ARCHAEOLOGICAL VARIABILITY WITHIN THE BISTI - STAR LAKE REGION NORTHWESTERN NEW MEXICO

EDITED BY

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Prepared for

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1.0 INTRODUCTION

by Meade F. Kemrer

1.1 PROJECT BACKGROUND

This report is the outcome of a Class II cultural resources inventory survey of Preference Right Lease Areas (PRLA's) located in the Bisti-Star Lake region in northwestern New Mexico. The project was conducted for the Bureau of Land Management, Albuquerque District, by ESCA-Tech Corporation of Albuquerque, New Mexico, under the terms and conditions of Contract Number YA-553-CTO-114 [SBA #580458(a) 80-C-0124], which was awarded October 23, 1980.

Gordon Frashier, Chief, Division of Resources, served as Contracting Officer's Authorized Representative and administered the project on behalf of the Bureau of Land Management, Albuquerque District. Meade F. Kemrer, Senior Archaeologist, and William E. Reynolds, Director of Operations, administered the project on behalf of ESCA-Tech Corporation and served as Co-Principal Investigators. C. Randall Morrison, District Archaeologist, and Margaret Obenauf, Archaeologist, Bureau of Land Management, Albuquerque, served as Project Inspectors.

1.2 PERSONNEL

A number of individuals contributed substantially to the successful completion of the various phases of this project. Mark Ganas directed the compilation of a regional archaeological data base, performed computer analyses, served as Crew Chief during the field work phase, and contributed directly to this report. Nancy Hewett Cella also directed the activities of a field crew, compiled inventory data, and assisted in report writing and editing. Richard Loose served as Project Coordinator and assisted in administrative, field, laboratory and report writing activities. Remote sensing, computer and statistical analyses were conducted by Craig Baker and Steven Sessions of NAS-Tech, Incorporated, of Albuquerque, New Mexico. They have detailed their contributions to the project in this report. Kurt Anschuetz served as a member of the field crew and assisted in site data compilation and report writing. Crew members who performed the field work include Wendy Allen, William Brancard, James Brandi, Daisy Levine, Alexa Roberts, and David Simons. Scientific illustrations for this report were drawn by Georgia Bayliss. Technical editing was accomplished by Michele Ann Tart. Mark Schander assisted in word processing.

The Bureau of Land Management, Albuquerque District, contributed to the successful completion of this project. The District Cultural Resource Inventory Files were made available for data compilation and analysis. Carol Thompson, Archaeologist, Environmental Assessment Projects Team, provided several base maps of the project area as well as environmental assessment data. During the field work phase of the project, the District Office supplied the survey crew with trailers which greatly enhanced the efficiency with which the field work was performed.

1.3 SCOPE AND PURPOSE OF THE PROJECT

The San Juan Basin in northwestern New Mexico is rich in coal, oil, gas and uranium deposits. Since the bulk of the mineral rights within the Basin is held by the Federal government, the Bureau of Land Management is currently evaluating the suitability of major tracts of land for coal development. These assessments include consideration of the effects of mining and related activities on cultural resources. This project is therefore designed to provide the Bureau of Land Management with information pertaining to the cultural resources located within the areas of potential adverse effects.

A previous BLM-sponsored cultural resources sample survey project, termed Bisti-Star Lake Phase I (Huse, et al. 1978), was conducted within this region to assess archaeological variability on lands designed for potential competitive lease coal development. The project to which this report pertains, termed Bisti-Star Lake Phase II, is a sample survey and assessment of coal-bearing tracts located within the center of the Phase I sample universe, but which had been excluded by BLM from the earlier survey.

The tracts of land of primary concern for this project are coal leases. The 26 leases, termed Preference Right Lease Application Areas (PRLA's), contain 77,590 acres of land. The PRLA tracts constitute the universe for this study. The spatial distribution of the PRLA's within the San Juan Basin is shown in Figure 1.

Information of particular importance for the Bureau of Land Management's assessment purposes included estimates of cultural resource content and cultural/temporal variability within the PRLA parcels. BLM therefore required that a study be performed to meet the following objectives:

1. Define the cultural/temporal variability of the cultural resources.

2. Define the range of variability in the types of cultural resources.

3. Estimate the nature of site density distributions.

4. Develop a predictive model for these three variables.

In order to meet these objectives, the project was divided into three phases: the initial model development phase (Phase I), the model testing phase (Phase II), and the model refinement phase (Phase III). Phase I, initial model development, entailed compiling an archaeological data base and an environmental data base; correlating these two bodies of data to create a first-approximation predictive model of cultural resources content and variability within the PRLA study area; and developing a sample survey design for the PRLA study area. Phase II, model testing, was accomplished by performing a sample inventory survey within the PRLA's and assessing the initial predictions from Phase I against the survey data. Pnase III, model refinement, involved incorporating the newly acquired sample inventory data into the archaeological data base and refining the predictive model. The methods and procedures employed in each of the project's phases are detailed in section 4 of this report.

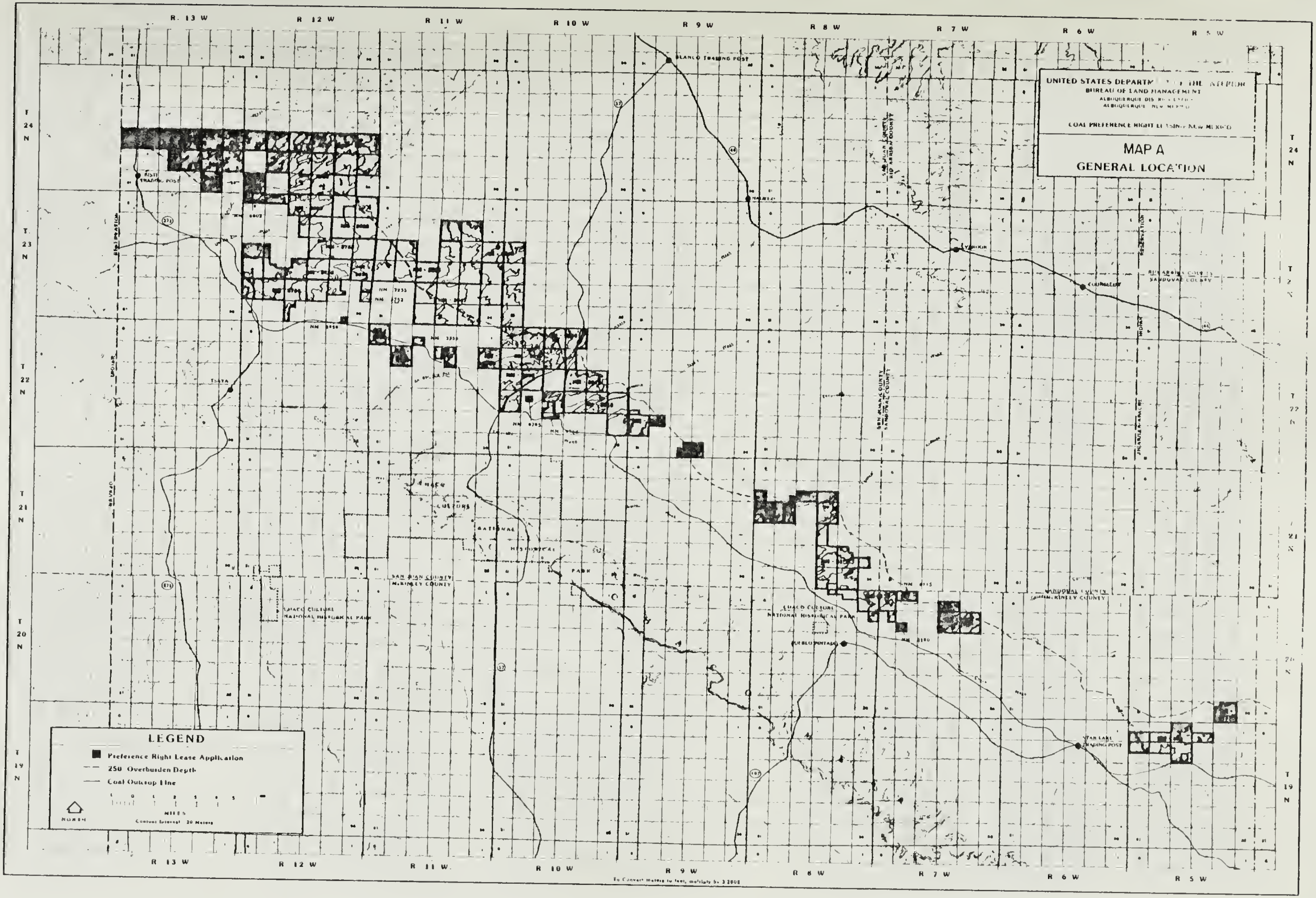


Figure 1. Spatial Distribution of PRLA's within the San Juan Basin (courtesy of the Bureau of Land Management, Albuquerque)

Initial model development (Phase I) was initiated October 23, 1980. An interim report (Baker, Sessions and Ganas 1981) which presented the cultural resources and environmental data bases as well as the initial predictive model for the PRLA study area was submitted to the Bureau of Land Management, Albuquerque District Office, on March 6, 1981.

Phase II (model testing) was begun on April 6, 1981 with the commencement of the survey and the implementation of the sample survey design. This phase was completed on July 20, 1981 with the submittal of all Sample Unit Reports and cultural resources data to the Bureau of Land Management, Albuquerque District Office.

Phase III (model refinement) was initiated on June 29, 1981 and was completed on August 21, 1981. The results of Phases I and III are detailed in section 6 of this report.

2.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

by Richard Loose and Meade Kemrer

2.1 PHYSIOGRAPHIC SETTING

The Bisti-Star Lake Phase II study area lies within the San Juan Basin, which is an asymetric structural depression with a northeast-trending axis. The study area is within the Navajo physiographic section of the Colorado Plateau province, as defined by Fenneman (1931), and is situated on the Chaco Plateau near the northern edge of the Chaco Slope (Warren 1967; Gregory 1916).

As defined by Warren (1967), the Chaco Plateau includes that portion of the central San Juan Basin that is north and east of Canyon Largo (see also Loose 1978). This area is a dissected plateau drained by tributaries of the San Juan and Chaco rivers and by headward-eroding tributaries of the Rio Puerco. Elevation in the study area ranges from 5770 feet above sea level at Bisti to 6780 feet above sea level at Star Lake.

2.2 CLIMATE

The climate is characterized by a semi-arid continental regime, with cold winters and warm summers. About half the annual precipitation falls in intermittent summer thunderstorms. Moderate amounts of snow fall in the winter (usually less than 15 inches). Winds are light to moderate, but can become quite strong in the spring (Maker, et al. 1978). Daily temperatures vary by as much as 40°F and temperatures over 100°F are common in the summer months. Recorded maximum temperatures include 109°F at Shiprock, 103°F at Farmington, and 106°F at Chaco Culture National Historic Park. The lowest temperatures recorded for these locations are -18°, -16° and -24°F respectively (Maker, et al. 1978).

Rainfall averages 7 to 10 inches per year in the Bisti area and increases with elevation to 12 to 14 inches a year in the immediate vicinity of Star Lake. Frost-free days range from 120 to 140 days a year in most of the study area (Ferrill 1978). Localized air drainage conditions may shorten the growing season to the 100 to 110 day range. The average annual moisture deficit ranges between 14 and 18 inches a year for most of the study area; this is about twice the annual rainfall amount. Because of this and the lack of nearby major bodies of water, the relative humidity of the study area is normally quite low (Ferrill 1978).

2.3 SUBSURFACE GEOLOGY

Since the archaeological survey sample was restricted to potential coal leasing areas, only two types of geological strata, the Kirtland Shale and the Fruitland Formation, underlie the selected quadrats. This is because the Fruitland Formation is the main coal-bearing unit in the central San Juan Basin. In many places the overlying Kirtland Shale is thin enough to allow stripping to the buried Fruitland coals.

Both these units are part of an upper Cretaceous deposit formed during the regressive sequence of a shallow inland sea. This created the Dakota Group (sandstone and shale), the Mancos Shale, the Mesa Verde Group (sandstone and shale), and the dark, marine Lewis Shale. The Pictured Cliffs Sandstone, above the Lewis Shale, represents deposits of the final regressive beach line, while the overlying Fruitland Formation and Kirtland Shale represent landward swamp and floodplain environments. Sediments above the Kirtland Shale such as the Ojo Alamo (sandstone) and the San Jose formations represent terrestrial erosion and deposition cycles in the Paleocene and Eocene epochs.

2.4 GEOMORPHOLOGY

The geomorphology of the study area is related to the general tectonic history of the San Juan Basin and several series of erosion and deposition of sediments. By the late stages of the Laramide orogeny, most of the uplifts which formed the rim of the San Juan Basin had been initiated. This is reflected in the lake bed deposits of the Nacimiento Formation, which indicate a closed basin prior to deposition of the San Jose Formation (Loose 1978).

Cenozoic erosional surfaces in the San Juan Basin are related to the entrenchment of the ancestral Colorado River system, which may have appeared as early as the Miocene. The earliest recognizable surfaces are those of mid-Tertiary peneplaination, first described by Dutton in 1882 and referred to as the "great denudation" (Dutton 1885). In 1901, Davis named this ancient surface the "plateau cycle" and labelled all subsequent events the "canyon cycle." Cooley, et al. (1969) largely substantiated the general interpretations of those earlier workers.

Tertiary erosional cycles can be divided as follows: the Valencia cycle of Miocene age, the Hopi Buttes-Zuni cycle of late Pliocene age and the Wupatki cycle of probable middle and late Pleistocene age.

Unfortunately, little work has been done in the San Juan Basin to correlate upland erosional events with the downcutting cycles previously mentioned. Love (1977) provides an excellent discussion of this problem. It is likely that most of the upper undissected surfaces in the study area are of Miocene or Pliocene age, with a well developed Pleistocene soil horizon older than 10,000 years. This is covered by sheet sand and linear dunes less than 10,000 years old. The bulk of this sand appears to have been deposited prior to the Archaic, probably in latest Pleistocene times (Reher and Witter 1977; Love 1977).

Love (n.d.) stresses that the exact nature of these dunes has not yet been been determined and refers to them as linear dunes, rather than longitudinal or transverse dunes (indicating mode of formation). Nials (n.d.) assumes that they are longitudinal dunes, as do Hack (1941) and Cooley, et al. (1969). This interpretation was based on external rather than internal dune morphology, along with patterns of arrested dunes. An equally strong argument for transverse dune formation can be made on the basis of the very consistent crest-to-crest spacing of 800 feet (Nials n.d.) and evidence that the most persistent annual wind direction in the south-central San Juan Basin is from the southeast rather than the southwest (Public Service Company of New Mexico 1980). It is also possible that these dunes are controlled by tectonically induced surface hydrology anomalies which stimulate linear coppice dune formation (John Gibbons 1980, personal communication).

Irrespective of how they are formed, linear dunes are the most prominent surface feature of much of the study area. These dunes vary in height from 1.5 m to more than 6.0 m, and vary in length from less than 0.2 km to more than 20 km (Love and Schultz 1980). These dunes often exhibit blowouts and playa-like structures which can hold water for short periods of time after intense rainfall. In areas where the old Plio/Pleistocene surfaces have been dissected, spectacular badlands areas are often formed in the underlying shales. In such badlands areas, the surface is relatively young and the odds of finding in situ prehistoric materials are low.

2.5 SOILS

In the most recent report on San Juan County (eastern part), the U.S. Soil Conservation Service defined soil as:

> ...a natural, three dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time (Keetch 1980:93).

Among the major distinguishing characteristics of soils are zonal horizons which are more or less parallel to the surface. These multiple horizons differ from one another in several ways. The color, texture, structure, consistency, porosity, and chemical reactivity of each horizon can vary considerably (in the vertical dimension) within a single soil. Horizons may be thick or thin, well developed or so weak that only detailed laboratory analysis can reveal their presence.

Processes which promote formation of soil horizons include movements of organic matter, soluble salts, carbonates, silicate clay minerals, oxides and silica. Factors of oxidation, hydration and percolation of ground water affect these movements (Smith 1974).

Processes which offset formation of soil horizons include soil mixing caused by root activity, burrowing insects, reptiles, mammals and amphibians, earthworm activity, frost heaving, shrink-swell action caused by some clays, soil creep on slopes, and wind and water erosion. Human activities such as plowing and irrigation which induce wind erosion can also mask or remove soil horizons.

