SECTION 19

ALLUVIAL VALLEY FLOORS

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SECTION 19 ALLUVIAL VALLEY FLOORS

19.1 Alluvial Valley Floor Determination

The major stream channels within and adjacent to the BHP Navajo Coal Company's (BNCC) mining lease were examined as part of a study by the New Mexico Bureau of Mines and Mineral Resources entitled "Identification of Alluvial Valley Floors in Strippable Coal Areas of New Mexico" (Love et al. 1981) (Appendix 19.A). The goal of this study was to distinguish "possible alluvial valley floors" from "lands clearly not alluvial valley floors" using guidelines released by the Office of Surface Mining Reclamation and Enforcement (OSM) prior to the study. The river systems within and adjacent to the BNCC mining lease considered in the 1981 study include San Juan and Chaco river systems. The Pinabete Mine Plan permit area (permit area) is located within the Navajo Coal Field Area of the Chaco River system, as described in Appendix 19.A. Specifically, the Navajo Coal Field Area includes the following U.S. Geologic Survey (USGS) 1:24,000 series quadrangles: The Hogback South, Kirtland Southwest, Newcomb Northeast, and The Pillar Northwest, corresponding to the permit area as described in Section 2 (Operation and Permit Description). The drainages analyzed within the BNCC mining lease area by the 1981 study include: Chaco River, Pinabete Arroyo, Cottonwood Wash, Brimhall Wash, Chinde Wash, and No Name Arroyo. The report concludes that although valley areas along the main stem of Chaco River meet the geologic criteria for an alluvial valley floor (AVF), there was inadequate water at that time to support agricultural activities. The report further concluded that watersheds within the Chaco River system, including those within the permit area were ephemeral and not able to provide adequate water for agricultural activities during the growing season. In addition, there was no evidence of successful current or historical flood irrigation practices in the area. Therefore, based on Love et al. (1981), the only "potential alluvial valley floors" on or adjacent to the permit area occurs along the San Juan River. The permit area is approximately 15.7 miles south of the San Juan River. The shortest watercourse from the permit area to the San Juan River, along the Pinabete Arroyo and Chaco River to its confluence with the San Juan River, is approximately 41.3 miles.

The potential for an AVF along the Chaco Wash tributaries, Cottonwood Wash, and Pinabete Arroyo, was examined by BNCC. They reviewed the available geologic, hydrologic, land use, soils, and vegetation data and analyses. BNCC determined that these watersheds do not contain alluvial valley floors and sought a negative alluvial valley floor determination from OSM in April 1992. The negative determination for Pinabete Arroyo and Cottonwood Arroyo was approved by OSM in June 1992. OSM's negative determination approval letter is included as Appendix 19.B.

In addition to the Cottonwood Arroyo and Pinabete Arroyo, BNCC has sought to determine if there are other streams within or adjacent to its mining lease with the potential for AVF. In April 2008 in conjunction with a previously proposed project, BNCC reviewed geologic, hydrologic, land use, soils, and vegetation resources of Area 4 South and Area 5 and submitted a request for an alluvial valley floor determination to OSM for the No Name Arroyo and Brimhall Wash. BNCC also sought a reconfirmation of OSM's 1992 determination for the Pinabete Arroyo. OSM provided its determination that the Pinabete Arroyo, No Name Arroyo, and Brimhall Wash are not alluvial valley floors in its July 2008 determination (Appendix 19.C).

Results of the Love et.al. (1981) study, together with previous AVF determinations within the BNCC mining lease area by OSM, and the multidisciplinary investigations associated with the Pinabete SMCRA permit application package were utilized to determine the presence or absence of AVFs within and adjacent to the permit area. Both geomorphic/geologic and water availability criteria form the basis for an AVF determination. Terrace and floodplain landforms on unconsolidated stream-laid deposits can be found along portions of the Chaco River, Pinabete Arroyo, and Cottonwood Arroyo. Alluvial well drilling along Pinabete Arroyo and Cottonwood Arroyo confirmed the occurrence of unconsolidated stream-laid deposits in association with these landform features adjacent to the permit area. However, the capability to flood irrigate within the Chaco River, Pinabete Arroyo, or Cottonwood Arroyo valley areas is precluded by the nature of stream flows, which occur infrequently and as flash-flow events. In addition, there is no evidence of successful current flood irrigation from these ephemeral streams within the permit area. Finally, there was a negative finding for Prime Farmland within the permit area (Section 14, Soils, Appendix 14.C). Therefore, BNCC concludes there are no AVFs within the permit area. OSM has agreed with this negative determination, as stated in Appendix 19.B and Appendix 19.C.

19.2 Alluvial Valley Floor Statutory Exclusion Determination

There are no AVFs present within or adjacent to the permit area. Therefore, this section is not applicable to the permit area. The 1992 and 2008 negative AVF determinations are discussed above in Section 19.1 and are provided in Appendix 19.B and Appendix 19.C, respectively.

19.3 Essential Hydrologic Functions of Alluvial Valley Floors

A determination has been made that there are no AVFs or waters supplying an AVF within the permit area. Therefore, this section is not applicable to the permit area. The 1992 and 2008 negative AVF determinations are discussed above in Section 19.1 and are provided in Appendix 19.B and Appendix 19.C, respectively.

19.4 Alluvial Valley Floor Information Collection and Analysis

Information used to complete this section came from current and historical baseline studies conducted within and adjacent to the permit area. Surface water, groundwater, and soils information, as well as Prime Farmland determinations were provided to OSM for their review and consideration as part of the request for negative determination.

Personnel

Persons or organizations responsible for data collection, analysis, and preparation of this permit application section:

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Love, D.W., J.W. Hawley, and T.C. Hobbs. 1981. Identification of Alluvial Valley Floors in Strippable Coal Areas of New Mexico. Prepared for Mining and Minerals Division, Energy and Minerals Department, Santa Fe, New Mexico.

Appendix 19.A

Identification of Alluvial Valley Floors in Strippable Coal Areas
of New Mexico, Love et al., October 1981

IDENTIFICATION OF ALLUVIAL VALLEY FLOORS IN STRIPPABLE COAL AREAS OF NEW MEXICO

Report to Emery Arnold, Director
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October 26, 1981

IDENTIFICATION OF ALLUVIAL VALLEY FLOORS IN STRIPPABLE COAL AREAS OF NEW MEXICO

Introduction

In 1977, the U.S. Congress protected agriculturally-important alluvial valley floors in the western states from disruption by surface mining (U.S. Congress, 1977; U.S. House of Representatives, 1977a, b). Guidelines released by the Region V Office of Surface Mining (OSM) on June 11, 1980, suggested identification and study of alluvial valley floors (AVF) in areas of surface-mineable coal proceed in three phases. Phase I consists of preliminary investigations which can be used quickly to distinguish between "possible alluvial valley floors" and "lands clearly not alluvial valley floors". The other two phases consider detailed analyses of geology, hydrology, biology and land use of areas containing possible alluvial valley floors. To expedite planning and review processes in the State of New Mexico, initial (Phase I) identification of "clearly not alluvial valley floors", "possibly not alluvial valley floors" and "potential alluvial valley floors" was carried out by the New Mexico Bureau of Mines and and Mineral Resources and the Energy and Minerals Department. Such preliminary classification allows the staff of the Energy and Minerals Department, mine operators and other involved parties time to concentrate on the bottomland areas in and adjacent to mine sites whose hydrologic and agricultral functions must be protected during and after mining operations.

