodology for determining successful reclamation. Compare and discuss your proposed reclamation procedures and methods of determining successful reclamation with applicable state practices.

Response

Details of the reclamation plans will be provided in new ER Section 4.6.3, Reclamation, which will be provded as a revision to the ER.

Question: Section 4.5.3, p. 4.5-3

Please discuss any documented cases of reclamation in this area. Compare the proposed reclamation of the mill and disposal site to such documented cases with respect to soil, nutrients, climate, vegetative communities, etc.

Response

TVA reclamation to date has been mainly associated with uranium drill sites in Fall River and Custer Counties, South Dakota, and Weston County, Wyoming. This reclamation has provided us with experience in a wide diversity of soil, nutrient, and vegetative conditions. Verbal approval of our drill pad reclamation has been received from the Hot Springs Office, South Dakota Department of Conservation and Elk Mountain Ranger District, Black Hills National Forest; written approval has been received from the Land Quality Division, District IV, Wyoming Department of Environmental Quality. Experience with soil suitability, plant varieties, and planting time gained from reclamation of local disturbed sites provided useful background for development of the mill and disposal site reclamation plan. This plan which will be included as an amendment to the environmental report will be modified as necessary once soil tests from the topsoil acquisition areas have been completed.

Additional information used in development of the plan was derived from research conducted in Wyoming, Montana, North Dakota, and Colorado. Examples of research reports used are:

- Bjugstad, A. J., ND. Reestablishment of Woody Plants on Mine Spoils and Management of Mine Water Impoundments. In: The Reclamation of Disturbed Arid Lands. R. A. Wright (ed.), University of New Mexico Press, Albuquerque, New Mexico, p. 196.
- Howard, G. S., Rauzi, F., and Schuman, G. E., 1979. Woody Plant Trials at Six Mine Reclamation Sites in Wyoming and Colorado, USDA SEA Prod. Res. Rep. No. 177.
- Howard, G. S., Rauzi, R., and Schuman, G. E., 1977. Growth of Selected Plants on Wyoming Surface-Mined Soils and Flyash, J. Range Management 30(4):306-310.
- Orr, H. K. 1977. Reestablishment of Wooded Waterways and Associated Upland Shrub Communities in Surface Coal Mining Areas of the Northwestern Great Plains. In: Fifth Symp. Surf. Mining and Reclamation (October 18-20, 1977, Louisville, Kentucky).
- Schuman, G. E., Berg, W. A., and Power, J. F., 1976. Management of Mine Wastes in the Western United States. In: Land Application of Waste Materials, Soil Conservation Society of America; Ankeny, Iowa.

Question: Section 4.3, p. 4.3-7

Please provide the following references:

1. Mine Reclamation Consultants, Historical Resources in the Edgemont Lease Area, Unpublished Manuscript, TVA, Norris, Tennessee, 1977.
2. Haug, James K., 1978, Cultural Resources Survey and Selected Silver King Mines Properties in Custer and Fall River Counties, South Dakota. A report prepared for the Tennessee Valley Authority, Contract No. TV-46932A.
3. Sigstad, John S. and Jolly, R., 1975. An Archeological Survey of Portions of Fall River and Custer Counties, South Dakota. A report prepared for the Tennessee Valley Authority. Report on file South Dakota Archeological Research Center, Ft. Meade, South Dakota.

Response

1. The requested reference is a compilation of color slides of structures and man-made features on the lease areas, maps identifying their location, and inventory sheets keyed to the

slides and maps and, therefore, is bulky and difficult to reproduce. A set of this information was provided to the State Historic Preservation Office, (SHPO), and representatives of that office participated in a joint field review of the base area to evaluate the survey findings. The SHPO has concurred in TVA's cultural assessment determination (refer to response to question on Sect. 4.3.2.3.3, p. 4.3-5, above).

2. The requested reference has been provided under separate cover.
3. The requested reference has been provided under separate cover.

Question: Section 4.5, General

Provide soils maps (approximately 1" = 500') indicating the location of the mill complex, proposed disposal site and alternatives, and any borrow areas for soils required for clay liner and topsoil.

Response

Soils maps that are available are provided in Attachment 2 which includes a legend for the maps. No maps at a scale of 1" = 500' were available for alternative site 8, so maps at a scale of 1" = 1000' had to be substituted. A 1" = 500' scale map of the preferred site was available and it is included. No maps of a scale less than 1" = 250,000' and no Soil Conservation Service soil maps are available for alternative site 10.

Question: Section 4.5.3, p. 4.5-3

Will the revegetated areas be protected from disturbance? If so, how? And, for how long?

Response

Revegetated areas will be protected until reclamation is complete. Fencing of the mill and disposal sites will be used to control access onto revegetated areas.

Land use restrictions on the tailings disposal site should allow further protection subsequent to reclamation. Livestock grazing is presently the projected use for this site. Deferred grazing seasons, moderate grazing pressure (50 percent utilization of standing crop), and uniform animal distribution are methods that could be utilized to protect the integrity of the tailings containment.

Due to the unrestricted nature of the reclaimed mill site, the degree of disturbance which occurs after that area is released for use is up to the administrating authority.

Question: Section 4.5.3, p. 4.5-3

Approximately how many years will be required to return the disturbed areas to their former species diversity/productivity? Provide case histories if available.

Response

Ecological studies indicate natural primary succession requires from 20 years to several hundred years to reach climax.[2,3,4] How much of a reduction in this time span is accomplished by topsoiling, fertilization, and reseeding is unknown. However, primary production levels of predisturbance communities are usually eclipsed by revegetated sites during the second or third growing season.[5] No information is currently available as to the long-term productivity of reclaimed sites.

Question: Section 4.5.3, p. 4.5-3

Will irrigation be used for the establishment of vegetation on disturbed areas? By using irrigation would it be possible to include a larger number of native plant species in the seeding mixture? Is sufficient suitable water available for use in any irrigation plan? If so, where could it be obtained?

Response

Irrigation in combination with fertilization has been shown effective in establishing vegetation on disturbed sites.[6] This practice is in question, however, due to lack of information on plant survival once irrigation is stopped.

Since soil moisture appears to be the most limiting factor in seedling survival, irrigation would allow germination of a larger number of species. However, competition for existing moisture once irrigation stops will certainly cause the loss of less competitive species and possibly the entire plant cover.

Irrigation could be carried out only through development of a well and considering the limitations already described, water development costs would not be cost effective. Water conservation practices such as pitting or water spreading could enhance plant survival without creating artificial conditions.

Question: Section 4.6.1.1.1, p. 4.6-1

Please provide a map depicting the distribution of the principal plant communities of the project area including alternate disposal sites.

Response

Maps showing the distribution of the principal plant communities of the preferred site and site 8 are provided in Attachment 3.[7] There is no base map of alternative site 10 and therefore no vegetative base map can be provided. As indicated in letter from L. M. Mills to Jack Martin dated January 8, 1980, a map showing the topographical features of site 10 will be provided once ground control has been obtained. When this map is completed, TVA will be able to perform a survey to identify the distribution of principal plant communities which will be made available to NRC.

Question: Section 4.6.1, p. 4.6-1

It is recognized that the mill site is already highly disturbed and contains little, if any, undisturbed natural communities. However, the preferred and alternate disposal sites might be considered natural communities and should have been surveyed for biotic characteristics. Was onsite ecological sampling conducted? If so, please describe in detail all methodologies and provide the results. If not, please describe in detail any future plans to survey the sites and provide the data when available

Response

Alternative disposal site No. 8 was included in ecological baseline studies performed by TVA consultants in 1975 and 1976. Vegetative survey methods are described in response to the question on Sect. 4.6.1.1.1, p. 4.6-1 and Table 4.6-1, below. Results of the vegetative survey are shown in the response to the question on Sect. 4.6.1.1.1, p. 4.6-1, above. Results of wildlife studies and methods used are provided in a report prepared by Mine Reclamation Consultants.[7] Pertinent sections of this report have been provided under separate cover.

The sequence of the ecological study of the preferred site should be as follows:

1. May 1980 - Analysis of soils for texture, pH, sodium content, sodium absorption ratio, electrical conductivity, nitrogen, phosphorus, potassium, selenium, iron, copper, and molybdenum content.
2. May 1980 - Avian census (within target plant communities) by line transects.
3. June 1980 - Big game days-use (within target plant communities) by line transects.
   - Estimation of ground cover and species composition for target plant communities. Line intercept sampling at randomly located stations in target plant communities will be used to generate such data.
   - Live trap estimates of small mammal populations taken at selected plant sampling stations.
4. September 1980 - Repeat Avian census.
5. October 1980 - Repeat big game days-use transects.
   - Analyze data.

Question: Section 4.6.1.1.1, p. 4.6-1 and Table 4.6-1

Please describe the methods used to determine the average total percent ground cover.

Response

Vegetation types were delinated by visual reconnaissance whereby sampling sites were located within representative types. At each sampling site, fifteen 0.6 x 0.6 m (2 ft. x 2 ft.) plots were distributed in a stratified random pattern [five plots within each of three 30.5 m (100 ft) transect lines]. Estimates of percentage ground cover for graminoids and forbs were then made for each plot. Three 30.5 m (100 ft.) transect lines were located in a stratified random pattern at the same sampling stations for line intercept determination of percentage shrub cover. The portion of shrub intercepted by the line was measured and recorded.

Average cover from each group of five plots was totaled and divided by three for average ground cover. To this was added the average of the three lines for the same site. This figure then represented average total percentage ground cover.

Question: <u>Section 4.6.1.1.1, p. 4.6-2</u>

This section states that as of January 1, 1979, no threatened or endangered plant species were known to occur on or near the disposal site. Based on a review of known distributions of threatened and endangered plant species and their habitat requirements, do potentially suitable habitats for these species occur within the areas proposed to be disturbed? (Explain.) Within the proposed alternate disposal sites? (Explain.) If so, were the potential habitats searched during appropriate times of the year? (Explain.)

<u>Response</u>

According to South Dakota Statutes 41-2-32, 41-2-18, and 34A-8-3, there are no plant species classified as threatened or endangered within the State.

Question: <u>Section 4.6.1.2.1, p. 4.6-3</u>

Because the project area could provide potential habitat for threaten' or endangered fauna, were all suitable habitats on and adjacent to areas proposed to be disturbed searched for such species during appropriate times of the year? Explain.

Response

Refer to response to the question on Sect. 4.6.1.2.1, p. 4.6-4, below.

Question: Section 4.6.1.2.1, p. 4.6-3

Do any prairie dog towns occur on or within a 1-mile radius of the mill, proposed disposal site, and alternate sites? If so, explain.

Response

There are no known prairie dog towns within 3.2 km (2 mi) of the mill or proposed disposal site.[7,8] Site 8 (Darrow open pits) lies 2.9 km (1.8 mi) northeast of an extensive prairie dog town in the NE 1/4 Sect. 15 T7S-R1E and SE 1/4 SW 1/4 Sect. 10 T7S-R1E. This town was surveyed in September 1977 and May 1979 for blackfooted ferrets. None were found during either survey. Site 10 lies within 0.8 km (0.5 mi) of an active prairie dog town, and to date TVA is unaware of any ferret surveys conducted in this town.

Question: Section 4.6.1.2.1, p. 4.6-4

Does the State of South Dakota have a list of endangered, threatened, rare, etc., species that supplements the Federal listing? If so, please provide a copy of this document.

Response

The State of South Dakota has a list of endangered and threatened species and is provided in Attachment 4. The State does not have any mollusks, plants, or crustaceans listed. Surveys for the presence of northern swift fox (*Vulpes velox hebes*) were conducted on the preferred site in May 1979. Habitat for river otter (*Lutra canadensis interior*), mountain lion (*Felix concolor*), and black bear (Ursus americanus) does not exist on the preferred site or Site 10. Although bear and mountain lion habitat once existed at Site 8, previous mining activity has rendered the site unsuitable for either species.

Only one fish species of concern, the plains topminnow a South Dakota threatened species, has been reported from the Cheyenne River adjacent to Edgemont. For additional discussion, refer to response to the question on Sect. 4.6.2.2, Fish, of Enclosure 2.

No surveys of the preferred site or Site 10 for threatened and endangered raptor or reptile/amphibian species has been made. A survey of Site 8 for threatened and endangered raptor nesting areas was conducted in May 1979.

Question: Section 4.6.1.2.3, p. 4.6-4

Please provide a detailed description of your plans to create riparian habitat at the mill site.

Response

Routing of Cottonwood Creek will approximate the historic channel configuration. Banks will be graded to a 10-degree slope with curves and berm crossings rip-rapped as necessary. The banks will be topdressed with 15 cm (6 in) to 21 cm (8 in) of soil suitable for plant growth.

Small to medium cobble (32-129 mm) may be added at random intervals in the stream channel to provide colonizing surfaces for benthos. Rip-rapping material may also be placed against banks or in midstream to provide additional aquatic habitat.

The following steps are currently anticipated to be followed in an attempt to establish a riparian-type community.

1. Streambank wheatgrass, western wheatgrass and yellow sweetclover will be seeded in a 10 m (30 ft) wide bank along both sides of the channel.
2. During the grass/forb mixture's second growing season, containerized shrub and tree seedlings will be planted in two 2.4 m (8 ft) wide bands plowed along the channel. The bands should be approximately 5 m (16 ft) apart to reduce competition. (The seedlings will be over-wintered in a lath house at the site to improve survival.)
3. Pygm [illegible]ashrub and willow seedlings will be planted at 1.5 m intervals in the streamside band with plains cottonwood seedlings replacing a shrub at each 20 m (65 ft) interval.
4. Russian olive, chokecherry, and buffaloberry will be planted at 1.5 m intervals in the outermost band.

Question: Section 5.1.1, p. 5.1-1

Please provide letters from all appropriate regulatory authorities stating applicable air quality monitoring requirements.

Response

It is anticipated that the requested letters will be available for submittal in March 1980.

Question: Section 6.0, General

Please describe the methodology used for alternate site selection. Include (1) a list of all selection criteria considered, including environmental factors, (2) how these criteria were weighted, and (3) a detailed discussion of the rationale for selecting the preferred alternative. Information presented for the alternate sites should be comparable to that provided for the preferred action.

Response

The requested information is in the process of being prepared for submittal. This information will be consistent with that presented to NRC, EPA, and the State of South Dakota at the meeting held in Edgemont, South Dakota, on August 30, 1979.

Question: Section 6.6, p. 6.6-4

Please provide the following report: Schreibeis, R., Morton May, and Robert Long, Vegetation Report--TVA Edgemont Leases, Unpublished Manuscript, TVA Norris, Tennessee, 1977.

Response

The vegetation information contained in the requested report is available within the unpublished manuscript by Mine Reclamatin Consultants[7] which has been provided under separate cover.

ENCLOSURE 2

Comments Concerning Surface Water Hydrology, Water Quality, Aquatic Biota, and Related Factors

Question: Section 2.1

The specific extent of erosion and potential leakage composition from the mill tailing site must be provided to address potential effects of leakages on water quality and stream biota of the Cheyenne River downriver from the proposed site.

Response

Erosion control measures are a key component of the proposed design. The measures include a sediment pond downstream of the impoundment dike, diversion ditches around the disposal site, the use of flat slopes for the impoundment, the siting of the disposal area at the drainage head, and other measures of site stabilization such as revegetation. These measures in conjunction with any additional actions that are warranted based on results of routine inspections and monitoring should assure that erosion and its effects on water quality and stream biota of the Cheyenne River are minimized (refer also to response to the question on Sect. 4.2, 4.2-14).

Similarly, reasonable assurance will be provided by the design of the disposal site to preclude seepage. However, long-term seepage will always be uncertain and additional protective measures cannot be justified as supported by NRC's "Draft Generic Environmental Impact Statement on Uranium Milling," April 1979 (refer to response to the question on Sect. 4.7, 4.7-2, below).

Based upon the proposed design and TVA data, it is expected that the effects on surface water quality of leakage from the tailings from the proposed disposal site will be small and probably nondetectable (refer to response to the question on Sect. 5.1.2, Surface Water, below).

Question: Section 4.2

Figure 4.2-1 is difficult to read. The applicant should provide a clear surface water map of the area specifically identifying locations of preferred and alternate sites and potentially effected water bodies.

What measures will be taken to prevent runoff onto and from the disposal site, and to prevent failure of the diversion ditches, and containment dike? The applicant should specify the expected life of the diversion ditches, their effectiveness, and how their effectiveness will be guaranteed.

What measures will be taken in the event of erosion from the disposal site to alleviate erosion? What steps will the applicant take to prevent runoff from reaching the Cheyenne River in the event of tailings erosion or dam failure?

Response

A regional map showing surface water features and disposal site locations is provided in Figure 1, attached. Figure 4.2-6 of the ER shows general locations of the sites with respect to the Cheyenne River. ER Figures 4.2-1, 4.2-2, 6.2-1, and 6.2-2 show the detailed drainage at each site and are reproductions of available topographic maps.

Refer to the following sections of revised Chapter 3 of the ER for discussion regarding diversion ditches and erosion control:

- 3.3, Disposal Site Preparation
- 3.4, Haul Road and Slurry Pipeline Construction
- 3.5, Mill Site Cleanup

The diversion dikes will remain for the life of the project. Routine inspections will be performed to ensure that the diversion ditches are properly maintained (refer to response to the question on Sect. 4.7, 4.7-2, below).

Question: Section 4.2, 4.2-6

The second paragraph says "There would be some increase in erosion and sedimentation in the drainage system during the period following closure of the containment area. . . ." Where will erosion be from? What effect will this have on the containment area and how will it be reduced or eliminated?

Mitigation calls for diversion of surface and subsurface runoff away from the containment area. What steps will be taken to alleviate erosion as a result of the diversion ditches channeling water with a confined outlet? What backup measures will be taken to reduce erosion from the containment site and the topsoil repository to reduce sediment in receiving water bodies?

Response

Erosion may occur from disturbed areas prior to reestablishment of vegetation. A sediment pond constructed below the impoundment dike will control any sediment runoff from these areas. For additional information, see revised Section 3.3, Disposal Site Preparation, of revised Chapter 3 of the ER.

Question: Section 4.2, 4.2-7

Will removal of contaminated material from existing stream banks at the milling site mobilize additional sediment and nonradioactive contaminants? If so, what measures will be taken to keep these out of the adjacent water bodies? What is the chemical composition of Cottonwood Creek and Cheyenne River sediments? What will be the effect on water quality and stream biota if these sediments are disturbed?

Response

During removal of contaminated material from stream banks at the mill site, excavating, loading, and hauling equipment will disturb soil at the site and cause temporary increases in loose soil and dust. Measures to protect adjacent water bodies from possible sediment-laden runoff would be those normally used during construction such as diverting runoff away from the disturbed area, controlling sediment-laden runoff on site by use of sedimentation ponds. Final site grading and reclamation would include contouring, topsoiling, and seeding to prevent erosion of the site. Mitigation measures for fugitive dust control are discussed in Section 4.1.2.3. Mitigation measures for protection of adjacent water bodies are discussed in Section 4.2.2.1.3.

Material disturbed within that area of the banks of Cottonwood Creek or the Cheyenne River between the stream bed and the top of banks would be subject to movement by wind, rainfall, and rises on these streams. A discussion of holding the bank material in place after disturbance will be contained in new ER Section 4.6.3, Reclamation, which will be provided at a later date. It is probable that some loose material will enter Cottonwood Creek and the Cheyenne River before it can be stabilized and be transported downstream during rises on these streams. Such movement could cause temporary, short-term increases in sediment concentrations and loads in the streams near the site, but the effects would very likely be undetectable a few miles downstream from the site. Section 3.5, Mill Site Cleanup, of revised Chapter 3 of the ER includes detailed plans for diversion of surface runoff at the mill site prior to cleanup operations and of the Cottonwood Creek channel diversion. These plans will prevent, to a large extent, the movement of sediment from the mill site.

The chemical composition of Cottonwood Creek and Cheyenne River sediments is not known at this time. The sediments will be analyzed to determine their degree of contamination and whether cleanup is warranted (see response to the question on Sect. 4.2.2.2.2, 4.2-16 of Enclosure 1). If cleanup is warranted, it would be scheduled at the end of the project.

Effects on downstream water quality and stream biota would be minimal. Cottonwood Creek will be diverted before cleanup in the immediate vicinity, thereby precluding further migration or loss of contaminants during the operation (refer to Section 3.5.2.1, Cleanup of Cottonwood Creek, of revised Chapter 3 of the ER). If any of the Cheyenne River sediments required removal, the cleanup would be scheduled during the low flow seasons of fall and winter (weather permitting) when most of the sediments would be exposed. Specific mitigative techniques for minimizing further migration of the contaminants in the Cheyenne River would be dependent upon the size and location of the contaminated sediments in relation to stream flow.

Question: Section 4.2, 4.2-7

Figure 4.2-2 location and identification of water quality monitoring sites should be clearly indicated on the map.

Response

The figure (see attached Figure 2) has been modified slightly to improve the clarity of the water quality monitoring stations. Station S-8 was inadvertently omitted from ER Figure 4.2-2.

Question: Section 4.2

Impacts. Last sentence of first paragraph. The applicant must present a plan outlining how subsurface drainage encountered below the tailings will be controlled on a long-term basis.

Response

It is assumed that this comment refers to Section 4.2.1.2.2, last sentence, first paragraph. A description of preparation of the disposal site in Section 3.3, Disposal Site Preparation, of revised Chapter 3 of the ER indicates that excavation of the disposal area will extend into the existing shale underlying the overburden material. It is anticipated that the shale will have low permeability and no control of subsurface drainage will be required. If engineering tests indicate this is not the case, additional excavation will be required and a clay liner installed over the disposal excavation to control subsurface drainage. Also see response to question on Section 4.7, 4.7-2, below.

Question: Section 4.2, 4.2-14

Mitigation. The applicant should submit a specific plan of erosion control measures to be taken at the mill site during decommissioning. The applicant should outline a monitoring program for implementation to ensure that water quality is not degraded by sediment or chemical contamination during decommissioning. If sedimentation is occurring even with control measures, what additional steps will be taken to alleviate the problem?

Response

A discussion of the erosion control plan is presented in revised Chapter 3 of the ER.

A surface water monitoring program is being planned for the mill site. Details will be finalized in coordination with the appropriate regulatory agencies.

Measures which TVA will take to address surface water quality issues are:

1. Establish an adequate water quality data base for predicting impacts of the decommissioning activities and for determining the actual impacts resulting from the activities.

   The key variables that need to be considered are flow, time, and point source and nonpoint source discharges resulting from human activities. The data base for the period December 1974 through September 1977 provides basic information on water quality during the high runoff season (May-July) and the low flow season (fall and winter months), but lacks sufficient depth to characterize water quality for a typical portion of the hydrograph prior to, during, and after a precipitation event of sufficient size to cause a substantial rapid change in stream stage or flow--a period in which water quality may change dramatically. Such data in conjunction with land use and other information is needed seasonally to quantitatively predict and document the impacts of the decommissioning activities upon water quality. TVA intends to begin collecting this type of baseline beginning in the spring of 1980.

2. Quantify water quality impacts of the proposed decommissioning activities to determine the conditions that may require use of additional mitigative measures.

   The only practical way to quantify the effects of the many variables that determine the probable hydrologic consequences of the decommissioning activities is through mathematical models. TVA is initiating actions for the adaptation of and/or development and use of such models for our uranium mining and milling activities. TVA plans to have model results available before tailings removal begins in order to identify additional mitigative measures as appropriate.

3. Determine and document the actual effectiveness of the mitigative measures used during the decommissioning activities.

   This will be achieved by a flexible site monitoring program tailored specifically to the nature of the decommissioning activities underway at any particular time. A good example of this type of monitoring would be that for determining the effectiveness of erosion control measures. Water quality (suspended solids) would be monitored downstream of disturbed areas several times during a precipitation event large enough to cause substantial runoff from the site, and compared to upstream control water quality to determine if additional mitigative measures are warranted. This would be done as practicable for each significant precipitation event until the effectiveness of the erosion control measures is demonstrated.

4. Determine and document the actual impact of the decommissioning activities upon the water quality of the Cheyenne River.

This will be achieved by implementing a monitoring program similar to the baseline program in conjunction with the monitoring for determining the effectiveness of the mitigative measures.

Definition of additional steps if sedimentation occurs with control measures would be dependent upon the reason or cause for the problem. The proposed monitoring program will identify whether sedimentation is likely to be a problem and the source of the sedimentation.

Question: Section 4.2

Table 4.2-3 and Table 4.2-4. (1) The applicant needs to give rationale for the limited number of samples taken for both chemical and physical water quality parameters. (2) Was the data presented in the tables collected on a seasonal basis? From the present data, it cannot be determined that the data presented in the table are not biased by time of sampling and limited number of samples. (3) Sampling stations on the Cheyenne River need to be located specifically above and below potential runoff from the disposal site. Water quality and biological data monitoring programs below the disposal site must be specifically established so that baseline data can be obtained prior to construction at the disposal site. The applicant needs to provide a discussion of the parameters analyzed, their compliance with EPA and SD water standards, and the effects of decommissioning on these water quality parameters.

Response

The wide range in the number of samples is a result of including data from all known sampling efforts. The surveys were conducted independently over a period of time by several agencies for different purposes. TVA's baseline surveys were conducted during the period September 1975 to September 1977 and these efforts were relatively consistent in detail. Minor adjustments were made beginning in June 1977, primarily adding a few parameters of interest and dropping a few parameters with concentrations below detectable limits. The few analyses reported for the periods

December 1974 and June 1975 are a result of preliminary site surveys.

TVA's data was collected semiannually during the high runoff season (May-July) and the low flow season (fall and winter months). Data for each TVA sampling effort has been forwarded to NRC's contractor, Oak Ridge National Laboratory.