In general, soils are characterized (from top to bottom in Figure 2) by a sequence of horizons. The uppermost layer, an A horizon, is recognized by the presence of organic materials and biological activities. Materials are removed from this horizon and deposited in the underlying B horizon, where residual concentrations of oxides and clays accompany alteration of mineral material little altered by pedogenic processes, while the R horizon is unweathered bedrock. These horizons are gradational and transitional.

	01	Undecomposed leaves, organics
	02	Decomposed organics
Horizons of maximum biological activity, removal of materials dissolved or suspended in water	A1	Mineral horizon with organics
	A2	Mineral horizon loss of clay, iron, or aluminum
	A3	Transitional
	B1	Transitional
Horizon of accumulation of materials and chemical alteration of materials	B2	Maximum B properties
	B3	Transitional
Weathered but little affected by pedogenic processes	C	Weathered mineral horizons
Unweathered rock	R	Unweathered bedrock

Figure 2. Idealized Soil Profile
(after Smith 1974)

2.5.1 Classification of Soils

The soil classification system presently used in the United States is a hierarchical grouping, based on genesis of soils as well as physical and chemical properties. This system includes all known soils of the world in ten broad groups called soil orders. The soil orders are divided into suborders, great groups, subgroups, families and series (Maker, et al. 1978). Although there may be differences in texture and underlying material, all soils within a series level have horizons that are similar in composition, thickness and arrangement. Within the series range, soils can differ in terms of slope, stoniness, salinity, moisture content, degree of erosion, etc. On the basis of such differences, soil series can be divided into phases (Keetch 1980). When used at the series level, the term "phase" is roughly analogous to the older concept of "type," which has been dropped by soil scientists in the United States. In early soil reports the term "type" was mainly related to textural properties within the plow layer, but is now consistent within the broader category of "phase" within a soil series (Smith 1974). It must be kept in mind that the term "phase" can also be applied as a subdivision of any of the higher soil classifications such as family, or great group, etc. In the same way the term "association" can be used at any level of soil classification. An association is a group of soils (order, family, series, etc.) geographically associated in a characteristically repetitive pattern and defined and delineated as a single map unit (Keetch 1980). This pattern is distinctive and proportional over a geographic area or landscape (Maker, et al. 1978).

If the pattern of occurrence of two or more series is particularly intricate, a soil complex is mapped or the names of the two series are connected by a hyphen and followed by a textural class name (Smith 1974). Usually such a complex consists of at least two soils which cannot be shown separately on a soil map but whose proportions within the complex are similar in all areas (Keetch 1980).

Soil groupings are a strict function of mapping scale, such that more detail can be shown on at a larger scale (Kosse, 1981 personal communication), or they are a function of land management or survey methodology constraints (Smith 1974). It should be kept in mind that soils within associations at the series level are frequently quite contrasting in nature (such as an association of old upland, active slope soils and moderately active, level soils) but can still be shown as one map unit.

According to Maker, et al. (1978), all soils in the study area may be classed as light-colored soils of the cool desertic region. The temperature of these soils at a depth of 20 inches is in the mesic regime, with a mean temperature between 47° and 59°F. These great groups include Torriorthents-Badland, Torriothents-Torrifluvents-Camborthids, Haplargids-Torripsamments and Rock Land-Torriothents. These terms mean that soils within the study area are characterized by shallow depth on upland slopes and ridges, slightly deeper in alluvial valleys and upland flats, with no pedogenic horizons or with weakly developed horizons except for the Typic Calciorthids (a member of the Haplargids-Torripsamments), which do have strongly calcareous surface layers and prominent lime zones at depths of 10 to 20 inches. Also, there are extensive areas of exposed badland, which is essentially a weathered outcrop of shale bedrock.

Soils used in the predictive model for this report were considered at the association (of series) level, at the complex level, and at the phase (of series) level. The six soil mapping units were selected on the basis of two principal criteria: their areal extent within and adjacent to the PRLA study area, and their visual distinctiveness on the SCS classified orthophoto quadrangles. In areal terms, these classes constitute 63% (within a range of 41-74%) of the pedological variation per 50-square mile soil map (Keetch 1980) which fell within the environmental zone utilized in this study. These six Soil Conservation Service soil classes are described below (data from Keetch 1980).

Blancot-Notal Association (BT)

This gently sloping map unit is found on fans and in valleys; it is 55 percent Blancot loam (0 to 5 percent slopes) and 25 percent Notal silty clay loam (0 to 2 percent slopes). Blancot loam is on fans and in upland valleys, while Notal silty clay is on fans and valley bottoms. Included areas of Stumble, Turley and Fruitland soils on fans and valley sides and Uffens soils on fans and valley bottoms make up about 20 percent of this mapping unit.

The Blancot soils are deep and well-drained, formed in alluvium derived predominately from sandstone and shale. This series is composed of loams, clay loams and sandy clay loams up to 60 inches deep. Blancot soil is moderately permeable and its wind erosion hazard is high. Potential vegetation on Blancot soil is mainly western wheatgrass, galleta, Indian ricegrass and fourwing saltbush. As the potential community deteriorates, forage plants are reduced and less preferable plants such as big sagebrush, Douglas rabbitbrush, broom snakeweed and annual forbs increase.

Notal soils are deep and well-drained, formed from alluvium derived from shale and sandstone. This series includes silty clay loam, brown clay and gray clay, with depths of up to 60 inches. Permeability is low, water erosion hazard is moderate and wind erosion potential is severe. The somewhat saline Notal soil supports alkalai sacaton, galleta, black greasewood and western wheatgrass. As the potential plant community deteriorates, plants such as black greasewood, big sagebrush, Douglas rabbitbrush and annual forbs increase.

Avalon-Sheppard-Shiprock Association (AZ)

This map unit is found on mesas and plateaus with slopes from 0 to 8 percent. The unit is made up of 35 percent Avalon sandy loam (0 to 5 percent slopes), 25 percent Sheppard loamy fine sand (3 to 8 percent slopes) and 25 percent Shiprock sandy loam (0 to 5 percent slopes). Small amounts of Doak and Shiprock Variant soils make up the remaining 15 percent of the total acreage.

Avalon soils are deep and well-drained, in alluvial and aeolian material that is locally derived. Loam and sandy loam up to 60 inches deep characterize this soil. Permeability is moderate and erosion potential is moderate to severe. Natural vegetation of the Avalon soils includes Indian ricegrass, winterfat, galleta and Mormon tea. Overgrazing indicators include broom snakeweed, big sagebrush, increased Mormon tea, and annual forbs.

Sheppard soils are deep and excessively drained, being formed of aeolian materials derived from sandstone and shale. Loamy fine sand and fine sand up to 60 inches deep are typical. Water erosion hazard is slight, but wind erosion can be severe. The potential community of Indian ricegrass, giant dropseed and alkalai sacaton deteriorates to broom snakeweed, big sagebrush, Mormon tea and annual forbs when under stress.

Shiprock soil is deep and well drained, being formed from aeolian material derived from sandstone and shale. Sandy loam and fine sandy loam over 60 inches deep are the main components of the Shiprock series. Water erosion potential is slight but wind erosion hazard can be quite high. The natural plant community of Indian ricegrass, blue grama and fourwing saltbush deteriorates with overgrazing to broom snakeweed, big sagebrush, Mormon tea and annual forbs.

Doak-Sheppard-Shiprock Association (DS)

This map unit is found on mesas, plateaus and terraces with slopes of 0 to 15 percent. The unit is 40 percent Doak loam (0 to 5 percent slopes), 30 percent Sheppard loamy fine sand (0 to 15 percent slopes), and 20 percent Shiprock fine sandy loam (0 to 5 percent slopes). Small areas of Avalon and Mayqueen soils make up to 10 percent of the total acreage.

Doak soils are deep and well-drained, developing in alluvium derived from sandstone and shale. Doak soils include loam, silty clay loam and clay loam up to 60 inches deep. Water erosion hazard is moderate, while wind erosion hazard is also moderate. Potential plants on Doak soils include blue grama, western wheatgrass and Indian ricegrass. Deterioration of this community produces broom snakeweed, rabbitbrush, big sagebrush and annual forbs.

Huerfano-Muff-Uffens Complex (HU)

This soil complex is found on mesas and valleys with slopes of 0 to 8 percent. The unit is 40 percent Huerfano sandy clay loam (0 to 3 percent slopes), 30 percent Muff very fine sandy loam (0 to 8 percent slopes), and 20 percent Uffens fine sandy loam (0 to 5 percent slopes). These components are so intermingled that they could not be separated at a scale of 1:63,360 (Keetch 1980). Up to 10 percent of this unit is composed of Avalon, Doak, Notal, and Shiprock soils.

Huerfano soils are shallow and well-drained, formed from alluvium and residuum of shale and siltstone. Sandy clay loam and clay loam up to 15 inches deep are characteristic. Water erosion hazard is moderate, while wind erosion hazard is severe. Vegetation on Huerfano soils is mainly alkalai sacaton, galleta, fourwing saltbush and black greasewood. Under stress, black greasewood, shadscale, broom snakeweed, and forbs increase.

Muff soils are moderately deep and well-drained. They are derived predominately from shale. Very fine sandy loam, fine sandy loam and clay up to 24 inches deep are the main components of this soil. Water erosion hazard is moderate, wind erosion hazard is severe. Muff soils have vegetation characteristics like Huerfano soils.

Uffens soils are deep and well-drained, being formed from shale. Fine sandy loams and very fine sandy loams combined with a substratum of clay loams are characteristic, with depths up to 60 inches. Water erosion hazard is slight, while wind erosion hazard can be severe. Alkalai sacaton, galleta, black greasewood and fourwing saltbush vegetation are included in the potential native plant community which degrades under stress to black greasewood, shadscale, broom snakeweed, and annual forbs.

Stumble-Notal Complex (SX)

This gently sloping map unit is found on valley sides, valley bottoms, and on fans, with slopes of 0 to 8 percent. Stumble loamy sand (0 to 8 percent slopes) makes up 55 percent of the unit. Thirty percent of the area is Notal clay loam (0 to 2 percent slopes). Small inclusions of Fruitland, Turley and Uffens soils make up the final 15 percent of the total acreage.

Stumble soil is deep and excessively drained, being derived predominately from sandstone and shale. Water erosion hazard is slight to none. Wind erosion hazard can be very severe. Potential plants include Indian ricegrass, giant dropseed, alkalai sacaton and sand sagebrush. Deterioration brings broom snakeweed, sand sagebrush, Mormon tea and sandhill muhly.

Doak-Avalon Association (DN)

This map unit is found on mesas, plateaus and terraces. As discussed previously, both Doak and Avalon soils are well-drained. The alluvially derived Doak soils range from loams to clay loams, whereas Avalon soils range from loamy sands to sandy loams and are derived from both aeolian and alluvial deposits.

Doak soils support blue grama, western wheatgrass, and Indian ricegrass. Avalon soils can potentially support galleta, Indian ricegrass, winterfat, and Mormon tea. Overgrazing generally produces high frequencies of snakeweed, rabbitbrush, big sagebrush, and annual forbs on these soils.

2.5.2 Drainage Systems

Another environmental variable utilized in the site prediction model is the wash systems which dissect the region. Washes are shallow and less erosionally spectacular than arroyos. They also have wide, flat, sandy bottoms with shallow stream braiding and little or no vegetation cover. Washes may exhibit some vertical wall development, but they are usually less than five feet deep, and the width-to-depth ratio is high (Hodges 1974).

Within and adjacent to the PRLA study area this environmental variable is defined by Chaco Wash and its tributaries which drain a major portion of the San Juan Basin.

Additional information concerning the identification, quantification and compilation of these variables into an environmental data base is discussed in section 4.2 of this report.

2.5.3 Soil Science in the Service of Archaeology

Over long periods of time, soils will reflect factors of climatic and vegetational change. However, chemical and morphological properties of soils are not easily erased and may preserve the impressions of the past environment (Lotspeich 1961). Soils have an inherent inertia that makes them change much more slowly than vegetational communities. Many soils are polymorphic (formed under varying conditions) and some soils are polygenetic (formed from more than one parent material). Processes that produce a particular soil chemistry may be reversible under some conditions and this must be considered when using soils to make climatic interpretations. It must also be kept in mind that soils of a particular association (of series or of groups) may be of drastically different ages. This is relevant when comparing archaeological site distributions, for perceived patterns may relate to the geological age of soil distribution rather than to the original patterns of human behavior (Loose 1980).

Archaeologists must also consider the inherent limitations of soil classifications, which are somewhat intuitive. They are based on economic factors of crop production and management, are limited by the map scale at which they are recorded (Kosse 1980, personal communication), and often change at state or county boundaries (Loose 1980) or in subsequent mapping projects. Lotspeich (1961:139) nicely sums up the problem:

> All archeological sites are not amenable to the use of pedogenic principles, this must be decided by various specialists after intensive reconnaissance and preliminary research followed by consultation. The maximum amount of information is best attained when specialists in several scientific disciplines pool their knowledge while striving towards a common goal. This requires close cooperation and understanding among the personnel involved; however, the team approach will ultimately be used for investigations dealing with complex relationships that cut across several disciplines.

In summary, soil scientists could undoubtedly generate soil classificatory schemes that could potentially be more useful for predicting site densities. Time and cost considerations, however, precluded the development of such a system for this study. On empirical grounds, moreover, the soil and wash classes utilized here have proven to be effective predictors of site frequencies and accurate indicators of site-environmental relationships, as will be demonstrated in the subsequent sections of this report.

3.0 CULTURE HISTORY OF THE SAN JUAN BASIN

3.1 PALEOINDIAN PERIOD by Meade Kemrer

The PaleoIndian Period is poorly represented in the San Juan Basin. Survey data rarely include more than one percent PaleoIndian materials (cf. Reher 1977; Huse, et al. 1978; Stuart and Gauthier:1981:66). Isolated projectile points constitute the bulk of PaleoIndian manifestations in the region, although an apparent multiple component PaleoIndian site has recently been recorded in the Navajo Indian Irrigation Project area (Lawrence Vogler 1980, personal communication), and another was recorded during the course of this survey. Future surveys of the Basin will undoubtedly yield additional sites, but it is unlikely that their numbers will ever be appreciably high.

This period is generally characterized as one in which most human groups were highly dependent on big game hunting, though most recent authors agree that this characterization is somewhat oversimplified (cf. Tainter and Gillio 1980:24-41; Stuart and Gauthier 1981:31). However, the view that PaleoIndians were generalized hunter-gatherers is also unwarranted.

PaleoIndian site patterning in the southern portion of northwestern New Mexico is consistent with large game hunting logistics (Judge 1973). Campsites and other limited activity loci are invariably located near and downwind from major water resources such as streams and playas which attracted animal herds. These sites are also in elevated settings where the occupants could monitor game animal movements over a considerable area. Site selection criteria differ markedly from those utilized by groups who were clearly broad-based hunter-gatherers during the succeeding Archaic Period. PaleoIndian inter-site variability in western New Mexico is low when compared with the Archaic. Judge (1973:193-318) recognizes only three types of PaleoIndian sites: base camps, processing sites and armament sites.

Base camps are relatively large multiple functional loci containing the outcomes of cooking, meat and hide processing, tool repair, manufacturing, and other maintenance activities. Processing sites can vary in size, but contain proportionately high quantities of meat and hide cutting and scraping tools. Armament sites contain a proportionately high incidence of artifacts related to projectile point manufacture, repair, and replacement activities. All three site types reflect a dependence on large game as a major source of subsistence. An example of a PaleoIndian armament site from this survey is presented in Figure 3.