Procedures

Phase I studies were designed to evaluate the surficial geologic characteristics, hydrologic characteristics, biologic characteristics and land use characteristics that qualify or disqualify valley floors as potential alluvial valley floors (Table 1). This evaluation included office review of available hydrologic and geomorphic information on parts of the San Juan and Raton Basins with strippable coal resources, as well as field reconnaissance of most major stream valleys in these areas. Hydrologic data were collected and analyzed by T.C. Hobbs. Field work involved traverses (vehicular and foot) across critical valley-floor and stream-channel areas, and visits to wells and gauging stations where hydrologic data have been collected. Figures shown below are prints from photographs of representative drainages which were selected from a large set of color slides taken to illustrate the geomorphic setting at each traverse site. Once field investigations indicated the presence of possible alluvial valley floors, aerial photographs of the areas were studied to map the possible extent of irrigation and subirrigation adjacent to the modern streams. References given at the end of the report are divided into published references available in major libraries, and unpublished reports and communications on file at the Mining and Minerals Division in Santa Fe, New Mexico.

Results

Drainages within the strippable coal areas of New Mexico include the San Juan River System, La Plata River System, Chaco River System, Rio Puerco System, Puerco River System, and the Vermejo River System (Map 1). Table 2 lists the stream segments and valley-floor areas visited, as well as the 1:24,000 and 1:62,500 scale quadrangle maps used in the study. Figure 1 shows monthly discharge for monitored streams in the region.

Phase I studies indicate that alluvial valley floors are not present in most areas with existing or planned coal mine operations. There are only two areas in the San Juan and Raton Basins where hydrologic conditions are favorable for presence of alluvial valley floors. These are the valleys of larger perennial streams that head in alpine areas of the Sangre de Cristo, San Juan and La Plata Mountains. River valley segments with potential alluvial valley floors identified in this study are shown by solid lines on Map 1. They are the valleys of the La Plata River above La Plata to the state line, the San Juan River above the Hogback to Farmington, and the Vermejo River above Dawson to Vermejo Park. Water is fed to these streams by precipitation, snow melt, springs and seeps and is sustained throughout the growing season. The quality of water is acceptable for plant growth, and the regional practice of flood irrigation and subirrigation is clearly visible. It should be stressed that these river-valley segments contain reaches that probably are not alluvial valley floors, but detailed studies will be needed to establish the presence or absence of alluvial valley floors. As suggested in the Office of Surface Mining draft guidelines (7-11-80), applicants for mining permits in or adjacent to these potential AVF areas should consider starting Phase II AVF studies as soon as possible.

Two valley segments on Map 1 are marked with a dashed-line symbol. These include the lower reaches of Caliente and York Canyons (tributaries to the Vermejo River). The valley-floor areas contain channels of small perennial streams, but have not been flood-irrigated and do not appear to have potential for flood irrigation. York Canyon discharge partly reflects Vermejo River diversion for coal processing at the Kaiser Mine. Due to the high water table, there may be short valley-floor segments where limited subirrigation of crops is possible. Therefore, these areas were not placed in the "clearly not alluvial valley floors" category and they are informally designated "possibly not alluvial valley floors". Each area must be evaluated further.

"Lands clearly not alluvial valley floors" are shown by dotted symbols on Map 1. Streams in these valleys are primarily ephemeral with local intermittent reaches. Nearly all of the drainages in this classification can be characterized as incised steep-walled stream channels with sparse vegetation, flowing in response to runoff from precipitation. Flows are short-lived, and total suspended concentrations reach as much as 400,000 mg/l (U.S. Geological Survey data from numerous years; see references). There is no evidence (hydrologic or historic land use) that the valley floors can be successfully utilized for agricultural production involving flood irrigation or subirrigation practices. This conclusion is supported by unpublished independent studies by the Bureau of Land Management and Soil Conservation Service that relate directly to agricultural land use in the San Juan Basin (i.e. identification of prime farmlands and soils suitable for irrigation, as well as alluvial valley floors).

Investigations in Specific Drainages

San Juan River

The San Juan River System includes the San Juan River itself and the Shumway and Westwater Arroyos in the Fruitland (Kf) Coal Field (Map 1). The San Juan River (Map 2) has been classified as a "potential alluvial valley floor", as discussed earlier. Farming activities and extensive irrigation systems (e.g. Farmer's Mutual Irrigation Ditch and Jewett Valley Ditch) are clearly visible (Figure 2; Map 2).

Shumway and Westwater Arroyos are ephemeral (except for waste water discharge from the San Juan Power Plant; Figure 3). The arroyo channels are deeply incised and generally free of vegetation. Due to the waste water discharge from the San Juan Power Plant, the water quality can not be evaluated effectively. Water quality records indicate total dissolved solids as high as 9,600 mg/l and pH as low as 2.7 (U.S. Geological Survey, 1979). Water supplied to farming activities at the lower end of the Shumway drainage comes from irrigation facilities along the San Juan River and not from the Shumway watershed. These field areas are included in the potential alluvial valley floor area of the San Juan River (Map 2).

La Plata River

Streams within the upper Fruitland (Kf) coal field along the La Plata River drainage include the La Plata River, Murphy and McDermott Arroyos and Cinder Gulch. The La Plata River is a potential alluvial valley floor (Map 3). Discharge records for the La Plata River at Farmington and the Colorado-New Mexico State line show perennial flow at both stations. Agricultural activities are present throughout the La Plata valley (Figure 4) and a well-established irrigation network exists (e.g. Pioneer Ditch, Highland Park Ditch, Greenhorn Ditch and Cunningham Ditch).

McDermott, Cinder Gulch (Figure 5) and Murphy Arroyos are ephemeral tributaries to the La Plata system. The streams are incised, steep-walled channels with sparse vegetation, flowing only in response to runoff from precipitation. No irrigation practices exist along any of the three drainages. Water within the alluvial aquifer is at a depth of about six feet. Water quality is poor, with total disolved solids reaching as high as 12,000 mg/l (Western Coal Company, 1980).

Chaco River

The Chaco River System includes drainages within the Navajo (Kf), Bisti (Kf), Toadlena (Kmv), Hogback (Kmv), Newcomb (Kmv), Standing Rock (Kmv), Chaco Canyon (Kmfu), and Star Lake (Kf) coal fields (Map 1; Table 2). All streams are ephemeral, flowing in response to runoff from precipitation (Figures 6-13), except for the main stem of the Chaco River below the Four Corners Power Plant, which has a waste water base flow of about 30 cfs (U.S. Geological Survey data) and a short intermittent reach at the west edge of Chaco Canyon. Most streams are incised 10 feet or more. Total suspended sediment is normally above 30,000 mg/l, and has been reported at ten times this amount. Total dissolved solids average about 300 mg/l. Water-control structures in this area include spreader dikes and check dams. There is no evidence that flood irrigation is now being used or has been used on a regional scale in the recent historic past.

Small plots of "dry land" farming have been observed (commonly less than one acre), but these generally depend upon precipitation and hand-carried water from wells rather than irrigation as a water source. There are a few areas where farming is being conducted along Escavada Wash and Chaco River where shallow alluvial or deeper ground water wells are used to obtain water for irrigation.

For the most part, watersheds within the Chaco River system are not able to deliver enough water to sustain significant agricultural activity during the growing season. For example, De-Na-Zin Wash, located south of Bisti Trading Post, has a drainage area of 184 square miles. Water records for this drainage indicate that flows vary in frequency and intensity, with long periods when no flow of water is recorded. From October 1978, to September 1979, the De-Na-Zin gaging station recorded a total discharge for the watershed of 8992 acre-feet. Between April and September, 3165 acre-feet was discharged. Of 3165 acre-feet, 2650 acre-feet occurred during the middle of August and 474 acre-feet occurred in July. From April 15 through July 2 (79 days), 21 acre-feet of discharge was recorded, occurring entirely during the last week in May. No flows were recorded in June and September. From this data, it is evident that agricultural activities would require storage facilities for water to sustain crops through the high stress periods such as no flow periods which occurred during June and September. The expense of storage facilities would probably outweigh the viability of farming in these areas.