TVA sampling stations for the Cheyenne River are shown in Figure 4.2-6 of the ER and are located above and below potential runoff from the disposal site. Baseline water quality and aquatic biological data are currently available, and as indicated in response to the question on Section 4.2, 4.2-14 above, additional water quality baseline data will be collected during 1980. A discussion of the water quality paramaters analyzed and a comparison with EPA and SD standards is contained in Section 4.2.2.1.1, and the effects of decommissioning is discussed generally in Sections 4.2.2.1.2 and 4.2.2.1.3. A more specific discussion of impacts will be included in a revision to the ER.

Attachment 5 is a plan for monitoring decommissioning impacts upon aquatic biota. This plan will specifically monitor biological communities downstream of the disposal area, in the Cheyenne River, and in Cottonwood Creek.

Question: Section 4.6.1.2, Impacts

"Decommissioning may require the rerouting of a reach of Cottonwood Creek" (1st sentence).

Section 4.2.1.1.2, Impacts, (paragraph 4) "The realignment and rip-rap of the banks of Cottonwood Creek through the tailings area are needed." Present a plan for decontamination of the streambed and margins. Include methods to be employed to reduce sedimentation and to provide habitat to restore aquatic productivity to Cottonwood Creek in the mill area.

1. Why should decommissioning require rerouting if tailings are to be removed?

2. What would be the extent of rerouting, i.e., how long a reach of the stream?

3. Show that rerouting itself would not cause mobilization of contaminants.

4. Where would the rerouted channel be located, particularly with respect to tailings piles?

5. What measures would be taken to reduce or prevent degradation of water quality and effects on stream biota?

6. What measures would be taken to prevent erosion of the newly created streambanks?

Response

1. Cottonwood Creek will be rerouted temporarily during mill site cleanup operations as discussed in Section 3.5.2.1, Cleanup of Cottonwood Creek, of revised Chapter 3 of the ER. After the eastern portion of the mill site has been cleaned, the permanent route for Cottonwood Creek will be prepared. It is expected to follow the original creek channel as close as practicable to form a gentle meandering course through the former mill site.
2. Cottonwood Creek will be diverted from a point prior to its entry on the mill site as shown on Figure 3.5-3 of revised Chapter 3 of the ER.
3. Information in response to this question is provided in response to question on Section 4.2, 4.2-7, above.
4. The location of the rerouted channel is shown on Figure 3.5-3 of revised Chapter 3 of the ER.

5. & 6. Degradation of water quality due to siltation can occur after reshaping the stream channel. Three methods will be employed to reduce erosion of the streambanks.

   a. Grade banks to a 10-degree slope.

   b. If rechannelization is completed in late spring, oats or barley can be seeded into the banks to provide rapid cover. Then in early fall, streambank wheatgrass, western wheatgrass, and yellow sweetclover will be seeded directly into the grain stubble to provide the permanent cover.

   c. Completion of rechannelization in late summer or early fall will require stabilization of the banks with native hay or acrylic/wood fiber mulch. The reclamation mixture could either be applied directly with the acrylic/wood fiber mulch or drilled into the banks and covered with the hay mulch.

Question: <u>Section 4.6.2, Aquatic</u>

There should definitely be data provided (TVA report) on "nonfish" biota. The applicant should provide data on number of individuals of collected taxa, taxa present, faunal diversity, date of sampling and number and type of samples at each site. (He should provide substrate (habitat type, i.e., pool, riffle) and water quality data at time of sampling.) The applicant should locate additional sampling sites on the Cheyenne River where tailings could enter the river from the proposed disposal site so that baseline data can be obtained prior to construction. The applicant should provide data on submerged and emergent vegetation in the water bodies sampled.

<u>Response</u>

A draft copy of the data (TVA report) was provided by letter dated November 13, 1979, from R. H. Shell (TVA) to Virginia Tolbert (Oak Ridge National Laboratory). The final report is provided in

Attachment 12. Plans for additional monitoring are outlined in response to the question on Section 4.2, above.

Question: Section 4.6.2.2, Fish

When and how many fish samples were taken? The applicant should explain why only 7 of the 34 species reported from the Cheyenne River drainage were collected. At present the low number of species collected points toward inadequate sampling. What about the remaining 27 species listed by Bailey (1962); are any of the remaining 27 species endangered or threatened?

Response

Explanation as to sampling techniques, species, and relative abundance are included in a report which was prepared for TVA's proposed Edgemont uranium mining project (refer to Attachment 6) of which the above is also applicable to the mill decommissioning.

Additional sampling reported the collection of 12 species in the Cheyenne River above Angostura Reservoir. While Bailey and Allum (1962)[9] collected 34 species throughout the Cheyenne River, the number of species collected from Angostura Dam upstream to the Fall River County line was 12 species, of which 3 were reservoir residents only. The remaining 22 species collected downstream in the Cheyenne were collected in tributaries (such as the Fall River) and in larger segments of the Cheyenne itself. As Angostura Dam blocks any potential immigration of the remaining 22 species into the section of the Cheyenne River around Edgemont, the mill decommissioning should have no impact on these species.

Only one species of concern, the plains topminnow Fundulus sciadicus, a South Dakota threatened species, has been reported from the Cheyenne River adjacent to Edgemont. Baxter and Simon (1970)[10] report the plains topminnow to be introduced to the Cheyenne River in Wyoming where it occurs in headwater streams. Collections by Bailey and Allum (1962)[9] did not record the plains topminnow in the Cheyenne River drainage in South Dakota. The preferred habitat for this species is aquatic vegetation. Natural fluctuations between wet/dry years or high/low flows within a year will make the location of the habitat variable. Most recent collections in areas adjacent to Edgemont did not record the presence of the topminnow or the preferred habitat. It appears that the plains topminnow is a transient species and its presence or absence will depend on the presence of the preferred habitat.

Attachment 7 compares the reported collections of species in the Cheyenne River.

Question: <u>Section 4.7, 4.7-2</u>

"Temporary and long-term control of runoff at the proposed disposal site may also be required." This does not seem compatible with the statement of no maintenance revegetation and self-maintaining runoff diversion. These cause some concern for the effectiveness and long-term stability of the containment dike. Specific information should be provided by the applicant on (1) the type diversion ditches to be used, (2) how the applicant will ensure long-term stability, (3) the probability of diversion ditch failure, (4) the effects of erosion and runoff in the event of failure, (5) measures to be taken and responsibility for correction in the event of failure, (6) expected life of the diversion ditches, and (7) how the diversion system will contribute to diversion of subsurface flow.

Should the lining at the disposal site do more than just minimize leaching and seepage into area waters since ground water could be in close proximity to the tailings and ground water has a history of getting into surface water in the Edgemont area? Give rationale for not using an artificial liner in addition to the clay liner. How close will ground water be to the tailings at the disposal site, i.e., how far below the tailings?

<u>Response</u>

A surface runoff isolation course will be prepared at the disposal site which will be excavated into the shale, thereby aiding in the removal of perched water as well as surface flow. The isolation course will be designed to handle runoff from a 100-year flood event. The isolation course will be sloped and revegetated to control erosion. Regular inspections will be performed and any necessary maintenance will be undertaken. In the unlikely event of failure of the isolation course during decommissioning operations, offsite runoff would reach the containmnet area. The water would be impounded and would evaporate from the decant pond and steps would be taken to repair the isolation course. After decommissioning, the impoundment area will be contoured so that runoff from it will be directed to the isolation courses. A discussion of the diversion ditches to be used at the disposal site is provided in Section 3.3, Disposal Site Preparation, of revised Chapter 3 of the ER. Refer also to response to question on Section 4.2, above.

TVA has utilized the relevant criteria set forth in NRC's "Draft Generic Environmental Impact Statement on Uranium Milling," April 1979 and in proposed Appendix A to 10 CFR Part 40 (44 Fed. Reg. 50,020, 1979) in designing the disposal site. NRC believes that these designs will provide reasonable assurance that seepage is precluded over both the short and long term. Although long-term stability, of course, will always to somewhat uncertain as recognized by the NRC design criteria, additional protective measures cannot be justified for this case. Moreover, the radioactivity in the tailings, unlike high level nuclear waste, poses a chronic as opposed to an acute hazard. Long and sustained exposure to radioactivity in the tailings pile would be required to produce detectable adverse effects. If degradation or failure of isolation were to occur, it would not lead to catastrophic radiation effects, and there would be ample time to take corrective action.

At present a clay liner is not anticipated. An artificial liner is not being considered because of numerous problems associated with its use. Difficulty in placing an artificial liner, problems of tearing during placement and during disposal operations, the necessity of providing a suitable base such as a clay layer in addition to a cover to make a suitable working surface, would greatly increase the cost without additional benefits. In addition, the reliability and longevity of an artificial liner have not been proven to the point of justifying the additional expense involved in purchasing and placing it. If a clay liner is necessary, this in addition to the shale below the disposal site should be sufficient to prevent contamination of ground water.

Detailed information regarding the depth of ground water in relation to the tailings at the disposal site will be provided at a later date. A typical stratigraphic column showing depths of aquifers is provided in ER Figure 3.3-2 of revised Chapter 3.

Question: <u>Section 5.1.2, Surface Water</u>

How often will inspections of the disposal site be made and how long will these inspections continue? Will there be surface water monitoring for ground water quality prior to and following decommissioning to detect leakage from under mine tailings at mill and disposal sites after decommissioning? There should be a specific monitoring plan to be implemented after decommissioning to ensure adequate monitoring of water quality for comparison with predecommissioning data.

Response

The disposal site will be routinely inspected by environmental personnel during sampling visits and at other times (which is expected to be frequent) to assure that mitigative measures for protection of water quality are implemented and are effective. Surface water monitoring will be conducted as described in Sections 5.1.2.2.1 and 5.1.5 of the ER. Specific details, including frequencies, are to be coordinated with the appropriate regulatory agencies (see response to the question on Section 4.2, 4.2-14, above) prior to implementation.

The effects on surface water quality of leakage from the tailings at the existing mill and from the proposed disposal site are expected to be small and probably nondetectable. Nonradiological data collected by TVA during the period September 1975 through September 1977 indicate that the contaminated ground water at the existing mill site was not adversely impacting the surface water quality of Cottonwood Creek and the Cheyenne River (see the Environmental Report, p. 4.2-16, last paragraph). A similar conclusion was made by Ford, Bacon & Davis Utah, Inc., in their "Engineering Assessment of Inactive Uranium Mill Tailings, Edgemont Site, Edgemont, South Dakota, May 1978." The proposed disposal site will be designed and constructed to effectively preclude seepage from the tailings (refer to Section 3.3, Disposal Site Preparation, of revised Chapter 3 of the ER).

Question: Sections 5.1.4.2.1, Nonfish and 5.1.4.2.2, Fish

The applicant should specify a replicated sampling program to be implemented after decommissioning corresponding to the same sites and time intervals as the baseline sampling program. This will ensure that data and sites are comparable for nonfish (benthos) and fish, both before and after decommissioning. Siltation as well as contaminants released during decommissioning could have a considerable impact on both benthos and fish (see Section 4.6.2. question, page 4).

Response

Refer to response to the question on Section 4.2, above.

Long-term monitoring beyond that specified in Attachment 5 will not be required unless significant construction impacts are documented. In such a case, monitoring will continue until the impacts are fully assessed (impacted community stabilizes).

Question: Section 6.2, Water

Alternative A Impact--As discussed in Section 4.2.2.2.1 (p. 4.2-15) there is contamination of both surface and ground water as a result of seepage from the tailing pond area. The applicant needs to present data on the extent of seepage at the mill site if this alternative is to be seriously considered. What would be the impact to the aquatic system of a 100-year flood escaping from the diversion ditch and entering the reclaimed area if this site was chosen?

Response

The ground water data show that the alluvial aquifer in the vicinity of the tailings ponds is heavily contaminated; however, the surface water data indicate that the contaminated ground water was not adversely impacting the water quality of Cottonwood Creek and the Cheyenne River (see response to the question on Section 5.1.2, Surface Water, above). Ground water data for 14 piezometers are listed in Table 4.2-7 and discussed in Section 4.2.2.2.1. These data, along with the ground water contours (Figure 4.2-4) indicate contamination would be confined to the near vicinity of the ponds and west to Cottonwood Creek and north to the Cheyenne River. If the natural hydraulic gradient is maintained, the fate of the contaminants not adsorbed or precipitated on the alluvial materials would eventually be to these two surface waters. If Alternative A was to be selected, a hydrologic barrier would be established around the ponds so that the contaminants would be thereafter effectively isolated and contained with no further movement.

The impact to the aquatic system of a flood escaping from the diversion ditch should be minimal as long as the integrity of the hydrologic barrier was not seriously impacted. The barrier would consist of a very low permeability material surrounding the tailings. This barrier would still be present if a flood breached the diversion ditch.

ENCLOSURE 3

Hydrology/Geology Comments and Questions

Question: General

The geology and seismology sections will need to be rewritten. As stated in previous correspondence, the geology section should include a discussion of the regional and site-specific structure, stratigraphy, and paleotectonic history. A regional and site-specific stratigraphic column will be required. A map indicating regional structural trends, and local active and inactive faults would be beneficial.

The seismology section should include historical or instrumentally recorded data indicating the number and magnitude and/or intensity of earthquakes that have occurred within a 160 km (100 miles) radius of the proposed disposal site.

Response

Revised ER Section 4.4, Geology, will provide a generalized discussion of the geology of the proposed disposal site. Also included in revised Chapter 3 of the ER is a stratigraphic column of the site prepared from available onsite data. More detailed stratigraphic and site-specific structural information will be available upon completion of field examinations (refer to response to the question on Proposed Disposal Site, below).

Seismicity of an area within 125 miles of the proposed disposal site will be included in revised Section 4.4, Geology, of the ER. A discussion of the regional structure of the Southern Black Hills and the paleotectonic history of the Southern Black Hills are provided in Attachments 8 and 9, respectively. Included also are regional structure maps for reference. In addition, a regional stratigraphic column is provided in Attachment 10.

Question: Proposed Disposal Site

Detailed hydrologic and geologic data will be needed for this site. In addition, please include the following:

1. Geologic cross sections parallel and perpendicular to the embankment.

2. Piezometric maps of the perched ground water at the disposal site and surrounding area.

Are monitoring wells going to be placed below (topographically) the embankment, and down-dip (geologically) the disposal site? If not, please explain why.

If monitoring wells are to be used, existing data on ground water quality at the disposal site will be needed.

Response

1. ER Figures 3.3-2 and 3.3-3 of revised Chapter 3 show a generalized stratigraphic column at the disposal site and a cross section of the impoundment dike, respectively. A more detailed description of the stratigraphy will not be available until the conclusion of field examinations which are now scheduled for the spring 1980. In the interim, a generalized discussion of the stratigraphy will be provided in revised Section 4.4, Geology, of the ER.

2. Figure 3-25 of the Engineering Analysis of Mill Facility Decommissioning and Long Term Tailings Stabilization [illegible] Remote Disposal Site Edgemont Site, Edgemont, South [illegible] January 1979, prepared for TVA by Ford, Bacon and Davis Utah, Inc., is a general map of perched ground water at the disposal site and surrounding area. Additional information will be provided following completion of field surveys.

Based on the conservative design of the disposal site (refer to revised Chapter 3 of the ER) TVA does not believe ground water will be impacted during the short and long term and therefore TVA does not propose any ground water monitoring for the disposal site.

Question: Present Tailings Site

Please discuss plans for the removal of existing contaminated soil material and ground water below the present site.

Response

A discussion of mill site cleanup is provided in Section 3.5, Mill Site Cleanup, of revised Chapter 3 of the ER.

Question: Transport of Tailings

If a pipeline slurry process will be used to transport the tailings, please indicate the water source(s) and give the total estimated consumptive use for each source.

Response

Information regarding the use of slurry pipeline is provided in Section 3.5.2.2, Handling Sequence of Tailings and Contaminated Material, of revised Chapter 3 of the ER.

Question: Alternative Sites

Please prepare a brief table listing the geologic and hydrologic advantages and disadvantages of alternative sites 8, 10, B, and the preferred site.

Response

Attachment 11 is a table giving a listing of information available regarding the geologic and hydrologic advantages of the requested sites. Most of this information was obtained from "Engineering Analysis of Mill Facility Decommissioning and Long Term Tailings Stabilization at a Remote Disposal Site, Edgemont Site, Edgemont, South Dakota" prepared by Ford, Bacon & Davis Utah, Inc., for TVA, January 1979.

ENCLOSURE 4

Additional Questions on the Edgemont Decommissioning

Question: Section 2.3

Please revise Table 2.3-1 to reflect the amount of substrate expected to be removed along with the tailing.

Response

Refer to revised Table 2.3-1 of the ER. Note that some of the values on this table have been revised since the transmittal of this table by letter from L. M. Mills (TVA) to Jack Martin (NRC) dated October 18, 1979.

Question: Section 3.2.2

Please locate the slurry pipeline on Figure 2.1-3.

Response

The location of the slurry pipeline is provided on revised Figure 3.3-4 of revised Chapter 3 of the ER.

Question: Sections 3.2.2.1 and 3.2.2.3

Revise these sections to reflect the use of the slurry pipeline. Provide more details of transportation and handling for wet tailing.

Response

Information regarding the use of the slurry pipeline and transportation of materials is provided in ER Sections 3.4, Haul Road and Slurry Pipeline Construction, and 3.5.2, Disposal of Tailings and Contaminated Material, of revised Chapter 3 of the ER.

Question: Section 3.2.2.2

This section is woefully inadequate to assess the impact of emplacement of wet tailings. Please revise the height of the dike to reflect the presence of ponded water. Classify dike, liner, and cap materials by the unified soil classification system. Provide embankment design details such as upstream and downstream slopes, characteristics of core and shell material, internal drains and filter criteria, riprap, long-term erosion control, foundation preparation, slope stability analysis to include the design earthquake, design flood, and downstream seepage catchment. (The above request assumes that Ford, Bacon and Davis' January 1979 design is obsolete as it addresses the impoundment of dry tailing.) Will the embankment rest directly on bedrock or be "floated" on alluvium? How will the tailing be dewatered: by floating decant barge, underdrains, or other? Provide a complete water budget discussing water input, recycle water, evaporation, seepage, and retained water. Do a seepage analysis of flow through the clay liner. Locate the position of ground water monitor wells adjacent to the impoundment, and describe instrumentation (such as piezometers) to be used during construction of the embankment.

Information regarding the preparation of the disposal site for tailings and contaminated material emplacement and the deposition of such in the disposal site is provided in Sections 3.3, Disposal Site Preparation and 3.5.2, Disposal of Tailings and Contaminated Material, of revised Chapter 3 of the ER.

Proposed Disposal Site of Enclosure 3)

Question: Section 3.2.3

Provide the design for the cap including thicknesses of various layers and final shaping. Locate a 100-year flood design spillway to divert water away from the embankment.

Response

Information regarding the final design of impoundment cover is provided in ER Figures 3.3-3, 3.3-5, and 3.5-2 of revised Chapter 3.

The final shaping of the impoundment cover will preclude the need for a spillway.

Question: Section 4.1.2.2.2

Please revise Table 4.1-11 to reflect the anticipated greater amount of substrate to be removed. Include volumes as well as weight estimates.

Response

This table will be revised as requested and included as a revision to the ER in March 1980.

REFERENCES

1. es K. Haug, 1978, Cultural Resources Survey and Selected Silver King Mines Properties in Custer and Fall River Counties, South Dakota. A report prepared for the Tennessee Valley Authority, Contract No. .. 46932A.

2. F. P. Odum, 1971. Fundamentals of Ecology. 3rd ed., W. B. Saunders, Co., p. 262.

3. National Academy of Sciences, 1974. Rehabilitation Potential of Western Coal Lands. Ballinger Publishing Co., p. 58.

4. W. L. Wagner, W. C. Martin, and E. F. Aldon, 1978. Natural Succession on Strip-Mined Lands in Northwestern New Mexico. Reclamation Review, vol. 1, p. 73.

5. B. Z. Richardson, E. E. Farmer, R. W. Brown, and P. E. Packer, 1975. Rehabilitation Research and Its Application on a Surface-Mined Area of Eastern Montana. In: Vol. 3, Fort Union Coal Field Symposium (April 25-26, 1975, Billings, Montana), p. 255.

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8. J. Ruwaldt, 1977. Black-Footed Ferret Survey, Edgemont, South Dakota, p. ..

9. Reeve M. Bailey and Marvin O. Allum, 1962. Fishes of South Dakota. Misc. Publ. UMMZ. 119. p. 131.

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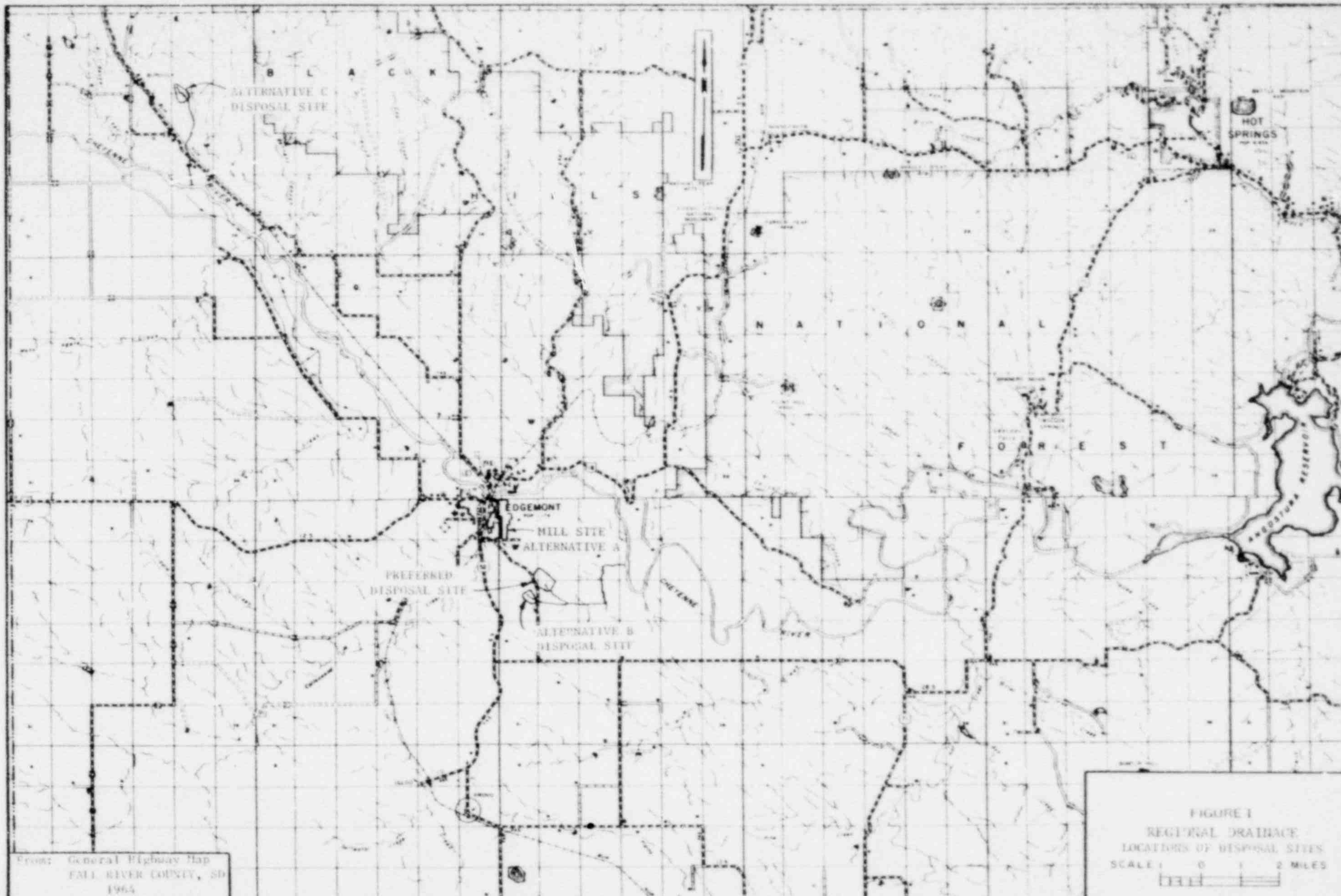
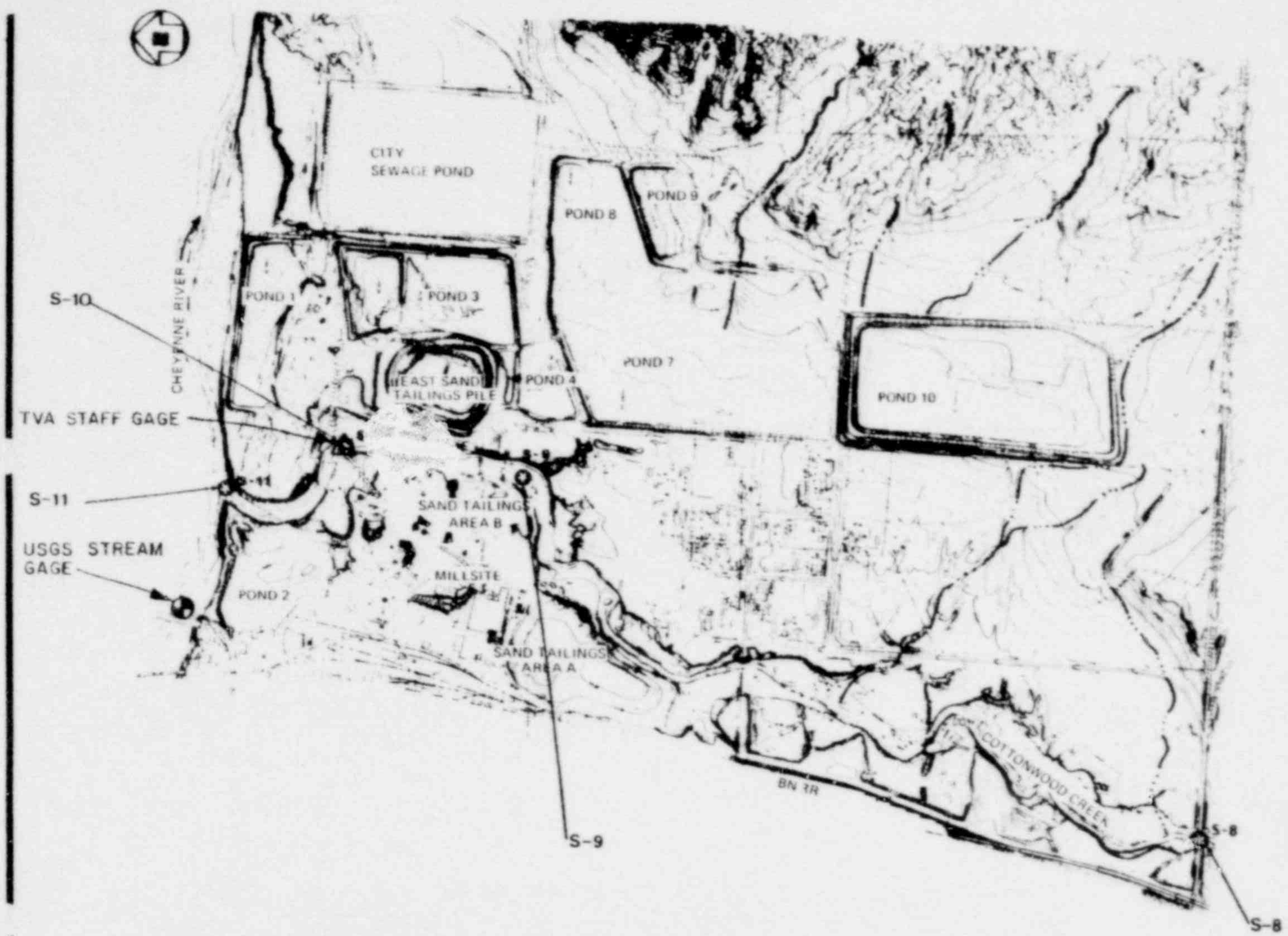


FIGURE 1
REGIONAL DRAINAGE
LOCATIONS OF DISPOSAL SITES



NOTE

MAP DRAWN FROM TVA SUPPLIED INFORMATION - CONTOURS VALID AS OF JUNE, 1977

WATER QUALITY MONITORING STATIONS

0 500 1000 FT

CONTOUR INTERVAL 2 FT

FIGURE 2

EDGEMONT MILL SITE

SURFACE WATER FEATURES

ATTACHMENTS

TO

SUPPLEMENT 1

EDGEMONT URANIUM MILL DECOMMISSIONING PLAN

ENVIRONMENTAL REPORT

ATTACHMENT 1

LETTER FR. SOUTH DAKOTA

:ATE HISTORIC RESERVATION OFFICER

ATTACHMENT 1

HISTORICAL PRESERVATION CENTER
University of South Dakota
Vermillion, S.D. 57069
Phone (605) 677 5314

SOUTH DAKOTA Department of Education and Cultural Affairs

October 17, 1979

Mr. Maxwell D. Ramsey, Recreation Program Coordinator
Recreation Resources Branch
Div. of Forestry, Fisheries, and Wildlife Development
Tennessee Valley Authority
Norris, Tennessee 37828

Re: Edgemont Uranium Mill Decommissioning Project; Fall River Co.