The cooler and moister Southwestern climatic conditions which obtained during the PaleoIndian Period undoubtedly enhanced the browsing/grazing potential of the San Juan Basin. Thus, larger herbivore populations could have been been sustained. However, the actual carrying capacity of this region during the late Pleistocene may well have regulated exploitative feasibility and thus the intensity with which the area was utilized by PaleoIndian groups. Nials' (1980) paleo-environmental reconstruction of the Navajo Indian Irrigation Project area, located 25 miles north of the PRLA study area, indicates that periods of dunal build-up associated with

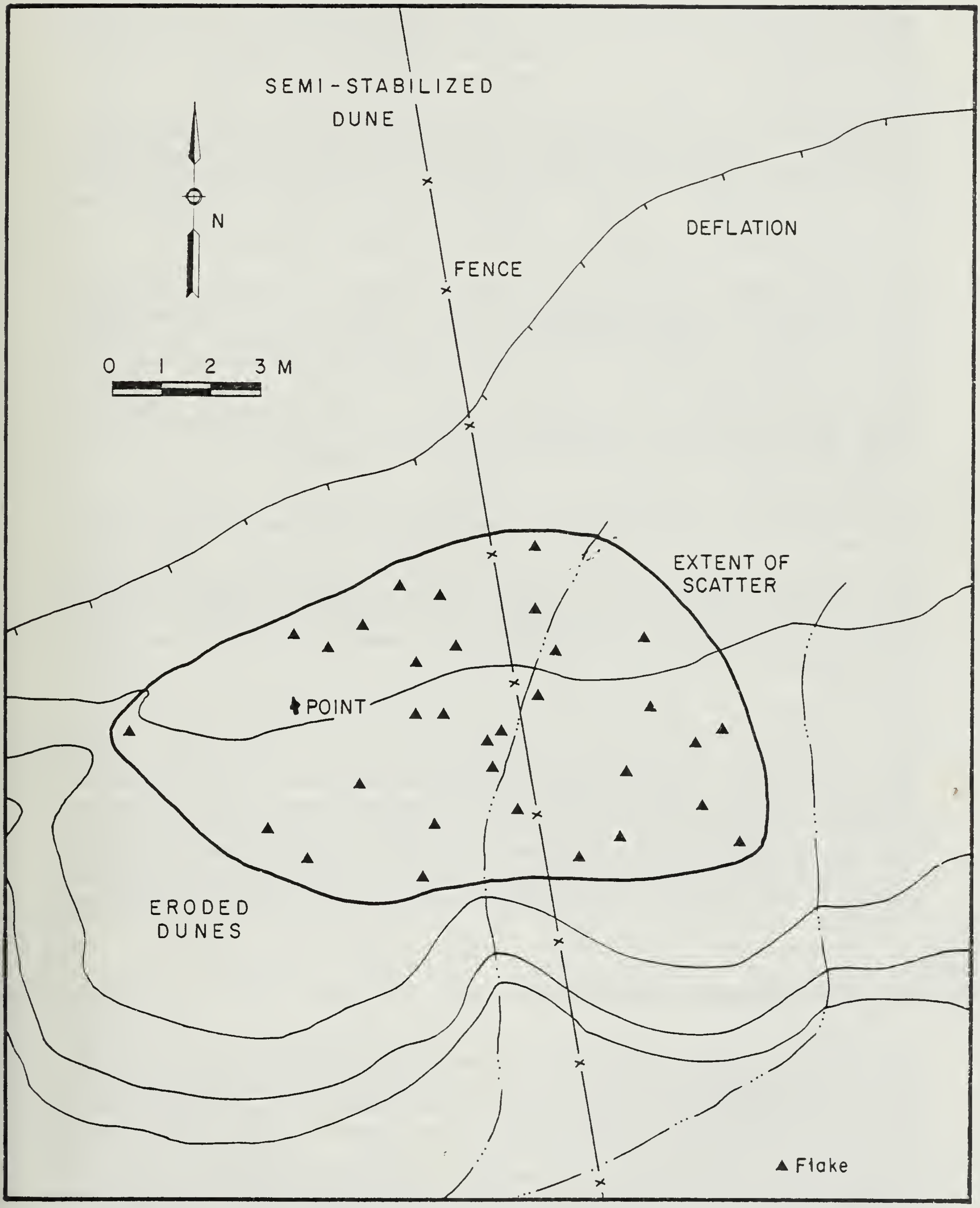


Figure 3. Site 40-14-3, a Belen Phase PaleoIndian Armament Site Recorded by this Survey

warmer and drier conditions occurred during the late Pleistocene. These data suggest that the San Juan Basin may have exhibited a lower carrying capacity relative to other Southwestern regions (cf. Wendorf and Hester 1962) and thus has been less attractive to PaleoIndian hunters.

The PaleoIndian Period is generally subdivided into at least four phases. During the Clovis Phase (10,000 to 8000 BC), hunter groups exploited such large fauna as mammoth and Bison antiquus using distinctive basally concave lanceolate spear points. No sites attributable to the Clovis Phase have been documented to date within the San Juan Basin, although a few isolated projectile points have been found (Reher 1977:401).

The Clovis Phase is followed by the Folsom (8000 to 7000 BC). Migratory herbivores such as Bison antiquus were the major quarry for these mobile hunting groups. Folsom spear points range somewhat smaller than Clovis points. They are, however, lanceolate and basally concave in form. The most diagnostic attribute is the long flake scar, the "flute", which runs medially from base to tip on those points. Folsom points are found in sigificantly higher frequencies than Clovis in the San Juan Basin (cf. Reher 1977:401; Sessions 1979:90; Reynolds 1980:Appendix C).

A later or perhaps contemporary co-tradition with the Folsom (Tainter and Gillio 1980:33) is the Midland or Belen Phase. These spear points exhibit the same size and shape as Folsom, except they are unfluted. Judge (1973) found that the shape and wear attributes of Belen cutting and scraping tools differed significantly from the Folsom tool assemblages. Midland (Belen) points have also been found in the San Juan Basin (Reher 1977:401; Sessions 1979:45), and a Belen Phase site, shown in Figure 3, was documented during the course of this survey.

The final phase in the PaleoIndian sequence (ca. 7000-5500 BC) is frequently termed the Cody Complex (Irwin-Williams 1973; Judge 1973). Large game, including bison and other migratory species, continued to be the major food source. Spear points are somewhat variable in form, are stemmed and unstemmed, and can exhibit flat to convex bases. A major distinguishing characteristic is the high flaking quality on points. Flake scar patterns include parallel, transverse, collateral and converging types. Cody Complex points have been found in the San Juan Basin with frequencies comparable to Folsom Midland spearpoints (Huse, et al. 1978:35; Sessions 1979:45).

3.2 ARCHAIC PERIOD by Meade Kemrer

The Archaic period is generally regarded as representing the interval during which a broad based hunting/gathering subsistence strategy emerged. The cultural/temporal sequence in the San Juan Basin has been reasonably well established and is compatible with the framework developed by Irwin-Williams (1973), who divides the Archaic Period into five phases.

The Jay Phase (5500-4800 BC) is usually characterized by large and small game procurement supplemented by plant foods, although plant processing equipment is rarely found (Irwin-Williams 1973:5). The most culturally/temporally sensitive artifact is the spear point. Jay Phase points are relatively large and have long stems, frequently with basally concave bases and shouldered notching.

The Bajada Phase (4800-3200 BC) represents an apparent increase in the range of biotic resources exploited by human groups. Plant processing equipment, particularly one-handed cobble manos and simple slab metates, occur frequently at Bajada sites. Projectile points have relatively long stems, shoulder notching, are often basally concave, and occasionally have serrated tips (Irwin-Williams 1973:6-7).

The succeeding San Jose Phase (3200-1800 BC) shares many characteristics with the Bajada, except for spear point shape attributes. San Jose points are shorter stemmed, often with concave bases, and have less pronounced shoulders and serrated tips. Plant processing equipment is common on San Jose sites, suggesting that both faunal and floral species were routinely exploited (Irwin-Williams 1973:8-9).

The Armijo Phase (1800-800 BC) may represent the interval during which maize agriculture was introduced as a supplement to the hunting and gathering subsistence base (cf. Irwin-Williams 1973:10-11). However, evidence for agriculture has not been documented for the Armijo Phase in northwestern New Mexico. Milling equipment and basally corner- and side-notched serrated projectile points characterize Armijo assemblages.

The En Medio Phase (800 BC-AD 400) is temporally and culturally equivalent to the Basketmaker II Phase of the Anasazi Period, but is included in the Archaic Period for this report. Although hunting and food collection remained economically important, agriculture also became increasingly significant as a food source. En Medio projectile points are corner-notched and occasionally are serrated (cf. Irwin-Williams 1973:12).

The San Juan Basin is rich in Archaic Period sites, particularly in those areas which contain aeolian sheet and dunal deposits. The relationship between the occurrence of Archaic sites and aeolian setting in the Basin was recognized by Bryan and Toulouse (1943) and Hadlock (1962). The Coal Gasification Project (CGP) survey of a 65-square mile tract located five miles north of the project area also confirmed the strong relationship between Archaic sites and sand dunes (Reher 1977). However, Reher (1977: 455) argues that a dunal setting per se is not the only contributing variable to Archaic site location. Rather, vegetative diversity appears to have been an important determinant. That is, Archaic sites are often associated with dunes and the "juxtaposition of three or more major plant communities."

The vegetative diversity hypothesis was indirectly supported by the results of the 24-square mile El Paso Coal Company (EPCC) survey located immediately northwest of the project area (Baker and Sessions 1979). The EPCC overall vegetative diversity index is at least one-third higher than the CGP's, and the EPCC Archaic site density value is three times higher than the CGP value (Baker and Sessions 1979:283-8). However, Archaic site density is very weakly correlated with vegetative diversity within the EPCC project area (Baker and Sessions 1979:283).

The Archaic Period in the San Juan Basin has become increasingly well understood and with this new knowledge, the ecotonal aspect of Archaic site location is more reasonably placed within the broader perspective of settlement and resource usage systems. Several recent studies within the region have recognized a considerable range in Archaic inter-site variability and differential locational patterning. Moreover, most of the site types appear to have persisted throughout the entire period. The location, size and kind of behavioral outcomes represented within the various site types are consistent with the logistical nature of hunter-gatherer settlement systems (cf. Binford 1980).

Discussed below are the various Archaic site types which have been recognized in the region by various research groups. From the standpoint of independent verification, it is satisfying to note that each study was conducted independently by a different research organization with widely differing analytical methods. Nonetheless, the correspondence in site typologies is remarkably high.

The studies incorporated into this synthesis of Archaic inter-site variablity include:

1. The survey of Blocks VI and VII of the Navajo Indian Irrigation Project (NIIP) in the Gallegos Canyon region located 25 miles north of the PRLA study area (Reynolds 1980).

2. The survey of the New Mexico Generating Station site of Public Service Service Company of New Mexico located adjacent to the PRLA study area (Powers 1979).

3. The survey of the Western Coal Co. federal lease located within the northern PRLA study area (Ganas 1980).

4. The El Paso Coal Company (EPCC) survey of an area five miles west of the northern PRLA study area (Sessions 1979).

5. The excavation of two Archaic sites in the Gallegos Canyon region located 25 miles north of the PRLA study area (Kemrer, et al. 1979).

6. The excavation of five Archaic components in the Coal Gasification Project (CGP) tract located 10 miles northwest of the PRLA study area Moore and Winter 1980).

7. The Phase I sample survey of the Bisti-Star Lake region which surrounds the PRLA study area (Huse, et al. 1978).

3.2.1 Archaic Site Types

Large/Main Camps

Main camps are behaviorally complex and contain multiple hearths, fire-cracked rock piles, several to numerous metates and manos, projectile points, numerous formal tools such as choppers, knives, scrapers and drills, and large quantities of lithic debitage related to primary, secondary and tertiary reduction, biface finishing, and tool retouching, as well as cores. This class of site is usually located on dunes immediately adjacent to major washes, large playas or springs (Huse, et al. 1978: 50-4; Anderson and Sessions 1979:63-4; Ganas 1980:20-8; Powers 1979: 32-50; Reynolds 1980: 5-22 to 5-31).

Large camps exhibit sufficient behavioral redundancy (often a series of multiple activity areas) that several groups undoubtedly occupied this class of site, probably on a seasonal basis. Large camps probably represent a highly important aspect of Archaic economic, social and religious systems. An example of a main camp is illustrated in Figure 4.

Small Camps

Although small camps are also behaviorally complex, they are only one half to one quarter the size of main camps. Small camps may contain one to several hearths, fire-cracked rock piles, one to several sets of manos and metates, projectile points, formal tools such as scrapers, choppers, drills, and knives, the outcomes of primary, secondary and tertiary biface thinning and flaking, tool reduction, and cores (Huse, et al., 1978: 50-4; Kemrer et al., 1979:14-31; Anderson and Sessions 1979:65; Reynolds 1980:5-21 to 5-23; Vierra 1980:351-6). Small camps are less strongly associated with dunes, but are highly correlated with major washes, springs or seeps (Ganas 1980:25-8; Reynolds 1980:5-24, 5-27). An example of a small camp is shown in Figure 5.

In terms of Archaic settlement systems, the significance of the small camp is largely unresolved. Vierra (1980:351-6) hypothesizes that the large and small camps are structurally contrastive; the large camps represent the seasonal macrobanding phase and the small camps specify the season-specific microbanding phase. Anderson and Sessions (1979:65) and Reynolds (1980:5-21) label the smaller sites "temporary camps." They imply that the large camps may have been continously occupied for two to six month periods, but that the population of base camp was fluid as small groups moved in and out of it. The small component groups, when exploiting an area remote from their main camp, generated the small camps. The main camps were moved, probably on a seasonal basis, to facilitate the exploitation of biotic resources in other areas.

Plant Processing Sites

Plant processing sites are recognized by their relatively small size, the presence of plant processing equipment (manos and metates), hearths, the absence of projectile points, low incidence of formal flaked tools, and moderate amounts of lithic debitage (Anderson and Sessions 1979:70; Ganas 1980:20-2; Powers 1980:39-49; Reynolds 1980:5-22). An example of a plant processing site is shown in Figure 6.

Plant processing sites are more randomly distributed over the landscape than other site types. Although their frequencies are high on aeolian soils, they are not strongly correlated with dunes or water resources (Ganas 1980:25-31; Powers 1980:49-52; Reynolds 1980:5-22). Powers (1979: 39-49) and Ganas (1980:20-2) recognize two classes of plant processing loci: those containing hearths and a relatively high frequency of formal