Puerco River

Streams in the Gallup (Kmv) coal field include the Puerco River, Defiance Draw, Burned Death Wash, Tse Bonita Wash, tributaries to Tse Bonita Wash, Coal Mine Wash, tributaries to Coal Mine Wash, Coal Mine Drainage, and the east and west forks of Catalpa Canyon (Figures 14-16). Except for Puerco River and part of Coal Mine Drainage, streams in the area are ephemeral, with deeply incised channels. Total suspended sediment in the northwestern ephemeral drainages is reported between 10,000 and 90,000 mg/l, and total dissolved solids are about 250 mg/l (Carbon Coal Company, 1979, 1980, 1981; Pittsburg and Midway Coal Company, 1981). No flood irrigation practices were found along the ephemeral drainages, and with stream channels so deeply incised, it is doubtful that any flood or subirrigation could exist.

Coal Mine Drainage flows intermittently from springs and seeps along the channel. The channel is incised discontinuously as an arroyo, but locally the channel is capable of overbank flooding and diversion to small (less than 10 acre) fields. No discharge records are available. Water analysis reports indicate the quality is poor, having total dissolved solids in the neighborhood of 4000 mg/l. Sulfate (SO_4) and Sodium (Na) concentrations are extremely high (Amcoal, Inc., 1978, 1979, 1980).

The Puerco River was a major ephemeral drainage prior to opening the Church Rock uranium mines. The Puerco River became perennial with base flow dependent upon mine dewatering at the Church Rock mines and sewage treatment at Gallup. Presently, the Puerco River has a base flow of about 3.0 cfs and peak flows occur between December and March (U.S. Geological Survey data). Water quality records are scarce, but episodic monitoring by the New Mexico Environmental Improvement Division shows a large variation in water quality, particularly after the tailings spill from the Church Rock area (Gallaher and Goad, 1981). No evidence of irrigation or subirrigation was found along the Puerco River near Mentmore.

Rio Puerco

The La Ventana (Kmv) coal field is within the Rio Puerco system. The Rio Puerco is intermittent in this area, as are some tributaries from the east. Diversions have been used for irrigation in the past, but none is used now. The Rio Puerco is incised up to 35 feet, and most tributaries are incised as well. An alluvial water table exists just below the stream bottom, with total dissolved solids of 1800 mg/l (Mining and Minerals Division, 1980, 1981; Ideal Basic Industries, 1980, 1981), but the vertical distance from the valley surface to the stream bottom precludes any type of subirrigation.

The Arroyo Hondo, San Pablo and San Miguel drainages can be considered intermittent, deriving their flow from precipitation, snow melt and seepage. All three drainages have deeply incised channels (at least 20 feet). Natural flood irrigation does not occur in these drainages. One land owner pumps water from the San Miguel drainage to the valley surface for crop use, but this is not considered a natural or gravity-fed irrigation system. No discharge or water quality data are available for these drainages.

Arroyo Balcon is an ephemeral drainage. No discharge or water quality reports were found. However, total suspended sediment is thought to be high during flows in response to runoff from precipitation events. A few stock tanks exist in the watershed, but normally they are dry.

Vermejo River

Drainages in the Raton coal field are part of the Canadian River system and include the headwaters of the Canadian River, Vermejo River, York Canyon, Salyers Canyon, Chimney Canyon, Caliente Canyon, Sawmill Canyon, Gachupin Canyon, Saltpeter Canyon, Spring Canyon, Dawson Canyon, Dillon Canyon, Raton Creek, and Potato Canyon. Vermejo River is considered a potential alluvial valley floor (Maps 1, 4, 5, Figures 17-22).

According to flow records, Vermejo River is perennial. Water quality is good, having total dissolved solids of about 200 mg/l. Suspended sediment in the base flow is generally about 30 mg/l while storm events produce much higher concentrations. Approximately 85 percent of all discharge occurs between May and September from precipitation and snow melt (U.S. Geological Survey data). Irrigation practices were employed in the past, but none was operating in 1980 (Figures 17 and 18).

Discharge in York Canyon and Caliente Canyon apparently is intermittent with perennial reaches (Figures 19-21). Water quality is good; total dissolved solids average about 280 ml/l (Kaiser Steel Corporation and Mining and Minerals Division, 1980). Discharge records are poor for the York Canyon drainage and virtually nonexistent for Caliente Canyon. Actual stream discharge computations were not part of the present study, so no conclusive interpretations can be made concerning the streams' potential to support significant agricultural activity. Stream channels are incised as much as 10 feet below the canyon floors (Figures 18-20). Appreciable amounts of vegetation line the channels. Because flow occurs at least intermittently and water quality is high, there is a potential for subirrigation at least. Further investigation needs to be conducted to verify irrigation potential.

All other drainages in the Raton Coal Field (KTvr) have been classified as "areas clearly not alluvial valley floors". These include Salyers Canyon, Chimney Canyon, Sawmill Canyon, Gachupin Canyon, Saltpeter Canyon, Spring Canyon, Dawson Canyon, Dillon Canyon (Figure 22), Raton Creek, Canadian River Canyon and Potato Canyon drainages. With the exception of Potato and Canadian Canyon drainages, all of these streams are ephemeral. Alluvium is extremely thin in places along the stream channels and stream channels are cut into bedrock in some areas. Flood plains locally are less than 50 feet wide. Water quality records for these streams are not available, but probably the quality is fair.

Discussion of Special Problems

Application of the suggested criteria for identifying alluvial valley floors encounters special problems in New Mexico. These include (1) the actual amount of water needed for crops compared with the two-acre-foot suggested criterion, (2) obtaining water rights for development of presently unirrigated land, (3) changes in stream regime due to other development in the area (i.e. uranium mine dewatering), and (4) minimizing disturbances to the hydrologic balance on and off mine sites, whether or not an alluvial valley floor is involved.

The two acre-feet of water per acre criterion discussed in the AVF guidelines may be adequate if the irrigation system employed is operating at near 100 percent efficiency. However, few systems operate at 100 percent efficiency. Sprinkler irrigation systems normally operate at about 65 percent efficiency, and flood irrigation ditches operate at about 30 percent efficiency (S.P. Neville, 1981, written communication). Unimproved flood irrigation ditches can be expected to operate at a lesser efficiency, depending upon the evaporation and infiltration characteristics of the structures. Thus, for alfalfa, 8.3 acre-feet of water would have to be diverted. Corn and other crops would require approximately 6 acre-feet of water.

Construction of structures to store water could enhance the amount available for irrigation in marginal areas. However, storage of water for irrigation requires a permit from the State Engineer for constructing structures and appropriating water (New Mexico Statutes, 1978). The persons involved would have to acquire existing water rights elsewhere in the hydrologic basins (San Juan and Raton). For the most part, these rights exist along the major perennial streams which would have more potential for productive agriculture than marginal lands along ephemeral channels.

As the present discharge along the Puerco River indicates, further mine dewatering and community development in the region could change many streams from being ephemeral to intermittent or perennial. This change in flow regime could affect the classification of the streams and make irrigation or subirrigation possible. However, the quality of mine water is not particularly good (Gallaher and Goad, 1981) and use permits would still have to be obtained because the water has already been appropriated.

Protecting essential hydrologic functions and maintaining the hydrologic balance in drainages disturbed by surface mining pose several difficult problems. The hydrologic balance and function of specific ephemeral streams are poorly understood. Maintenance of an alluvial aquifer upstream and downstream from a mined area may be impossible during the period of mining, but the system may return to near base-line conditions after mining ceases. Transport of water and sediments through areas disturbed by mines must be maintained in order to balance base-line conditions downstream. This implies that runoff and sediment production from mined areas may not need to be minimized and that water quality may not need to be upgraded beyond that produced by the natural system.

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Table 1. Guideline Criteria Indicative of Alluvial Valley Floors.