Dear Mr. Ramsey:

This office is in receipt of materials submitted regarding the nature of the above project. Thank you very much for your reply. To assist your compliance with Section 106 of the National Historic Preservation Act (PL 89-665); Executive Order 11593, Protection and Enhancement of the Cultural Environment; 36 CFR 800; and other laws and regulations pertinent to the protection of historic, archaeological or culturally significant properties, the State Historic Preservation Officer makes the following comment:

We have received and reviewed your determination of no effect for the above referenced project and concur with your determination, as the information provided is sufficient documentation that no significant cultural resources will be affected.

Your cooperation in this matter is most appreciated.

Yours truly,

for John J. Little
State Historic Preservation Officer

jkm
cc: Robert Alex, State Archaeologist

ATTACHMENT 2

SOILS MAPS

ATTACHMENT 2

POOR ORIGINAL

FALL RIVER CO., SD
1/77
PRELIMINARY, SUBJECT TO CHANGE

TABLE NO. 2 SOIL INTERPRETATIONS FOR USE AS TOPSOIL AND SUITABILITY OF SOIL MATERIAL FOR PLANT GROWTH

MAP SYMBOL	MAPPING UNIT NAME	SLOPE (PERCENT)	COMPOSITION (PERCENT)	THICKNESS OF "A" HORIZON IN INCHES	SUITABILITY AS TOPSOIL 1/	REMARKS	DEPTH TO BEDROCK IN INCHES	SUITABILITY OF SOIL MATERIAL FOR PLANT GROWTH 2/	REMARKS
1	HOVEN SILT LOAM	0-2	85	2	POOR	THIN LAYER, EXCESS SODIUM DENSE COMPACT SUBSOIL	>60	POOR	EXCESS SODIUM
2	LOHMILLER SILTY CLAY LOAM	0-2	85	8	FAIR	TOO CLAYEY	>60	FAIR	TOO CLAYEY
3	HAVERSON SOILS	0-2	85	6	GOOD	—	>60	GOOD	—
4	STETTER SILTY CLAY LOAM, SALINE	0-2	85	2	POOR	TOO CLAYEY, EXCESS SALT	>60	POOR	TOO CLAYEY, EXCESS SALT
5	STETTER CLAY	0-2	85	2	POOR	TOO CLAYEY	>60	POOR	TOO CLAYEY
6	AQUOLLS	0-2	85	-	UNSUITED	TOO WET	>60	POOR	TOO WET
7	BANKARD SOILS	0-2	90	5	POOR	THIN LAYER, TOO SANDY	>60	FAIR	TOO SANDY
8	GLENBERG FINE SANDY LOAM	0-2	90	6	GOOD	—	>60	GOOD	—
9	PITS, GRAVEL	—	95	-	—	—	—	POOR	TOO GRAVELLY
10	PITS, MINE	—	95	-	—	—	—	POOR	TOO ROCKY
13	MOSHER SILT LOAM	0-2	85	8	POOR	EXCESS SODIUM, DENSE COMPACT SUBSOIL	>60	POOR	EXCESS SODIUM
15	ARVADA VERY FINE SANDY LOAM	0-4	85	4	POOR	THIN LAYER, EXCESS SODIUM, DENSE COMPACT SUBSOIL	>60	POOR	EXCESS SODIUM
16	HISLE-SLICKSPOTS COMPLEX	0-6							
	HISLE PART		65	2	POOR	THIN LAYER, EXCESS/SODIUM, DENSE/COMPACT SUBSOIL	20-40	POOR	EXCESS SODIUM
	SLICKSPOTS PART		25	-	—	—	—	—	—
17	SWANBOY CLAY	0-3	90	2	POOR	TOO CLAYEY, EXCESS SALT	>60	POOR	TOO CLAYEY, EXCESS SALT
18A	NUNN CLAY LOAM	0-2	85	8	FAIR	TOO CLAYEY	>60	FAIR	TOO CLAYEY
18B	NUNN CLAY LOAM	2-6	90	8	FAIR	TOO CLAYEY	>60	FAIR	TOO CLAYEY
18C	NUNN CLAY LOAM	6-9	90	8	FAIR	TOO CLAYEY	>60	FAIR	TOO CLAYEY
19A	SATANTA LOAM	0-2	85	9	GOOD	—	>60	GOOD	—
19B	SATANTA LOAM	2-6	85	9	GOOD	—	>60	GOOD	—
19C	SATANTA LOAM	6-9	85	9	GOOD	—	>60	GOOD	—
20A	ALTVAN LOAM	0-2	95	9	FAIR	SAND AND GRAVEL AT 20-40 INCHES	>60	FAIR	THIN LAYER
20B	ALTVAN LOAM	2-6	90	9	FAIR	SAND AND GRAVEL AT 20-40 INCHES	>60	FAIR	THIN LAYER
21A	MITCHELL VERY FINE SANDY LOAM	0-2	95	18	GOOD	—	>60	GOOD	—
21B	MITCHELL VERY FINE SANDY LOAM	2-6	85	18	GOOD	—	>60	GOOD	—
22B	JAYEM FINE SANDY LOAM	2-9	85	13	GOOD	—	>60	GOOD	—
23B	DAILEY FINE SAND	0-6	85	14	POOR	TOO SANDY	>60	POOR	TOO SANDY
23C	DAILEY FINE SAND	6-12	85	14	POOR	TOO SANDY	>60	POOR	TOO SANDY
24B	ALICE FINE SANDY LOAM	2-9	85	10	GOOD	—	>60	GOOD	—

(Reference: 7)

POOR ORIGINAL

ATTACHMENT 2 (cont.)

FALL RIVER CO, SD
1/77
PRELIMINARY, SUBJECT TO CHANGE

TABLE NO. 2 SOIL INTERPRETATIONS FOR USE AS TOPSOIL AND SUITABILITY OF SOIL MATERIAL FOR PLANT GROWTH

MAP SYMBOL	MAPPING UNIT NAME	SLOPE (PERCENT)	COMPOSITION (PERCENT)	THICKNESS OF "A" HORIZON IN INCHES	SUITABILITY AS TOPSOIL 1/	REMARKS	DEPTH TO BEDROCK IN INCHES	SUITABILITY OF SOIL MATERIAL FOR PLANT GROWTH 2/	REMARKS
25B	MURDO SOILS	0-9	85	3	POOR	THIN LAYER	>60	FAIR	TOO CLAYEY, THIN LAYER
25E	MURDO-SCHAMBER COMPLEX	9-40							
	MURDO PART		45	3	POOR	SLOPE, THIN LAYER	>60	POOR	SLOPE
	SCHAMBER PART		40	7	POOR	THIN LAYER, SLOPE	>60	POOR	THIN LAYER, SLOPE
30B	SAVO SILTY CLAY LOAM	2-6	85	9	FAIR	TOO CLAYEY	>60	FAIR	TOO CLAYEY
33A	TILFORD SILTY CLAY LOAM	0-2	85	10	FAIR	TOO CLAYEY	>60	FAIR	TOO CLAYEY
33B	TILFORD SILTY CLAY LOAM	2-6	90	10	FAIR	TOO CLAYEY	>60	FAIR	TOO CLAYEY
34A	VALE SILT LOAM	0-2	85	9	FAIR	TOO CLAYEY	>60	FAIR	TOO CLAYEY
34B	VALE SILT LOAM	2-6	90	9	FAIR	TOO CLAYEY	>60	FAIR	TOO CLAYEY
34C	VALE SILT LOAM	6-9	85	9	FAIR	TOO CLAYEY	>60	FAIR	TOO CLAYEY
35	BARNUM SILT LOAM	0-2	85	5	FAIR	THIN LAYER, LIMY	>60	GOOD	—
40B	MORKA SILT LOAM, SANDSTONE SUBSTRATUM	2-6	85	7	FAIR	BEDROCK BELOW 30 INCHES	>30	FAIR	THIN LAYER
42D	BUTCHE-BONEEK LOAMS	3-15							
	BUTCHE PART		60	4	POOR	THIN LAYER	<20	POOR	THIN LAYER
	BONEEK PART		25	6	FAIR	THIN LAYER, SLOPE, TOO CLAYEY	>40	FAIR	TOO CLAYEY, SLOPE
42E	BUTCHE-ROCK OUTCROP/COMPLEX	15-30							
	BUTCHE PART		60	4	POOR	THIN LAYER, SLOPE	<20	POOR	SLOPE, THIN LAYER, ROCKS
	ROCK OUTCROP PART		25	-	—	—	—	—	—
42F	ROCK OUTCROP-BUTCHE COMPLEX	25-50							
	ROCK OUTCROP PART		65	-	—	—	—	—	—
	BUTCHE PART		20	4	POOR	THIN LAYER, SLOPE	<20	POOR	SLOPE, ROCKS
44B	BONEEK SILT LOAM	2-6	85	6	FAIR	THIN LAYER, TOO CLAYEY	>40	FAIR	TOO CLAYEY
48	VALENT LOAMY FINE SAND	6-25	85	7	POOR	SLOPE	>60	POOR	SLOPE, TOO SANDY
49B	TUTHILL FINE SANDY LOAM	0-6	85	15	GOOD	—	>60	GOOD	—
49C	TUTHILL FINE SANDY LOAM	6-9	85	15	GOOD	—	>60	GOOD	—
62	ZIGWEID-NIHILL LOAMS	6-20							
	ZIGWEID PART		45	15	FAIR	TOO CLAYEY, SLOPE	>60	FAIR	TOO CLAYEY, SLOPE
	NIHILL PART		45	7	POOR	SLOPE	>60	POOR	SLOPE
67C	COLBY-MORKA SILT LOAMS	6-15							
	COLBY PART		~~40~~ 50	7	FAIR	SLOPE	>60	FAIR	SLOPE
	MORKA PART		35	6	FAIR	SLOPE	>60	FAIR	SLOPE
68A	MORKA SILT LOAM	0-2	90	6	GOOD	—	>60	GOOD	—
69A	RICHFIELD SILT LOAM	0-2	90	7	FAIR	TOO CLAYEY	>60	FAIR	TOO CLAYEY
69B	MORKA SILT LOAM	2-6	90	6	GOOD	—	>60	GOOD	—
69C	MORKA SILT LOAM	6-9	85	6	GOOD	—	>60	GOOD	—

ATTACHMENT 2 (cont.)

POOR ORIGINAL

FALL RIVER CO, SD
1/77
PRELIMINARY, SUBJECT TO CHANGE

TABLE NO. 2 SOIL INTERPRETATIONS FOR USE AS TOPSOIL AND SUITABILITY OF SOIL MATERIAL FOR PLANT GROWTH

MAP SYMBOL	MAPPING UNIT NAME	SLOPE (PERCENT)	COMPOSITION (PERCENT)	THICKNESS OF "A" HORIZON IN INCHES	SUITABILITY AS TOPSOIL 1/	REMARKS	DEPTH TO BEDROCK IN INCHES	SUITABILITY OF SOIL MATERIAL FOR PLANT GROWTH 2/	REMARKS
76B	MINNEQUA-MANVEL SILTY CLAY LOAMS	2-6							
	MINNEQUA PART		50	11	FAIR	THIN LAYER, LIMY, TOO CLAYEY	20-40	FAIR	THIN LAYER, TOO CLAYEY
	MANVEL PART		35	13	FAIR	THIN LAYER, LIMY, TOO CLAYEY	>60	FAIR	TOO CLAYEY
76D	MINNEQUA-MIDWAY SILTY/CLAY LOAMS	6-25							
	MINNEQUA PART		50	13	POOR	SLOPE	20-40	POOR	SLOPE
	MIDWAY PART		40	8	POOR	SLOPE, THIN LAYER	<20	POOR	SLOPE, THIN LAYER
77A	MANVEL SILTY CLAY LOAM	0-2	90	13	FAIR	THIN LAYER, LIMY, TOO CLAYEY	>60	FAIR	TOO CLAYEY
79F	SHINGLE-PENROSE-ROCK/OUTCROP COMPLEX	15-40							
	SHINGLE PART		55	9	POOR	THIN LAYER, SLOPE	<20	POOR	THIN LAYER, SLOPE
	PENROSE PART		20	6	POOR	THIN LAYER	<20	POOR	THIN LAYER
	ROCK OUTCROP PART		15	-	—	—	—	—	—
80A	BACA SILTY CLAY LOAM	0-2	85	3	POOR	THIN LAYER	>60	FAIR	TOO CLAYEY
80B	BACA-RAZOR SILTY CLAY LOAMS	2-6							
	BACA PART		55	3	POOR	THIN LAYER	>60	FAIR	TOO CLAYEY
	RAZOR PART		35	4	POOR	THIN LAYER	20-40	FAIR	THIN LAYER, TOO CLAYEY
86	DEMAR SILTY CLAY LOAM	0-2	90	3	POOR	THIN LAYER, TOO/CLAYEY	>40	POOR	TOO CLAYEY
89	BROADHURST CLAY	2-9	85	4	POOR	TOO CLAYEY	>60	POOR	TOO CLAYEY
90	GRUMMIT-SNOMO CLAYS	3-15							
	GRUMMIT PART		55	6	POOR	TOO CLAYEY	<20	POOR	TOO CLAYEY, THIN/LAYER
	SNOMO PART		30	7	POOR	TOO CLAYEY	>40	POOR	TOO CLAYEY
91	GRUMMIT-ROCK OUTCROP COMPLEX	3-40							
	GRUMMIT PART		60	6	POOR	TOO CLAYEY, TREES	<20	POOR	TOO CLAYEY, THIN/LAYER, TREES
	ROCK OUTCROP PART		30	-	—	—	—	—	—
95A	KYLE CLAY	0-2	90	4	POOR	TOO CLAYEY	>[illegible]	POOR	TOO CLAYEY
95B	KYLE CLAY	2-6	85	4	POOR	TOO CLAYEY	>60	POOR	TOO CLAYEY
96B	PIERRE CLAY	2-6	85	4	POOR	TOO CLAYEY	20-40	POOR	TOO CLAYEY
97D	PIERRE-SAMSIL CLAYS	6-25							
	PIERRE PART		60	4	POOR	TOO CLAYEY, SLOPE	20-40	POOR	TOO CLAYEY, SLOPE
	SAMSIL PART		25	3	POOR	TOO CLAYEY, SLOPE	<20	POOR	TOO CLAYEY, THIN/LAYER, SLOPE
98D	SAMSIL-PIERRE CLAYS	6-15							
	SAMSIL PART		60	3	POOR	TOO CLAYEY	<20	POOR	TOO CLAYEY, THIN LAYER
	PIERRE PART		25	4	POOR	TOO CLAYEY	20-40	POOR	TOO CLAYEY
98F	SAMSIL CLAY	15-40	85	3	POOR	TOO CLAYEY, SLOPE	<20	POOR	THIN LAYER, TOO CLAYEY SLOPE
142	LAKOA-MAITLAND LOAMS	15-40							
	LAKOA PART		45	6	POOR	SLOPE, TREES	30-60	POOR	SLOPE, TREES
	MAITLAND PART		40	12	POOR	SLOPE, TREES	>60	POOR	SLOPE, TREES
148A	DWYER LOAMY FINE SAND	0-2	90	6	POOR	THIN LAYER, TOO SANDY	>60	FAIR	TOO SANDY

POOR ORIGINAL

ATTACHMENT 2 (cont.)

FALL RIVER CO., SD
1/77
PRELIMINARY, SUBJECT TO CHANGE

TABLE NO. 8 SOIL INTERPRETATIONS FOR USE AS TOPSOIL AND SUITABILITY OF SOIL MATERIAL FOR PLANT GROWTH

MAP SYMBOL	MAPPING UNIT NAME	SLOPE (PERCENT)	COMPOSITION (PERCENT)	THICKNESS OF "A" HORIZON IN INCHES	SUITABILITY AS TOPSOIL 1/	REMARKS	DEPTH TO BEDROCK IN INCHES	SUITABILITY OF SOIL MATERIAL FOR PLANT GROWTH 2/	REMARKS
148B	DWYER LOAMY FINE SAND	2-6	90	6	POOR	THIN LAYER, TOO SANDY	>60	FAIR	TOO SANDY
148D	DWYER LOAMY FINE SAND	9-25	90	6	POOR	THIN LAYER, SLOPE	>60	POOR	SLOPE
197D	PIERRE-GRUMMIT CLAYS	6-25							
	PIERRE PART		55	4	POOR	TOO CLAYEY, SLOPE	20-40	POOR	TOO CLAYEY, SLOPE
	GRUMMIT PART		30	6	POOR	TOO CLAYEY	<20	POOR	TOO CLAYEY, THIN/LAYER

1/ SUITABILITY FOR USE AS TOPSOILS REFERS GENERALLY TO THE A HORIZON.

2/ THE COLUMN "SUITABILITY OF SOIL MATERIAL (MIXED) FOR PLANT GROWTH" REFERS TO SUITABILITY OF MATERIALS TO 60 INCHES OR TO BEDROCK THAT WILL SUPPORT VEGETATION OR IS A MEDIUM OF PLANT GROWTH, BASED UPON GENERAL TEXTURE, STRUCTURE, ERODIBILITY, AVAILABLE WATER CAPACITY, SOLUBLE SALT CONTENT, DEPTH, AND ACCESSIBILITY OR AVAILABILITY.

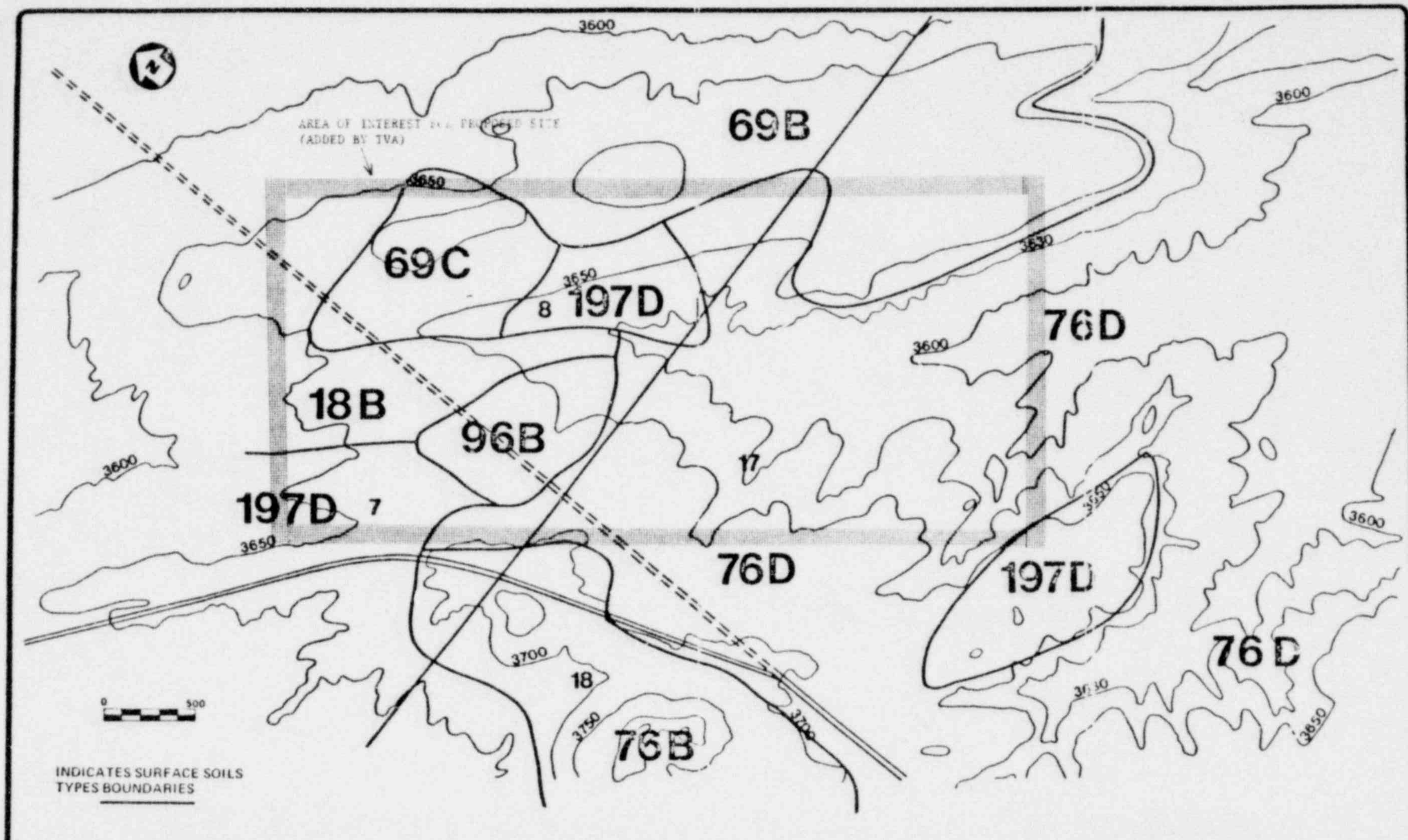


FIGURE 3-15 Surface Soil Classification

(Reference: Ford, Bacon, & Davis Utah, Inc., January 1979)