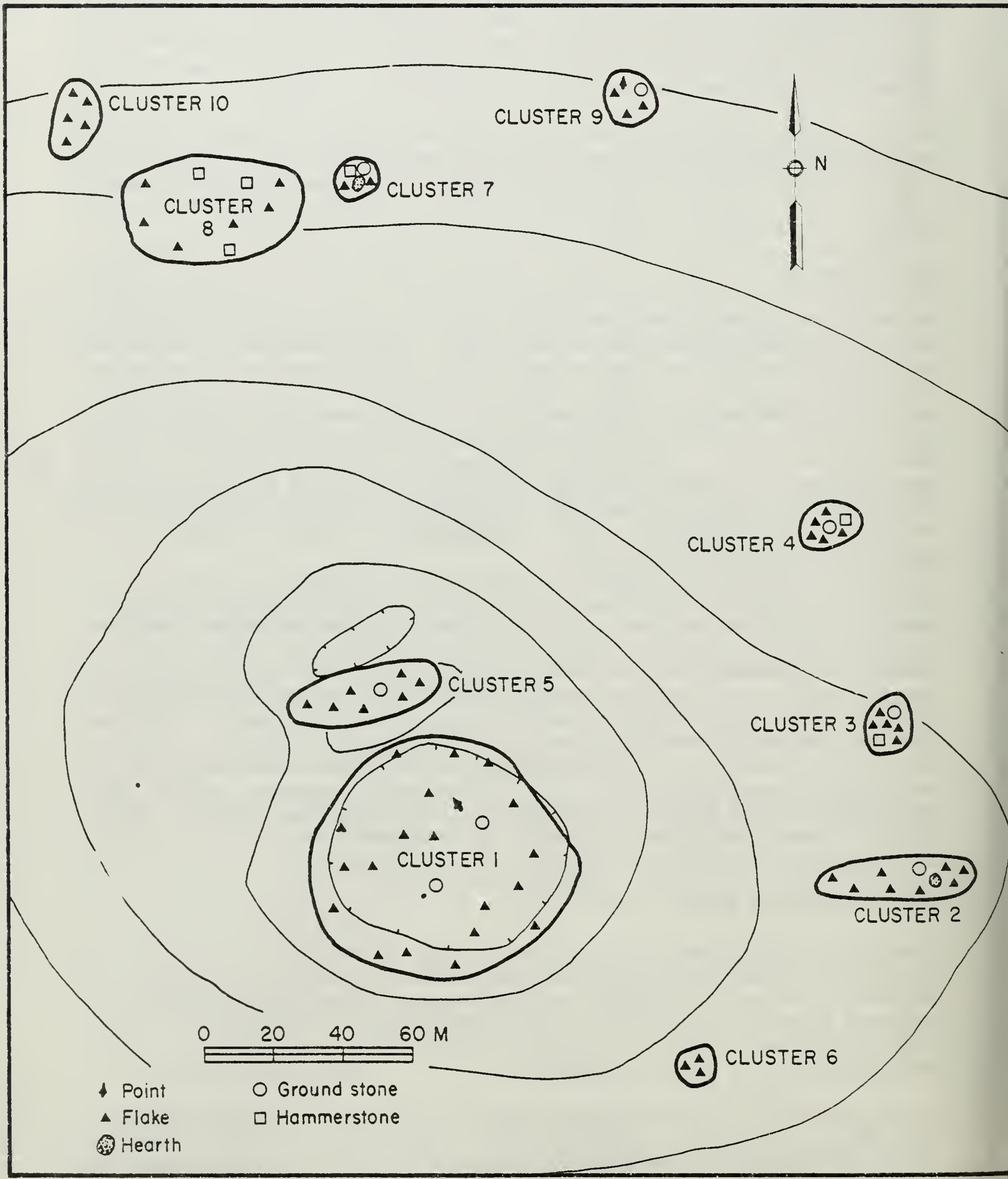


Figure 4. Site 30-13-3, an Archaic Period Main Campsite Recorded by this Survey

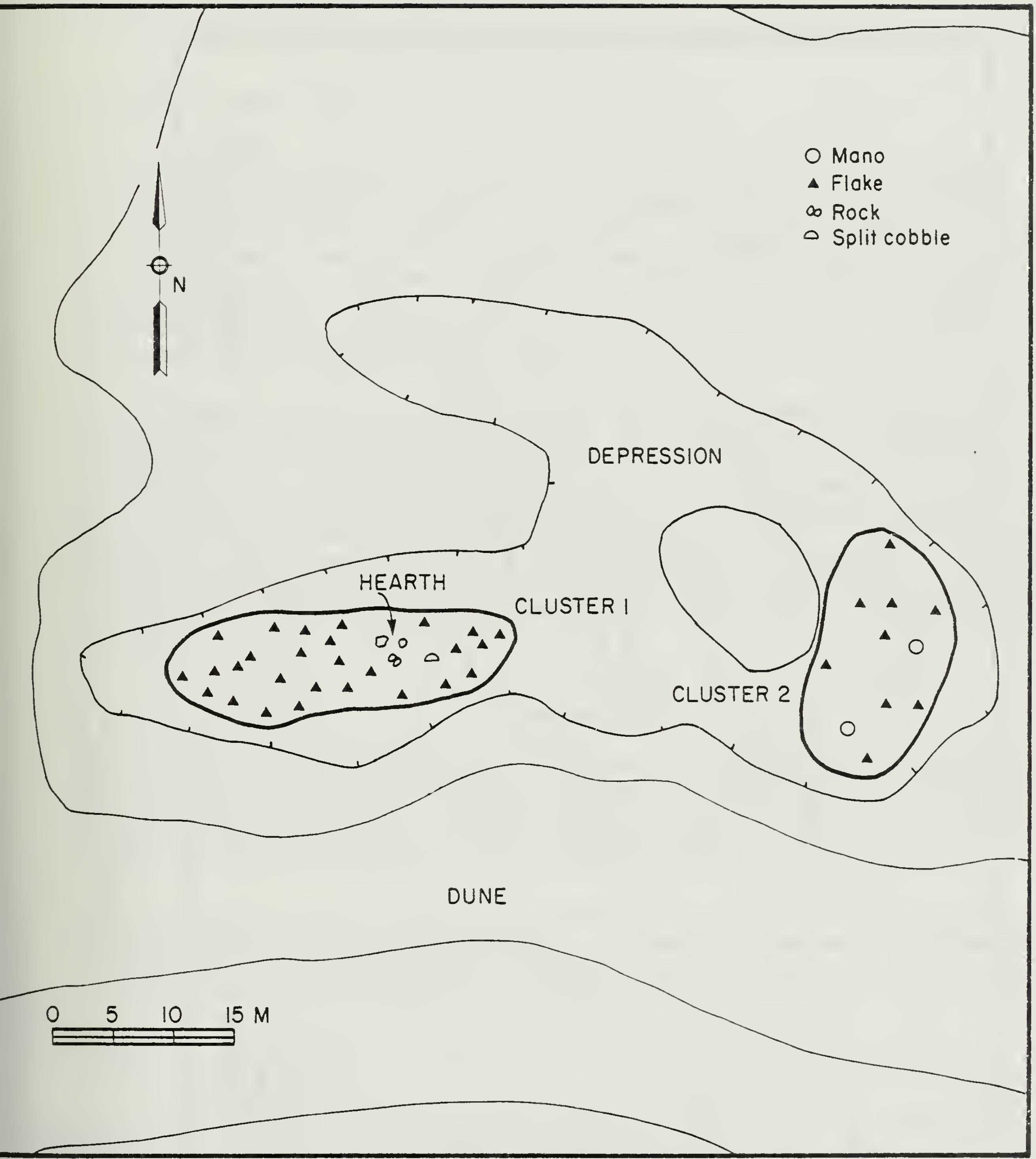


Figure 5. Site 37-11-2, a Small Campsite Recorded by this Survey

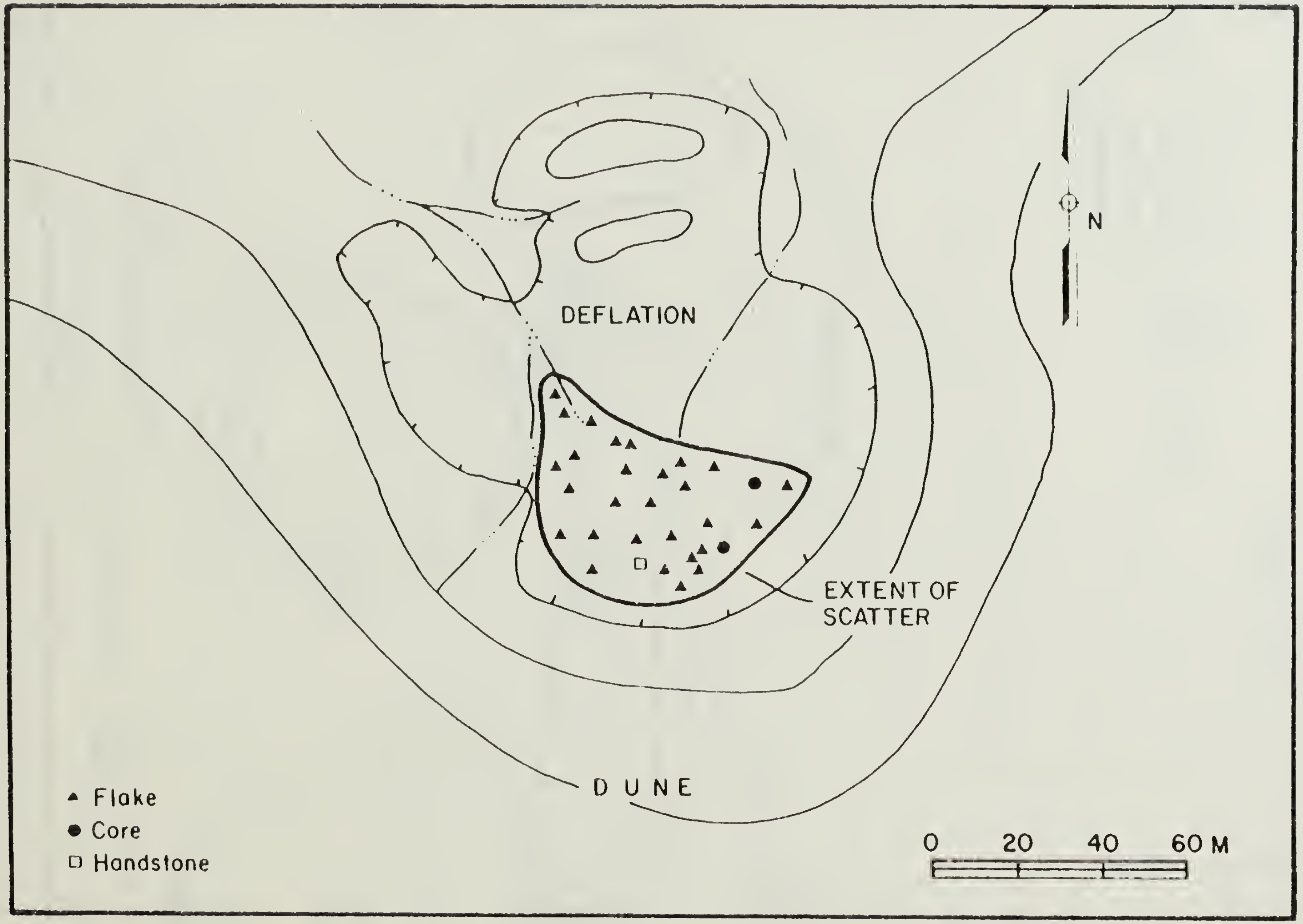


Figure 6. Site 40-14-10, a Plant Processing Locus Recorded by this Survey

tools, and those without hearths and with a low frequency of flaked tools. The differences may be related to the types of plants being processed or to different stages of the plant processing sequence. Collectively, however, plant processing sites clearly represent a limited set of activities which contrast significantly with campsites and other site types.

Plant Procurement Sites

Plant procurement sites are small and do not contain hearths or grinding equipment. Although lithic debitage is present, formal tool frequencies are low; utilized flakes represent the most common tool class (Ganas 1980: 19-20; Powers 1979:40-7; Reynolds 1980:5-22). Plant procurement loci are nearly always found on aeolian soils but are nearly randomly located with respect to dunes and water resources (Ganas 1980:27; Powers 1979:50). Reynolds (1980:5-22, 5-25), however, found that this type of site was spatially clustered in the NIIP Blocks VI and VII area. Figure 7 illustrates an example of a plant procurement site.

Not all researchers explicitly recognize this site type. Anderson and Sessions (1979:65) for example, list this set of attributes for his "undifferentiated, limited activity sites" class. Plant procurement sites, nonetheless, are recognizable as a class which contrasts markedly from others in the Archaic settlement system. The fact that plant procurement can be at least somewhat differentiated from processing is interesting in terms of logistics and possible intra-group task assignments. This differentiation may well represent the logistical solution to the problem of harvesting plant foods that may have been widely but not densely distributed.

Hunting Camps

Hunting camps are recognized by the presence of projectile points and other formal tools, such as scrapers, drills and knives, lithic debitage which includes biface thinning and retouching debris, and frequently, hearths. Grinding equipment is absent (Kemrer, et al. 1979:31-45; Anderson and Sessions 1979:70).

Hunting camp loci have not been reported in sufficient numbers to assess their spatial/locational characteristics. They do, however, represent a distinctive site type which is in some instances behaviorally and locationally separate from plant food collection and processing.

Lithic Procurement Loci

Lithic procurement loci can vary in size from single flaking events to broad zones containing the outcomes of numerous procurement events. Procurement loci are characterized by the high incidence of primary reduction and cobble testing debris. Formal tools, hearths and grinding equipment are generally absent. These sites are highly associated with their resource areas, particularly lag and outwash gravels (Anderson and Sessions 1979:70; Ganas 1980:19; Powers 1979:30, 50).

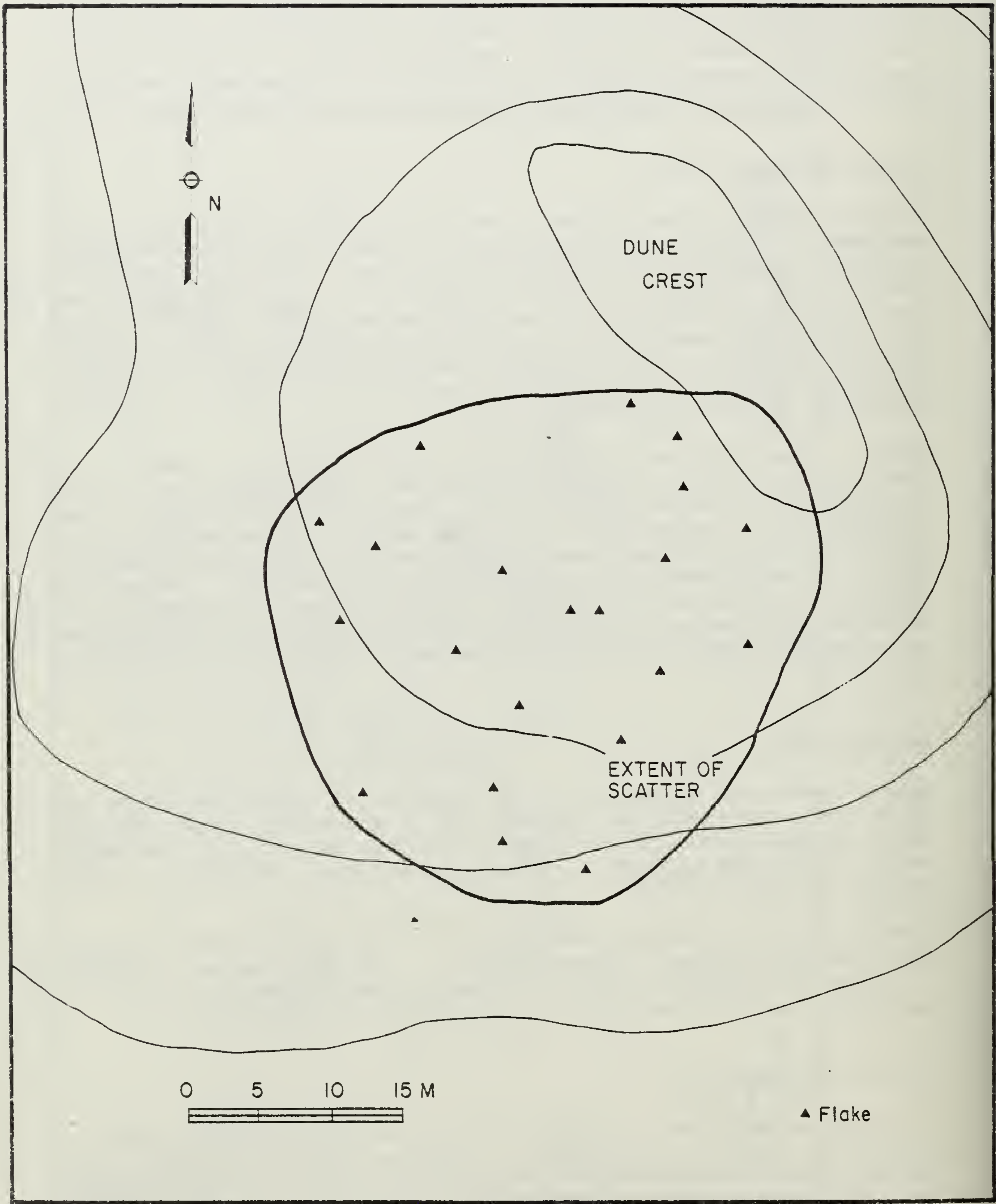


Figure 7. Site 37-11-5, a Plant Procurement Site Recorded by this Survey

3.2.2 Intensity of Usage During the Archaic Period

The intensity with which the San Juan Basin was utilized by Archaic groups changes dramatically through time. Data from eight archeological surveys conducted within the Basin were examined. All sites, site components, and isolated occurrences which could be unambiguously assigned on the basis of projectile point style to a particular phase within the Archaic were compiled. This information is presented in Table 1. The data in Table 1 are ordered on the basis of geography, with the northernmost surveys listed at the top and the southernmost at the bottom of the table.

A number of striking patterns are evident in these data. First, the proportional incidence of components by phase are similar among surveys. Thus no major differential usage of areas within the Basin either within or between phases is evident. Second, site frequencies covary strongly with isolated occurrences through time. Since the temporally/culturally sensitive indicators are projectile points, the question arises whether inter-phase comparisons measure relative hunting dependency or general usage intensity. Assuming that isolated projectile points represent loss while hunting and points on sites represent discards from point replacement, manufacture and repair activities, the data from Table 1 indicate that the ratio between hunting and maintenance activities are relatively constant between phases. Therefore, the site and isolated occurrence frequencies probably specify general usage intensity levels.