Surficial Geologic Criteria

1. Alluvial valley floors are underlain by nearly horizontal deposits of gravel, sand, silt and clay which are deposited by streams.
2. An alluvial valley floor is coursed by a bankfull channel at least 3.0 feet wide and 0.5 feet deep.
3. Valley width is greater than 50 feet.
4. Low terraces and distal portions of alluvial fans integrated with modern streams in lowland areas adjacent to modern streams may be included as parts of alluvial valley floors.

Hydrologic Criteria

1. The watershed must be capable of producing flood irrigation or have a potential for subirrigation which could sustain agricultural activities (generally more than 2 acre-ft of water per acre for irrigation; shallow water table for subirrigation).
2. The nature of waters used for irrigation are of a quality which poses no detrimental effect to soils or plants.
3. To the point to which it is economically feasible, the water to be used for irrigation can be taken readily from the watershed, in a manner which does not violate state or federal laws, and will not adversely affect any downstream users.
4. There is evidence that either flood irrigation or subirrigation is a regional practice.

Vegetative Criteria

1. Abundant vegetation in lowlands compared with adjacent areas.
2. Agriculturally-useful vegetation indicative of a shallow water table.
3. Evidence of recent hay production.

Land-use Criteria (other than those mentioned above)

1. Regional pattern of flood irrigation or subirrigation.
2. Standards for water application must be consistent with regional practice.
3. Area of alluvial valley floor generally must be more than 10 acres.

Exclusions

1. Colluvial and other surficial deposits along the valley margins which are higher than the modern flood plain and "are not irrigated by diversion of natural flow or ephemeral flood flow and are not subirrigated by underflow" (U.S. House of Representatives, 1977a).
2. Upland areas which are underlain by thin colluvial deposits.

Table 1 (cont'd)

3. Valleys without stream channels.
4. Areas where water quality data or solids data indicate that long-term degradation of the soil resource would result in reduction of the agricultural utility of the area.
5. Undeveloped range lands not significant to farming.
6. Small acreages within otherwise "clearly not alluvial valley floors".

Table 2.

Drainages checked under phase I of alluvial valley floor determination.

	Name of Coal Field Area	7½ Minute Quadrangle Map Name and Number
	Fruitland Field (Kf)	
**	La Plata River	La Plata (4-2)
	McDermott Arroyo	La Plata (4-2)
	Cinder Gulch	La Plata (4-2)
	Murphy Arroyo	La Plata (4-2)
	Westwater Arroyo	Waterflow (3-3)
	Shumway Arroyo	Waterflow (3-3
**	San Juan River	Waterflow (3-3), Fruitland (27-2), The Hogback North (26-1)
	Navajo Field (Kf)	
	Chaco River	The Hogback North (26-1), The Hogback South (26-4), Newcomb NE (50-1), Newcomb SE (50-4)
	Pinabete Wash	Newcomb NE (50-1), The Pillar NW (51-2)
	Cottonwood Wash	The Hogback South (26-4), Kirtland SW (27-3)
	Brimhall Wash	Newcomb SE (50-4), Burnham Trading Post(51-3)
	Chinde Wash	The Hogback North (26-1), Fruitland (27-2)
	northern No Name (Tpotla)	The Hogback South (26-4)
	southern No Name	Newcomb NE (50-1)
	Bisti Field (Kf)	
	Chaco River	Newcomb SE (50-4), Great Bend (74-1), The Pillar 3 NW (75-2), The Pillar 3 NE (75-1)
	Hunters Wash	Newcomb SE (50-4), Burnham Trading Post (51-3), Bisti Trading Post (51-4)
	Alamo Wash (tributary to De-na-zin)	Alamo Mesa West (52-3), Tanner Lake (76-2)
	De-na-zin Wash (Coal Creek)	The Pillar 3 NE (75-1), Tanner Lake (76-2)
	Ah-shi-sle-pah Wash	Pueblo Bonito NW (77-2), Pretty Rock (76-1), Kin Klizhin Ruins (76-4)
	Kimbeto Wash	Kimbeto (77-1), Pueblo Bonito (77-3)
	Escavada Wash	Pueblo Bonito (77-3), Sargent Ranch (77-4), Fire Rock Well (77-3)
	Toadlena Field (Kmv)	
	Chaco River	Newcomb SE (50-4)
NC	Captain Tom Wash	Newcomb SE (50-4), Newcomb (50-3)
	(others not checked)	

Table 2 (cont'd)

<u>Hogback Field (Kmv)</u>	
Chaco River (lower) (others not checked)	The Hogback North (26-1), Chimney Rock (2)
<u>Chaco Canyon Field (Kmfu)</u>	
Chaco River	Tanner Lake (76-2), La Vida Mission (76-3), Kin Klizhin Ruins (76-4), Pueblo Bonito (77-3)
Tsaya drainage	Tanner Lake (76-2), Pretty Rock (76-1)
NC Kim-ne-ni-oli Wash	La Vida Mission (76-3)
No Name tributaries	La Vida Mission (76-3)
<u>Eastern Standing Rock Field (Kmfl)</u>	
Orphan Annie Tank	Orphan Annie Rock (125-1)
tributaries	Orphan Annie Rock (125-1)
<u>Star Lake Field (Kf)</u>	
Chaco Wash	Pueblo Pintado (102-2), Pueblo Alto Trading Post (102-1), Star Lake (103-2)
Gallo Wash	Pueblo Bonito (77-3), Sargent Ranch (77-4), Fire Rock Well (78-3)
Escavada Wash	Pueblo Bonito (77-3), Sargent Ranch (77-4), Fire Rock Well (78-3)
Canada Alemita	Fire Rock Well (78-3), Lybrook SE (78-4)
Arroyo Pueblo Alto	Pueblo Alto Trading Post (102-1), Star Lake (103-2)
Papers Wash	Star Lake (103-2)
<u>La Ventana Field (Kmv)</u>	
Rio Puerco	San Pablo (105-2), La Ventana (105-3)
Arroyo Hondo	San Pablo (105-2)
San Pablo	San Pablo (105-2)
<u>Gallup Field (Kmv)</u>	
Puerco River	Gallup West (121-4), Gallup East (122-3), Manuelito (145-2)
Defiance Draw	Tse Bonita School (121-2), Samson Lake (121-3), Gallup West (121-4)
Burned Death Wash	Twin Lakes (121-1), Gallup West (121-4)
Tse Bonita Wash	Tse Bonita School (121-2), Zith-Tusayan Butte 4 NE (A129-1)
Tributary to Tse Bonita Wash	Zith-Tusayan Butte 4 NE (A129-1)
Coal Mine Wash (P&M)	Tse Bonita School (121-2), Zith-Tusayan Butte 4 NE (A129-1)

Table 2 (cont'd)

	Tributary to Coal Mine Wash (P&M)	Tse Bonita School (121-2), Zith-Tusayan Butte 4 NE (A129-1)
	Coal Mine drainage (Sundance)	Bread Springs (146-2)
	Catalpa Canyon	Bread Springs (146-2)
	Catalpa Canyon east tributary	Bread Springs (146-2)
	<u>Raton Field (KTvr)</u>	
**	Vermejo River	Casa Grande (17), Cimarron (41), Colfax (42-3)
*	York Canyon	Casa Grande (17)
	Salyers Canyon	Casa Grande (17)
	Chimney Canyon	Casa Grande (17)
*	Caliente Canyon	Casa Grande (17)
	Sawmill Canyon	Casa Grande (17)
	Gachupin Canyon	Casa Grande (17)
	Saltpeter Canyon	Saltpeter Mountain (42-2), Colfax (42-3)
	Spring Canyon	Cimarron (41)
	Dawson Canyon	Cimarron (41), Saltpeter Mountain (42-2)
	Dillon Canyon	Tin Pan Canyon (18-1), Raton (19-2)
	Raton Creek	Raton (19-2)
	Canadian River Canyon	Casa Grande (17), McWilliams Canyon (18-2)
	Potato Canyon	McWilliams Canyon (18-2)