ATTACHMENT 3

MAPS SHOWING PRINCIPAL PLANT COMMUNITIES

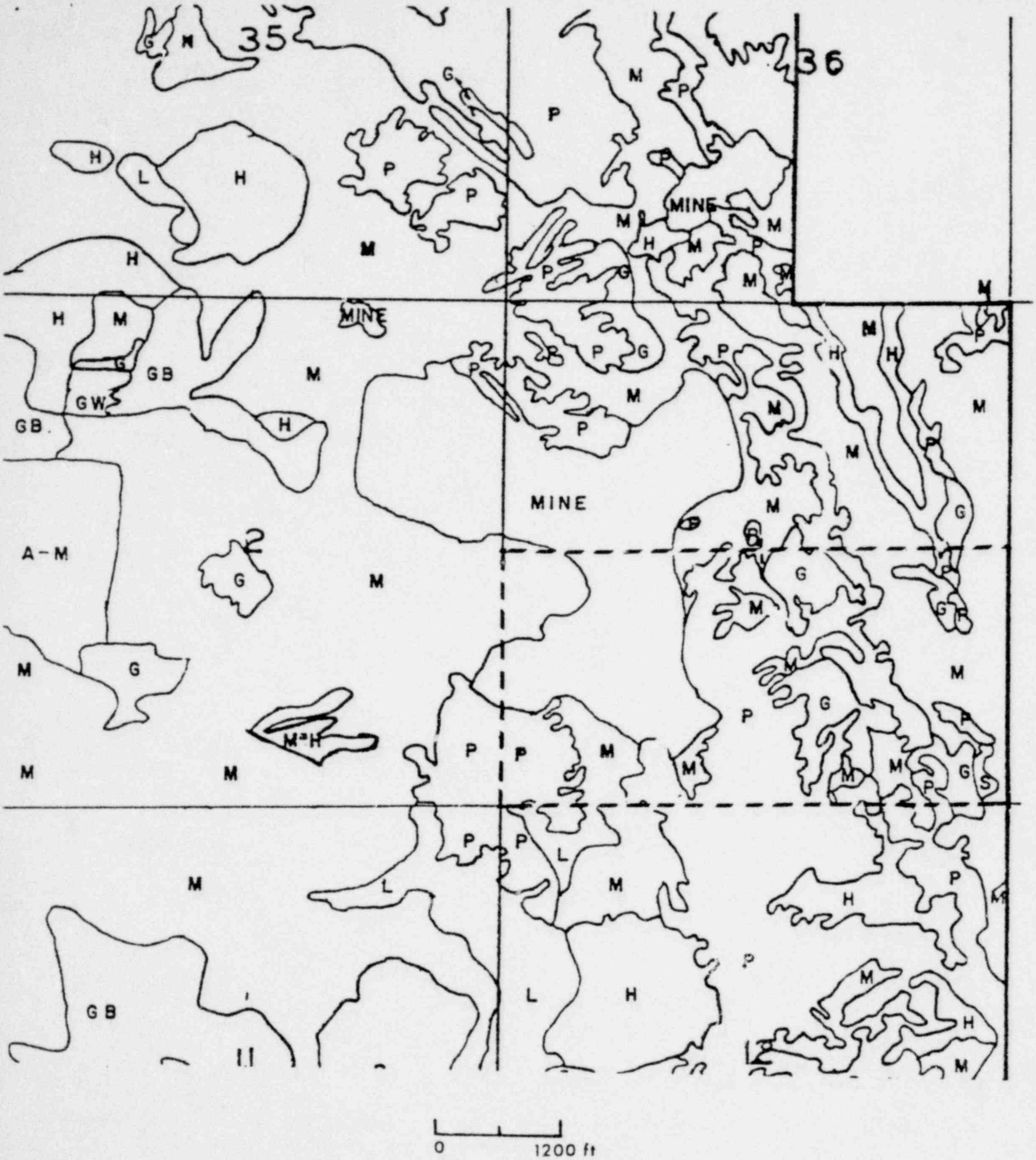
ATTACHMENT 3

POOR ORIGINAL

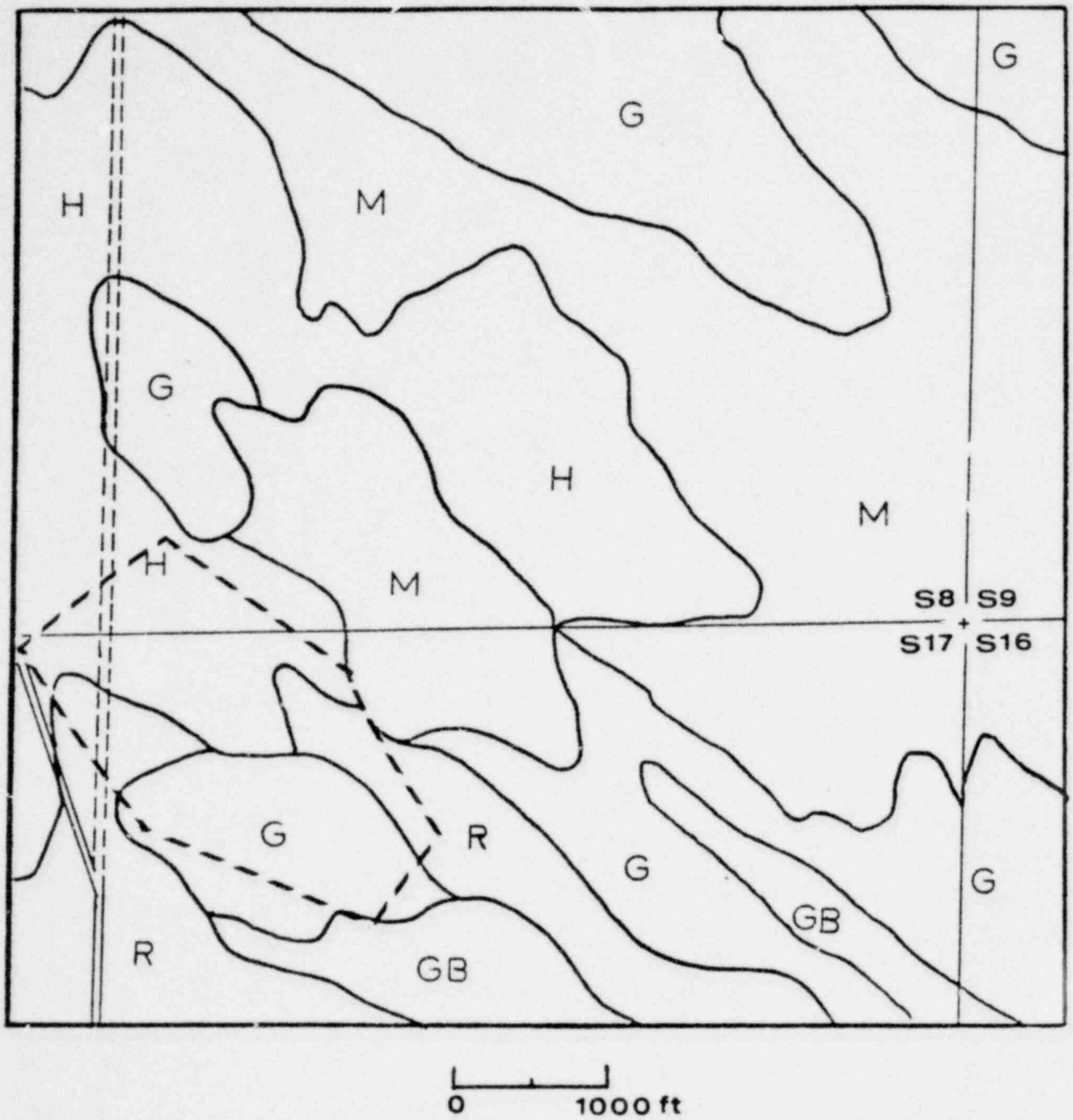
VEGETATIVE ASSOCIATIONS FOR THE EDGEMONT, SOUTH DAKOTA AREA

Community	Total Perennial Cover (percent)	Representative Dominant Species
Abandoned-invaded A	10.5	buffalo grass, blue grama, sand diopseed, needle and thread, western wheatgrass
Silver sagebrush S	26.0	silver sagebrush, buffalo grass, western wheatgrass, blue grama, sandberg bluegrass
Big sagebrush, medium stand M	23.0	big sagebrush, buffalo grass, blue grama, western wheatgrass, sandberg bluegrass
Silver sagebrush-big sagebrush BS	30.0	big sagebrush, silver sagebrush, buffalo grass, blue grama, western wheatgrass
Big sagebrush, heavy stand H	23.0	big sagebrush, blue grama, buffalo grass, sandberg bluegrass, western wheatgrass
Sand sagebrush SA	21.0	sand sagebrush, big bluestem, sandseed, plains prickly pear, threadleaf sedges, blue grama
Grassland G	17.0	buffalo grass, blue grama, sandberg bluegrass, threadleaf sedge
Little bluestem L	16.0	little bluestem, needle leaf sedge, wild buckwheat, prairie sandreed, Louisiana sagewort
Prairie dog town PD	17.0	buffalo grass, blue grama, plains prickly pear, scarlet globe mallow
Rough breaks R	14.0	big sagebrush, wild buckwheat, blue grama, buffalo grass, side oats grama
Black greasewood-big sagebrush GB	19.0	black greasewood, big sagebrush, western wheatgrass, blue grama, alkali sacaton
Black greasewood GW	18.5	black greasewood, blue grama, sand dropseed, buffalo grass, western wheat grass
Cottonwood bottoms C	16.5	plains poplar, western wheatgrass, buffalo grass, yellow sweet clover, common dandelion
Ponderosa pine P	8.1	ponderosa pine, skunkbush sumac, blue grama, buffalo grass, western wheatgrass, big sagebrush, fringed and Louisiana sagewort, [illegible]

(Reference: 7)



VEGETATIVE ASSOCIATION MAP FOR ALTERNATIVE DISPOSAL SITE NO. 8



- - - PROPOSED CONTAINMENT AREA

VEGETATIVE ASSOCIATION MAP FOR THE PREFERRED DISPOSAL SITE

ATTACHMENT 4

LIST OF ENDANGERED AND THREATENED SPECIES

ATTACHMENT 4

SOUTH DAKOTA

LIST OF ENDANGERED AND THREATENED SPECIES

Mammals

Scientific Name	Common Name	Portion of Range Where Endangered or Threatened
Endangered:		
**Mustela nigripes*	Black-footed ferret	Entire
Threatened:		
Vulpes velox hebes [T]	Northern swift fox	Entire
Lutra canadensis interior [T]	River otter	Entire
Felix concolor [T]	Mountain lion	Entire
Ursus americanus [T]	Black bear	Entire
Undetermined:		
None Reported		

Besides the species mentioned in the report, there is a strong possibility that other South Dakota endangered and/or threatened species could occur in your proposed mining area. These species include the northern swift fox (Vulpes velox hebes); mountain lion (Felis concolor); black bear (Ursus americanus): and the plains topminnow (Fundulus sciadicus). A copy of South Dakota's endangered and threatened species list is enclosed for your information. Surveys should be done to determine if these species are present before mining activities begin.

[T]Under this listing no hunting is allowed! Pers. Comm. J. C. Sharps, August 7, 1979.
*Denotes species on Federal endangered list.

January 30, 1978

LIST OF ENDANGERED AND THREATENED SPECIES

Birds

Scientific Name	Common Name	Portion of Range Where Endangered or Threatened
Endangered:		
**Haliaeetus leucocephalus*	Bald eagle (southern)	Entire
**Falco peregrinus anatum*	Peregrine falcon	Entire
**Grus americana*	Whooping crane	Entire
**Numenius borealis*	Eskimo curlew	Entire
Sterna albifrons athalassos	Interior least tern	Entire
Threatened:		
Pandion haliaetus	Osprey	Entire
Tryngites subruficollis	Buff-breasted sandpiper	Entire
Undetermined:		
Buteo regalis	Ferruginous hawk	

Another point of concern is the nesting raptor populations in this area. Minimum disturbance during their nesting period is critical. We have several species using this general area for nesting purposes, which include golden eagles (Aquila chrysaetos): prairie falcons (Falco mexicanus); merlin (Falco columbarius); American kestrel (Falco sparverius); redtail (Buteo jamaicensis); ferruginous hawk (Buteo regalis); goshawk (Accipiter gentilis); sharp-shinned hawk (Accipiter striatus); and Cooper's hawk (Accipiter cooperii).

*Denotes species on Federal endangered lists.

January 30, 1978

Human disturbance of these species during nesting and while raising their young could cause nest abandonment or death to young raptors. Care should be taken not to approach within 1/2 to 3/4 mile of active nests. If it would be convenient, I would be glad to meet with you or your representative to discuss methods to lessen the impact of mining activities to these wildlife species.

LIST OF ENDANGERED AND THREATENED SPECIES

Fish

Scientific Name	Common Name	Portion of Range Where Endangered or Threatened
Endangered:		
Umbra limi	Central mudminnow	Entire
Semotilus margarita	Pearl dace	Entire
Fundulus diaphanus	Banded killifish	Entire
Threatened:		
Scaphirhynchus albus	Pallid sturgeon	Entire
Hybopsis gelida	Sturgeon chub	Entire
Hybopsis meeki	Sicklefin chub	Entire
Phoxinus eos	Northern redbelly dace	Entire
Phoxinus neogaeus	Finescale dace	Entire
Catostomus catostomus	Longnose sucker	Entire
Percopsis omiscomaycus	Trout-perch	Entire
Fundulus sciadicus	Plains topminnow	Entire
Undetermined:		
Percina maculata	Blackside darter	
Percina phoxocephala	Slenderhead darter	
Hybopsis gracilis	Flathead chub	
Nocomis biguttata	Hornyhead chub	
Hybopsis storeriana	Silver chub	
Phenacobius mirabilis	Suckermouth minnow	
Notropis rubellus	Rosyface shiner	
Notropis shumardi	Silverband shiner	
Notropis blennius	River shiner	
Notropis topeka	Topeka shiner	
Notropis heterolepis	Blacknose shiner	
Hypentelium nigricans	Northern hogsucker	
Moxostoma erythrurum	Golden redhorse	
Cycleptus elongatus	Blue sucker	

LIST OF ENDANGERED AND THREATENED SPECIES

Reptiles and Amphibians

Scientific Name	Common Name	Portion of Range Where Endangered or Threatened
Endangered Reptiles:		
None reported		
Threatened Reptiles:		
Emydoidea blandingi	Blandings Turtle	Entire
Graptemys pseudogeographica	False Map Turtle	Entire
Trionyx spiniferus	Spiny softshell Turtle	Entire
Heterodon platyrhinos	Eastern hognose snake	Entire
Tropidoclonion lineatum	The Lined Snake	Entire
Storeria dekayi	Brown Snake	Entire
Storeria occipitomaculata	Northern red-bellied snake	Entire
Undetermined Reptiles:		
Thamnophis proximus	Western ribbon snake	
Eumeces fasciatus	Five-lined skink	
Endangered Amphibians:		
None reported		
Threatened Amphibians:		
None reported		
Undetermined Amphibians:		
Hyla chrysoscelis	Tree Frog	
Rana sylvatica	Wood Frog	
Necturus maculosus	Mudpuppy	

ATTACHMENT 5

AQUATIC MONITORING PLAN

ATTACHMENT 5

MONITORING PLAN
AQUATIC BIOLOGY
EDGEMONT DECOMMISSIONING

Overview

A monitoring program for documenting changes in population densities and diversity in perennial waters due to perturbations is at best difficult due to seasonal and annual variability within the indigenous biological communities of fish, macroinvertebrate and plankton. The effectiveness of monitoring programs become much reduced when target streams have intermittent flows such that the quality and extent of substrates available to aquatic biota becomes highly variable. Therefore, the emphasis of the monitoring program for Edgemont Mill Decommissioning will be placed on assessing those waters which meet the criteria of being (1) perennial and (2) within the area of possible impact. Waters which meet these criteria are the Cheyenne River, Cottonwood Creek and three ponds which lie within the ephemeral drainage between the proposed disposal site and the Cheyenne River. Five sites will be evaluated on the Cheyenne River, to allow an upstream control as well as downstream stations to detect possible short-term or long-term changes within the biological community. Sampling results will be correlated with climatic and flow data. Due to the great variability in flows, only biological collections made within comparable flow regimes will be utilized to detect changes from baseline conditions.

Procedures

Approximate sample sites are located on Figure 1. Sites will be established during an initial sampling trip in the Spring of 1980 and will approximate those sites used in baseline studies. Monitoring will be seasonal (four times a year) during construction activities and after completion of construction activities. A survey of Cottonwood Creek (baseline data already collected) will be made after decommissioning, at such a time as deemed appropriate to document recolonization of the reach to be rerouted away from the existing mill site. The monitoring program will concentrate on documenting the standing crops and diversities of fish, macrobenthic, and planktonic organisms.

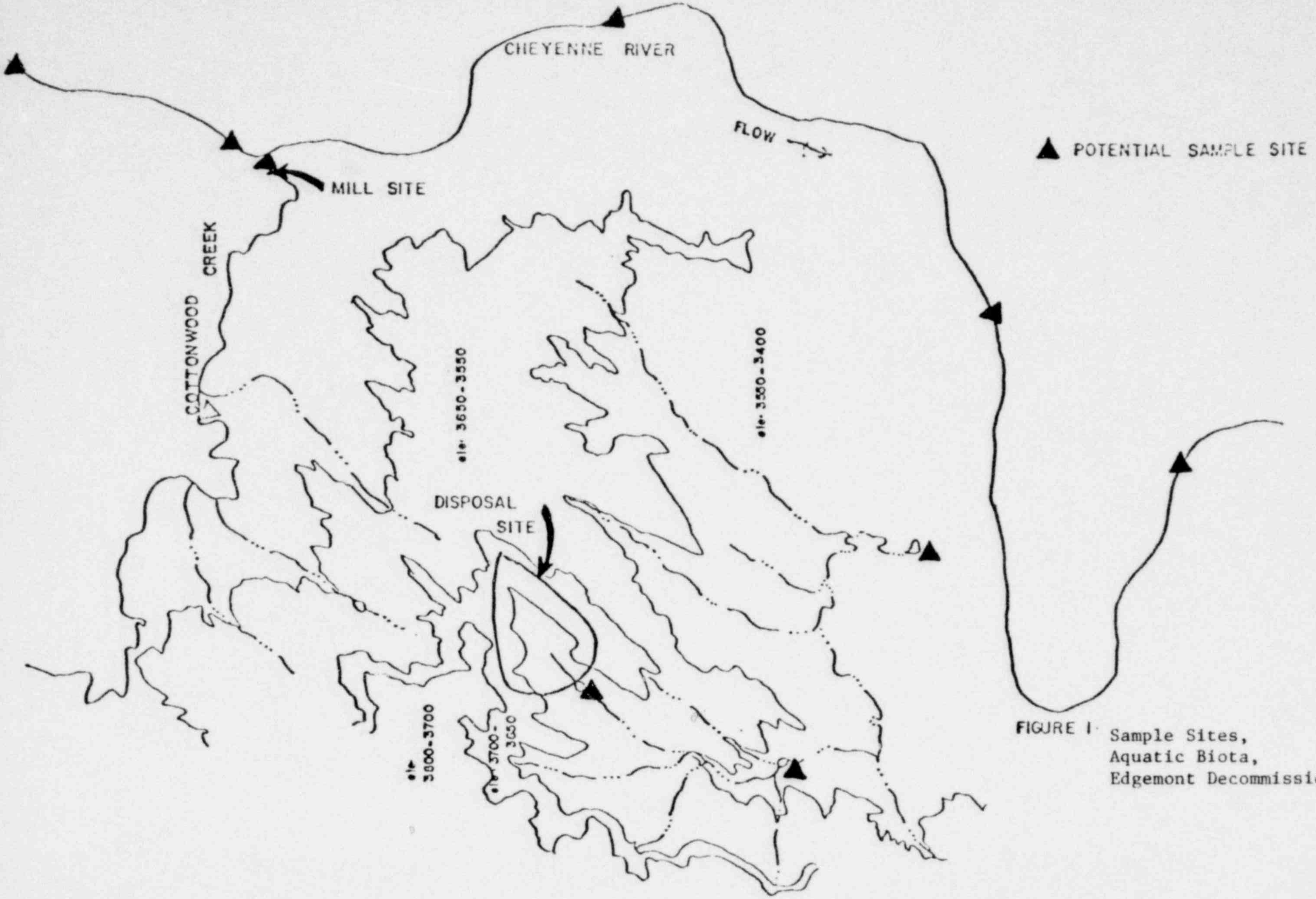


FIGURE 1 Sample Sites, Aquatic Biota, Edgemont Decommissioning

ATTACHMENT 6

FISHERIES RESOURCES OF THE CHEYENNE RIVER BASIN

FALL RIVER COUNTY, SOUTH DAKOTA

MAY 18-22, 1979

ATTACHMENT 6

FISHERIES RESOURCES OF THE CHEYENNE RIVER BASIN
FALL RIVER COUNTY, SOUTH DAKOTA
May 18-22, 1979

Fisheries and Aquatic Ecology Branch
Division of Water Resources
Tennessee Valley Authority

July 1979

Fisheries Resources of the Cheyenne River Basin
Fall River County, South Dakota
May 18-22, 1979

Prepared by
Richard B. Fitz

Investigators

Larry Beeman
Joe Feeman
Richard Fitz
Clayton Marlow
Charles Saylor
Dale Wilhelm
Doug Yoder

FISHERIES RESOURCES
CHEYENNE RIVER BASIN
FALL RIVER COUNTY, SOUTH DAKOTA

An evaluation of the Cheyenne River fisheries resources in the western portion of Fall River County, South Dakota was conducted in May 1979 by Tennessee Valley Authority biologists. Data were collected for use in an Environmental Impact Statement concerning planned uranium mining operations by TVA and its contractors. Sample sites were located on the Cheyenne River and two major perennial tributaries (Figure 1). In addition, data from the most recent fisheries investigations on Angostura Reservoir were acquired from the South Dakota Department of Game, Fish and Parks.

Basin Description

The Cheyenne River in the western portion of Fall River County is a typical high plains riverine habitat. Flowing through a broad valley, the present river channel is generally very wide in relation to base flow regimes (<100 cfs). Gradient from the Wyoming line to the Edgemont area is low and creates an aquatic habitat characterized by long reaches of moderate depth (generally less than 15 cm) interspersed by occasional "deep" pools (>75 cm) and shallow riffles (<5 cm). Irregularities in substrate elevations combined with low flows produce small sloughs and backwater areas with little flow.

Water velocities although low (generally less than 0.2 meter per second) are sufficient to keep the substrate in all but the deeper pools relatively free of silt. These areas are composed primarily of shifting fine- to coarse-grained sand. Deep pools, as indicated, are heavily silted and in some areas examined deposition was as great as 40 cm. Substrate in riffle

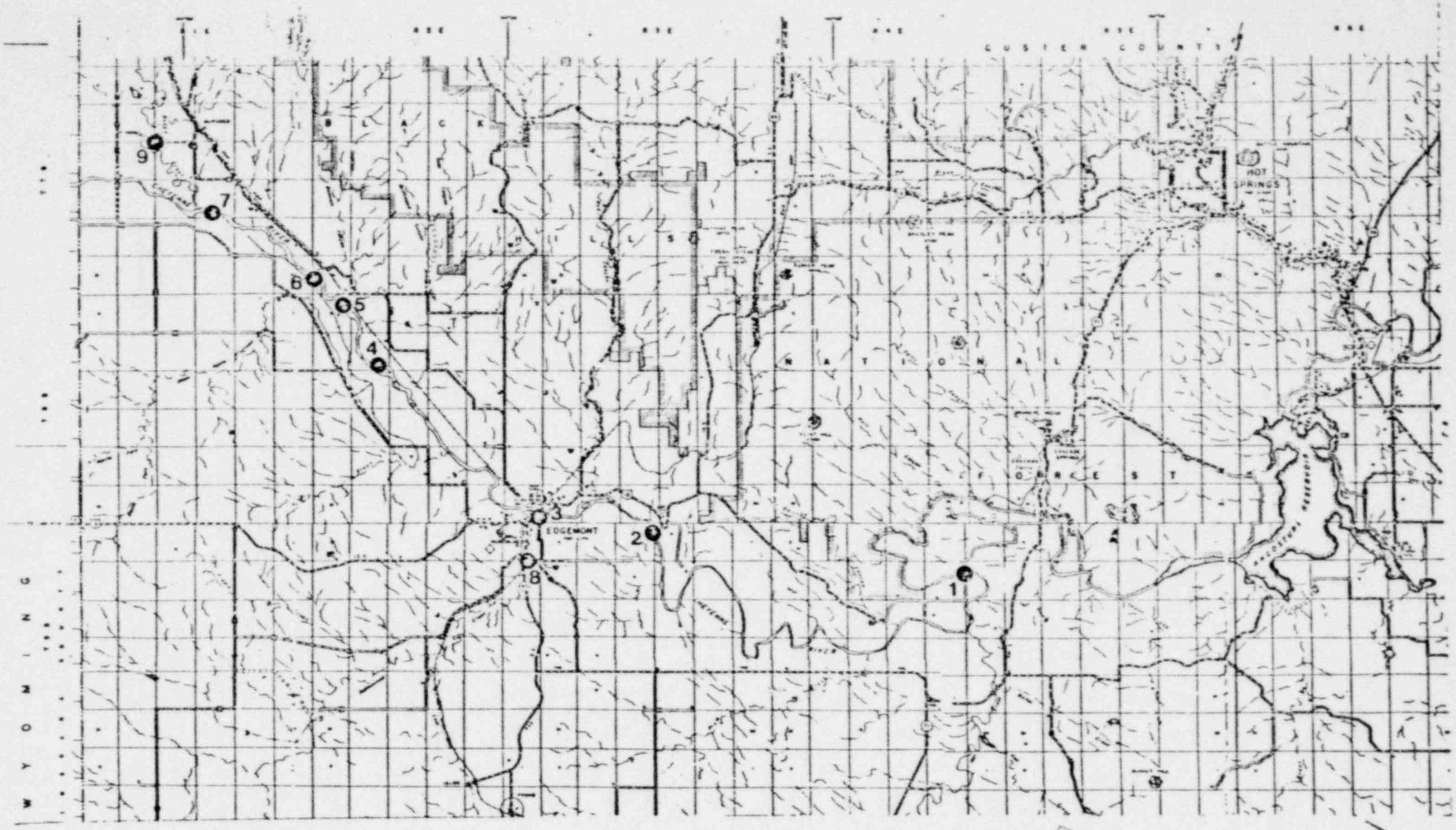


FIGURE 1 FISH SAMPLE STATIONS, CHEYENNE RIVER BASIN, MAY 18-22, 1979

areas is characterized by cobbles (stones 5-15 cm in diameter) interspersed by coarse sand.