A dramatic shift in usage intensity occurs in the San Jose Phase. The data from Table 1 were transformed to adjust for differences in the duration of each phase to make the phases directly comparable to each other. The total number of sites, isolates and all components was divided by the number of years within each phase as estimated by Irwin-Williams (1973). The resulting values represent the average number of sites, isolates and all components generated per year in all survey areas listed in Table 1. The outcome of this analysis is shown in Figure 8.

Two patterns are evident in Figure 8. First, the highest level of usage intensity occurs in the San Jose Phase. Second, usage intensity increases within the Archaic, with the San Jose, Armijo and En Medio Phases exhibiting levels at least twice as high as the earlier Jay and Bajada Phases.

These patterns undoubtedly have cultural/ecological and demographic significance and warrant additional research. The peak within the San Jose Phase probably indicates an interval when hunter-gatherer systems were particularly successful within the Basin, a phase during which indigenous populations probably grew and possibly also an interval when groups migrated into the Basin. The shift to higher levels of usage intensity from the San Jose through the En Medio Phases probably reflects real growth and maintenance of a base population from which the San Juan Anasazi developed.

The Archaic Period is unique within the culture history of the San Juan Basin. The hunter-gatherer mode of subsistence persisted for about 6000 years--the lengthiest adaptation in the history of the Basin.

Table 1. Archaic Component Distribution in the San Juan Basin

Survey	Jay	Bajada	San Jose	Armijo	En Medio
	Archaic Period Phases				
NIIP, Blocks IV-V (Elyea, et al. 1979)	4	3	11(5)	2	7 (4)
NIIP, Blocks VI-VII (Reynolds 1980)	2(1)	1	6(9)	2(2)	2 (4)
EPCC (Sessions 1979)	1(2)	1	16(9)	7(5)	3 (9)
Bisti-Star Lake I (Huse et al. 1978)	-	7(1)	9(5)	6(4)	20(5)
Bisti-Star Lake II (this report)	-	1(1)	1	1(1)	5
Western Coal Federal (Ganas 1980)	1	-	2	1	1
Alamito (Wilson 1979)	(3)	(2)	3(3)	1	2
Black Lake (Chapman and Biella 1980)	3	4(1)	9(2)	3	7
Total Sites	11	17	57	23	47
Total Isolates	(6)	(5)	(33)	(12)	(22)
All Components	17	22	90	35	69

Parentheses indicate isolated occurrences; other numbers indicate sites.

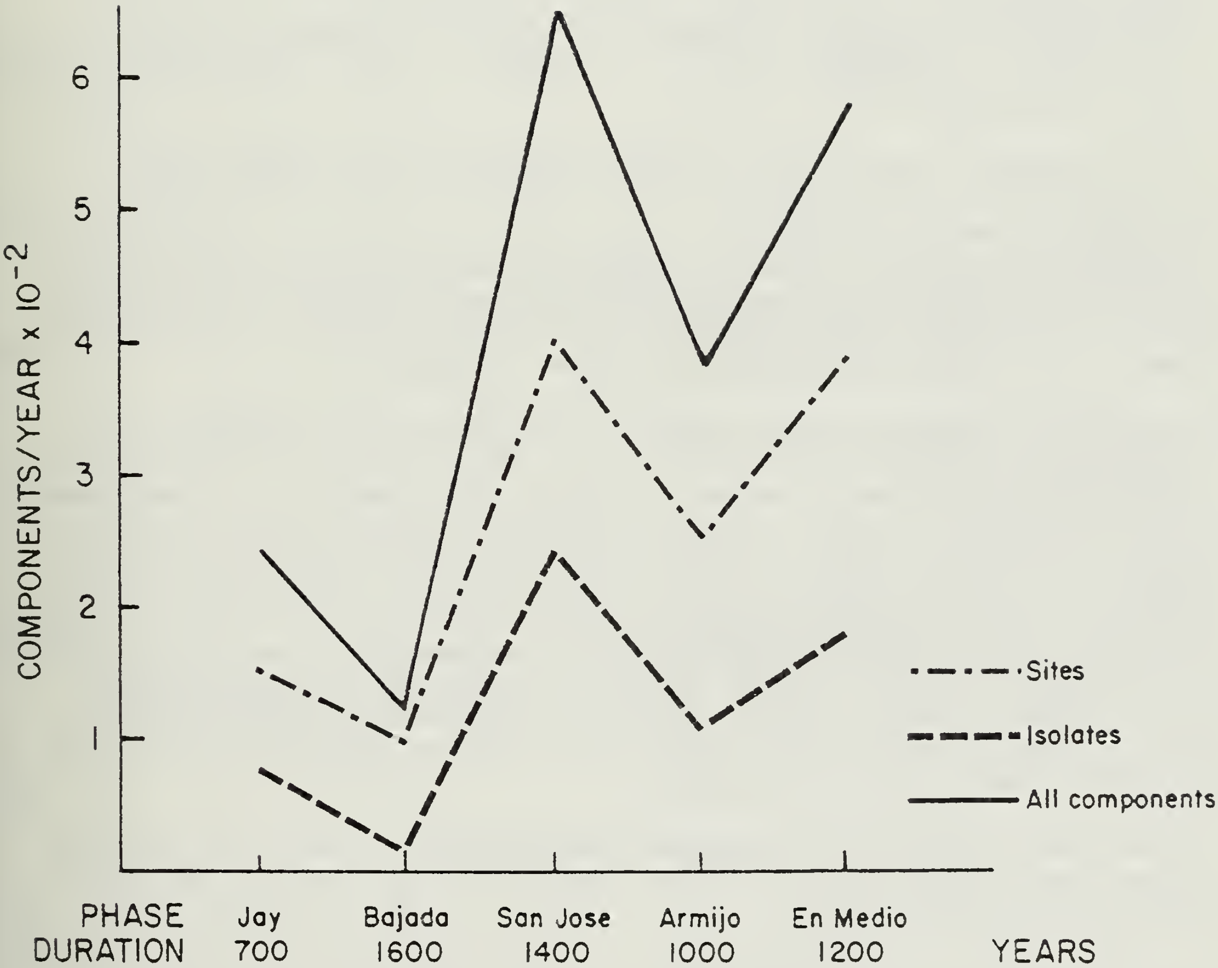


Figure 8. Intensity of Archaic Usage in the San Juan Basin

3.3 ANASAZI PERIOD by Richard Loose and Meade Kemrer

3.3.1 The Cultural/Temporal Sequence

Several recent overviews describe the basic sequence of the development of the eastern Anasazi (cf. Magers n.d.; Hewett 1977; Loose 1978; Cordell 1978; Tainter and Gillio 1980; Stuart and Gauthier 1981).

In general, these overviews present a chronology similar to that of the Pecos Classification shown in Figure 9.

AD 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500

Basketmaker II	Basket-maker	Pueblo I	Pueblo II	Pueblo III	Pueblo IV

Figure 9. Pecos Classification Sequence (after Loose 1978)

The number of modified versions of this basic sequence are currently utilized by various investigators, depending upon their particular research biases or the geographic areas in which they have conducted their research. A comparison of four cultural/temporal sequences applicable to the eastern Anasazi within the San Juan Basin is shown in Figure 10.

The sequence utilized in this report is that utilized by Marshall, et al. (1979), illustrated in Figure 10. Several factors underlie the selection of this cultural/temporal sequence. First, this sequence was developed from a synthesis of major Anasazi population concentrations throughout the entire San Juan Basin, whereas the sequences developed by Gladwin (1945), Vivian and Mathews (1969), and Toll, et al. (1980) were largely developed from data from the central Chaco Canyon area. The sequence developed by Hayes (1981) is comprehensive, but perhaps too eclectic, since his synthesis includes Anasazi cultural developments outside the Basin. Second, Loose is most familiar with the sequence developed by Marshall, et al. (1979), since he was responsible for the implementation of the San Juan Anasazi Communities project.

The earliest phase in this sequence, Basketmaker II, has been discussed in the previous section (3.2), and represents the terminal (En Medio) phase of the Archaic Period.

Semi-subterranean architecture such as that found at Shabik'eschee Village in Chaco Canyon characterized the Basketmaker III Phase (AD 450-750) (Figure 11). Shabik'eschee has 18 circular or rectangular pithouses, 48 associated storage structures, and a centrally located religious structure (great kiva).

Cultigens such as corn, squash, and beans served as the major source of food during this phase, although campsites related to the procurement of indigenous plant and animal foods are also common.

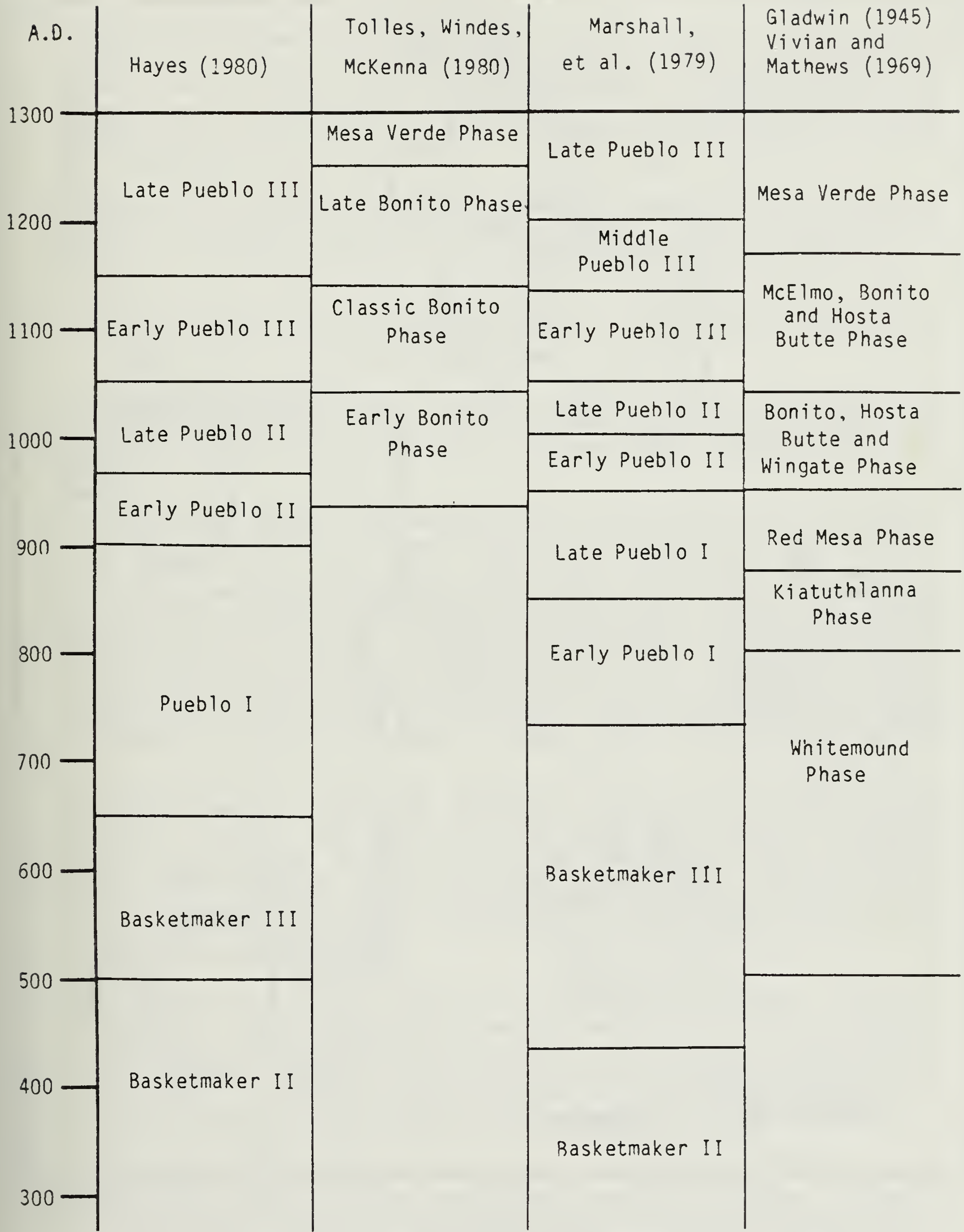


Figure 10. Modified Pecos Classification Sequence

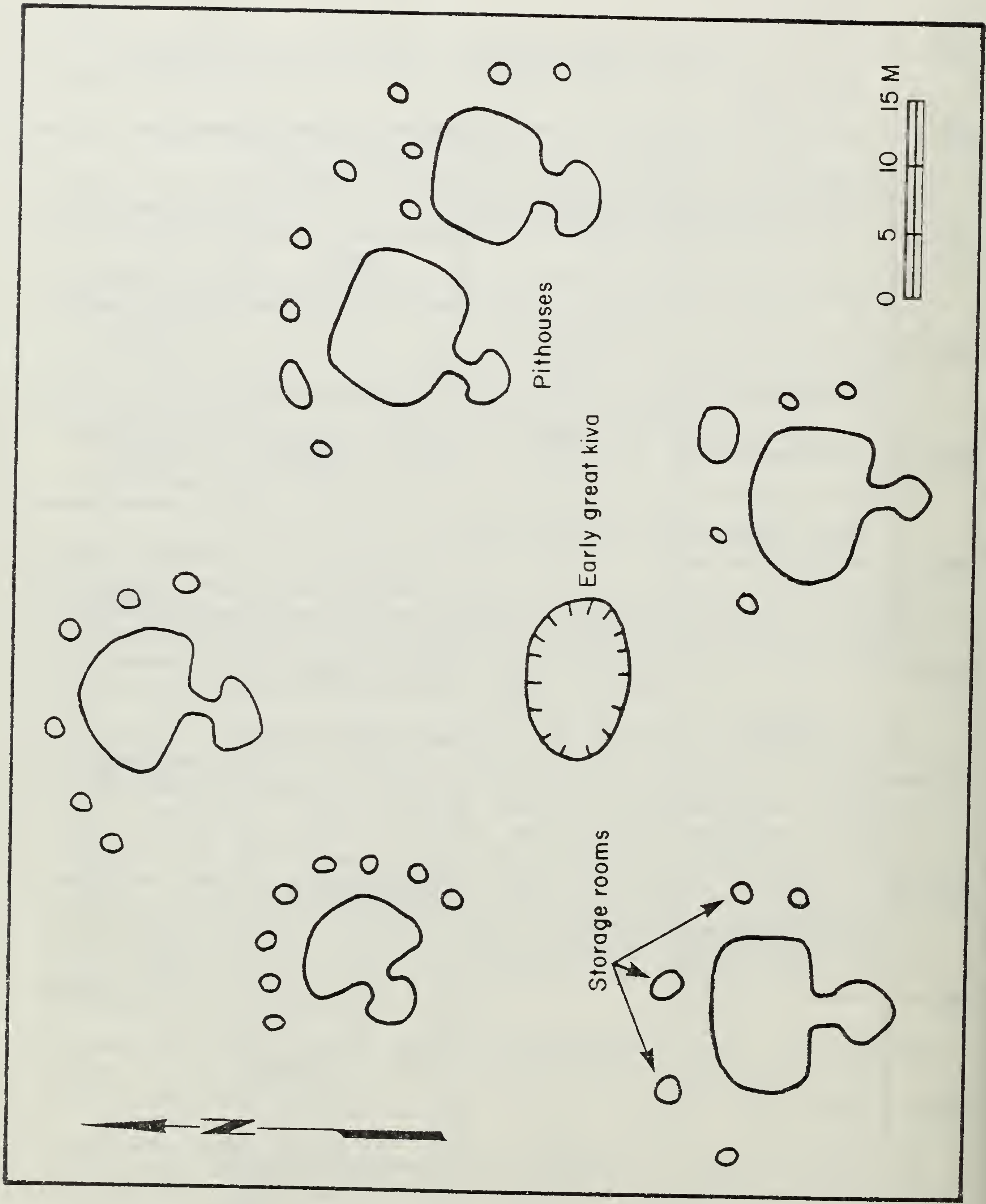


Figure 11. Plan of a Typical Basketmaker III Community

True ceramics appeared during the Basketmaker III phase. The undecorated utilitarian vessels found on BM-III sites within the San Juan Basin are plain graywares such as Chapin Gray (Mesa Verde Series) and Bennett Gray (Chuska Series). Decorated ceramics include Lino B/G (Kayenta Series), and the Mesa Verde whitewares, La Plata B/W and Chapin B/W (cf. Windes 1977; Marshall, et al. 1979).