** Potential AVF, needs intermediate level investigations (Part II OSM Guidelines).

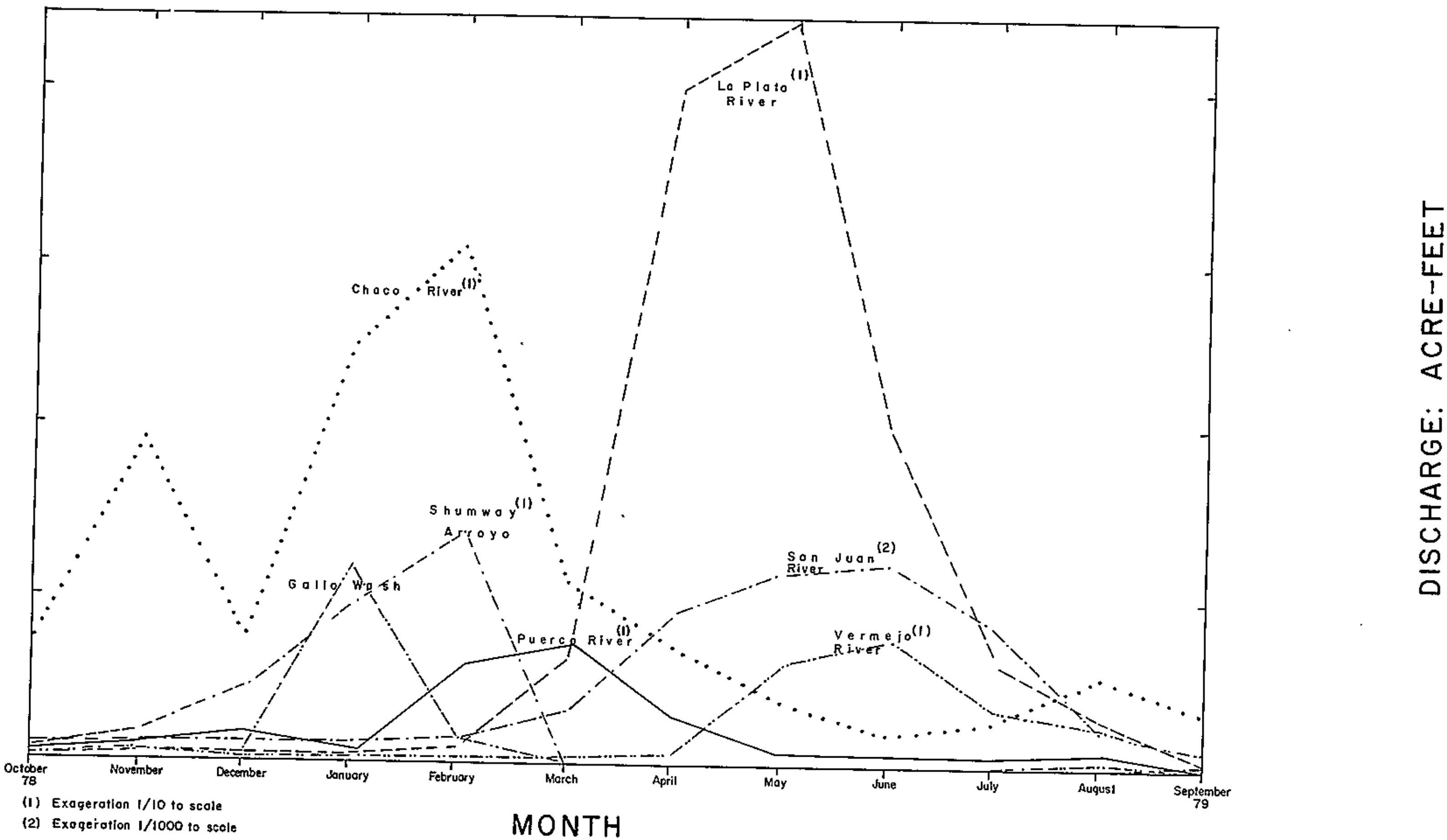
* Possibly not AVF, may need intermediate level investigations.

NC Not completely checked in this study

Drainages not marked with asterisks or NC are "clearly not alluvial valley floors".

List of Figures

List of Figures (cont'd)



(1) Exageration 1/10 to scale
(2) Exageration 1/1000 to scale

SOURCE: USGS,WRD 1979

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OFR 188

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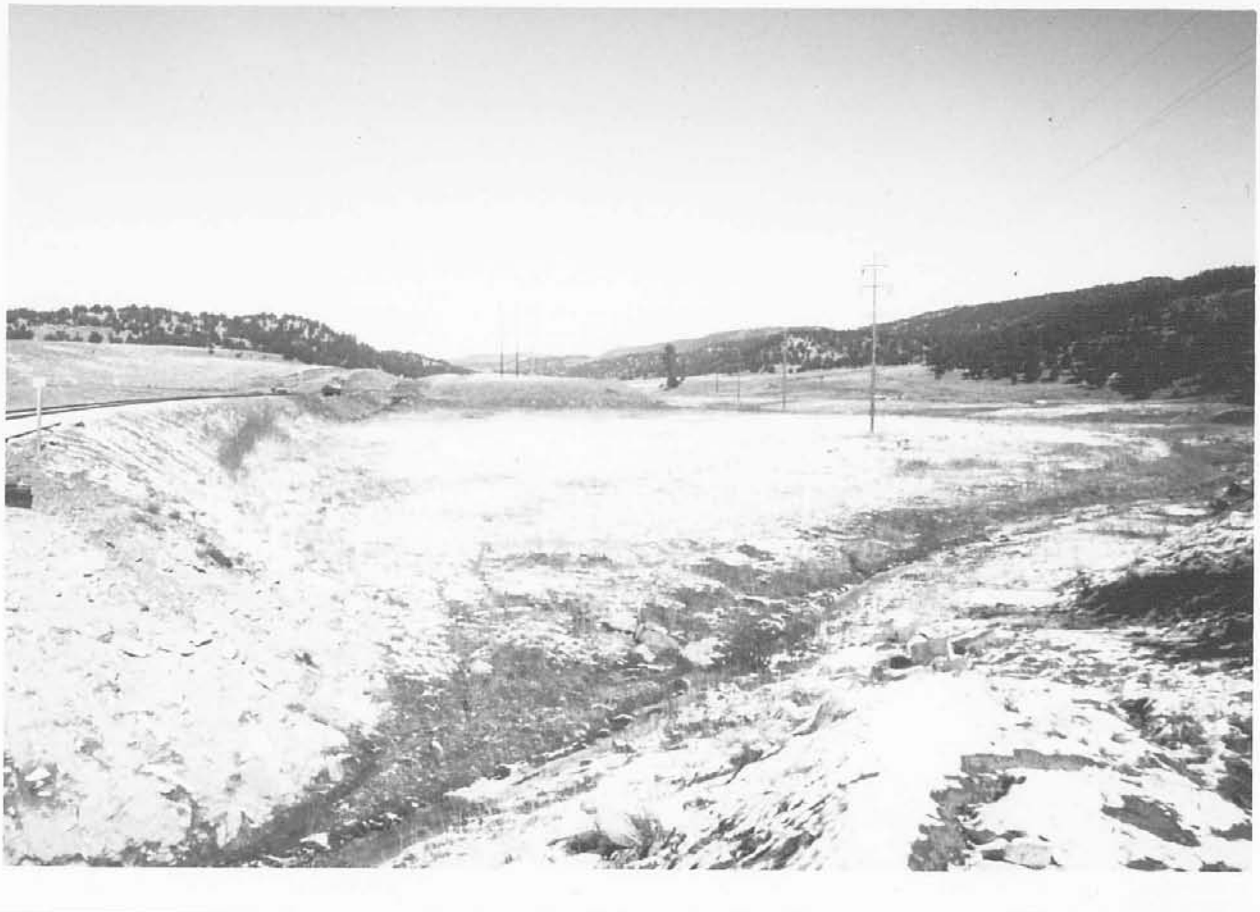