The lack of large substrate and manmade or natural obstructions in the river channel provides little cover for fish. This is compounded by little effective security from overhanging riparian vegetation. The physical nature of the river and lack of vegetative cover combine to produce yearly temperature regimes in the river having extreme variations. These factors, plus an apparent scarcity of invertebrate food items, are the primary variables controlling the diversity and production of the fish population in the river.

Within the study vicinity there are only two perennial tributaries to the Cheyenne River. Other stream channels have water only during spring runoff or following heavy precipitation. In some cases small pools are present in an otherwise dry watercourse. These are created by such factors as poor soil drainage or intersection with the water table.

The two major tributaries (Beaver Creek and Cottonwood Creek) are similar in topographic character to the Cheyenne River. Beaver Creek arises in eastern Wyoming and flows southeasterly to its confluence with the Cheyenne River in South Dakota near Burdock. Its flow at this point is approximately one-fourth that of the Cheyenne. Ambient temperature at its mouth was approximately 3°C lower than the Cheyenne reflecting the trout habitat which occurs in the Wyoming portion. Cottonwood Creek, while it is perennial, has little influence on the biotic or abiotic character of the Cheyenne. At the time of TVA's investigation the flow was approximately 1 cfs compared to the Cheyenne flow at Edgemont of 33 cfs.

Sampling Methods

Initally fish were collected using a 30-foot bag seine, a 15-foot common sense minnow seine, and a backpack electrofishing unit. However, the lack of debris in the river and the relatively smooth substrate made it possible to take adequate samples using only the seines. In addition, the high specific conductance of the water limited the efficienty of the electrofishers.

Each sample area was seined until it became apparent, in the biologist's opinion, that all species were represented. All habitat types (i.e., riffles, pools, sloughs, backwaters, etc.) were sampled within each area. Sample effort, although variable from site to site, was somewhat greater than normal due to previous reports that the plains topminnow (Fundulus sciadicus), listed as a threatened species by the State of South Dakota, had been found in the area.

Fish Populations

A total of nine sample sites were examined over approximately 35 miles of the Cheyenne River as well as in Beaver and Cottonwood Creeks (Table 1). Twelve species were found over the nine sample stations (Table 2). All of these species are widespread (Blair et al. 1957) and none occur on the South Dakota list of threatened and endangered species.

Plains minnow, Hybognathis placitus - This species occurred at all sample locations except for Cottonwood Creek and overall was the most abundant. Habitat associations included all shallow and deep flowing water.

Sand shiner, Notropis stramineus - The sand shiner was also a ubiquitous species occurring at all nine locations. No habitat preference was apparent as it was found in all situations.

Plains killifish, Fundulus kansae - This species also occurred at all locations and was confined almost entirely to backwater areas with little or no current flow.

Table 1. Location and description of sample stations, May 1979.

Station 1.	Cheyenne River. NE¼ Sec 11 R4E T9S Fall River County		
	Width		22-27 m
	Depth		3-15 cm
	Substrate		Bedrock 70% Sand 15% Cobble 15%
	Flow Characteristics		Pool 50% Riffle 50%
Station 2.	Cheyenne River. NE¼ SEC 4 R3E T9S Fall River County		
	Width		9-27 m
	Depth		3-121 cm
	Substrate		Sand 70% Silt 30%
	Flow Characteristics		Pool 80% Riffle 20%
Station 3.	Cheyenne River. SE¼ Sec 31 R3E T8S Fall River County		
	Width		14-27 m
	Depth		3-5 cm
	Substrate		Sand 70% Silt 20% Cobble 10%
	Flow Characteristics		Pool 55% Riffle 40% Backwater 5%
Station 4.	Cheyenne River. SE¼ and SW¼ Sec 8 R2E T8S Fall River County		
	Width		14-27 cm
	Depth		6-30 cm
	Substrate		Sand 70% Silt 20% Cobble 10%
	Flow Characteristics		Pool 70% Riffle 25% Backwater & Slough 5%

Table 1. (Continued)

Station 5. Cheyene River at Marietta. NE¼ Sec 6 R2E T7S
Fall River County

Width	3-10 m
Depth	3-30 cm
Substrate	Sand 80%
	Silt 10%
	Cobble 10%
Flow Characteristics	Pool 80%
	Riffle 20%
	No deep pools present

Station 6. Cheyenne River. SW¼ Sec 31 R2E T7S
Fall River County

Width	18-36 m
Depth	3-50 cm
Substrate	Sand 70%
	Silt 20%
	Cobble 10%
Flow Characteristics	Pool 80%
	Riffle 20%
	Backwater & Sloughs-tr

Station 7. Cheyenne River and Beaver Creek at confluence. SW¼ Sec 22 R1E T7S
Fall River County

Width	
Cheyenne River	18-36 m
Beaver Creek	9-12 m
Depth	
Cheyenne River	3-76 cm
Beaver Creek	3-120 cm
Substrate	
Cheyenne River	Sand 70%
	Silt 20%
	Cobble 10%
Beaver Creek	Silt 100%
Flow Characteristics	
Cheyenne River	Riffle 6
	Pool 38%
	Backwaters & sloughs 2%
Beaver Creek	Pool 98%
	Riffle 2%

Table 1. (Continued)

Station 8.	Cottonwood Creek. SE¼ Sec 1 R2E T9S Fall River County	
	Width	0.5-3 m
	Depth	2-15 cm
	Substrate	Cobble 40% Sand 40% Silt 20%
	Flow Characteristics	Riffle 60% Pool 40%
Station 9.	Beaver Creek. SW¼ Sec 9 and NE¼ Sec 17 R1E T7S Fall River County	
	Width	4-6 m
	Depth	6-127 cm
	Substrate	Silt 80% Sand 15% Cobble 5%
	Flow Characteristics	Pool 90% Riffle 10%

Table 2. Species distribution and relative abundance (percent composition) in the Cheyenne River Basin, May 1979.

Species	Relative Abundance (Percent)								
	Station								
	1	2	3	4	5	6	7	8	9
Plains minnow	-	2	20	29	27	45	74	-	7
Sand Shiner	92	83	62	22	28	22	tr*	55	50
Plains killifish	4	tr	4	22	7	6	19	36	1
Fathead minnow	4	4	tr	14	2	15	1	-	10
Flathead chub	-	tr	9	9	28	4	2	-	15
Longnose dace	-	-	3	1	3	5	1	9	11
River carpsucker	-	tr	-	1	2	-	1	-	1
Channel catfish	-	5	-	tr	-	1	-	-	2
Green sunfish	-	-	tr	tr	1	tr	tr	-	2
White sucker	-	6	-	-	-	-	tr	-	-
Carp	-	-	tr	-	tr	-	tr	-	-
Black Bullhead	-	-	-	-	tr	-	-	-	tr

*tr - <1 percent

Fathead minnow, Pimephales promelas - The fathead minnow was collected at eight sample sites and occurred in all habitat types.

Flathead chub, Hybopsis gracilis - Occurring at all sample locations except the lower Cheyenne River and Cottonwood Creek, this species was found in all main channel habitat types.

Longnose dace, Rhinichthys cataractae - This species was not abundant at any of the seven locations where it was collected. It was almost entirely associated with areas of swift current.

River carpsucker, Carpiodes carpio - All specimens collected were juveniles and in all probability came from stocks in Angostura Reservoir. The species was confined to the deeper main channel areas.

Channel catfish, Ictalurus punctatus - Channel catfish were collected primarily from large, deep holes with relatively slow current. Size of specimens ranged from 25 grams to over 2 kilograms. The broad range of age classes and the good condition of the specimens examined indicate the population is healthy and reproductively viable in this area of the Cheyenne River Basin.

Green sunfish, Lepomis cyanellus - Although the green sunfish occurred at six of nine sample sites, it was never abundant. A total of 25 specimens was collected, almost exclusively from deep, slow-moving waters, only one of which was large enough (>100 mm) to be considered harvestable.

White sucker, Catostomus commersoni - This was collected at only two stations and was found in deep pool areas. The widely spaced occurrences indicate that the species is probably distributed throughout the river in very low numbers.

Carp, Cyprinus carpio - Four specimens were collected, all of which were juveniles. It is unlikely, due to the physical characteristics of the river, that this species is ever very abundant.

Black bullhead, Ictalurus melas - The black bullhead was collected at only two stations and was associated with deep pool areas.

In addition to those species documented, seasonal migration of redhorse (Moxostoma spp.) from Angostura Reservoir is probable. Rainbow trout (Salmo gairdneri) are stocked in the upper areas of the Beaver Creek drainage by the Wyoming Game and Fish Department and may occur in the Burdock vicinity during the colder months.

The most recent data on fish populations in Angostura Reservoir were collected in 1975 by the South Dakota Department of Game, Fish and Parks. Gill and trap net studies produced a total of 13 taxa (Table 3). In addition to those species documented, a small reproducing population of northern pike (Esox lucius) is also present.

Catch per unit effort from trap nets when compared with the State-wide average indicates that the fish population is somewhat depressed (Table 4). Relative abundance for species comparable ranged from 1 to 69 percent of the State-wide mean.

Sport Fishing

No information is available on sport fisherman use or harvest from either Angostura Reservoir or the Cheyenne River. In an unpublished report prepared by the South Dakota Department of Game, Fish and Parks (1971), the reservoir is characterized as providing good fishing during the spring and fall months. An unpublished fisheries survey conducted in 1975 describes summer angling as good with moderate pressure while winter fishing is characterized as good light pressure. In both cases, walleye (Stizostedion vitreum vitreum) and smallmouth bass (Micropterus dolomieui) are the predominant species in the catch.

Angling in the Cheyenne River and tributaries in the project vicinity is an unknown quantity; however, observations by TVA biologists while assessing the fish population over a five-day period suggest that use is very light. Only one fisherman was seen and this period included a weekend.

Table 3. Species collected in gill and trap nets from Angostura Reservoir, South Dakota, June 1975.*

Northern Pike	Esox lucius
Carp	Cyprinus carpio
Golden shiner	Notemigonus crysoleucas
River carpsucker	Carpiodes carpio
White sucker	Catostomus commersoni
Redhorse	Moxostoma sp.
Black bullhead	Ictalurus melas
Channel catfish	Ictalurus punctatus
Bluegill	Lepomis macrochirus
Smallmouth bass	Micropterus dolomieui
Crappie	Pomoxis sp.
Yellow Perch	Perca flavescens
Walleye	Stizostedion vitreum vitreum

* From unpublished data provided by the South Dakota Department of Game, Fish and Parks.

Table 4. Average number of fish caught by species in trap nets from Angostura Reservoir (June 1975) and State-wide.*

Species	Average Number Per Net	
	Angostura	State-wide
River carpsucker	20.1	29.3
Carp	1.8	21.1
Channel catfish	0.8	1.3
Bluegill	0.2	23.8
Crappie sp.	0.4	27.6
Yellow perch	2.2	13.0
Walleye	1.4	3.5

* From unpublished data provided by the South Dakota Department of Game, Fish and Parks.

Threatened and Endangered Species

No State or Federally listed threatened or endangered fish species occur in the project vicinity.

Potential Nonradiological Impacts

Water released from mining operations into the surface drainage system will meet all NPDES requirements for the protection of aquatic life. Increased surface flows as a result of this will provide expanded aquatic habitat and will potentially create additional fisheries production although it is expected to be insignificant.

Withdrawals of subsurface water may lower the water table to the point that some stock ponds and persistent pools in intermittent streambeds will go dry. Aquatic life present will then necessarily be eliminated.

Increased turbidity during construction activities will be minimal and should have no impact on fisheries resources in the Cheyenne River, its tributaries or Angostura Reservoir.

As previously discussed in Section 2.9.2.2, employee growth as a result of the project will amount to 160 people with an estimated total population growth of 565. The influx of new people could cause additional stresses to the fish resource of the region. It is difficult to assess the magnitude of these potential impacts. Measures to be taken to ensure mitigation are discussed below. By using the percentage of the population in the State of South Dakota who fish (24 percent), it is estimated that approximately 135 fishermen will move into the area as a result of the project. Careful planning and coordination between TVA, its operator, and the various State and Federal agencies, will be necessary to reduce any significant impacts.

ATTACHMENT 7

TABLE COMPARISON OF FISH SPECIES

COLLECTED IN THE CHEYENNE RIVER

ATTACHMENT 7

TABLE COMPARISON OF FISH SPECIES COLLECTED IN THE CHEYENNE RIVER

	Bailey and Allum		TVA	South Dakota Dept. Game, Fish & Parks
	1962 Entire Cheyene drainage	Fall River Co. above Angostura Dam	1979	1975
Salmo trutta	(X)			
Salmo gairdneri	(X)			
Salvelinus fontinalis	(X)			
Esox . lucuis				(X)
Hiodon alosoides	X			
Cyprinus carpio	(X)		(X)	
Carassius auratus	(X)			
Notemigonus crysoleucas	(X)	(X)		(X)
Semotilus atromaculatus	X			
Hybopsis plumbea	X			
Hybopsis gracilis	X	X	X	
Hybopsis gelida T	X			
Rhinichthys cataractae	X	X	X	
Notropis stramineus missuriensis	X	X	X	
Hybognathus placitus	X	X	X	
Hybognathus nuchalis	X			
Pimephales promelas	X	X	X	
Carpiodes carpio	X		X	
Moxostoma macrolepidotum	X			Moxostoma sp.
Catostomus commersoni	X	X	X	X
Catostomus catostomus T	X			
Pantosteus platyrhynchus	X			
Ictalurus melas	X	X	X	X
Ictalurus punctatus	X		X	X
Noturus flavus	X			
Fundulus kansae	(X)		(X)	
Lota lota	X			
Micropterus salmoides	(X)	(X)		
Micropterus dolomieui				(X)
Lepomis cyanellus	(X)	(X)	(X)	
Lepomis macrochirus	(X)			(X)
Lepomis humilis	(X)			
Ambloplites rupestris	(X)			
Pomoxis sp.				(X)
Stizostedion vitreum	(X)	(X)		(X)
Perca flavescens	(X)	(X)		(X)
Totals	34	12	12	13
Native	20	9	9	7
Introduced	14	3	3	6

X Species present
(X) Species present has been introduced
T Listed as Threatened by the State of South Dakota

ATTACHMENT 8

THE REGIONAL STRUCTURE OF THE SOUTHERN BLACK HILLS

ATTACHMENT 8

The Regional Structure of the Southern Black Hills

The regional uplift of the Black Hills probably began in the Late Cretaceous time and continued until Early Eocene time (Bartram, 1940). The Black Hills uplift consists of an arcuate north to northwest trending dome-shaped anticline that is surrounded by the Missouri Plateau (Fenneman, 1931). It was suggested by Chamberlin (1945), that compression from a northeast direction may have produced north by northwest shear zones that determine the outline of the Black Hills. This area may be divided into three parts--eastern, central, and western--each having a different structural character. The eastern part of the area is folded into three relatively large sinuous south-plunging anticlines and several smaller anticlines which shape the southern end of the uplift. The Black Hills gravity axis coincides with the Chilson Anticline five miles east of Edgemont, South Dakota. Nearly all of these anticlines are asymmetrical having a gentle southeast-dipping flank, a deep west-dipping flank, and a parallel syncline lying about one mile west of the crest.

The west side of this folded area is bounded by the south-plunging Sheep Canyon Monocline which lies along the flank of the Chilson Anticline. The central part of the Black Hills uplift consists of the southwest-dipping flank of the Black Hills, which is modified by the broad Dewey Terrace, by three northwest-trending anticlines, the northeast-trending normal faults of the Dewey and Long Mountain Structural Zones and smaller normal faults throughout the area.

Several anticlines transect through the southern Black Hills area. The Dudley Anticline is asymmetric, slightly arcuate and is located two miles east of Hot Springs, South Dakota. This anticline can be traced to the south for approximately nine miles along the outcrop of the Inyan Kara Group to the Cheyenne River, and then one and a half miles north to Angostura Reservoir. This south-plunging anticline has an amplitude of six hundred feet and about one hundred feet of closure (Wolcott, 1967).

The largest fold of the Southern Black Hills is the Cascade Anticline that occurs two miles west of Hot Springs, South Dakota. The Cascade Anticline has an amplitude of 1,300 feet with approximately 650 feet of structural closure. The steep west flank of this asymmetric anticline attains a maximum dip of 70° to the southwest with an average dip of 5° to the southeast on the eastern flank. To the west of the Hot Springs area, this anticline forms a ridge on the dip slopes of the Minnekahta Limestone. This south-plunging structure follows a sinuous 17 mile long course as it trends to the southwest, south, and then to the southeast, respectively.

The south-plunging Chilson Anticline is approximately 30 miles long and is about 5 miles east of Edgemont, South Dakota. This asymmetric fold has an amplitude of 800 feet and its gentle flank dips about 2° to the southeast. The topographic high along the axis of the structure can be noticed by the resistant sandstone of the Inyan Kara Group.

The Cottonwood Creek Anticline is a southwest-trending, gently dipping anticline with little or no topographic expression. This fold has an amplitude of only 100 feet and the exposed strata, of Cretaceous Age, are shales.

The southwest flank of the Black Hills is modified by the Dewey, Edgemont, and Livingston structural terraces. The Dewey Terrace is bounded by Fanny Peak Monocline on the west and bisected by the Dewey Fault Zone. The Edgemont Terrace is present at Edgemont, South Dakota, north of Cottonwood Creek Anticline and is bounded on the east by the Sheep Canyon Monocline. Much of this terrace is overlain by alluvium of Quaternary Age. The Livingston Terrace is on the west by the Sheep Canyon Monocline with the Chilson Anticline to the east (Ryan, 1964).

Faults are common in the southern Black Hills, but are sparse in the folded eastern portion. Most of the faults present are steeply dipping to vertical northeast-trending normal faults. Generally, the north sides of the faults are upraised as occurs with the faults associated with the Dewey and Long Mountain Structural Zones.

The Dewey Structural Zone consists of sinuous en echelon steeply dipping to vertical normal faults, which uplifts the north side of the zone about 500 feet that may be the result of fault displacement and drag features. This fault zone can be traced for 13 miles northeastward across the Dewey and Jewel Cave, southwest quadrangles, before the zone bifurcates to the east. One branch continues east for 6 miles and the other branch trends an equal distance to the northeast. Horizontal movement along this fault has not been reported; however, the sinuous en echelon trace of the faults in this area suggest that minor strike-slip component of movement may exist within the fault zone (Robinson and others, 1964).

Seven miles north of Edgemont, South Dakota, the Long Mountain Structural Zone consists of small northeast-trending normal faults, exposing rocks of the Inyan Kara Group and of the Sundance Formation. Many individual faults within this zone have been traced less than one mile. These individual faults are more clearly defined approximately 2 miles to the southwest, where the faults border a structural terrace and the northwest sides of the faults are uplifted. Some of these faults have as much as forty feet of displacement adjacent to the fault and as much as sixty feet of additional structural relief, which may be the results of folding of the strata.

In the Clifton and Dewey quadrangles arcuate and sinuous faults and low-angle faults have been mapped in addition to the northeast trending faults. The sinuous faults are randomly oriented and may be associated with the arcuate faults, such as those eleven miles north of Dewey. In this area, the faults are locally associated with highs in anomalous gravity measurements, which indicate high relief on the buried surface of Precambrian rocks. These faults may have resulted from compaction of sediments around these highs in the basement rocks or resulted from dissolution and removal of evaporates in the Minnelusa Formation (Cappels, 1963).

There are two major sets of joints in the southern Black Hills area. These two joint sets strike northeast in the northern and central parts of the area, whereas in the eastern part of the area the dominant orientation is to the northwest (Figure A). These two differences probably reflect divergent stresses that deformed the two major basement blocks (Gott and others, 1974).

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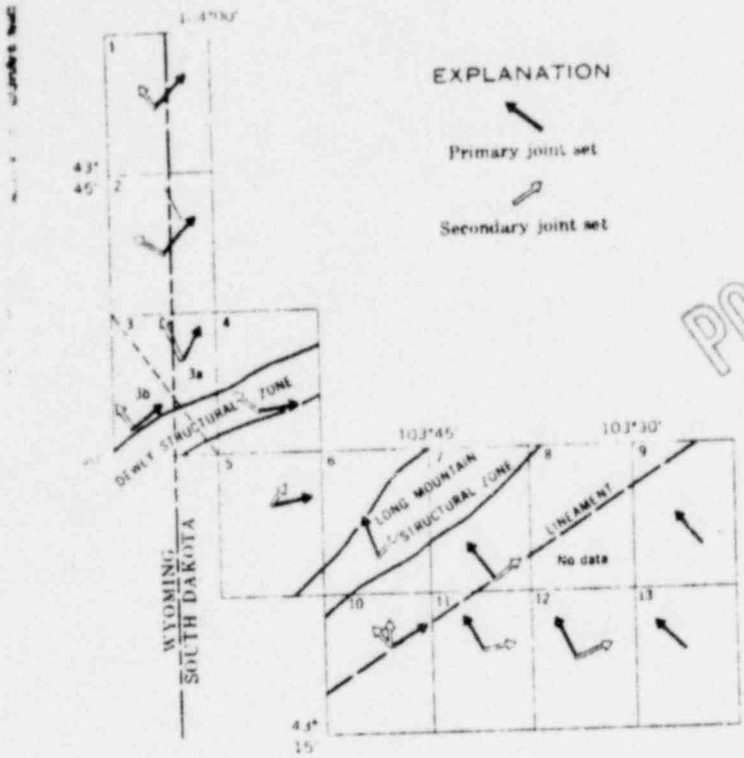
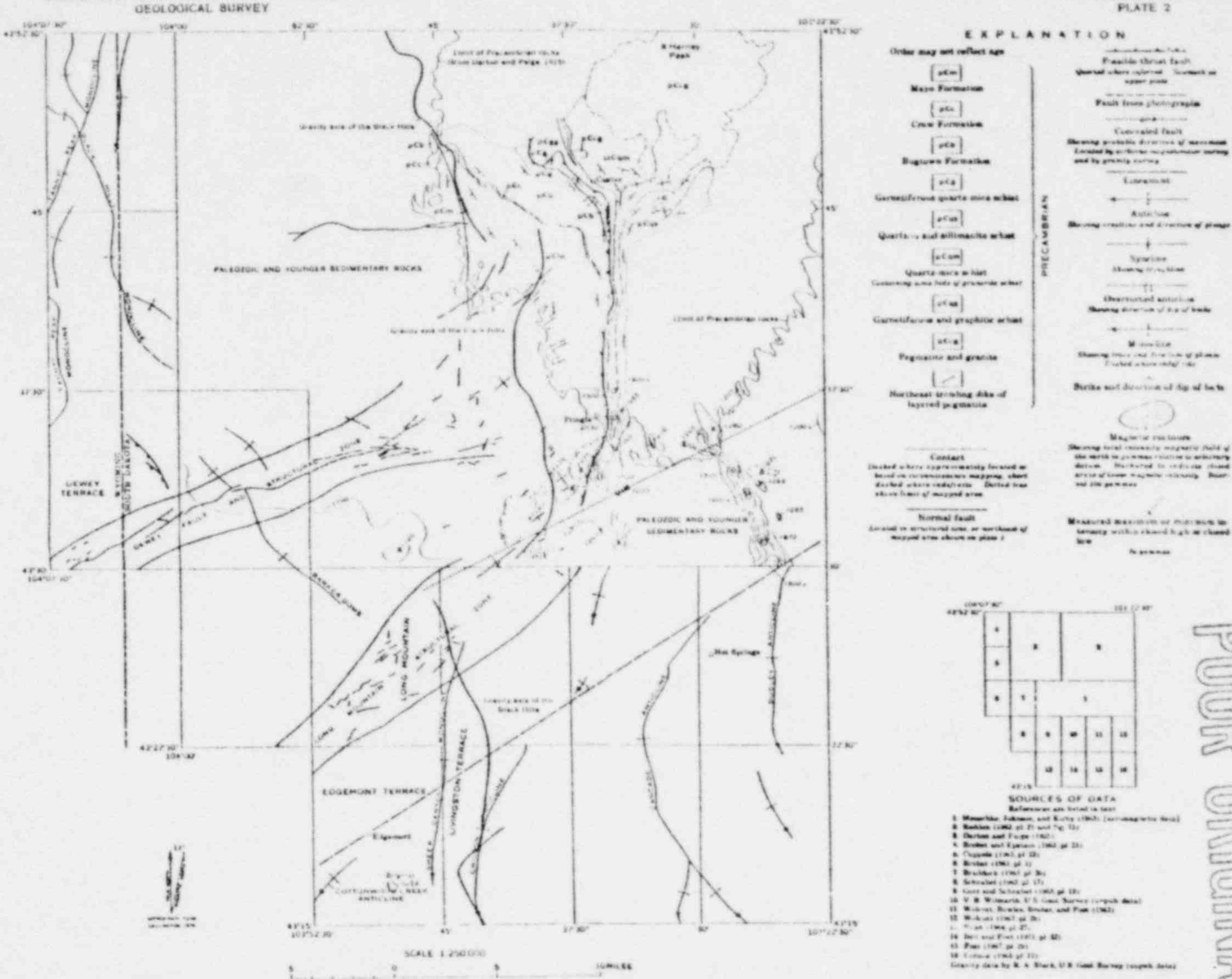