Above-ground architecture became increasingly common during the succeeding Pueblo I Phase (AD 750-950). A typical village, such as that shown in Figure 12, includes both surface and semi-subterranean structures.

The large great kiva is also common in Pueblo I villages. Surface architecture is generally wattle-and-daub (jacal) construction, although masonry structures are not uncommon.

Dependence upon agricultural products appears to have increased, for hunting and plant food collecting loci appear to be less numerous in the San Juan Basin. The spear or dart was replaced by the bow and arrow during the Pueblo I phase.

Ceramics became increasingly varied. From the early portion of the Pueblo I Phase (AD 750-850), plain and neck-banded graywares such as Lino Gray, Sheep Springs Gray, Kana'a Gray, Tocito Gray, and Moccasin Gray are common. Decorated ceramics from the AD 750-850 interval include Piedra B/W, Kana'a B/W, La Plata B/W, and Lino B/G. From later in the Pueblo I Phase AD 850-950), utility wares include Gray Hills Banded and small amounts of Captain Tom and Mancos corrugated wares. Late Pueblo I decorated ceramics include Red Mesa B/W, Tunicha B/W, Newcomb B/W, Cortez B/W, Burnham B/W, Naschitti B/W, and Brimhall B/W. San Juan redwares are also common from throughout the Pueblo I Phase (cf. Windes 1977; Marshall, et al. 1979).

The classic Chacoan settlement pattern emerged in the San Juan Basin during the Pueblo II Phase (AD 900-1050). At Chaco Canyon proper, the pattern is somewhat confused by the heavy population density and long, continuous occupation of the area (ca. AD 450-1300). Outside of Chaco Canyon, small domiciles clustered around large multiple story community centers with great kivas are a typical pattern (Marshall, et al. 1979). Associated public works such as reservoirs, dams, irrigation canals and roads are also common.

Small structures from this period are characterized by random, irregular ground plans, and kivas are often enclosed within room blocks. Masonry is simple or sometimes compound, but without a rubble core. Banded or decorative veneer is absent. (This corresponds to the Hosta Butte Phase of Gladwin 1945). The number of rooms rarely exceeds 25 or 30 total per structure. These sites are often called villages.

Larger sites from this period are known as Bonito Phase, McElmo Phase, towns, great houses, outliers, satellites, or public buildings. The main characteristic of these structures is a preconceived ground plan (Loose 1976, Judge 1976, Marshall, et al. 1979, Judge et al. 1980). These structures have large rooms and high ceilings, kivas that are intentionally incorporated into elevated square roomblocks (Marshall, et al. 1979). They are constructed with cored and veneered masonry (Loose 1976), well

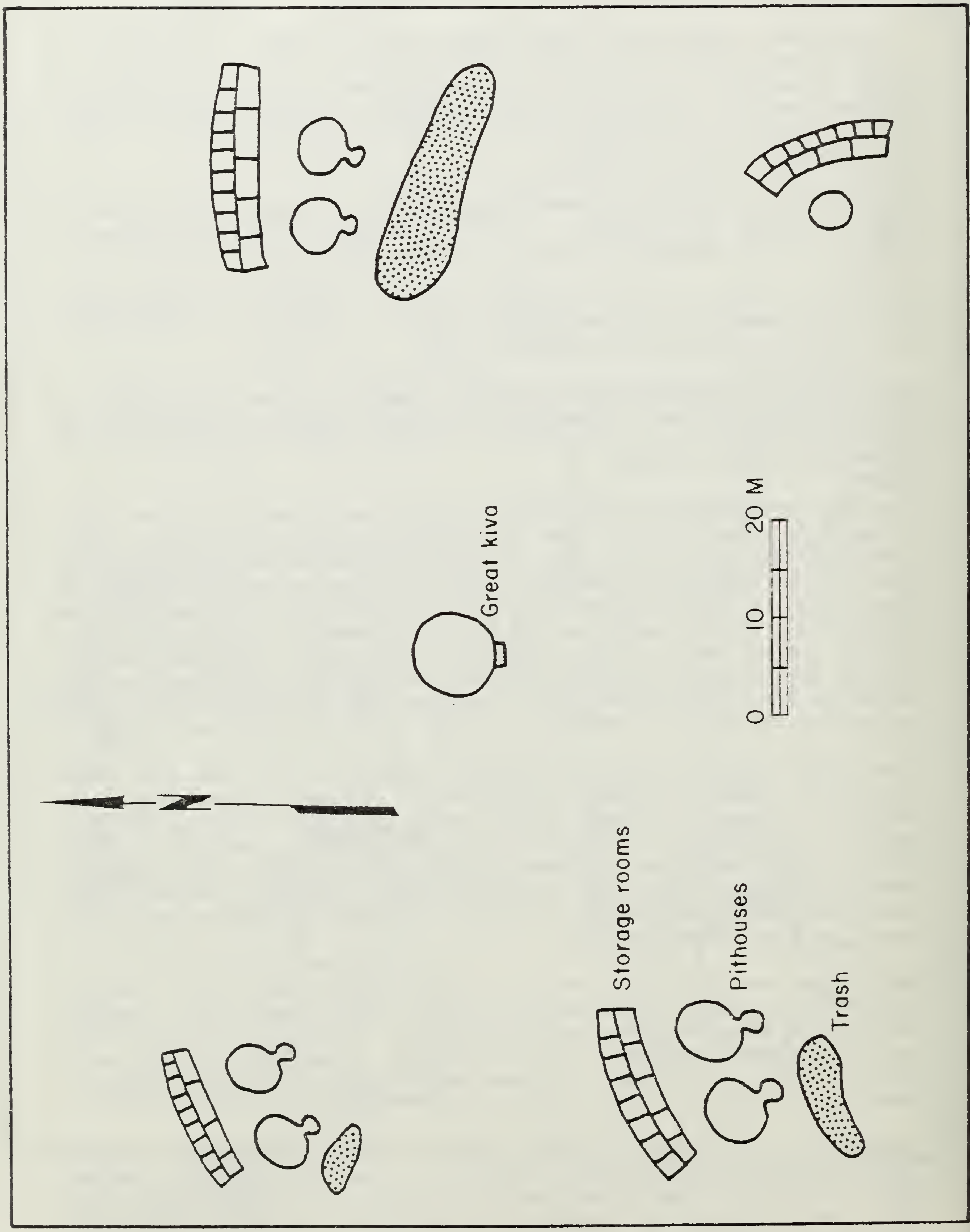


Figure 12. Plan of a Typical Pueblo I Community

executed right angle corners and impressive long, straight walls. Both McElmo and Bonito Phase structures share many of these characteristics. An example of an Anasazi Pueblo II community is shown in Figure 13.

Dependence upon agriculture appears to have been high during the Pueblo II Phase, although campsites related to indigenous biotic resource procurement and processing also occur.

Ceramics varied greatly during the Pueblo II Phase. In terms of general trends, unslipped corrugated plainwares became increasingly popular over plain and banded graywares, and black-on-white decoration became more predominant over black-on-gray and redwares.

During the early portion (AD 900-950) of the Pueblo II Phase, plainwares are dominated by types such as Captain Tom Corrugated, Blue Shale Corrugated, and Mancos Corrugated. Decorated wares include Red Mesa B/W, Cortez B/W, Burnham B/W, Toadlena B/W, and Escavada B/W. San Juan redwares are present, but in relatively small amounts. The latter half of the Pueblo II Phase (AD 950-1050) is represented mainly by Blue Shale Corrugated and Mancos Corrugated plainwares and decorated wares such as Chuska B/W, Escavada B/W, Taylor B/W, Mancos B/W, and some San Juan redwares (cf. Windes 1977; Marshall, et al. 1979).

During the early portions of the Pueblo III Phase (AD 1050-1150), construction of public architecture continued in Chaco Canyon and several outliers were also established, such as the Salmon Ruin site, constructed in the late 1000's and Aztec Ruin, built in the early 1100's. However, other communities in the southernmost portion of the San Juan Basin were apparently abandoned during this interval (Marshall, et al. 1979). Based upon tree-ring evidence, pueblo construction virtually ceased in the entire Four Corners region by AD 1140 and did not resume until AD 1180 (cf. Kemrer, et al. 1971:29).

Following the decline of the major Anasazi communities, only small scattered villages of Mesa Verdean affiliation remained in the San Juan Basin during the latter portion of the Pueblo III Phase (AD 1150-1300). This late Anasazi occupation follows the collapse of the "Chacoan Phenomenon" and is characterized by single story, poorly executed masonry, is lacking major public works such as lengthy irrigation ditches, dams, roads and great kivas. Rooms are small, and no smaller domiciliary structures are associated. An example of a typical late Pueblo III community is shown in Figure 14.

By AD 1350, however, the study area was completely abandoned. This occupational hiatus persisted until the Athapascan peoples (Navajos and Apaches) occupied the study area from the north, approximately 250 to 300 years later.

Ceramic styles also reflect culture change within the Pueblo III Phase. During the early portion of this phase (AD 1050-1150), plainwares are dominated by Blue Shale Corrugated, Mancos Corrugated, Hunter Corrugated, and Mesa Verde Corrugated types. Decorated wares are extremely varied and include Chaco B/W, Mancos B/W, Chuska B/W, Toadlena B/W, Gallup B/W, Escavada B/W, Black Mesa B/W, Sosi B/W, Dogoszhi B/W, and smaller amounts

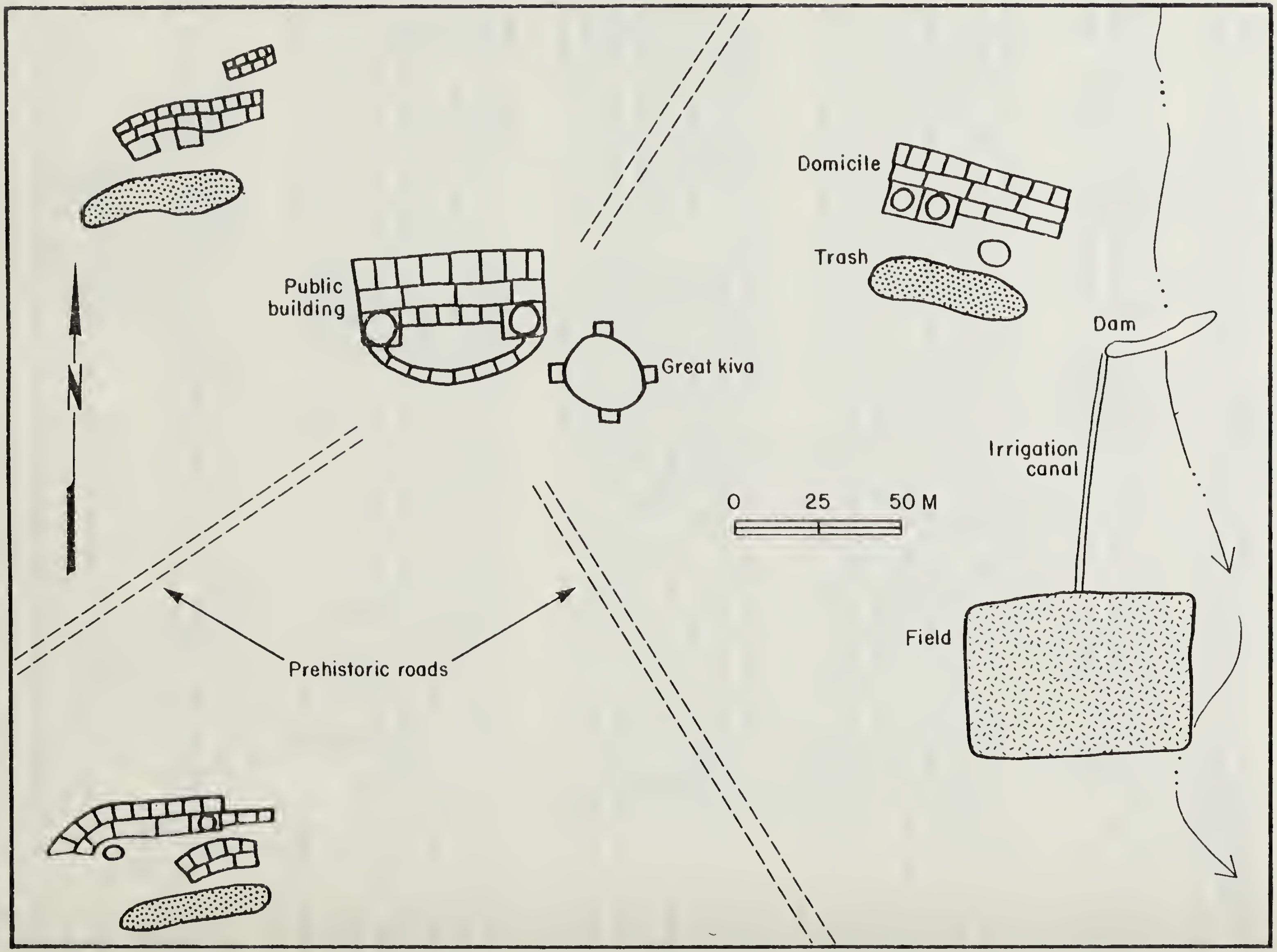


Figure 13. Plan of a Typical Pueblo II-Pueblo II/III Community

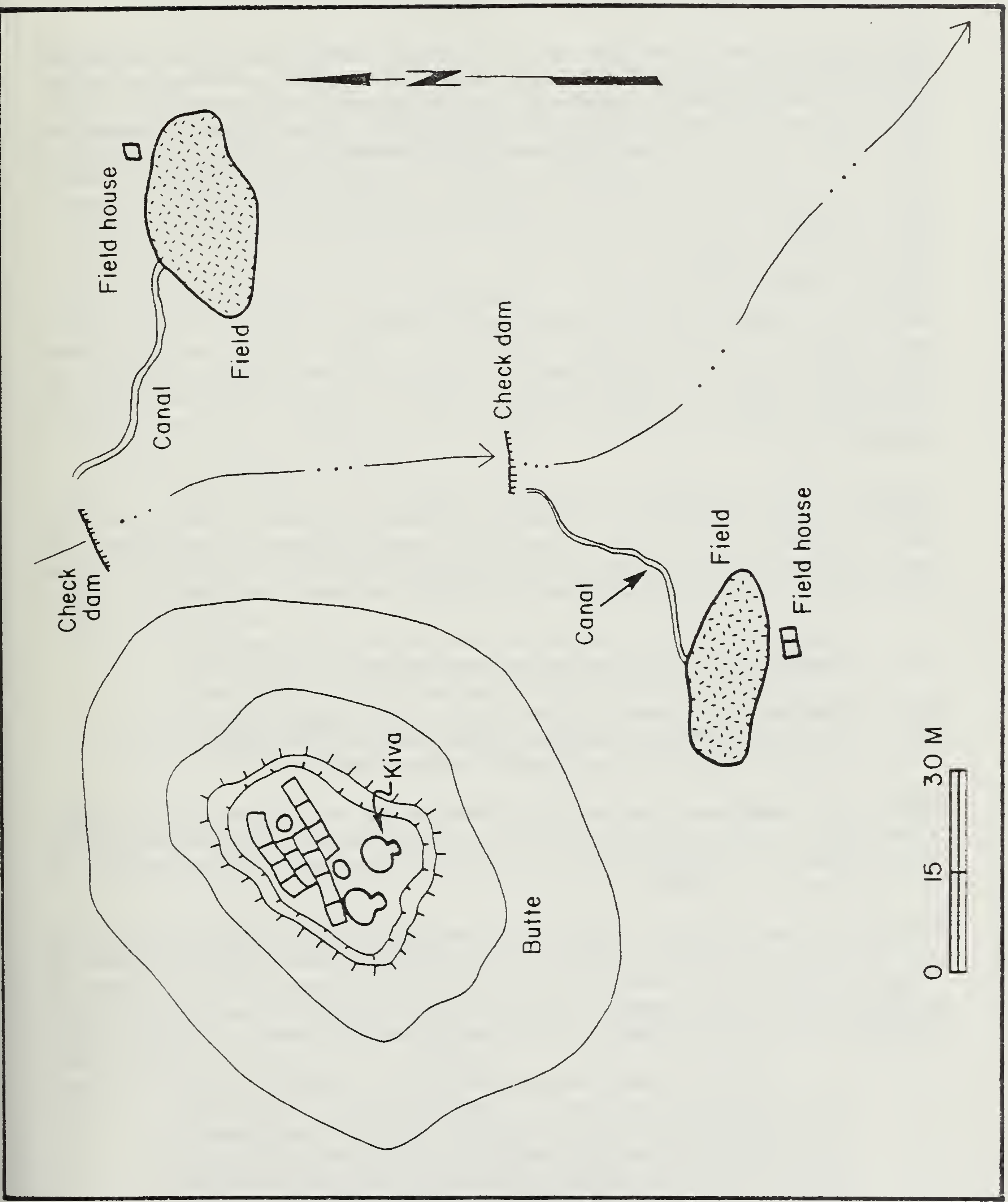


Figure 14. Plan of a Typical Late Pueblo III Community

of McElmo B/W and Nava B/W. Redwares, particularly Puerco B/R and Wingate B/R, are also present.