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21

EXPLANATION FOR MAP I (IN POCKET)

Potential alluvial valley floors

Possibly not alluvial valley floors

Drainages clearly not alluvial valley floors

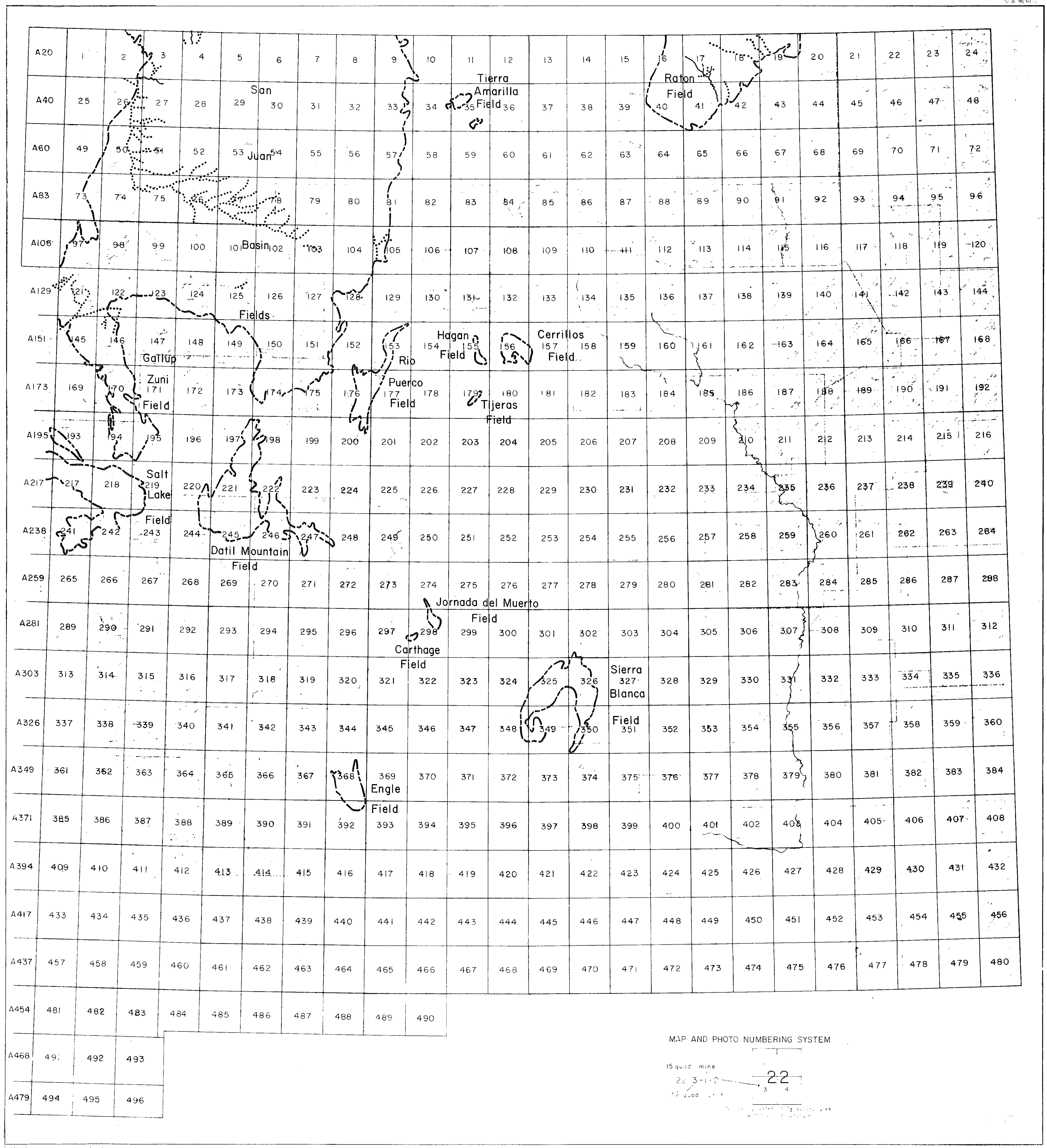
EXPLANATION FOR MAPS 2,3,4, AND 5 (IN POCKET)

Potential alluvial valley floors

Possibly not alluvial valley floors

Peripheral low-lying areas capable of irrigation

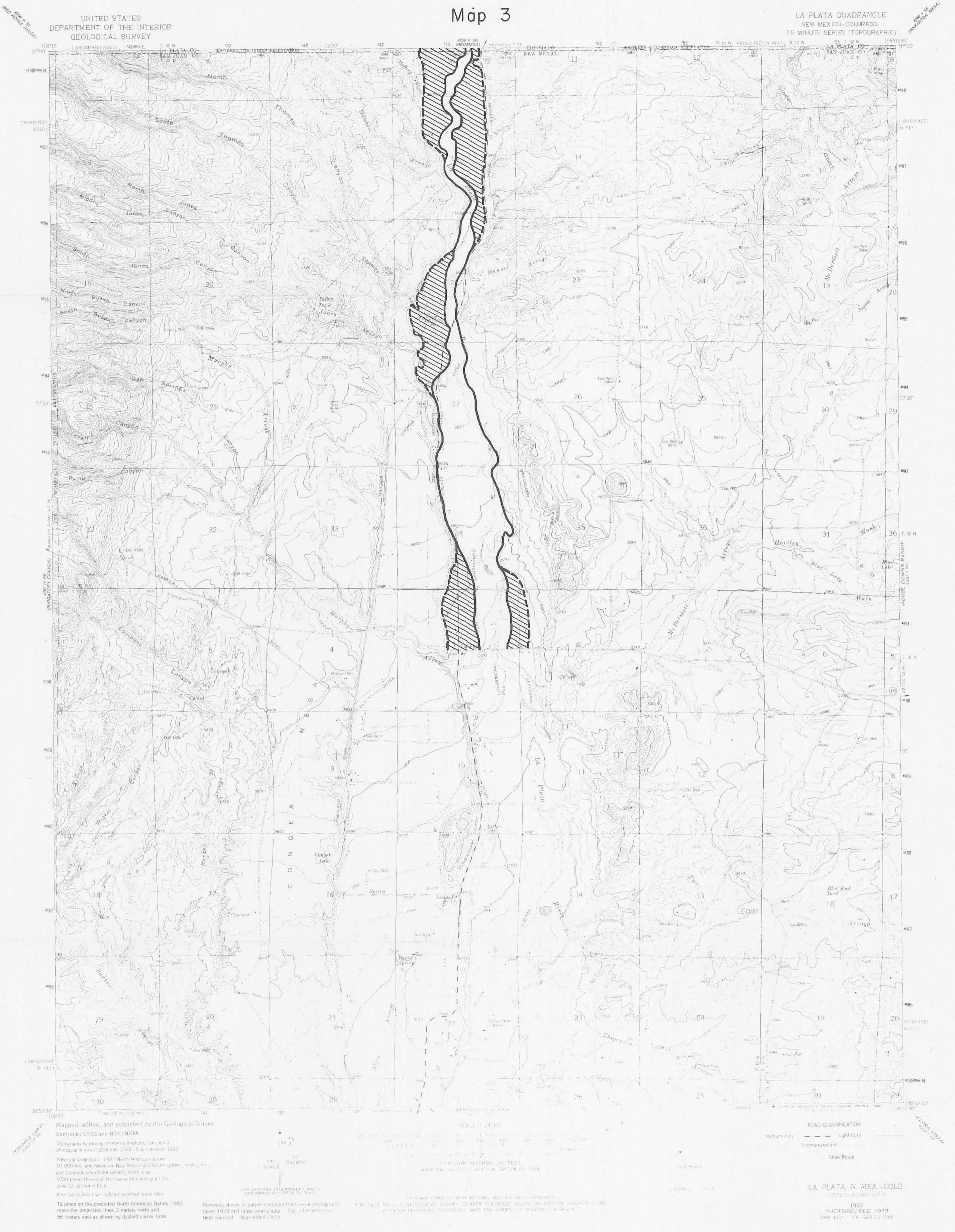
Map I


San Juan Basin Fields
Tierra Amarilla Field
Raton Field
Gallup Zuni Field
Hagan Field
Cerrillos Field
Rio Puerco Field
Tijeras Field
Salt Lake Field
Datil Mountain Field
Jornada del Muerto Field
Carthage Field
Sierra Blanca Field
Engle Field
MAP AND PHOTO NUMBERING SYSTEM
15 quad mine
22 3-1-2
22