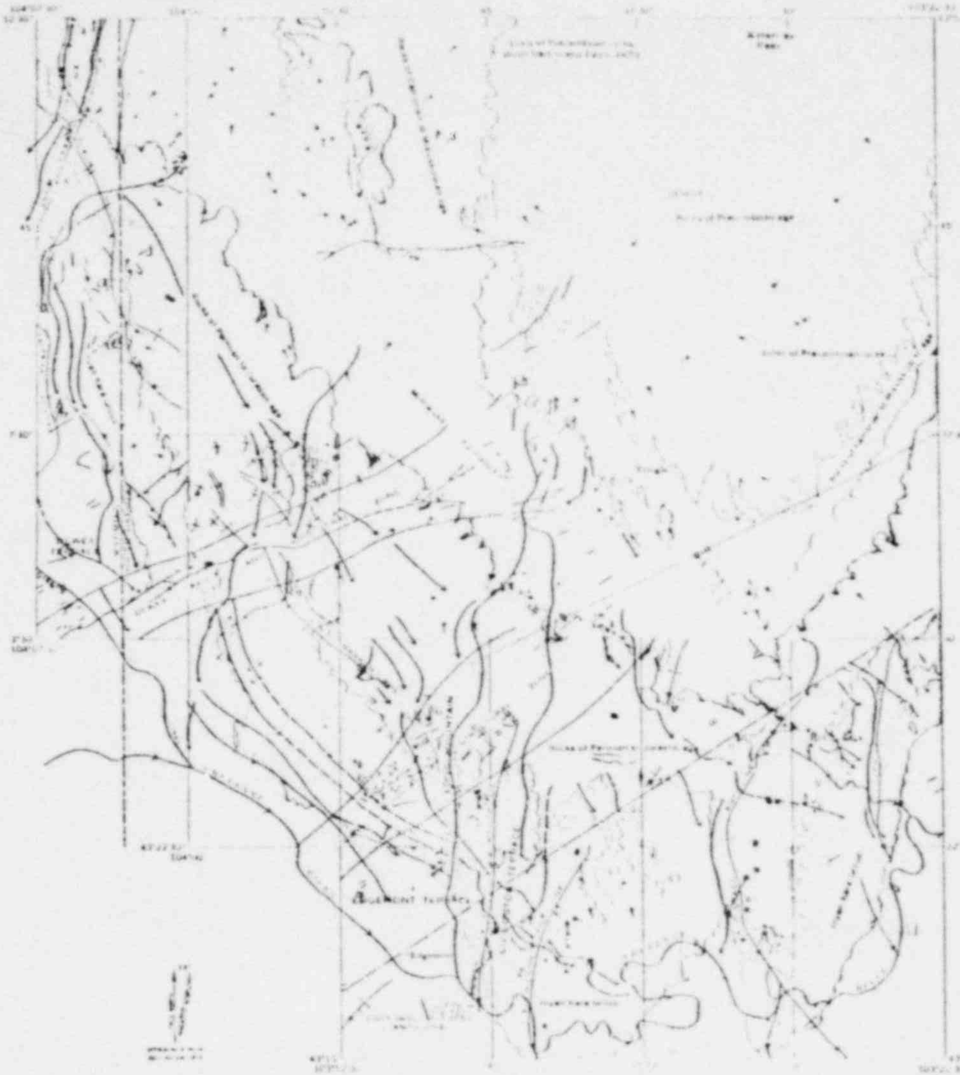
Map No.	Reference	Joint Sets Primary	Joint Sets Secondary
1	Brobst and Epstein (1963)	N. 45° E.	N. 20°-45° W.
2	Cuppels (1963)	N. 40°-50° E.	N. 50°-60° W.
3a	Brobst (1961)	N. 10°-45° E.	N. 10°-40° W.
3b	do	N. 45°-60° E.	N. 10°-40° W.
4	Braddock (1963)	N. 80° E.	N. 50° W.
5	Schnabel (1963)	N. 75°-85° E.	N. 35°-45° E.
6	Gott and Schnabel (1963)	N. 20° W.	NE.
7	Wilmarth and Smith (1957a, b, c, d)	N. 30°-40° W.	N. 50°-60° E.
8	Wolcott and others (1962)	No data	No data.
9	D. E. Wolcott (unpub. data, 1969)	N. 40° W.	
10	Ryan (1964)	N. 60° E.	N., N. 40° W.
11	Bell and Post (1971)	N. 30° W.	N. 75°-80° E.
12	Post (1967)	N. 20°-40° W.	N. 70° E.
13	J. J. Connor (unpub. data, 1969)	N. 40°-50° W.	

FIGURE A.— Average orientation of joint sets in the southern Black Hills. **(Gott and others, 1974)**



MAP OF PART OF THE SOUTHERN BLACK HILLS, SOUTH DAKOTA AND WYOMING, SHOWING MESOZOIC AND CENOZOIC DEFORMATION ALONG PRECAMBRIAN STRUCTURES

POOR ORIGINAL



MAP SHOWING MAJOR TECTONIC ELEMENTS, MINOR FAULT AND SOLUTION COLLAPSE STRUCTURES, SPRINGS, PALEOSTREAMS, AND URANIUM DEPOSITS IN THE SOUTHERN BLACK HILLS, SOUTH DAKOTA AND WYOMING

EXPLANATION

Contact

Normal fault

Possible thrust fault

Fault from photographs

Concealed fault

Lineament

Anticline
Showing crestline and direction of plunge

Syncline
Showing troughline

Monocline

Breccia pipe or collapse structure in Inyan Kara Group or Morrison Formation

Breccia pipe or collapse structure in Sundance Formation

Breccia pipe or collapse structure in Spearfish Formation, Minnekahta Limestone, or Opeche Formation

Breccia pipe or collapse structure in Minnelusa Formation

Syncline

Area containing structures of possible solution origin

Topographic depression in Inyan Kara Group or younger rocks

Topographic depression in Sundance Formation

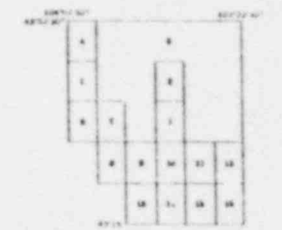
Topographic depression in Spearfish Formation or Minnekahta Limestone

Paleostream of Tertiary and early Quaternary age

Uranium deposit

Spring

Water well



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POOR ORIGINAL

ATTACHMENT 9

THE PALEOTECTONIC HISTORY OF THE SOUTHERN BLACK HILLS

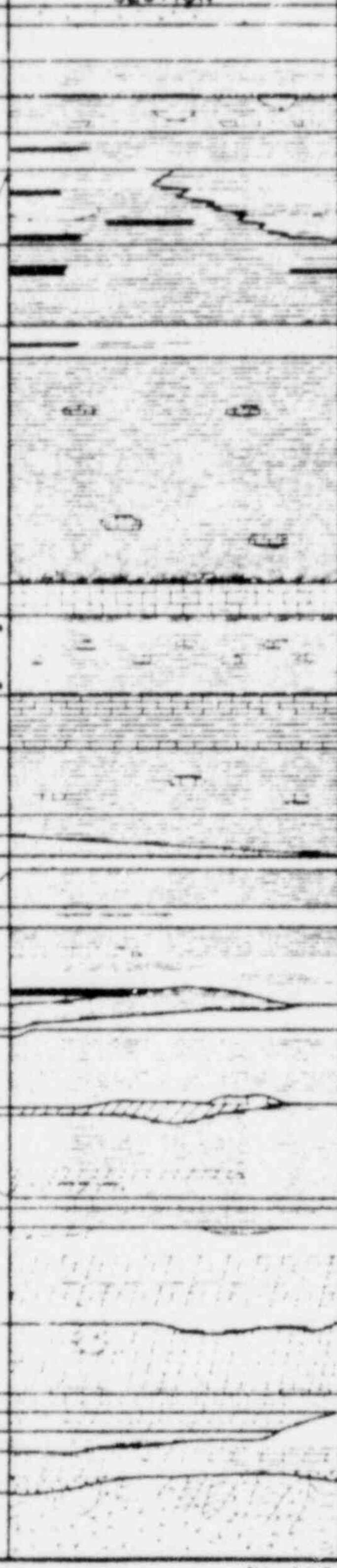
ATTACHMENT 10

REGIONAL OUTCROP SECTION OF THE BLACK HILLS AREA

ATTACHMENT 10

TWENTIETH ANNUAL FIELD CONFERENCE—1968

REGIONAL OUTCROP SECTION OF THE BLACK HILLS AREA



		Formation	[illegible]	Description
QUATERNARY		SANDS AND GRAVELS	0-50	Sand, gravel, and boulders
TERTIARY	PLIOCENE	OGALLALA GROUP	0-100	Light colored sands and silts
TERTIARY	MIOCENE	ARIKAREE GROUP	0-500	Light colored clays and silts; White ash bed at base
TERTIARY	OLIGOCENE	WHITE RIVER GROUP	0-600	Light colored clays with sandstone channel fillings and local limestone lenses
TERTIARY	PALEOCENE	FORT UNION FORMATION: TONGUE RIVER MEMBER	0-425	Light colored clays and sands, with coal beds farther north
TERTIARY	PALEOCENE	FORT UNION FORMATION: CANNONBALL MEMBER	0-225	Green marine shales and yellow sandstones, the latter often as concretions
TERTIARY	PALEOCENE	FORT UNION FORMATION: LUDLOW MEMBER	0-350	Somber gray clays and sandstones with thin beds of lignite
— ? —				
CRETACEOUS	UPPER	HELL CREEK FORMATION (Lance Formation)	425	Somber colored soft brown shale and gray sandstone, with thin lignite lenses in the upper part. Lower half more sandy. Many loglike concretions and thin lenses of iron carbonate
CRETACEOUS	UPPER	FOX HILLS FORMATION	25-200	Grayish white to yellow sandstone
CRETACEOUS	UPPER	PIERRE SHALE	1200-2000	Principal horizon of limestone lenses giving teepee buttes Dark-gray shale containing scattered concretions Widely scattered limestone masses, giving small teepee buttes
CRETACEOUS	UPPER	Sharon Springs Mem		Black fissile shale with concretions
CRETACEOUS	UPPER	NIOBRARA FORMATION	100-225	Impure chalk and calcareous shale
CRETACEOUS	UPPER	CARLILE FORMATION (Turner Sand Zone)	400-750	Light-gray shale with numerous large concretions and sandy layers
CRETACEOUS	UPPER	Wall Creek Sands		Dark-gray shale
CRETACEOUS	UPPER	GREENHORN FORMATION	(25-30)	Impure slabby limestone. Weathers buff
CRETACEOUS	UPPER	GRANEROS GROUP	(200-350)	Dark-gray calcareous shale, with thin Orman Lake limestone at base
CRETACEOUS	UPPER	GRANEROS GROUP: BELLE FOURCHE SHALE	300-550	Gray shale with scattered limestone concretions Clay spur bentonite at base
CRETACEOUS	LOWER	GRANEROS GROUP: MOWRY	150-250	Light gray siliceous shale. Fish scales and thin layers of bentonite
CRETACEOUS	LOWER	GRANEROS GROUP: MUDDY (DYNNESON, NEWCASTLE)	20-60	Brown to light yellow and white sandstone
CRETACEOUS	LOWER	GRANEROS GROUP: SKULL CREEK SHALE	170-270	Dark gray to black shale
CRETACEOUS	LOWER	INYAN KARA GROUP: FALL RIVER [DAKOTA (?)] ss	10-200	Massive to slabby sandstone
CRETACEOUS	LOWER	INYAN KARA GROUP: LAKOTA FM (Fuson Shale; Minnewaste ls)	10-188 0-25 25-485	Coarse gray to buff cross-bedded conglomeratic ss, interbedded with buff, red, and gray clay, especially toward top. Local fine-grained limestone
JURASSIC		MORRISON FORMATION	0-220	Green to maroon shale. Thin sandstone
JURASSIC		UNKPAPA SS	0-225	Massive fine grained sandstone
JURASSIC		SUNDANCE FM (Redwater Mem, Lak Member, Hulett Member, Stockade Beaver, Canyon Spr Mem)	250-450	Greenish-gray shale, thin limestone lenses Glauconitic sandstone; red ss near middle
JURASSIC		GYPSUM SPRING	0-45	Red siltstone, gypsum, and limestone
TRIASSIC		SPEARFISH FORMATION	250-700	Red sandy shale, soft red sandstone and siltstone with gypsum and thin limestone layers
— ? —		Goose Egg Equivalent		Gypsum locally near the base
PERMIAN		MINNEKAHTA LIMESTONE	30-50	Massive gray, laminated limestone
PERMIAN		OPECHE FORMATION	50-135	Red shale and sandstone
PERMIAN / PENNSYLVANIAN		MINNELUSA FORMATION	350-850	Yellow to red cross-bedded sandstone, limestone, and anhydrite locally at top. Interbedded sandstone, limestone, dolomite, shale, and anhydrite Red shale with interbedded limestone and sandstone at base
MISSISSIPPIAN		PAHASAPA (MADISON) LIMESTONE	300-630	Massive light-colored limestone. Dolomite in part. Cavernous in upper part
DEVONIAN		ENGLEWOOD LIMESTONE	30-60	Pink to buff limestone. Shale locally at base
ORDOVICIAN		WHITEWOOD (RED RIVER) FORMATION	0-60	Buff dolomite and limestone
ORDOVICIAN		WINNIPEG FORMATION	0-100	Green shale with siltstone
CAMBRIAN		DEADWOOD FORMATION	10-400	Massive buff sandstone. Greenish glauconitic shale, flaggy dolomite, and flatpebble limestone conglomerate. Sandstone, with conglomerate locally at the base
PRE-CAMBRIAN		METAMORPHIC and IGNEOUS ROCKS		Schist, slate, quartzite, and arkosic grit intruded by diorite, metamorphosed to amphibolite, and by granite and pegmatite

(Modified from WGA Guidebook, 1968)

DEPARTMENT OF GEOLOGY AND GEOLOGICAL ENGINEERING 1968
South Dakota School fo Mines and Technology
Rapid City, South Dakota
Note: Muddy Sandstone Revision by G. Wulf, 1968

ATTACHMENT 11

SITES	GEOLOGIC ADVANTAGES	DISADVANTAGES	HYDROLOGIC ADVANTAGES	DISADVANTAGES
8	No geologic structures to affect disposal operation. Open pits available with overburden.	Sandstone bedrock potentially mineral reserves of uranium and vanadium		Vertical and lateral movement of fluids through sandstone (Fall River Aquifer).
10	Natural basin requiring little excavation. No geological structures to affect disposal operations.	Underlying sandstone with interbedded shale. Active erosional forces with slope instability. Cover material not available.		Good ground water percolation and lateral movement through sandstone.
B		Inferred fault north of site. Active erosional forces with slope In-stability.	Probable low hydraulic conductivity and high sorptive capacity of soils.	Possible migration of waste leachates along fault trace.
Proposed Disposal Site	Site underlain by impermeable shale. Low erosion potential. Cover material available.	Excavation required.	Disposal area would not affect underlying con-fined aquifer. No vertical or lateral movement of fluids, due to impermeable shale base.	Possible perched water table.

GEOLOGIC AND HYDROLOGIC INFORMATION FOR ALTERNATIVE SITES 8, 10, B AND THE PROPOSED DISPOSAL SITE

ATTACHMENT 11

GEOLOGIC AND HYDROLOGIC INFORMATION FOR ALTERNATIVE SITES 8, 10, B, AND THE PROPOSED DISPOSAL SITE

ATTACHMENT 9

The Paleotectonic History of the Southern Black Hills

The Laramide uplift of the Black Hills is the result of a major vertical force (Noble, 1952). The uplift indicates that many structures within the area were formed by secondary compressive stresses from a westerly direction. These lateral stresses acted in a northeast to easterly direction, but locally the direction was from the southeast.

The three northwest-trending anticlines were formed by northeastward compression in the central area and by low-angle reverse faults north of the Dewey structural zone. The strike of faults associated with the Dewey structural zone appears that the stress was from an eastward direction. This can be seen by looking higher on the flank of the Black Hills toward the axis of the uplift. The general northeast strike of the major joint sets changes dramatically to the easterly orientation in the Jewel Cave quadrangle. This change is thought to be the resultant in stress orientation that is related to a buttressing effect by the granitic intrusion at Harney Peak and to the deflection of the compressive force to the east. It is thought that the stress was transmitted through a basement block lying to the north of the Dewey structural zone. Those structures may be aligning themselves to structures which paralleled northeast-trending structures of the Precambrian Age. Geophysical data indicate a large concealed northeast-trending wrench fault that is northeast of the Long Mountain structural zone. A similar structure is found by a sharp bend in the aeromagnetic anomaly survey and is concealed north of Hot Springs (Meuschke and others, 1963). This structure appears to have yielded to Laramide deformational stresses and was influenced by the folding of asymmetrical anticlines in the eastern part of the area. This concealed structure is coincident with the north end of a lineament that is marked by a northeasterly bend. The eastward compressive force exerted by the northern block would have imparted both eastward and southward force vectors on the southern block. This block is adjacent to the northern block and could have formed stress which would have formed from an east to southeast direction. This in turn probably is responsible for the eastward deflection of the anticlinal folds along this concealed lineament.

This divergent orientation of forces acting upon these two blocks created a different orientation for the major joint set on each side of this wrench fault. The major joint set on the northern block strikes to the northeast but the major set of joints on the southern block strikes northwesterly (Gott and others, 1974). This, perhaps, was the result of the wrench fault, since this lineament occurs between the Dewey and the Long Mountain structural zone.

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Meuschke, J. L., Johnson, R. W., and Kirby, J. R., 1963, "Aeromagnetic Map of Southwestern Part of Custer County, South Dakota," U.S. Geol. Survey Geophys. Inv. Map GP-362.

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Additional Material

Sales, J. K., 1968, "Regional Tectonic Setting and Mechanics of Origin of the Black Hills Uplift," Wyoming Geol. Assoc. Guidebook, 20th ann. Field Conf., p. 10-27.

ATTACHMENT 12

INVESTIGATIONS OF THE COMPOSITION AND DIVERSITY OF NONFISH AQUATIC BIOTA ON THE TVA EDGEMONT URANIUM PROPERTIES

ATTACHMENT 12

TVA/ONR-79/13

INVESTIGATIONS OF THE COMPOSITION AND DIVERSITY OF NONFISH AQUATIC BIOTA ON THE TVA EDGEMONT URANIUM PROPERTIES

D. C. Wade and J. R. Wright, Jr.
Office of Natural Resources
Tennessee Valley Authority

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Availability Unlimited

TVA/EP - 78/06

TENNESSEE VALLEY AUTHORITY

Office of Natural Resources
Division of Water Resources

INVESTIGATIONS OF THE COMPOSITION AND DIVERSITY OF NONFISH AQUATIC BIOTA ON THE TVA EDGEMONT URANIUM PROPERTIES

Prepared by

D. C. Wade and J. R. Wright, Jr.
Water Quality Branch

Chattanooga, Tennessee
December 1979

ABSTRACT

As part of a program to acquire uranium to fuel its nuclear-powered steam-electric generating plants, the Tennessee Valley Authority (TVA) plans to mine uranium-vanadium ore deposits in the southwestern Black Hills area of Fall River and Custer Counties, South Dakota, and Weston and Niobrara Counties, Wyoming. Four mine sites have been identified (within 15 miles of Edgemont) and are referred to collectively as the Edgemont Uranium Mining Properties.

Surface waters flowing through the Edgemont properties were sampled in September 1975 and June 1976 to document the composition and diversity of indigenous aquatic communities during a dry and wet season, respectively. Sampling sites were selected on the basis of two criteria: (1) the need to delineate preoperational conditions in the vicinity of potential mining and milling activities and (2) the need to define the biological communities indigenous to each of the representative habitats and each of the major substrates.

Aquatic (surface) habitats on the Edgemont Uranium Properties are relatively diverse, and often subject to extreme environmental change. The combination of shallow water and extreme temperatures often results in a freezing of the entire water column during the winter months. Vernal snowmelt and subsequent periods of heavy rainfall may produce spates and flooding, while seasonal periods of minimal rainfall result in little or no streamflow.

Biological populations inhabiting these locally and seasonally perturbed, intermittent streams often have transient or ephemeral larval and/or adult stages. Zoomacrobenthic recolonization of temporarily perturbed areas is accomplished through surface water drift, survival of desiccation-resistant eggs, new egg deposition, and groundwater migration of larvae or adults. Like the habitats, composition and diversity vary with meteorological conditions, geographic location, and season.

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ON THE TVA EDGEMONT URANIUM PROPERTIES

INTRODUCTION

As part of a program to acquire uranium to fuel its nuclear-powered steam-electric generating plants, the Tennessee Valley Authority (TVA) plans to mine uranium ore deposits in the southwestern Black Hills area of Fall River and Custer Counties, South Dakota, and Weston and Niobrara Counties, Wyoming. Four mine sites--Burdock, Darrow, Runge, and Spencer Richardson--have been identified. All four sites are located within 15 miles of Edgemont and are referred to collectively as the Edgemont Uranium Mining Properties.

Surface waters flowing through the Edgemont properties were sampled in September 1975 and June 1976 to document the composition and diversity of indigenous aquatic communities during a dry and wet season, respectively. Sampling sites were selected on the basis of two criteria: (1) the need to delineate preoperational conditions in the vicinity of potential mining and milling activities and (2) the need to define the biological communities indigenous to each of the representative habitats (riffles, pools, vegetative areas) and each of the major substrates (silt, clay, detritus, cobble, submerged and emergent aquatic plants). Ten sampling stations were established and designated as stations 1, 2, and 3 on Beaver Creek; station 4 on Pass Creek; station 5 on an unnamed pond near the Burdock No. 1 shaft; stations 6 and 10 on the Cheyenne River; and stations 7, 8, and 9 on Cottonwood Creek. The locations of these stations and the proposed mining sites are shown in Figure 1.

Two sites, Pass Creek and an unnamed pond near Burdock No. 1 mine shaft, were sampled only in 1976 because they were not identified as being in the vicinity of mining activities until after the 1975 survey was completed. The upper two stations on Beaver Creek (Wyoming) were not sampled in 1976 because of flooding.

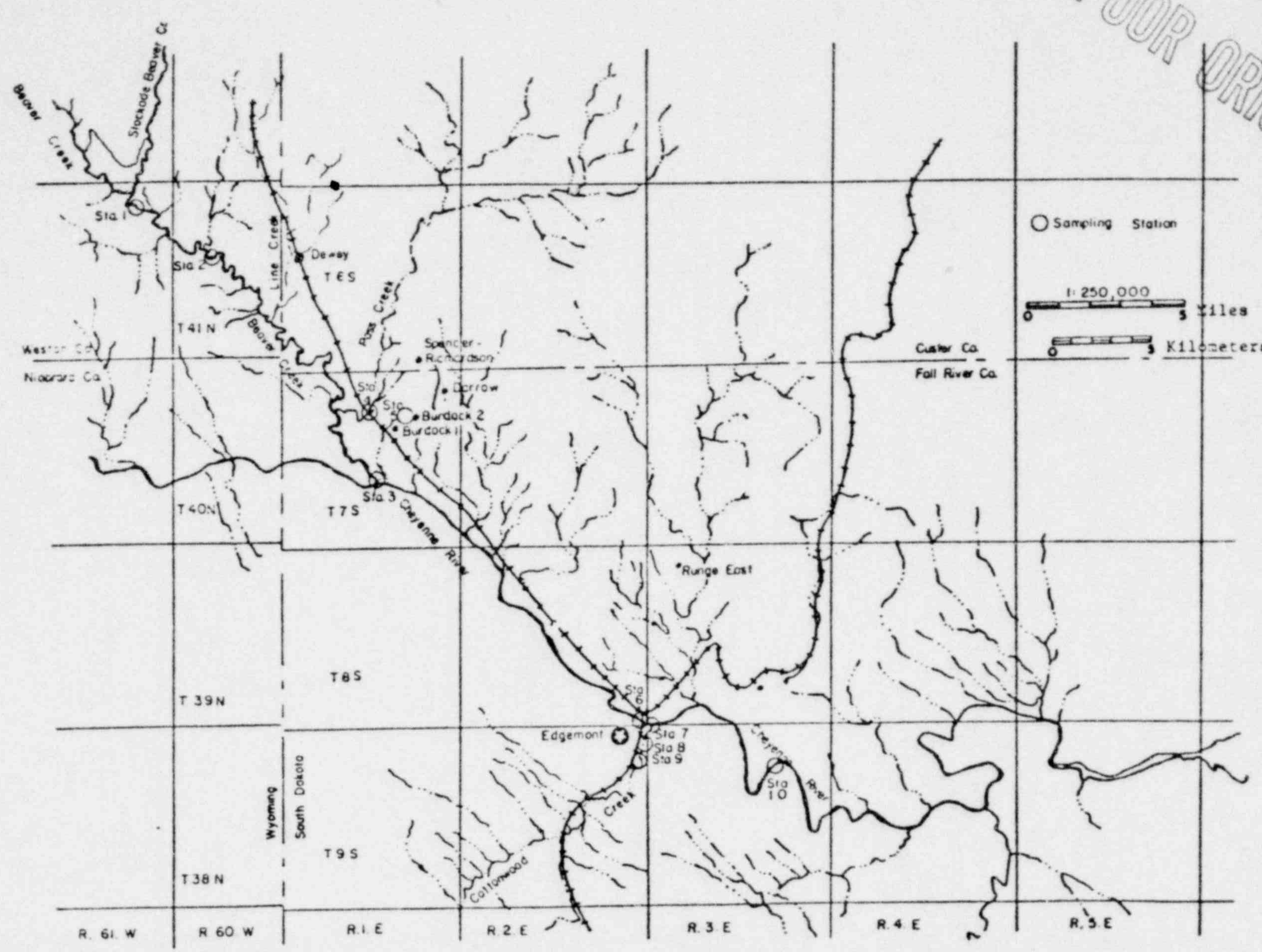

Figure 1. Biological sampling stations and potential mining sites on the Edgemont Uranium Properties.