The later portion of the Pueblo III Phase (AD 1150-1300) is characterized by the same corrugated styles, with Hunter Corrugated and Mesa Verde Corrugated predominating. Decorated ceramic types change within this interval. From AD 1150-1200, Nava B/W and McElmo B/W are popular types, but Mesa Verde B/W and Crumbled House B/W predominate in the AD 1200-1300 interval. Although Wingate B/R persists through this interval, Puerco B/R is replaced by St. Johns B/R after AD 1200 (Windes 1977; Marshall, et al. 1979).

3.3.2 Anasazi Roads

Two of the sample parcels in this survey (39-9 and 39-13) fell on the linear feature called the Great North Road. Parcel 39-13 had the highest site density of any sample parcel, and also the most Anasazi sites, although this parcel is remote from any known Chacoan outlier. It is about three miles north of the Kin Indian Ruin and about six miles south of Pierre's Ruin.

Obenauf (1980) provides an excellent background on the history of investigation of the prehistoric roads in the San Juan Basin. These features were considered to be Anasazi roads by elderly Navajos at the turn of the century; early traders also noticed the road system. When Gordon Vivian interviewed Mrs. Richard Wetherill in 1948, she mentioned that:

> North of Alto in certain lights you can still see what appears to be a wide roadway running down to the Escavada. In the old days this was very clearly defined in the spring or early summer because the vegetation on it was different from any other and it could be traced clear to the San Juan (Gordon Vivian 1948).

Judd (1954) mentioned some of the difficulties in differentiating canals from wagon roads. He also promised a discussion on "processional paths" and "ceremonial highways" in a future publication. Unfortunately, he didn't keep his promise.

By 1972, R. Gwinn Vivian, Thomas R. Lyons and George J. Gumerman had used air photo-interpretation and ground checking to establish a series of "recognition criteria" which were unique to the linear features found in association with the Chacoan ruins. Vivian (1972:10) described the recognition criteria he used in 1970 and 1971 as follows:

> . . . wide, cleared, primary roads averaging nine meters in width with edges of banked earth or low masonry walls and bases of earth or bedrock; spur roads averaging four and one-half meters in width with edges and bases similar to primary roads; stairways cut into native sandstone with squared sides and widths up to nine meters; wide masonry stairs at minor cliff edges, and masonry and earth ramps at major cliff edges. In some instances roads were cut through low hills. Roadways

> also were marked by relatively straight courses showing occasional slight alterations in degree of orientation.

Lyons and Hitchcock (1977) mention Vivian's criteria and also point out that fence lines, telephone lines and modern two-track vehicular roads can be confused with prehistoric roads. They also point out that environmental factors such as moisture retention, vegetation density, and erosion also affect visibility of the roads.

Ware and Gumerman (1977) used the same criteria and added the use of low-sun-angle light as an additional variable to help locate the low linear swales which are identified as Chacoan roads on aerial photographs but are difficult to see on the ground. Test trenches revealed that the roads had variable formality of construction. Ultimately, Ware and Gumerman compiled a list of 18 road attributes which were grouped as follows:

1. those which pertain to gross morphological configurations of the courses

2. those which are a direct or indirect consequence of alterations in natural drainage patterns

3. those which directly relate to cultural features, such as masonry walls, stone curbing, etc.

Obenauf (1980) refined the recognition patterns used by earlier workers as outlined below:

1. All roads mapped initiate and/or terminate at a known Chacoan town.

2. The roadway segments are exceptionally linear. All segments mapped are straight; when a road changes direction, even slightly, it does so with a "dogleg" turn rather than with a curve.

3. The roads do not avoid low topographic obstacles as do historic roads in the area.

4. The roads appear as dark lines on the photographs.

5. In the photographs, the roads often exhibit a slight depression when viewed under a stereoscope.

Hayes (1981) mentions that many segments of roadways which are visible in air photographs can not always be found on the ground. His survey of Chaco Canyon identified 104 segments of roads or trails, of which 57 were Navajo and 48 were Anasazi. Navajo roads were found to:

> ... curl up the slopes, seeking easy grades suitable for horseback and wagon traffic. The worn tracks of iron tires are often apparent on expanses of slick rock, but there is seldom any designed improvement other than an occasional crude stone wall at switch-backs or on the downhill side of a slope. (Hayes 1981: 45)

Recognition criteria for Anasazi roads were the same as those used by the other researchers mentioned in this report. The survey also found 26 sites which had stairs or steps associated with the identified road system. Six of these were Navajo trails. At eleven sites they found an earthfilled masonry retaining wall, probably used as a ramp or landing stage. All of these are associated with roadways.

The Bureau of Land Management is currently conducting a study of prehistoric road systems in the San Juan Basin in order to develop a comprehensive set of management guidelines. The BLM has adopted Obenauf's recognition criteria and generated a summary outline for a more complete consideration of this class of cultural resource.

None of the researchers previously mentioned has published any exhaustive lists of what can cause linear or curvilinear features observable in air photos or on the ground. Such features include:

1. Structural geologic lineaments

   a. faults
   b. joints
   c. breached anticlines
   d. monoclines
   e. facies contacts
   f. ancient strand lines
   g. structurally controlled drainages or dune patterns

2. Volcanic geologic features

   a. dikes
   b. erosionally exposed sills
   c. lava flows following old drainage channels

3. Erosion features

   a. various types of drainages
   b. differentially eroded hogbacks
   c. axial gravel terraces
   d. natural overflow levees

4. Aeolian features

   a. longitudinal dunes
   b. transverse dunes
   c. drainages controlled by dunes a and b

5. Game and livestock trails

6. Man-made features

   a. prehistoric roads
   b. prehistoric canals
   c. prehistoric walls
   d. historic roads, canals or walls
   e. fences
   f. telephone lines, transmission lines and pipelines
   g. plow scars
   h. railroads

7. Linear artifacts from the particular imaging process, scratches on the negative or print, etc.

Criticism has been leveled at ground checking linear features mapped from aerial photography (Flynn 1981). Since no mechanism for absolutely dating roads has yet been developed, some researchers feel that ground checking roads merely proves that "cameras don't lie" (Judge 1981), unless field and laboratory methods independent of aerial identification and primary ground checking are used.

However, a preliminary ground check can eliminate many of the linear feature categories 1-5 although it cannot differentiate between historic and prehistoric roads. Canals can be confused with roads in bottomland areas, but are quickly eliminated when they are found on gradients too steep for irrigation purposes.

The association of linear features with Bonito Phase Chaco Anasazi sites has been emphasized after fieldwork by Holsinger (1901); Judd (1954, 1964); Gordon Vivian (1948); Gwinn Vivian (1970, 1972); Morenon (1975); Ware and Gumerman (1977); Lyons and Hitchcock(1977); Brethauer (1978); Marshall, et al. (1979); and Obenauf (1980).

Clearly, the linear features called roads (using the various aforementioned recognition patterns) are associated with Chacoan sites. Either the Chacoans, the Navajos, or the historic Anglo traders built them. Mexicans or Spaniards are not likely to have built these roads, since the San Juan Basin was under the firm control of the Navajos until the middle 1860's and Hispanic expeditions into the area were short and usually of a military nature (see Carroll n.d.).

In the summer of 1973, a survey team under the supervision of C.R. Morrison ground checked portions of the south road system from Chaco Canyon to Kin Ya-a. They found this road to fall within the recognition parameters of Ware and Gumerman (1977). Segments of the southern road have also been documented on video tape taken from a helicopter by Public Service Company of New Mexico and re-checked in the fall of 1981 by Morrison, Obenauf and Nials. This field check revealed prehistoric construction features and prehistoric trash on the ground.

Marshall, et al. (1979) documented linear features falling within the recognition pattern of Obenauf (1980) at eleven Chacoan outliers in the southcentral and southern San Juan Basin. Obenauf (1980) estimates that 200 miles of possible prehistoric roadway are associated with at least 25 known Chacoan outliers.

It is inconceivable that the handful of early traders or Anglo military explorers could have developed such a road system connecting Chacoan sites only (Mesa Verdean, McElmo phase, and earlier phases are not road associated). It is also inconceivable that the sparse and locally independent Navajo populations could have accomplished such a feat and not incorporated such a monumental effort into their folklore and mythology. This same statement also basically applies to the Pueblo peoples who presently live on the periphery of the San Juan Basin. Future research in the San Juan Basin should address the reality of an eastern Anasazi world of some 30,000 square miles connected by linear surface modifications, regardless of what they are called.

The exact function of this prehistoric road system has stimulated much discussion and clearly merits additional investigation. Frisbie (1972), for example, noted that many researchers argue that the road system represents military, religious and trade linkage among and between communities, with the central Chaco Canyon communities serving as the hub of this network, much like the pochteca system in prehistoric Mexico. Unfortunately, direct supportive evidence for this model is lacking. In this regard, Obenauf (1980:79) makes the most reasonable statement possible, given the lack of pertinent data:

> The prehistoric roadway network has important implications for the past economic and social systems in the San Juan Basin. The engineered nature of the roadways, the extent of the network (over 400 miles of possible prehistoric roadway have now been mapped), the width of the roadways, the number of links in the system, the associated features--all of these aspects of the roadway network suggest that a great labor in vestment was necessary for its construction. Both current anthropological theory and common sense tell us that the Chacoans were unlikely to invest such a considerable amount of labor in roadway construction unless there were an economic return on it, that the outliers and towns in Chaco Canyon were linked by the roadway network into some kind of economic and social system.

An hypothesis posed by Vivian and Buettner (1973:9-10) suggests that perhaps the most important commodity moving along Chacoan roads was information:

> Despite the fact that Chacoan towns are separated by as much as 150 kilometers, they all display a remarkable degree of homogeneity. Chacoan towns, in fact, appear to have reached a level of community-wide integration unknown in the Puebloan Southwest prior to or since that time. We would hypothesize that the Chacoan roads served as both a symbolic and practical mechanism for strengthening community identification on the town level within the greater Chacoan area.... In sum, we urge a closer examination and more refined evaluation of the Chaco data and the development of multiple working hypotheses for explaining the function of Chacoan towns and Chacoan roads.

3.3.3 Anasazi Population Change

A compilation of dated Anasazi site components from several surveys in the vicinity of the PRLA study area illustrates the changes in occupational intensity through time. The data are derived from the following studies: the CGP area (Reher 1977), the Bisti-Star Lake Phase I survey

(Huse, et al. 1978), the EPCC survey (Sessions 1979), the Alamito survey (Wilson 1979), the PNM Bisti study (Powers 1979), the Western Coal-Federal survey (Ganas 1980), and the Bisti-Star Lake Phase II survey (this report). These data are summarized in Table 2.

As shown in Table 2, occupational intensity increases rapidly in the Pueblo I/Pueblo II to Pueblo II interval, decreases somewhat in the Pueblo II/Pueblo III interval, and drops sharply in the Pueblo III Phase. Clearly the San Juan Basin was not abandoned suddenly, for occupational intensity levels had been dropping for approximately 200 years.

Table 2. Anasazi Component Distribution in the San Juan Basin

Phase	Time Interval (AD)	Number of Components	Percent of Total	Components/ Year
BM-III	450 - 650	7	1.5	.035
BM-III/ P-I	650 - 750	9	2.0	.090
P-I	750 - 850	17	3.7	.170
P-I/II	850 - 950	46	10.0	.460
P-II	950 - 1050	172	37.5	1.720
P-II/III	1050 - 1150	143	31.1	1.430
P-III	1150 - 1300	65	14.2	.430

3.4 HISTORIC PERIOD by Meade Kemrer

Three major cultural groups used and occupied the San Juan Basin during the Historic Period: the Navajos, the Spanish/Mexicans and the Anglos. Each group is discussed separately here. Particular emphasis is placed on the Navajos, since the majority of the historic cultural resources in the San Juan Basin are attributed to this group.

3.4.1 Spanish/Mexican

Spanish/Mexican sites which date to the ca. AD 1600-1846 interval are extremely rare in the San Juan Basin. Only 29 sites, constituting 0.3% of all sites recorded in the Basin by February 1979, are Spanish/Mexican (Stuart and Gauthier 1981:67). However, the small number of these sites is explicable. The frequently hostile Spanish/Mexican relations with the Navajo precluded any intensive usage of the San Juan Basin by Hispanics. Thus the area was, in effect, ceded to the Navajo (cf. Reeve 1959, 1960; Brugge 1980:7-48).

Spanish/Mexican sites are usually of two types: small homesteads (ranchlas) and campsites. Rancherlas are generally of stone or adobe construction, small (one to four rooms), and associated with livestock and agricultural features (cf. Haecker 1976). Campsites, which are extremely rare, were produced by Spanish/Mexican ranchers and by the military or exploratory expeditions which occasionally traversed the San Juan Basin (cf. Brugge 1980:7-48).

3.4.2 Anglo

Anglos began to settle in New Mexico after the Mexican-American War ended in 1846, when the American Southwest was ceded to the United States by Mexico by the Treaty of Guadalupe Hidalgo. Northwestern New Mexico, however, was not settled or utilized by Anglos until the 1870's (McNitt 1962; Palmer 1967; York 1979). Factors which inhibited Anglo usage of the San Juan Basin include continued hostilities with the Navajo until 1868, and the lack of access into the Basin until railroads were constructed in the late 1880's (York 1979:277).

Anglo population growth in the Basin was stimulated in the 1880-1920 interval by the development of the cattle and sheep ranching industry, profitable trade with the Navajo, and the opening of the San Juan Basin to homesteading between 1908-1912 (York 1979).

Anglo usage stabilized or perhaps dropped somewhat during the Depression Era but increased sharply after World War II when gas, oil, uranium, and coal development began (York 1979:287-290). Energy-related development continues to support an increasingly larger population in the Basin today.

These historically documented changes in the Anglo use of the San Juan Basin are reflected in the archaeological record, although the incidence of recorded Anglo sites in the rural portions of the Basin is still less than 1% of the cultural resource base (cf. Stuart and Gauthier 1981:67).

The earliest Anglo site types are trading posts and ranching-related sites such as pens/corrals, temporary herding sites and ranch buildings. Within the San Juan Basin, trading post operators were often ranchers as well; thus trading post sites often include ranching-related features (cf. York 1979:276-180). Although a few trading posts are currently operating, the majority of the posts closed in the 1960-1970 interval, when significant portions of the local Navajo clientele acquired wage labor jobs and motor vehicles, and began to purchase goods in nearby towns (York 1979:278). Ranching also declined during the Depression, when the Taylor Grazing Act sharply curtailed herd sizes on federally controlled lands in an attempt to prevent overgrazing and erosion. Cattle ranching, however, is still practiced in the Basin.

A few Anglo homesteads dating to the early twentieth century have been recorded in the San Juan Basin (cf. Reynolds 1980). These are small farm/ranching enterprises. It should be noted that traders and large ranching operators also frequently homesteaded the parcel which contained their ranching/trading headquarters (York 1979:276-81).

Evidence for the post-World War II gas, oil, uranium and coal development related activities are found throughout the Basin in the form of oil and gas wells, land survey benchmarks and cairns, uranium claim markers, exploratory coring loci, and mining sites.