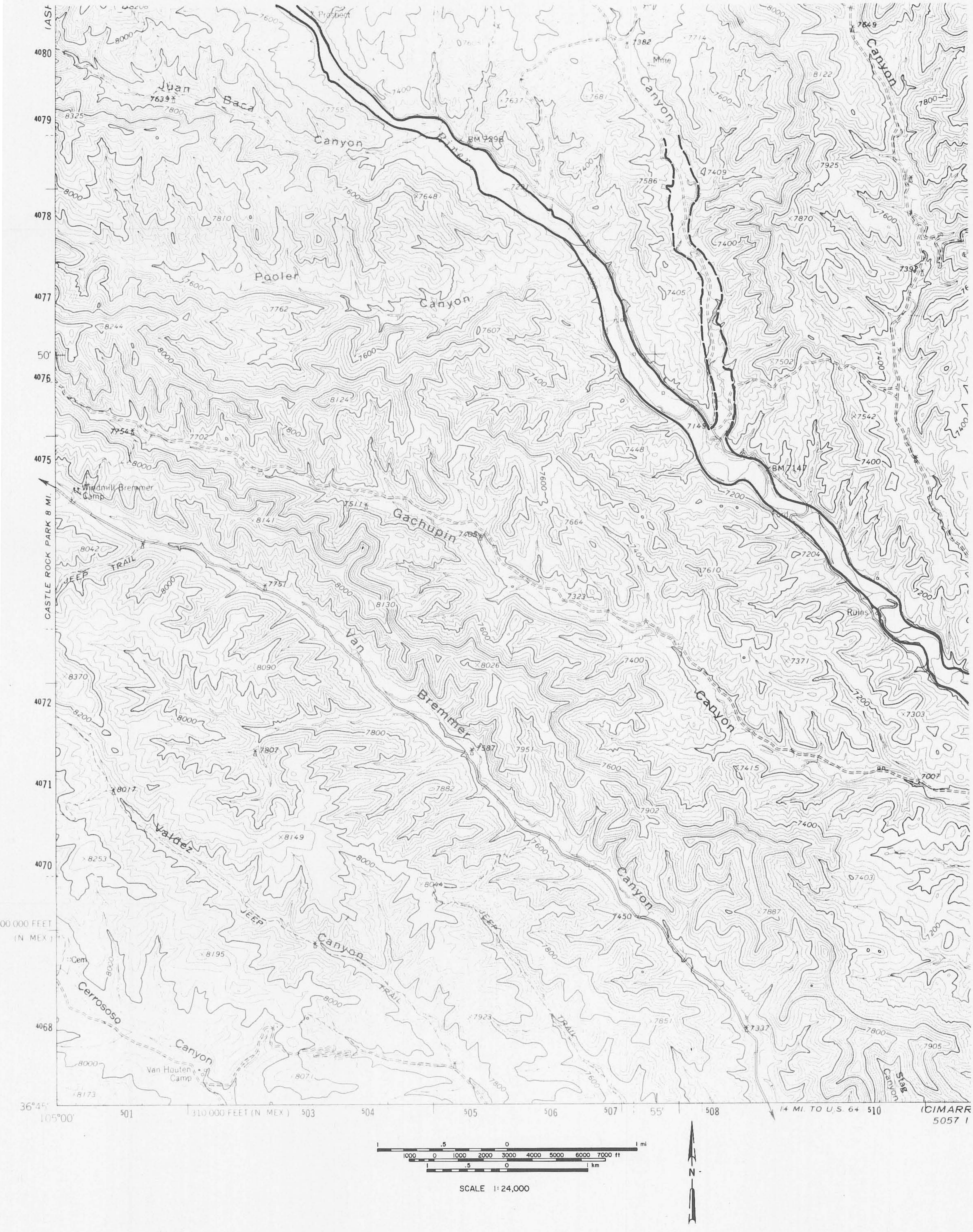
Map 2


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
7.5 MINUTE SERIES (TOPOGRAPHIC)
THE MEADOWS
Hutch
Canyon
Shumway
Jewett Valley
Waterflow
SAN JUAN RIVER
NAVAJO INDIAN RESERVATION
Fruitland
Kirtland
MORGAN LAKE
NAVAJO
Four Corners Powerplant
Mapped, edited, and published by the Geological Survey
Control by USGS, NOS/NOAA, and U. S. Bureau of Reclamation
CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
ROAD CLASSIFICATION
FRUITLAND, N. MEX.
1966
PHOTOREVISED 1979
WATERFLOW, N. MEX.
1963
PHOTOREVISED 1979