DESCRIPTION OF HABITATS AND STREAM CLASSIFICATIONS

General

Surface waters on the Edgemont uranium properties provide habitats suitable for a variety of aquatic biota. Habitats range from stream courses that contain water only during or after heavy precipitation to streams that maintain flow throughout the year. Most of the streams experience at least occasional intermittent or interrupted flows as a result of extreme seasonal meteorological variability. The effects of variable flow on habitat are significant. Quantities of silt are deposited at times, while the streambed is scoured at others.[2] During periods of extremely low flow, portions of the benthic substrate can be exposed and subjected to rapid drying.

Beaver Creek

Beaver Creek and its major tributary, Stockade Beaver Creek, are classified by the State of Wyoming as class I waters: that is, they support game fish and have the hydrologic and natural water quality potential to support game fish. From the Wyoming-South Dakota border to the Cheyenne River, Beaver Creek is classified by the State of South Dakota as being suitable for cold-water marginal fish life propagation, limited contact recreation, wildlife propagation, stock watering, and irrigation. Beaver Creek flows through a gully-like watercourse in a southeasterly direction through the western perimeter of the Edgemont properties into the Cheyenne River. Its benthic substrate is composed of sands, cobble, and scattered amounts of aquatic vegetation through most of its course with clay, sands, and cobble at the mouth. Although Beaver Creek may experience extended periods of no flow, volume and flow were adequate in September 1975 (normal dry season) to conduct biological sampling from T. 41N, R. 61W (Figure 1) to its mouth.

Pass Creek

Pass Creek is classified by the State of South Dakota as an intermittent stream, subject to extensive periods of no flow. However, a permanent aquatic ecosystem exists at the railroad crossing (T. 7S, R. 1E), where Pass Creek combines with a flowing well. This ecosystem is characterized by emergent vegetation, a very soft, deep benthic substrate, and a diverse macrobenthic community. During the June 1976 survey, only minimal flow was present in Pass Creek above the well.

Unnamed Pond Near Burdock No. 1 Shaft

During the June 1976 survey, a pond ecosystem was identified in the immediate mining area. This pond is located northwest of the Burdock No. 1 mine shaft and has been diked to serve as a holding pond for mine dewatering operations. The pond is apparently dry during most of the year; however, in June it contained about 0.6 m (2 ft) of water and supported a flourishing biota. The benthic substrate was soft clay, which supported several areas of emergent vegetation (grasses).

Cottonwood Creek

Cottonwood Creek, a perennial stream, drains an area south of the town of Edgemont before flowing through the existing uranium mill properties and directly into the Cheyenne River. Representative habitats include a pool and riffle area upstream from the existing mill, a pooled area upstream from a culvert on the mill properties, and a free-flowing segment at the creek mouth. Soft substrates were dominant and often supported a dense growth of emergent and overhanging vegetation. The water depth was essentially the same [less than 0.6 m (2 ft)] during both the 1975 and 1976 surveys.

Cheyenne River

The Cheyenne River is classified by the State of South Dakota as being suitable for propagation of warm-water, semipermanent fish life; limited contact recreation; wildlife and stock watering; and irrigation. During the dry season many reaches of the river contain no surface water or only isolated small pools. At Edgemont in September 1975 the river contained minimal flow and was only 0.6 to 0.9 m (2 to 3 ft) wide; just downstream of Edgemont all surface flow ceased. Consequently, most of the benthic substrate was exposed and dry. In June 1976 the entire natural stream channel was filled with very turbid water, 0.76 m (2.5 ft) deep.

MATERIALS AND METHODS

Macroinvertebrates were collected primarily from natural benthic substrates using a Surber Square Foot Sampler. At stations where submerged or emergent aquatic vegetation was present, collections were made by sweeping a round wire net through the vegetation. Zooplankton were collected with a Wisconsin tow net whenever water depths permitted. In shallower areas, samples were collected with buckets, and a measured volume was poured through the Wisconsin net. Phytoplankton were collected in 1-L middepth-to-surface grab samples.

DESCRIPTION OF INDIGENOUS MACROBENTHIC FAUNA AND PLANKTONIC FLORA

General

Organisms comprising biological communities in Edgemont surface waters include species indigenous to springs, riffles, stream pools, and quiescent waters. Like habitats, composition and diversity vary significantly with geographic location and season. Greater than normal population oscillations occur as a result of such environmental disturbances as spates, floods, or low flow because many species are adapted to a limited range of flow conditions. Although most aquatic plants are sessile, many of the animals are vagile, at least during some phase of their life cycle. All sessile organisms depend on current for bringing foodstuffs to them, but vagile forms may seek out foods in different parts of the stream and may even move from one habitat to another. Most stream insects deposit many eggs to overcome the detrimental effects of environmental perturbation. Larval mortality is high and can be caused by many factors, including excessive or insufficient flow. Communities removed by scouring or drying are repopulated primarily by drift when stream conditions (flow) become conducive to the maintenance of that community.

Beaver Creek

Macrobenthos

Marcobenthic data presented in Tables 1 and 2 reflect the number of species and individuals collected per square meter of substrate. Diversity (d) in the fall was greatest at station 1 (T. 41N, R. 61W) and lowest at station 2 (T. 41N, R. 60 W), near exploratory drilling on the Dewey Terrace properties. The low diversity at station 2 resulted because most of the organisms (566 out of 593) belonged to a single taxon, the caddisfly Cheumatopsyche. Diversity at the mouth of Beaver Creek (station 3) was also low, with only three taxa present, Cheumatopsyche again being dominant. In the subsequent early summer sampling (June 1976), diversity at the mouth of Beaver Creek was greater (57 organisms representing 14 taxa).

Phytoplankton

The phytoplankton community of Beaver Creek was a well-balanced chlorophyte/chrysophyte-dominated assemblage comprised of 13 genera. Data shown in Table 3 identify the number of algal cells per liter and the percentage composition of each taxonomic group. Although stations 1 and 2 were similar in both the species present and relative species abundance, station 3 showed several differences: (1) Diatoma was only encountered at station 3, having a mean value of 79,400 cells/L; (2) Ankistrodesmus, a chlorophyte identified at all stations, was much more prevalent at station 3 (1,550,000 cells/L as compared with 26,500 cells/L at station 2 and 18,700 cells/L at station 1); and (3) Cyanophyta (blue-green algae) comprised only 3 percent of the phytoplankton assemblage at station 3 in contrast to 29 percent and 17 percent at stations 1 and 2, respectively.

Zooplankton

Zooplankton data are recorded in Table 4 as the number of organisms per unit sampling effort (60-ft tow with Wisconsin net). As expected, populations were greatest at the mouth of Beaver Creek, even though the order Cladocera was not represented. Most of these organisms were either copepod nauplii or the rotifer Trichotria pocillum. A total of 19 taxa was collected.

TABLE 1. MACROINVERTEBRATES COLLECTED FROM NATURAL SUBSTRATES IN BEAVER CREEK, WESTON COUNTY, WYOMING, AND FALL RIVER COUNTY, SOUTH DAKOTA (SEPTEMBER 1975)

Organism	Number of organisms per square meter							
	Station 1[a]			Station 2[a]			Station 3[a]	
	Sample 1	Sample 2	Mean	Sample 1	Sample 2	Mean	Sample 1	Sample 2[b]
Coleoptera								
Elmidae (aquatic beetle)							11	
Dubiraphia sp. (adult)	11		5.5					
Stenelmis sp.				11		5.5		
Diptera								
Chironomidae (midge)		22	11.0				22	
Empididae (dance fly)				11		5.5		
Simuliidae (black fly)								
Prosimulium (?) sp.	32		16					
Hemiptera								
Naucoridae (creeping water bug)								
Ambrysus sp.		11	5.5	11		5.5		
Lepidoptera								
Pyralidae (aquatic moth)								
Parargyractis (?) sp.				11		5.5		
Odonata								
Calopterygidae (damselfly)								
Hetaerina americana	22	11	16.5					
Coenagrionidae (damselfly)								
Enallagma sp.		11	5.5					
Gomphidae (dragonfly)								
Gomphus (*Gomphurus*) *externus*		11	5.5					
Trichoptera								
Hydropsychidae (caddisfly)							86	
Cheumatopsyche sp.	43	32	37.5	743	388	565.5		
Hydropsyche sp.				11		5.5		
Total	108	98	103.0	798	388	593.0	119	

[a]Station 1 was 2 miles NW of U.S. 35 bridge; station 2 was 250 ft upstream from U.S. 35 bridge; station 3 was at the mouth (see Figure 1).
[b]Sample 2 from station 3 was lost in the laboratory.

TABLE 2. MACROINVERTERBRATES COLLECTED FROM NATURAL SUBSTRATES IN BEAVER CREEK, AND UNNAMED POND, AND PASS CREEK ON TVA MINING PROPERTIES, FALL RIVER COUNTY, SOUTH DAKOTA (JUNE 1976)

	Number of organisms per square meter																	
	Station 3[a]						Station 4[a]						Station 5[a]					
Organism	S-1	S-2	S-3	S-4	S-5	Mean	S-1	S-2	S-3	S-4	S-5	Mean	S-1	S-2	S-3	S-4	S-5	Mean
Amphipoda																		
Talitridae																		
Hyalella azteca									22	75	86	36.6		11				2.2
Coleoptera																		
Dytiscidae																		
Brachyvatus sp.														11		11		4.4
Coptotomus sp.																11		2.2
Laccophilus sp.								43				8.6			11	11		4.4
Elmidae																		
Ordobrevia sp.				11		2.2												
Hydrophilidae																		
Berosus sp.															11			2.2
Diptera																		
Ceratopogonidae			11	22		6.6	11		11		22	8.8		11	11			4.4
Pupae					11	2.2				11		2.2						
Chironomidae																		
Ablabesmyia mallochi gr.									11			2.2						
Ablabesmyia peleensis gr.										32		6.4						
Conchapelopia			11		11	4.4				11		2.2						
Cricotopus sp. 2								22				4.4						
Cryptochironomus fulvus gr.	11				22	6.6			11	11		4.4						
Cryptotendipes pseudotener gr.		11				2.2												
Dicrotendipes sp. 1							54	11	11	32	11	23.8						
Dicrotendipes sp. 2								43		54		19.4						
Endochironomus							11				11	4.4						
Micropsectra			11	22		6.6												
Monopelopia									11			2.2						
Procladius							32		11	11		10.8			11	11		4.4
Psectrocladius nigrus gr.											11	2.2						
Psectrocladius sp. 1							75	355	11	140	140	144.2						
Pseudochironomus sp. 1								11	11	86	32	28.0						
Pseudochironomus sp. 2							22					4.4						
Rheotanytarsus							11	32		11		10.8						
Tanypus (n.r.) pupae			11			2.2												
Tanytarsus							248	11				51.8						
Tanytarsus sp. 1							43		11	22	11	17.4						
Unidentified pupae										11		2.2						
Tabanidae																		
Chrysops sp.							11					2.2						
Gonomyia sp. 2														11				2.2
Pupae			11		11	4.4												

TABLE 2 (continued)

Organism	Station 3[a] S-1	S-2	S-3	S-4	S-5	Mean	Station 4[a] S-1	S-2	S-3	S-4	S-5	Mean	Station 5[a] S-1	S-2	S-3	S-4	S-5	Mean
	Number of organisms per square meter																	
Ephemeroptera																		
Baetidae									11			2.2						
Baetis sp.										22		4.4						
Callibaetis sp.													11	32	32	65	11	30.2
Caenidae																		
Caenis sp.										32		6.4						
Heptageniidae				11		2.2												
Gastropoda																		
Physidae																		
Physa sp.								11				2.2						
Hemiptera																		
Corixidae			11			2.2												
Cenocorixa (n.r.) sp.													11					2.2
Notonectidae																		
Buenoa sp.															11			2.2
Nematoda																		
Mermithidae							11					2.2						
Odonata																		
Coenagrionidae																		
Ischnura sp.										22		4.4						
Gomphidae																		
Gomphus sp.					22	4.4												
Oligochaeta					43	8.6	11		22		11	8.8						
Trichoptera																		
Hydropsychidae																		
Cheumatopsyche sp.					11	2.2												
Total	11	11	55	66	131	54.8	540	539	154	572	335	430.2	22	76	98	109	11	61.0

[a]Station 3 was at the mouth of Beaver Creek (Edgemont Mine - Dewey Terrace); station 4 was on Pass Creek at road crossing; and station 5 was at unnamed pond near Burdock No. 1 shaft (see Figure 1).

TABLE 3. PHYTOPLANKTON COLLECTED FROM BEAVER CREEK, WESTON COUNTY, WYOMING, AND FALL RIVER COUNTY, SOUTH DAKOTA (SEPTEMBER 1975)

Organism	Number of cells per liter: Station 1[a] Sample 1	Sample 2	Mean	Station 2[a] Sample 1	Sample 2	Mean	Station 3[a] Sample 1	Sample 2	Mean
Chrysophyta (diatoms)									
Cocconeis sp.	9,345	9,345		12,460	12,460		12,460	18,690	
Cymbella sp.	3,115	9,345		6,230	3,115		12,460	9,345	
Epithemia sp.					3,115				
Gomphonema sp.		9,345			3,115		6,230		
Navicula sp.	15,575	12,460		3,115	6,230		9,345	18,690	
Nitzschia sp.	3,115	3,115			3,115			12,460	
Surirella sp.	3,115	6,230		12,460	31,150				
Synedra sp.	9,345			6,230	3,115		15,575	3,115	
Diatoma sp.							140,175	18,690	
Melosira sp.							6,230	9,345	
Total	43,610	49,840	46,725	40,495	65,415	52,955	202,475	90,335	146,405
Chlorophyta (greens)									
Ankistrodesmus sp.	52,955	43,610		18,690	18,690		2,002,945	1,105,825	
Cymbella sp.		21,805							
Golenkinia sp.				9,345					
Pandorina sp.				18,690					
Scenedesmus sp.		12,460					6,230		
Schroederia sp.	21,805			9,345	6,230				
Chlamydomonas sp.							15,575	3,115	
Cosmarium sp.							6,230		
Total	74,760	77,875	76,318	56,070	24,920	40,495	2,030,980	1,108,940	1,569,960
Cyanophyta (blue-greens)									
Anabaena sp.	52,955	46,725			6,230				
Chroococcus sp.					18,690				
Oscillatoria sp.	3,115						6,230	112,140	59,185
Spirulina sp.				12,460					
Total	56,070	46,725	51,398	12,460	24,920	18,690			
Euglenophyta									
Euglena sp.	3,115		1,558				12,460		6,230
Percentage composition									
Chrysophyta	24.6	28.6	26.5	37.1	56.8	47.2	9.0	6.9	8.2
Chlorophyta	42.1	44.6	43.4	51.4	21.6	36.1	90.2	84.6	88.1
Cyanophyta	31.6	26.8	29.2	11.4	21.6	16.7	0.3	8.8	3.3
Euglenophyta	1.8		0.9				0.5		0.3

[a]Station 1 was 2 miles NW of U.S. 35 bridge; station 2 was 250 ft upstream from U.S. 35 bridge; station 3 was at the mouth (see Figure 1).

TABLE 4. ZOOPLANKTON COLLECTED FROM BEAVER CREEK, WESTON COUNTY, WYOMING, AND FALL RIVER COUNTY, SOUTH DAKOTA (SEPTEMBER 1975)

Organism	Number of organisms per 60-ft tow[a]								
	Station 1[b]			Station 2[b]			Station 3[b]		
	Sample 1	Sample 2	Mean	Sample 1	Sample 2	Mean	Sample 1	Sample 2	Mean
Rotataria									
Brachionus budapestinensis	6	6	6.0						
Brachionus urceolaris					13	6.5	23	23	23.0
Brachionus quadridentatus							8		4.0
Lecane sp.								8	4.0
Monostyla sp.							8	38	23.0
Trichotria pocillum							15	113	64.0
Keratella cochlearis		6	3.0						
Mytilinia sp.					6	3.0			
Polyarthra sp.		6	3.0	13		6.5			
Tripleuchlanis sp.									
Unidentified (contracted) rotifer							15		7.5
Cladocera									
Bosmina longirostris		19	9.5						
Diaphanosoma (instar)	6	6	6.0						
Copepoda									
Cyclopoida (copepodid)		13	6.5	1		0.5	23	68	45.5
Diaptomus (copepodid)	6		3.0						
Cyclops vernalis				1		0.5			
Eucyclops agilis		6	3.0		6	3.0			
Mesocyclops edax					6	3.0			
Tropocyclops prasinus								8	4.0
Nauplii	19		9.5				53	195	124.0
Total	37	62	49.5	15	31	23.0	145	453	299.0

[a] Wisconsin plankton net.
[b] Station 1 was 2 miles NW of U.S. 35 bridge; station 2 was 250 ft from U.S. 35 bridge; station 3 was at the mouth (see Figure 1).

Pass Creek

Macrobenthos

Ten families and 26 species were collected from Pass Creek (Table 2). Sixteen of the species were from the family Chironomidae, an indication of the quiescent waters and soft substrate types present at this site. The numbers of organisms ranged from 154 to 540 per square meter, with a mean value of 428. The family Chironomidae comprised 75 percent of the macrobenthic numbers.

Phytoplankton

Phytoplankton samples (Table 5) were collected from the main flow of Pass Creek upstream from the flowing well. The data are indicative of communities occupying flowing waters, with Chrysophyta being the only group represented. Navicula, Nitzschia, and Synedra combined for a mean value of 14,800 cells/L.

Zooplankton

Zooplankton samples were also collected from the main flow of Pass Creek upstream from the flowing well. The data, presented in Table 7, are also indicative of the shallow, flowing water habitat. The population density was 5500 organisms/m^3. Total numbers included five species of rotifers, two species of cladocerans, and larval and immature copepods.

Unnamed Pond Near Burdock No. 1 Shaft

Macrobenthos

Macrobenthic data are reported in Table 2 as number of organisms per square meter. The dominant organism was the mayfly Callibaetis, which accounted for 50 percent of the macroinvertebrate density. A mean of 61 organisms/m^2, representing 11 taxa, was collected.

Phytoplankton

Phytoplankton data are presented in Table 5 as the number of cells per liter and percentage composition for each group; 86 percent of the phytoplankton community was composed of the division Euglenophyta, with Euglena as the dominant organism. The mean density was 108,000 cells/L.

Zooplankton

Twenty taxa of zooplankton were identified from this site, and population density exceeded 900,000 organisms/m^3 (Table 7). Rotatoria, cladocera, and copepoda accounted for 33 percent, 2 percent, and 66 percent of the total assemblage, respectively.

TABLE 5. PHYTOPLANKTON COLLECTED IN SURFACE SAMPLES FROM PASS CREEK AND AN UNNAMED POND ON TVA MINING PROPERTIES, FALL RIVER COUNTY, SOUTH DAKOTA (JUNE 1976)

	Number of cells per liter					
	Station 4[a]			Station 5[a]		
Organism	Sample 1	Sample 2	Mean	Sample 1	Sample 2	Mean
Chrysophyta (diatoms)						
Navicula sp.		9,861			6,574	
Nitzschia sp.	3,287					
Synedra sp.	16,435			16,435	6,574	
Total	19,722	9,861	14,792	16,435	13,148	14,792
Euglenophyta						
Euglena sp.				72,314	72,314	
Trachelomonas sp.				13,148	29,583	
Total				85,462	101,897	93,680
Percentage composition						
Chrysophyta	100	100	100	16.1	11.4	13.6
Euglenophyta				83.9	88.6	86.3

[a]Station 4 was on Pass Creek at road crossing; station 5 was at unnamed pond near Burdock No. 1 shaft (see Figure 1).

TABLE 6. ZOOPLANKTON COLLECTED FROM PASS CREEK AND AN UNNAMED POND ON TVA MINING PROPERTIES, FALL RIVER COUNTY, SOUTH DAKOTA (JUNE 1976)

	Number of organisms per cubic meter					
	Station 4[a]			Station 5[a]		
Organism	S-1	S-2	Mean	S-1	S-2	Mean
Rotataria						
Asplanchna seiboldi				2,273		1,137
Brachionus bidentata				36,364	45,455	40,910
Brachionus quadridentatus				120,455	50,000	85,228
Brachionus urceolaris	682		341			
Euchlanis sp.				9,091	2,273	5,682
Lecane luna				195,455	168,182	181,819
Lecane sp.	682		341			
Monostyla sp.	682		341			
Notholca squamula	682	682	682			
Polyarthra sp.					2,273	1,137
Synchaeta sp.				2,273		1,137
Trichotria sp.		1,364	682			
Cladocera						
Alona costata				9,091		4,546
Bosmina longirostris		682	341			
Ceriodaphnia (instars)				2,273	2,273	2,273
Chydorus sp.	682	682	682	364	182	273
Macrothrix laticornis				2,273	91	1,182
Moina affinis				2,273	364	1,319
Simocephalus vetulus				2,273	6,818	4,546
Copepoda						
Cyclopoida (copepodid)	1,364	91	728	206,818	195,455	201,137
Cyclops varicans rubellus				11,364	2,273	6,819
Diaptomus (copepodids)				4,546	4,546	4,546
Diaptomus clavipes				11,364	6,818	9,091
Diaptomus siciloides				6,818	2,273	4,546
Eucyclops agilis				259,091	143,182	201,137
Nauplii	682	2,046	1,364	254,546	175,000	214,773
Total	5,456	5,547	5,502	1,139,005	807,458	973,238

[a]Station 4 was on Pass Creek at road crossing; station 5 was at unnamed pond near Burdock No. 1 shaft (see Figure 1).

TABLE 7. MACROINVERTEBRATES COLLECTED FROM COTTONWOOD CREEK AND THE CHEYENNE RIVER, FALL RIVER COUNTY, SOUTH DAKOTA (SEPTEMBER 1975)

	Number of organisms per sample[a]															
	Station 6[b]			Station 7[b]			Station 8[b]			Station 9[b]				Station 10[b]		
Organism	Sample 1	Sample 2	Mean	Sample 1	Sample 2	Mean	Sample 1	Sample 2	Mean	Sample 1	Sample 2	Sample 3	Mean	Sample 1	Sample 2	Mean
Amphipoda (scuds)																
Talitridae																
Hyalella azteca												1	0.3			
Coleoptera (beetles)																
Hydrophilidae																
Tropisternus sp.					1	0.5		4	2.0			8	2.7			
Diptera																
Chironomidae (midges)												1	0.3			
Chironomus sp.																
Cryptochironomus sp.																
Dicrotendipes sp.										2			0.7	10.8		5.4
Tanypus sp.							2	2	2.0					10.8		5.4
Dolichopodidae	10.8		5.4													
Ephydridae (n.r.)					1	0.5										
Ephemeroptera (mayflies)																
Baetidae																
Baetis sp.										2			0.7			
Callibaetis sp.								3	1.5			3	1.0			
Gastropoda (snails)																
Physidae														129.2	236.8	103.0
Physa sp.				32	15	23.5	24	34	29.0		1	7	2.7			
Hemiptera (aquatic bugs)																
Belostomatidae																
Belostoma												1	0.3			
Corixidae											1		0.3			
Naucoridae																
Ambrysus sp.	10.8		5.4											26.5		10.8
Notonectidae																
Notonecta sp.												4	1.3			
Odonata																
Aeshnidae (dragonflies)																
Anax junius								1	0.5							
Coenagrionidae (damselflies)																
Agria fumipennis violacea								5	2.5							
Agria sedula (n.r.)		10.8	5.4											43.1		21.5
Enallagma antennatum (n.r.)								3	1.5	2	2		1.3			
Gomphidae (dragonflies)																
Gomphus (Gomphurus) sp.														10.8	10.8	10.8
Ophiogomphus severus														10.8		5.4
Trichoptera (caddisflies)																
Hydropsychidae																
Cheumatopsyche sp.	226.0	53.3	139.9													
Total	247.6	64.6	156.1	32	17	24.5	26	52	39.0	6	4	25	11.6	237.0	247.6	242.3

[a] A sample consisted of 10 sweeps made with a 6-in. wire net for sites 1, 2, and 3; data for sites 4 and 5 are reported as number per square meter.
[b] Station 6--Cheyenne River upstream from Highway 18 bridge (control); station 7--Cottonwood Creek at mouth; station 8--Cottonwood Creek at culvert; station 9--Cottonwood Creek at bridge crossing, upstream from mill (control); station 10--Cheyenne River at Francis Koeller farm (see Figure 1).

Cottonwood Creek

Macrobenthos

Macrobenthic data are shown in Table 7 for 1975 and in Table 8 for 1976. The data in Table 7 are quantified in terms of sampling effort, but are not related to substrate area. Data in Table 8 are the number of organisms collected per square meter. In September (1975), 15 taxa of macroinvertebrates were identified: 3 taxa from station 7, 7 taxa from station 8, and 11 taxa from station 9. The snail, Physa, was the dominant organism at every station, representing 96 percent of the station 7 community, 74 percent of the station 8 community, and 23 percent of the community at station 9. In June (1976), 44 taxa were identified: 8 from station 7, 10 from station 8, and 38 from station 9 (which included samples from both riffle and pool habitats). Of the 38 taxa at station 9, 22 were species of the family Chironomidae (midges).

The 1975 data resulted from a sampling methodology that collected primarily from the vegetative substrates. In 1976 the major substrate sampled was the stream bottom, which included clay, silt, and cobble substrate types. These data reflect the disparity in sampling methodology in that many more species were collected in the 1976 survey. Combining the data from both years should provide an adequate description of the Cottonwood Creek community.