Map 3

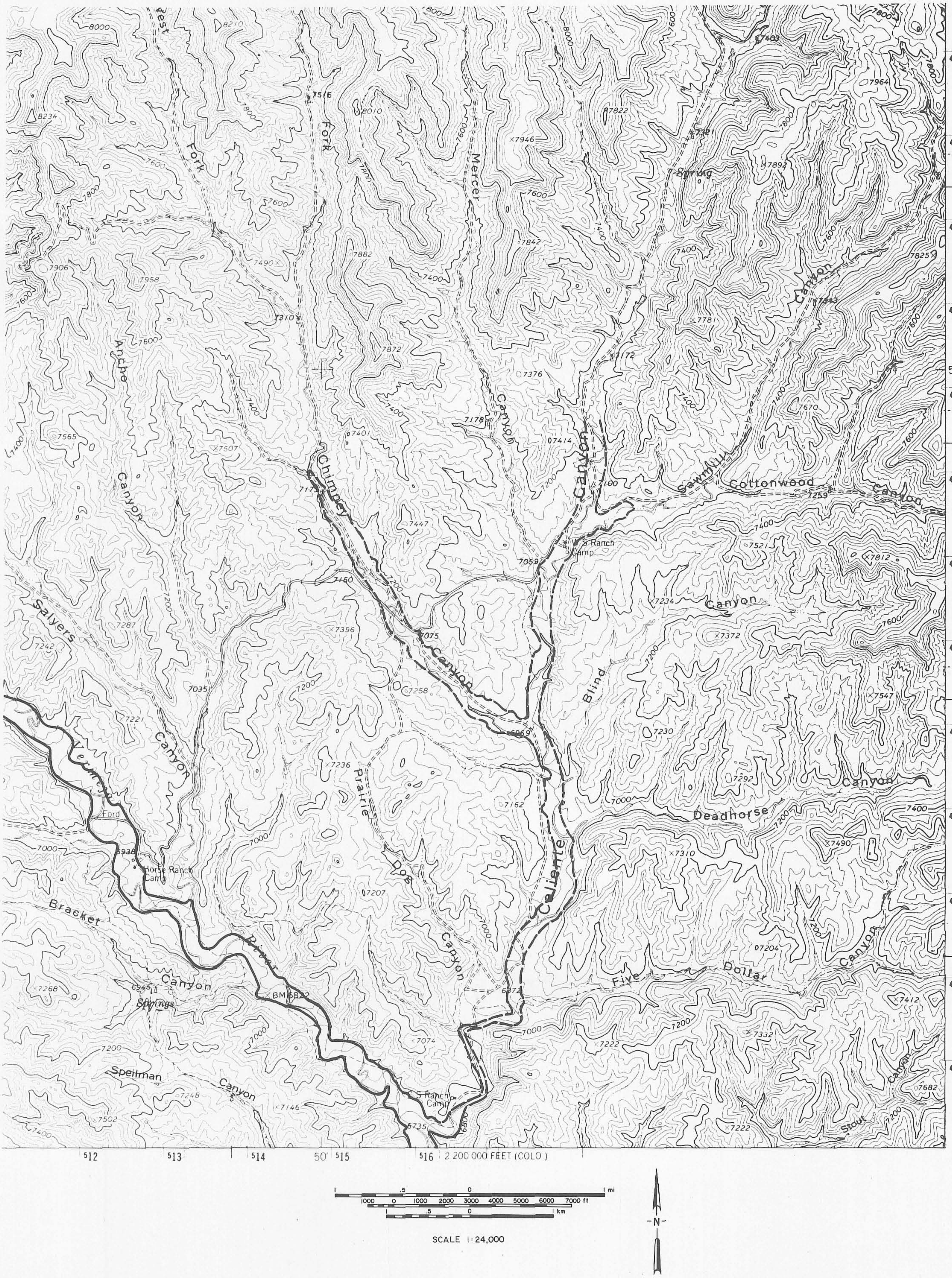

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
LA PLATA QUADRANGLE
NEW MEXICO-COLORADO
7.5 MINUTE SERIES (TOPOGRAPHIC)
COLORADO
NEW MEXICO
SOUTHERN UTE INDIAN RESERVATION
North Thomas
South Thomas
Thomas Canyon
North Jones Canyon
Middle Jones
South Jones Canyon
North Buzan Canyon
South Buzan Canyon
Murphy
Oak Springs
Trail Canyon
Pump Canyon
Coalbank Canyon
Walker
Conger Mesa
Conger Lake
Spring
Barry Spring
Talley Tank
Jones Arroyo
Mossel Arroyo
Hartley Wash
Blue Lake Wash
Blue Lake
Mc Dermott
Cinder Gulch Arroyo
La Plata
Tom Cross
Blue Rock Tank
Arroyo
Gas Well
Drill Hole
Mapped, edited, and published by the Geological Survey
Control by USGS and NOS/NOAA
CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
ROAD CLASSIFICATION
Light duty
Unimproved dirt
State Route
LA PLATA, N. MEX.-COLO.
1963
PHOTOREVISED 1979
To place on the predicted North American Datum 1983 move the projection lines 2 meters north and 56 meters east as shown by dashed corner ticks

Map 4



Juan Baca Canyon
Pooler Canyon
Gachupin Canyon
Van Bremmer Canyon
Valdez Canyon
Cerrososo Canyon
Stag Canyon
Canyon
Prospect
Mine
Ruins
Windmill Bremmer Camp
Van Houten Camp
Cem
JEEP TRAIL
CASTLE ROCK PARK 8 MI.
BM 7298
BM 7147
14 MI. TO U.S. 64
310 000 FEET (N. MEX.)
00 000 FEET (N. MEX.)
36°45'
105°00'
55'
50'
(CIMARR
5057 I
SCALE 1:24,000
1 mi
ft
1 km
N

Map 5



Fork
Fork
Mercer
Canyon
Spring
Anche
Canyon
Chimney
Canyon
Canyon
Sawmill
Cottonwood
Canyon
S Ranch
Camp
Salyers
Canyon
Blind
Canyon
Prairie
Dog
Canyon
Deadhorse
Canyon
Caliente
Ford
Horse Ranch
Camp
Bracket
Canyon
River
Springs
Speilman
Canyon
Five
Dollar
Canyon
Stout
Canyon
S Ranch
Camp
BM 6822
2 200 000 FEET (COLO.)
50'
SCALE 1:24,000
N

Appendix 19.B

OSM Pinabete and Cottonwood Arroyo Alluvial Valley Floor
Determination Letter Dated June 1992

United States Department of the Interior

OFFICE OF SURFACE MINING
Reclamation and Enforcement
Brooks Towers
1020 15th Street
Denver, Colorado 80202

TAKE PRIDE IN AMERICA

June 3, 1992

JUN 1992
RECEIVED
Environmental
Quality

Mr. David Porterfield
BHP-Utah International
Navajo Mine
P.O. Box 155
Fruitland, New Mexico 87416

Dear Mr. Porterfield:

The Office of Surface Mining Reclamation and Enforcement, (OSM), has completed its review of BHP-Utah International Inc.'s, (BHP), April 14, 1992 submittal of a request for a minor revision and negative determination for an Alluvial Valley Floor concerning the Cottonwood Arroyo and Pinabete Wash for permit NM-0003B. This letter serves to notify you that your request has been granted as minor revision NM-0003-B-I-07.

BHP's submittal supporting a negative determination for an Alluvial Valley Floor concerning the Cottonwood Arroyo and Penabete Wash has been determined to be satisfactory.

By copy of this letter OSM requests other Federal and tribal agencies to insert pages, exhibits, etc., previously received concerning the above approved minor revision into the approved PAP.

If you have any questions or concerns, please contact Carl R. Johnston at (303) 844-5910.

Sincerely,

for Peter A. Rutledge, Chief
Federal Programs Division

cc: Director, AFO
Navajo Nation - Zaman
BLM - Farmington District Office
BIA - Navajo Area Director
USF&WS, NM - Field Supervisor

Appendix 19.C

OSM Brimhall and No Name Arroyo Alluvial Valley Floor

Determination Letter Dated July 2008

United States Department of the Interior

OFFICE OF SURFACE MINING
Reclamation and Enforcement
P.O. Box 46667
Denver, Colorado 80201-6667

IN REPLY REFER TO:

NM-0038

July 17, 2008

Ms. Daphne Place
Navajo Mine Extension Project
BHP Billiton
300 W. Arrington, Suite 200
Farmington, New Mexico 87401

Certified Mail
Return Receipt Requested

RE: Request for Determination for Alluvial Valley Floor and Prime Farmland
OSM Project No. NM-0038-A-O-01

Dear Ms. Place:

The Office of Surface Mining Reclamation and Enforcement (OSM) has received BHP Billiton's (BHP's) submittal dated April 8, 2008 (OSM ID No. 08/07/11-06) requesting a determination for Alluvial Valley Floor (AVF) and Prime Farmland for the proposed Navajo Mine Extension Project (NMEP) permit area. In accordance with the regulations at 30 CFR 785.19(a) permit applicants who propose to conduct surface coal mining and reclamation operations within a valley holding a stream or in a location where the permit area or adjacent area includes any stream, in arid and semiarid regions of the United States, may request the regulatory authority to make an alluvial valley floor determination. Three ephemeral stream channels exist within or adjacent to the NMEP – Brimhall Wash, Pinabete Arroyo and No Name Arroyo. In 1992 OSM made a determination that Pinabete Arroyo was not an AVF. BHP's April 8, 2008 submittal requesting a determination for Brimhall Wash and No Name Arroyo has been reviewed and we have determined that Brimhall Wash and No Name Arroyo are not AVFs.

If you have any questions please call Brenda Steele at 303-293-5046.

Sincerely,

Richard A. Holbrook, Chief
Program Support Division

Enclosure
cc: OSM, Albuquerque Field Office
Navajo Minerals Department
BLM Farmington Resource Area
BIA Navajo Regional Office