Phytoplankton

In September (1975), the populations varied from station to station (Table 9). Upstream from the existing mill (station 9), the population was dominated by chrysophytes and chlorophytes (51 percent/41 percent). The pool area above the culvert (station 8) had the same percentage of chrysophytes (55 percent), but a much lower percentage of chlorophytes (6 percent). Chlorophytes were replaced by cyanophytes and euglenophytes, which composed 18 and 22 percent, respectively, of that population. At the mouth (station 7), the chrysophyte values dropped to 28 percent, cyanophytes remained at 18 percent, and euglenophytes increased to 42 percent. Actual cell counts for each station ranged from 228,000 cells/L at station 7 to 574,000 cells/L at station 8. In June (1976), chrysophytes constituted the dominant algal group at all stations, representing 80 percent, 74 percent, and 51 percent of the populations at stations 7, 8, and 9, respectively (Table 10). The only significant difference between stations was that cyanophytes accounted for 38 percent of the phytoplankton numbers at station 9, whereas cyanophytes at station 7 and 8 were below 10 percent. Phytoplankton densities ranged from 317,000 cells/L and 428,000 cells/L to 1,150,000 cells/L at stations 9, 7, and 8, respectively.

Zooplankton

In 1975 (fall) water depth at the mouth was not sufficient for sampling, but samples were collected upstream at stations 8 and 9. As expected, the numbers of species and organisms were greater in the pool

POOR ORIGINAL

TABLE 8. MACROINVERTEBRATES COLLECTED FROM COTTONWOOD CREEK AND THE CHEYENNE RIVER, FALL RIVER COUNTY, SOUTH DAKOTA (JUNE 1976)

Organism	Number of organisms per square meter																																		
	Station 6[a]						Station 7[a]						Station 8[a]						Station 9[a]											Station 10[a]					
	S-1	S-2	S-3	S-4	S-5	x̄	S-1	S-2	S-3	S-4	S-5	x̄	S-1	S-2	S-3	S-4	S-5	x̄	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	x̄	S-1	S-2	S-3	S-4	S-5	x̄
Amphipoda																																			
Hyalella azteca																				54	183		129	86	22	11			48.5						
Coleoptera																														11					2.2
Berosus sp.											11	2.2																				11			2.2
Enochrus sp.													11					2.2	11									11	2.2						
Helipluss sp.																					11		11						2.2						
Helophorus sp.									11			2.2																					11		2.2
Hydrophorus (n.r.) sp.																				11									1.1						
Diptera																																			
Ablabesmyia mallochi sp.																					11		22	22					5.5						
Ceratopogonidae		11				2.2															11		22	22					5.5						
Cladotanytarsus					11	2.2																									11		11	11	6.6
Cladotanytarsus n. sp.																															22				4.4
Conchapelopia sp. 1	11			22		6.6		11				2.2					43	8.6				11					76	11	9.8					11	2.2
Cricotopus bicinctus													280	237		22	194	146.6	22				130	281	11	43	495	86	106.8						
Cricotopus sylvestris																22		4.4																	
Cricotopus (pupae)																											22		2.2						
Cricotopus sp. 1				11	11	4.4								11				2.2	11		152		86	22					27.1						
Cricotopus sp. 2				11		2.2		11				2.2	151	119			183	90.6		11	22			22		22	1055	54	118.6						
Cryptochironomus fulvus													11					2.2				22							2.2						
Cryptotendipes pseudotener gr.																							22	43					6.5						
Dicrotendipes sp. 1																								32					3.2						
Dicrotendipes sp. 2																				11	54		11	43					11.9						
Micropsectra	32			76		21.6														11				22			11		4.4						
Muscidae										11		2.2																							
Orthocladiinae																					11						11		2.2						
Phaenopsectra			11			2.2																													
Polypedilum				11		2.2																													
Procladius																				86			11	65	11				17.3						
Psectrocladius psilopterus gr.																					11								1.1						
Psectrocladius sp. 1								22				4.4								11									1.1						
Pseudochironomus sp. 1																					11			11					2.2						
Pseudochironomus sp. 2																							54						5.4						
Pupae																	11	2.2			22						22		4.4						
Rheotanytarsus													11					2.2	11		22		76	356			32		49.7						
Simulium sp.	32		11			8.6			11			2.2														11	32	11	5.4						
Stictochironomus varius gr.																						11							1.1						
Tanytarsus																															11				2.2
Tanytarsus sp. 1																				54	130	11		32	11				23.8						
Thienemanniella																					11						11		2.2						
Unidentified pupae																	11	2.2													11				2.2
Ephemeroptera																																			
Baetis sp.	11					2.2			11			2.2									11		11	11					3.3						
Caenis sp.																					11			22	11				4.4						
Hemiptera																																		11	2.2
Corixidae																							11	11					2.2						
Sigara (n.r.) sp.																						11			11				2.2						
Nematoda	11					2.2																													
Odonata																																			
Gomphus sp.	22			11		6.6																													
Ischnura sp.																				11						11			2.2						
Sympetrum sp.																												11	1.1						
Oligochaeta													344	43	11	22	32	90.4				•												11	2.2
Decapoda																								11					1.1						
Gastropoda																																			
Physa sp.																									22				2.2						
Total	119	11	22	142	22	63.2	-	44	33	11	11	19.8	808	410	11	66	474	353.8	55	238	673	77	606	1092	99	98	1178	184	491.1	11	55	11	22	44	28.6

[a]Station 6--Cheyenne River upstream from Highway 18 bridge, station 7--Cottonwood Creek at mouth, station 8--Cottonwood Creek at culvert; station 9--Cottonwood Creek at bridge crossing, upstream from mill, station 10--Cheyenne River at Francis Koeller farm (see Figure 1).

TABLE 9. PHYTOPLANKTON COLLECTED IN SURFACE SAMPLES FROM COTTONWOOD CREEK, FALL RIVER COUNTY, SOUTH DAKOTA (SEPTEMBER 1975)

Organism	Number of cells per liter								
	Station 7[a]			Station 8[a]			Station 9[a]		
	Sample 1	Sample 2	Mean	Sample 1	Sample 2	Mean	Sample 1	Sample 2	Mean
Chrysophyta (diatoms)									
Achnanthes sp.				42,731	36,157		9,861	13,148	
Caloneis sp.							3,287		
Chaetoceros sp.								32,870	
Cocconeis sp.					26,296			3,287	
Cymbella sp.	3,287				6,574		6,574	16,435	
Diatoma sp.							42,731	19,722	
Gyrosigma sp.	6,574						3,287		
Melosira sp.					9,861		6,574		
Navicula sp.	36,157	42,731		187,359	124,906		32,870	23,009	
Nitzschia sp.	23,009	6,574		19,722	13,148		3,287	3,287	
Stephanodiscus sp.				6,574	13,148		9,861	19,722	
Surirella sp.								3,287	
Synedra sp.	6,574	6,574		32,870	42,731		39,444	32,870	
Total	75,601	55,879	65,740	289,256	272,821	281,039	152,776	167,637	162,707
Chlorophyta (green algae)									
Ankistrodesmus sp.					3,287				
Chlamydomonas sp.	9,861	6,574							
Chlorella sp.				32,009	3,287				
Dictyosphaerium							62,453		
Kirchneriella sp.				3,287				3,287	
Micractinium sp.		13,148							
Oocystis sp.		13,148							
Scenedesmus sp.	13,148								
Schroederia sp.				23,009			101,897	101,897	
Total	23,009	32,870	27,940	58,305	6,574	32,440	164,350	105,184	134,767
Cyanophyta (blue-green algae)									
Anabaena sp.							32,870		
Dactylococcopsis sp.	6,574			23,009	16,435		3,287	3,287	
Merismopedia sp.									
Oscillatoria sp.	7,396	18,079		68,205	38,622				
Spirulina sp.	30,405	25,474		9,861	33,692				
Total	44,375	43,553	43,964	101,075	88,749	94,912	36,157	3,287	19,722
Euglenophyta									
Euglena sp.	85,462	111,758		124,906	92,036				
Phacus sp.							3,287		
Trachelomonas sp.					6,574		3,287	6,574	
Total	85,462	111,758	98,610	124,906	98,610	111,758	6,574	6,574	6,574
Percentage composition									
Chrysophyta	33.1	22.9	28.0	50.4	58.5	54.5	43.2	59.3	51.3
Chlorophyta	10.1	13.5	11.8	10.2	1.4	5.8	45.0	37.2	41.1
Cyanophyta	19.4	17.8	18.6	17.6	19.0	18.3	9.9	1.2	5.6
Euglenophyta	37.4	45.8	41.6	21.8	21.1	21.5	1.8	2.3	2.1

[a]Station 7--mouth; station 8--culvert below mill; station 9--bridge crossing, upstream from mill (control) (see Figure 1).

POOR ORIGINAL

TABLE 10. PHYTOPLANKTON COLLECTED IN SURFACE SAMPLES FROM COTTONWOOD CREEK AND THE CHEYENNE RIVER, FALL RIVER COUNTY, SOUTH DAKOTA (JUNE 1976)

	Number of cells per liter								
	Station 7[a]			Station 8[a]			Station 9[a]		
Organism	Sample 1	Sample 2	Mean	Sample 1	Sample 2	Mean	Sample 1	Sample 2	Mean
Chrysophyta (diatoms)									
Cocconeis sp.	9,861	13,148			13,148				
Cymbella sp.	3,287			6,574	39,444			6,574	
Fragilaria sp.							13,148		
Gomphonema sp.	19,722								
Gyrosigma sp.	42,731	36,157		19,722	65,740			19,722	
Melosira sp.							32,870	16,435	
Navicula sp.	220,229	82,175		667,261	657,400		39,444	46,018	
Nitzschia sp.	26,296	46,018		13,148	16,435				
Pinnularia sp.							9,861		
Pleurosigma sp.							39,444		
Stephanodiscus sp.				3,287				6,574	
Surirella sp.	3,287						3,287		
Synedra sp.	111,758	49,305		36,157	36,157		69,027	23,009	
Total	437,171	226,803	331,987	746,149	828,324	787,237	207,081	118,332	162,675
Chlorophyta (green algae)									
Chlamydomonas sp.	32,870						23,009	13,148	
Chlorella sp.	32,870							3,287	
Cosmarium sp.				6,574					
Dictyosphaerium sp.				29,583					
Oocystis sp.	26,296								
Scenedesmus sp.				13,148	52,592				
Total	65,740	26,296	46,018	49,305	52,592	50,949	23,009	16,435	19,722
Cyanophyta (blue-green algae)									
Anabaena sp.					55,879		134,767	98,610	
Oscillatoria sp.	36,979	9,861		58,344	50,127				
Spirulina sp.				8,218	9,861				
Total	36,979	9,861	23,420	66,562	115,867	91,215	134,767	98,610	116,689
Euglenophyta									
Euglena sp.	29,583			92,036	180,785				
Trachelomonas sp.	23,009			3,287	6,574		36,157		
Total	52,592		26,296	95,323	187,359	141,341	36,157		18,079
Percentage composition									
Chrysophyta	73.8	86.3	80.1	77.9	70.0	74.0	51.6	50.7	51.2
Chlorophyta	11.1	10.0	10.5	5.2	4.4	4.8	5.7	7.0	6.4
Cyanophyta	6.2	3.8	5.0	7.0	9.8	8.4	33.6	42.3	38.0
Euglenophyta	8.9		4.5	10.0	15.8	12.9	9.0		4.5

[a]Station 7--mouth; station 8--culvert below mill; bridge crossing upstream from mill (control).

area at station 8 than in the flowing waters at station 9 (Tables 11 and 12). The difference occurred primarily within the group Rotatoria, which exhibited three species with 60 organisms per sample at station 9 and 17 species with 351 organisms per sample at station 8. In June (1976), species diversity ($\bar{d}$) increased from above the existing mill to the mouth with 14, 18, and 23 species identified from the respective sampling sites. Density was greatest at station 8 with 22,400 organisms/m^3. Stations 7 and 10 reported 17,000 organisms/m^3 and 15,000 organisms/m^3, respectively.

Cheyenne River

Macrobenthos

In September (1975), station 6 had a total of 167 organisms/m^2, 84 percent of which belonged to the genus *Cheumatopsyche*. Only two other macroinvertebrate species were present, along with the vertebrate *Fundulus kansae* (Plains killifish). In June 1976 the diversity was much greater; of the 15 taxa present, the midge *Tanytarsus* was dominant (29 percent). In September, station 10 consisted of only small isolated pools, but contained a total of 242 organisms/m^2, 76 percent of which were the snail *Physa*. In June 1976 a much more diverse habitat was present (the river channel was full of water), and 10 taxa were identified. The data are summarized in Tables 8 and 9.

Phytoplankton

In September the upstream station (flowing water) contained a mean of 87,000 cells/L, representing seven genera (Table 13). The dominant group was Chrysophyta (52 percent). At the downstream station the phytoplankton was representative of isolated pool environments; phytoplankton numbers exceeded 4×10^6 cells/L, and bluegreens comprised 55 percent of the total assemblage. In June the stations were similar (Table 14); both were dominated by Chrysophyta, with population numbers ranging from 46,000 to 91,000 cells/L. This similarity is indicative of the voluminous flow of the Cheyenne River during the early summer sampling period.

Zooplankton

Data are not available from the downstream station because (1) the September 1975 water levels did not permit sampling, and (2) the heavy silt load of the stream in June 1976 precluded enumeration. In September the upstream station contained six taxa, with the larval copepods comprising 52 percent of the population (Table 11). In June 14 taxa were identified, with the larval copepods comprising 46 percent of the population, and plankton density was measured at 41,000 organisms/m^3 (Table 12).

TABLE 11. ZOOPLANKTON COLLECTED FROM COTTONWOOD CREEK AND THE CHEYENNE RIVER, FALL RIVER COUNTY, SOUTH DAKOTA (SEPTEMBER 1975)[a]

	Number per 60-ft tow[b]								
	Station 6[c]			Station 8[c]			Station 9[c]		
Organism	S-1	S-2	$\bar{x}$	S-1	S-2	$\bar{x}$	S-1	S-2	$\bar{x}$
Rotataria									
Brachionus angularis		23	12	15		8			
Brachionus bidentata					15	8			
Brachionus havanaensis	8		4						
Brachionus quadridentatus				15		8			
Brachionus urceolaris				15		8			
Contracted rotifer				30		15			
Euchlanis sp.				15		8	15		15
Gastropus sp.				15		8			
Hexarthra sp.				15	15	15			
Keratella quadrata				15		8			
Lecane sp.				120	105	113	30		30
Monostyla quadridentata					15	15			
Monostyla sp.				30	15	23			
Mytilinia sp.				60		30			
Notholca squamula							15		15
Platyias quadricornis				15		8			
Polyarthra sp.				75		38			
Synchaeta sp.				60		30			
Trichotria sp.				15		8			
Cladocera									
Alona rectangula					6	3			
Bosmina longirostris	23	12		180		90	15		15
Chydorus sp.				75	75	75	7		7
Diaphanosoma leuchtenbergianum		1	1						
Simocephalus (instar)							2		2
Copepoda									
Cletocamptus sp.				2	6	4	30		30
Cyclopoida (copepodids)	2	2	2	45	135	90	75		75
Cyclops vericans rubellus					1	1			
Eucyclops agilis									
Eucyclops speratus					45	23			
Harpacticoida (copepodids)							45		45
Macrocyclops albidus					1	1			
Nauplii	45	23	34	240	570	405	300		300
Total zooplankton	78	49	65	1,052	1,004	1,043	534		534

[a]Stations 7 and 10 were not sampled due to insufficient water depths.
[b]Wisconsin plankton net.
[c]Station 6--Cheyenne River upstream from Highway 18 bridge (control); station 8--Cottonwood Creek at culvert below mill; station 9--Cottonwood Creek at bridge crossing, upstream from mill (control).

TABLE 12. ZOOPLANKTON COLLECTED FROM COTTONWOOD CREEK AND THE CHEYENNE RIVER, FALL RIVER COUNTY, SOUTH DAKOTA (JUNE 1976)

Organism	Station 6[a]			Station 7[a]			Station 8[a]			Station 9[a]		
	Number of organisms per cubic meter											
	S-1	S-2	$\bar{x}$	S-1	S-2	$\bar{x}$	S-1	S-2	$\bar{x}$	S-1	S-2	$\bar{x}$
Rotataria												
<u>Asplanchna</u> sp.												
<u>Brachionus bidentata</u>		4,091	2,046	1,364		682						
<u>Brachionus caudatus</u>							1,818		909			
<u>Brachionus quadridentatas</u>	5,455		2,728					909	455			
<u>Brachionus rubens</u>				455		228						
<u>Brachionus urceolaris</u>	1,818		909									
<u>Cephalodella</u> sp.		1,364	682									
Contracted rotifer				909		455	4,546	7,273	5,910	455		228
<u>Euchlanis</u> sp.											909	455
<u>Keratella crassa</u>							909		455			
<u>Keratella earlinae</u>								909	455			
<u>Lecane ungulata</u>		2,727	1,364									
<u>Lecane</u> sp.		4,091	2,046	1,364	1,364	1,364		4,546	2,273	455		228
<u>Lophocharis salpina</u>											455	228
<u>Monostyla bulla</u>					455	228						
<u>Notholca squamula</u>	1,818	6,818	4,318	455	455	455		909	455	1,364	2,273	1,819
<u>Polyarthra</u> sp.				455		228				455	455	455
<u>Rotaria neptunia</u>					455	228	909		455			
<u>Rotaria</u> sp.												
<u>Synchaeta</u> sp.				1,364		682						
<u>Testudinella</u> sp.					455	228						
<u>Trichocerca</u> sp.								909	455	909	909	909
<u>Trichotria</u> sp.				455	228			1,818	909	1,818	1,818	1,818
Cladocera												
<u>Bosmina longirostris</u>				9,091	1,364	5,228	909	1,818	1,364	10,000	455	5,228
<u>Chydorus</u> sp.		1,364	682	455	1,364	910		909	455	455	1,364	910
<u>Diaphanosoma leuchtenbergianum</u>				455		228						
<u>Daphnia</u> (instar)				455	91	273	91		46			
<u>Daphnia parvula</u>				455		228						
<u>Daphnia retrocurva</u>				455	455	455						
<u>Simocephalus vetulus</u>		91	46									
Copepoda												
<u>Cletocamptus</u> sp.		1,364	682									
<u>Cyclopoida</u> (copepodid)	5,455	5,455	5,455	909		455		1,818	909		909	455
<u>Cyclops vernalis</u>				455	455	455	91		46			
<u>Eucyclops agilis</u>				91	273	182	909	1,818	1,364	455		228
<u>Eucyclops prionophorus</u>										455		228
<u>Eucyclops speratus</u>	1,818		909	273		137						
<u>Harpacticoida</u> (copepodid)		1,818	909	455		228						
Nauplii	5,455	32,727	19,091	4,091	1,818	2,955	2,727	6,364	4,546	1,818	1,818	1,818
<u>Paracyclops fimbriatus poppei</u>				455		228		1,818	909			
Total zooplankton	21,819	61,910	41,867	24,916	9,004	16,968	12,909	31,818	22,370	18,639	11,365	15,007

[a]Station 6--Cheyenne River upstream from Highway 18 bridge (control); station 7--Cottonwood Creek at mouth; station 8--Cottonwood Creek at culvert below mill; station 9--Cottonwood Creek at bridge crossing, upstream from mill (control); station 10--Cheyenne River at Francis Koeller farm (see Figure 1). Samples at station 10 could not be enumerated due to the presence of large amounts of silt.

TABLE 13. PHYTOPLANKTON COLLECTED IN SURFACE SAMPLES FROM THE CHEYENNE RIVER, FALL RIVER COUNTY, SOUTH DAKOTA (SEPTEMBER 1975)

Organism	Number of cells per liter: Station 6[a] Sample 1	Station 6[a] Sample 2	Station 6[a] Mean	Station 10[a] Sample 1	Station 10[a] Sample 2	Station 10[a] Mean
Chrysophyta (diatoms)						
Achnanthes sp.	49,305			756,010	719,853	
Cymatopleura sp.				23,009	36,157	
Cymbella sp.				6,574		
Gyrosigma sp.				3,287		
Navicula sp.	46,018			726,427	667,261	
Nitzschia sp.				19,722	23,009	
Stephanodiscus sp.	6,574			3,287	16,435	
Synedra sp.	16,435	6,574		62,453	88,749	
Total	118,332	6,574	62,453	1,600,769	1,551,464	1,576,117
Chlorophyta (green algae)						
Chlamydomonas sp.					6,574	
Chlorella sp.		13,148				
Chodatella sp.				26,296		
Dictyosphaerium sp.				95,323	65,740	
Oocystis sp.				13,148		
Protococcus sp.				105,184		
Scenedesmus sp.				46,018	19,722	
Schroederia sp.	9,861					
Tetraedron sp.				3,287		
Total	9,861	13,148	11,505	289,256	92,036	190,646
Cyanophyta (blue-green algae)						
Dactylococcopsis sp.		13,148		3,287		
Merismopedia sp.	13,148			2,228,586	2,340,344	
Oscillatoria sp.				18,900	23,831	
Total	13,148	13,148	13,148	2,250,773	2,364,175	2,307,474
Euglenophyta						
Euglena sp.				75,601	105,184	
Total				75,601	105,184	90,393
Pyrrophyta (dinoflagellates)						
Glenodinium sp.				3,287		
Total				3,287		1,644
Percentage composition						
Chrysophyta	83.7	20	51.9	37.9	37.7	37.8
Chlorophyta	7.0	40	23.5	6.9	2.2	4.6
Cyanophyta	9.3	40	24.7	53.3	57.5	55.3
Euglenophyta				1.8	2.6	2.2
Pyrrophyta				0.1		0.1

[a]Station 6--upstream from Highway 18 bridge (control); station 10--Francis Koeller farm (see Figure 1).

TABLE 14. PHYTOPLANKTON COLLECTED IN SURFACE SAMPLES FROM THE CHEYENNE RIVER, FALL RIVER COUNTY, SOUTH DAKOTA (JUNE 1976)

Organism	Number of cells per liter					
	Station 6[a]			Station 10[a]		
	Sample 1	Sample 2	Mean	Sample 1	Sample 2	Mean
Chrysophyta (diatoms)						
Caloneis sp.				3,287		
Cocconeis sp.		13,148				
Cymbella sp.	6,574					
Fragilaria sp.		26,296				
Gyrosigma sp.				3,287	3,287	
Melosira sp.	9,861	13,148				
Navicula sp.	13,148			19,722	32,870	
Nitzschia sp.				3,287		
Rhiocosphenia sp.					3,287	
Surirella sp.		29,583		3,287	3,287	
Synedra sp.	16,435			9,861	3,287	
Total	46,018	82,175	64,097	42,731	46,018	44,375
Chlorophyta (green algae)						
Chlorella sp.	3,287			3,287		
Scenedesmus sp.	13,148					
Total	16,435		8,218	3,287		1,644
Cyanophyta (blue-green algae)						
Oscillatoria sp.	17,257	9,039				
Total	17,257	9,039	13,148			
Euglenophyta						
Euglena sp.				3,287		
Total				3,287		1,644
Percentage composition						
Chrysophyta	57.7	90.1	73.9	86.7	100.0	93.4
Chlorophyta	20.6		10.3	6.7		3.3
Cyanophyta	21.6	9.9	15.8			
Euglenophyta				6.7		3.3

[a]Station 6--upstream from Highway 18 bridge (control); station 10--Francis Koeller farm (see Figure 1).

SUMMARY AND CONCLUSIONS

Aquatic habitats on the Edgemont Uranium Properties are relatively diverse and often subject to extreme environmental change. The combination of shallow water and extreme temperatures results in a freezing of the entire water column during the winter months. Vernal snowmelt and subsequent periods of heavy rainfall may produce spates and flooding, while seasonal periods of minimal rainfall result in little or no streamflow.

Biological populations inhabiting these locally and seasonally perturbed intermittent streams often have transient or ephemeral larval and/or adult stages. Zoomacrobenthic recolonization of temporarily perturbed areas is accomplished through surface water drift, survival of desiccation-resistant eggs, new egg deposition, and groundwater migration of larvae or adults. Like the habitats, composition and diversity vary greatly with meteorological conditions, geographic location, and season.

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Surface waters flowing through the Edgemont Uranium Mining Properties (South Dakota) and Wyoming) were sampled in September 1975 and June 1976 to document the composition and

16. Abstract (Limit: 200 words)

Surface waters flowing through the Edgemont Uranium Mining Properties (South Dakota and Wyoming) were sampled in September 1975 and June 1976 to document the composition and diversity of indigenous aquatic communities during a dry and wet season. Sampling sites were selected on the basis of two criteria: (1) the need to delineate preoperational conditions near potential mining and milling activities and (2) the need to define the biological communities indigenous to each of the representative habitats and each of the major substrates.

Aquatic habitats on the Edgemont Properties are relatively diverse, and often subject to extreme environmental change. The combination of shallow water and extreme temperatures often results in a freezing of the entire water column during the winter months. Vernal snowmelt and subsequent periods of heavy rainfall may produce spates and flooding, while seasonal periods of minimal rainfall result in little or no streamflow.

Biological populations inhabiting these locally and seasonally perturbed, intermittent streams often have transient or ephemeral larval or adult stages. Zoomacrobenthic recolonization of temporarily perturbed areas is accomplished through surface water drift, survival of desiccation-resistant eggs, new egg deposition, and groundwater migration of larvae or adults. Like the habitats, composition and diversity vary with meteorological conditions, geographic location, and season.

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