3.4.3 Navajo

The third major cultural group which utilized the San Juan Basin during the Historic Period is the Navajo. Late nineteenth through twentieth century Navajo sites were frequently not recorded by early archeological surveys (Stuart and Gauthier 1981:74-5). Within the last ten years, however, cultural resource inventories are more complete; Navajo components usually constitute 50-70% of the site assemblage from any given tract (cf. Reher 1977; Huse, et al. 1978; Sessions 1979; Ganas 1980; Reynolds 1980).

The earliest Navajo cultural/temporal phase represented within the San Juan Basin is the Gobernador Phase (AD 1700-1775). Sites attributable to this interval vary in size and complexity. Site types include small sherd and lithic scatters, multiple hearth campsites, single to multiple habitation sites and walled, fortress-like villages termed "pueblitos" (Dittert, et al. 1961; Hester 1962; Huse, et al. 1978).

Sites are usually situated on mesa tops or in settings which provide seclusion, with high visibility of the surrounding terrain (Carlson 1965; Kemrer and Graybill 1970). Site location is undoubtedly related to defense and protection from Ute and Spanish raids. Two Gobernador Phase habitation sites from the Blocks IV and V area of the Navajo Indian Irrigation Project are a noteworthy exception, for they are located in a relatively open setting (Elyea, et al. 1979:I-110-1; II-138-9). Subsequent excavations recorded that one of these sites was completely burned, with artifacts found in situ (William Reynolds, personal communication 1979). It is likely that this site was destroyed in a raid.

Artifacts associated with Gobernador Phase sites include Dinetah and Dinetah Indented plainwares and Gobernador Polychrome ceramics, lithic debitage and small side-notched projectile points (Huse, et al. 1978:89). Habitation structures include forked stick hogans and rectangular to circular masonry structures (Carlson 1965). Other features include sweatlodges and occasionally, corrals (Hester 1962:44-5).

Gobernador Phase Navajo sites have been recorded in areas adjacent to the San Juan PRLA study tract, including the CGP area (Reher 1977:52-4), on mesa tops located northeast of the PRLA's (Huse, et al. 1978: Figure 19), and in Chaco Canyon (Vivian 1959).

The Gobernador Phase is succeeded by the Cabezon Phase (AD 1775-1868). Settlement types and their location characteristics remain similar to those of the previous interval (cf. Huse, et al. 1978:89), for the Navajo were threatened by Ute, Mexican, and after 1846, American raids.

A major population shift occurred during this phase. Navajo groups began to depopulate the Gobernador region of northwestern New Mexico and moved westward into the Canyon de Chelly and Black Mesa areas (Hester 1962:76-86; Kemrer 1974:127-36). Several historically documented factors stimulated this migration. Ute, Mexican, and later in this phase, American raids on Navajo settlements increased (Ward, et al. 1977:218-21; Kemrer 1974:1346). Navajo groups also acquired more sheep and goats and were becoming increasingly reliant on pastoralism as a subsistence source. The westward migration therefore fulfilled two goals: it brought Navajos into regions with greater grazing potential, and into areas remote from enemies who would steal or destroy their herds (Kemrer 1974:143-51).

Another major event was the Carson Campaign against the Navajo in 1863-1864. American military troops, volunteer militia and Utes systematically raided Navajo villages, capturing and destroying livestock and crops. Colonel "Kit" Carson then sent notification for all Navajos to surrender. By 1864, some 8000 Navajos had surrendered and were incarcerated at Bosque Redondo near Fort Sumner in eastern New Mexico. Except for a few extremely isolated groups, Navajos were forced to abandon northwestern New Mexico and and northeastern Arizona. Sites dating to the 1864-1867 Bosque Redondo interval are extremely rare (cf. Kemrer 1974:132-6). In 1868, the Navajo signed a peace treaty and were released to a reservation in northeastern Arizona and northwestern New Mexico (Bailey 1964).

Temporally diagnostic ceramics associated with Cabezon Phase sites include Gobernador and Navajo Polychromes, Navajo Filleted and Dinetah Plainwares (Brugge 1963; Huse, et al. 1978:82). Other artifacts attributable to this period include contemporary Puebloan wares, lithic debitage and tools, and some Mexican metal and ceramic items (cf. Hester 1962).

Pueblitos which date to this period are rare. Most homestead sites contain forked pole, cribbed log and masonry hogans, sweat lodges, and corrals. Campsites are also common (Huse, et al. 1978:89).

The period following the Navajo return from Fort Sumner in 1868 is termed the Post-Bosque Redondo Readjustment Phase (1868-1880) by Bailey and Bailley (1978:23). Although most of the Navajos returned to the 1868 Treaty Reservation, many Navajos utilized the eastern off-reservation grasslands in the San Juan Basin for sheep herding. The eastern off-reservation area was settled so intensively that by 1899, more Navajos occupied this area than the reservation (Johnston 1966). Sheep herding, which was strongly encouraged by the government's agents, became the major subsistence base for Navajos.

Anglo traders, recognizing a lucrative market in the exchange of food and manufactured goods for sheep and goat products, established trading posts within and adjacent to the reservation in the 1870-1880 interval. Since the off-reservation area was subject to less government regulation and control, more posts were established in the non-reservation portions of the San Juan Basin than in the reservation areas (York 1979).

The impact of trade on the Navajo was dramatic. The incidence of manufactured goods found in Navajo sites increased by several thousand percent within the 1870-1900 interval (Brugge 1964). By 1900, the Navajo had developed a viable pastoralist subsistence base supplemented by trade. Although luxury trade goods are relatively rare, food, utensils, clothing and tools are common on Navajo sites within the San Juan Basin which date to 1870-1900 (Ward, et al. 1977). The strong Anglo-Navajo economic interdependence through trade persisted until 1933 (Bailey and Bailey 1978:24).

Changes in land jurisdiction and tenure followed Navajo off-reservation use and occupancy of the San Juan Basin. A series of Executive Orders from 1878-1913 expanded the boundaries of the Navajo Indian Reservation in the San Juan Basin of New Mexico and in other areas in northeastern Arizona and southeastern Utah (Johnston 1966:24). The Dawes Severalty Act of 1877 was also utilized to give Navajo users of non-reservation public lands legitimate surface ownership rights. Between 1908 and 1913 many Navajo groups occupying the San Juan Basin received 160-acre allotments (York 1979). Most of these parcels are still held by descendants of the original allottees.

The livestock reduction program mandated by the Taylor Grazing Act produced significant cultural and demographic changes for Navajos within the 1933-1955 interval (cf. Aberle 1966). Herds were reduced to slow the rates of overgrazing, erosion and arroyo cutting. The Stock Reduction Program was rigorously enforced within the reservation, stimulating movement into the adjacent off-reservation public lands. Fencing and grazing permit requirements, however, reduced the availability of off-reservation public lands.

The principal outcome of these events for the pastoralist Navajo was economic loss and hardship. For some individuals and groups living on the reservation, tribal development projects provided wage labor jobs, particlarly during the 1930-1939 Depression Era (Parman 1976). Navajos living off-reservation probably took greater advantage of wage labor opportunities than their reservation-dwelling counterparts. In the San Juan Basin, for example, many Navajos worked as seasonal labor for the railroads, commercial agriculturalists, traders, and ranchers within the 1930-1940 period (York 1979:281-5). Thus, during the Depression Era, virtually all Navajos lost a portion of their pastoralist subsistence base, and some, especially in the off-reservation areas, replaced this loss with wage labor.

The process of becoming increasingly dependent upon cash income accelerated during World War II (1941-1945). Navajos worked in factories, joined the Armed Forces, and became increasingly involved with seasonal wage labor (York 1979:285-7). Sheep herding, however, was still an economic supplement for most Navajo corporate groups.

The post-war recession curtailed the number of wage labor jobs available to Navajos. However, with the advent of gas and oil exploration and extraction in the 1950's, employment opportunities increased, particularly in the San Juan Basin. Energy development continues to provide jobs for Navajos in increasingly large numbers. Concomitant with increased dependence on a cash economy, sheep herding has decreased somewhat in importance. Most rural Navajo residents in the San Juan Basin, however, still maintain some livestock, either directly or through investment in the herds of their kinsmen (York 1979:288-91).

This series of historically documented events has significance for the distribution of Navajo site frequencies within the San Juan Basin. In the CGP area, which was incorporated into the Navajo Reservation through an Executive Order in 1880 (Johnston 1966:24), site frequencies peak sharply in the 1905-1935 interval and decline sharply in the 1935-1975 period (Reher 1977:74). This pattern suggests that the increase in Navajo usage coincides with the period when the pastoralist-based subsistence strategy had reached its full potential. The rapid decline in Navajo settlement in the 1935-1945 interval coincides with the implementation of the stock reduction program. The question remaining, however, is whether the drop in site frequencies represents depopulation or whether any given group occupying the CGP area tended to generate fewer sites due to the constraints of the stock reduction program.

Comparable data from the surrounding off-reservation lands may provide an important clue regarding population shifts and usage intensity. Data from datable Navajo site components were collected from the following surveys: Bisti-Star Lake, Phase I (Huse, et al. 1978), the Western Coal-Federal Survey (Ganas 1980), the PNM-Bisti Survey (Powers 1979), the Alamito Survey (Wilson 1979) and Bisti-Star Lake, Phase II (this report). The distribution of dated site components through time is presented in Table 3.

Table 3. Navajo Site Component Frequencies in the Off-Reservation San Juan Basin

Time Interval	Site Components	Percent of Total
1868-1880	1	0.3
1880-1907	28	8.4
1907-1933	47	14.1
1933-1950	105	31.5
post-1950	152	45.7
Totals	333	100.0

The 1868-1907 site frequencies in Table 3 are probably somewhat underrepresented due to the relative paucity of datable artifacts. Chronological assignment to the 1907 to post-1950 interval is less of a problem and the data are therefore more reliable.

The data in Table 3 show a significant increase in site frequency in the 1933-1950 period. This contrasts markedly with the CGP survey findings. Apparently a population shift took place during the period that the stock reduction program was implemented on the reservation. It is likely that many Navajo Reservation occupants began to utilize the off-reservation area more intensively in an attempt to maintain large herd populations.

Site types attributable to the 1868 to post-1950 period do not substantially change. Four major site classes are defined here: long-term habitation sites, temporary camps, limited activity and sacred/religious loci.

Long-term habitation sites typically contain one or more dwellings (hogans), ash/trash dumps, one or more corrals, outdoor stove/ovens (hornos) and a sweat lodge. These sites are occupied for a number of years, either permanently, or seasonally, with the occupants shifting residences in the spring and fall (cf. Adams 1963). Dwellings vary in style and construction materials, depending on environmental setting and income level. In the untimbered portions of the San Juan Basin, for example, circular or rectangular masonry hogans are common (cf. Reher 1977; Powers 1979), whereas in the pinyon-juniper woodlands, cribbed log, forked stick and vertical pole hogans are more numerous (cf. Huse, et al. 1978).

Dwelling styles have changed somewhat, and these changes accompany socioeconomic change, particularly increased participation in the cash economy in the off-reservation areas. Forked pole hogans have been constructed less frequently since the 1930's, and wooden frame and cinderblock houses are constructed more frequently since the 1940's (Tremblay, et al. 1954). An example of a long-term Navajo habitation site is shown in Figure 15.

Temporary camps are generally associated with spring-fall herding activities. They generally contain one to several tent pads, hearths, ash/trash dumps and corrals. These camps may be moved periodically during the season, depending on pasturage quality and the availability of water (cf. Ganas 1980). An example of a Navajo temporary camp is illustrated in Figure 16.

Limited activity loci vary in both form and function. They include stone cairns marking grazing boundaries, isolated trash dumps, coal mining areas, isolated hearths, scarecrows, fields, water control devices, isolated windbreaks and summer shades/ramadas (cf. Huse, et al. 1978; Powers 1979).

Sacred/religous sites are also variable. The most complex member of this class is the ceremonial Squaw Dance site, which can contain dancing areas, hornos, hearths, trash dumps, a ceremonial forked pole hogan (Yei hogan), and one or more ramadas. Another type of ceremonial site consists of a cluster of one to four sweat lodges. Other sacred/religous sites include burials and shrines, usually marked by a cairn, which are frequently located on Anasazi sites (cf. Fransted n.d.; this report, Appendix 1).

In summary, the quantity and quality of information concerning the cultural history of the San Juan Basin for the Historic Period has improved considerably within the past several years. Cultural resource surveys and assessments frequently include ethnohistoric (cf. Ward, et al. 1977; Wilson 1979), ethnographic (cf. York 1979) and ethnoarchaeological (cf. Ganas and York 1980) investigations. The latter approach has proven to be particularly efficient and productive. Ganas and York (1980), for example, have documented a significant shift in post-1930 Navajo seasonal mobility patterns which integrates pastoralism with wage labor in the Bisti area.

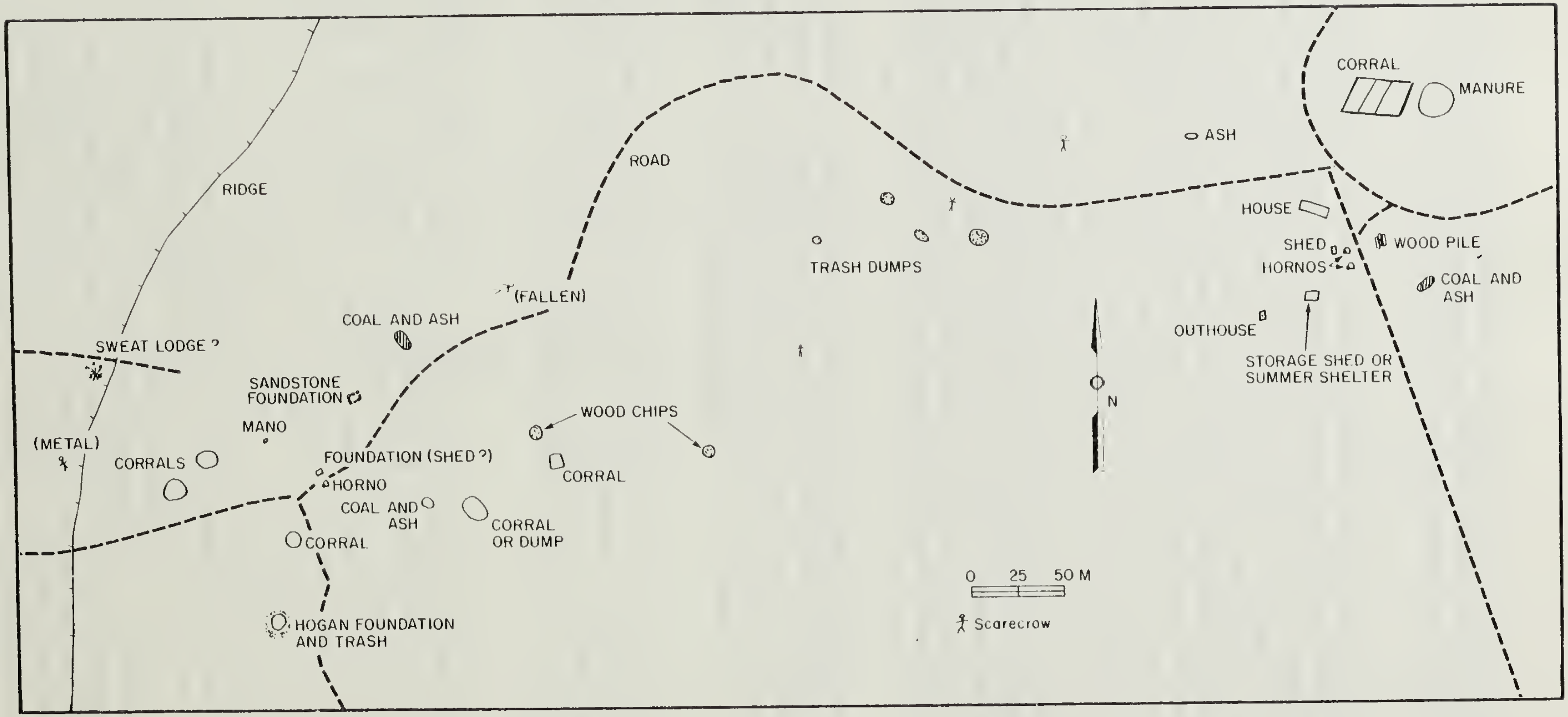


Figure 15. Site 40-14-3, a Navajo Long-term Habitation Site Recorded by this Survey

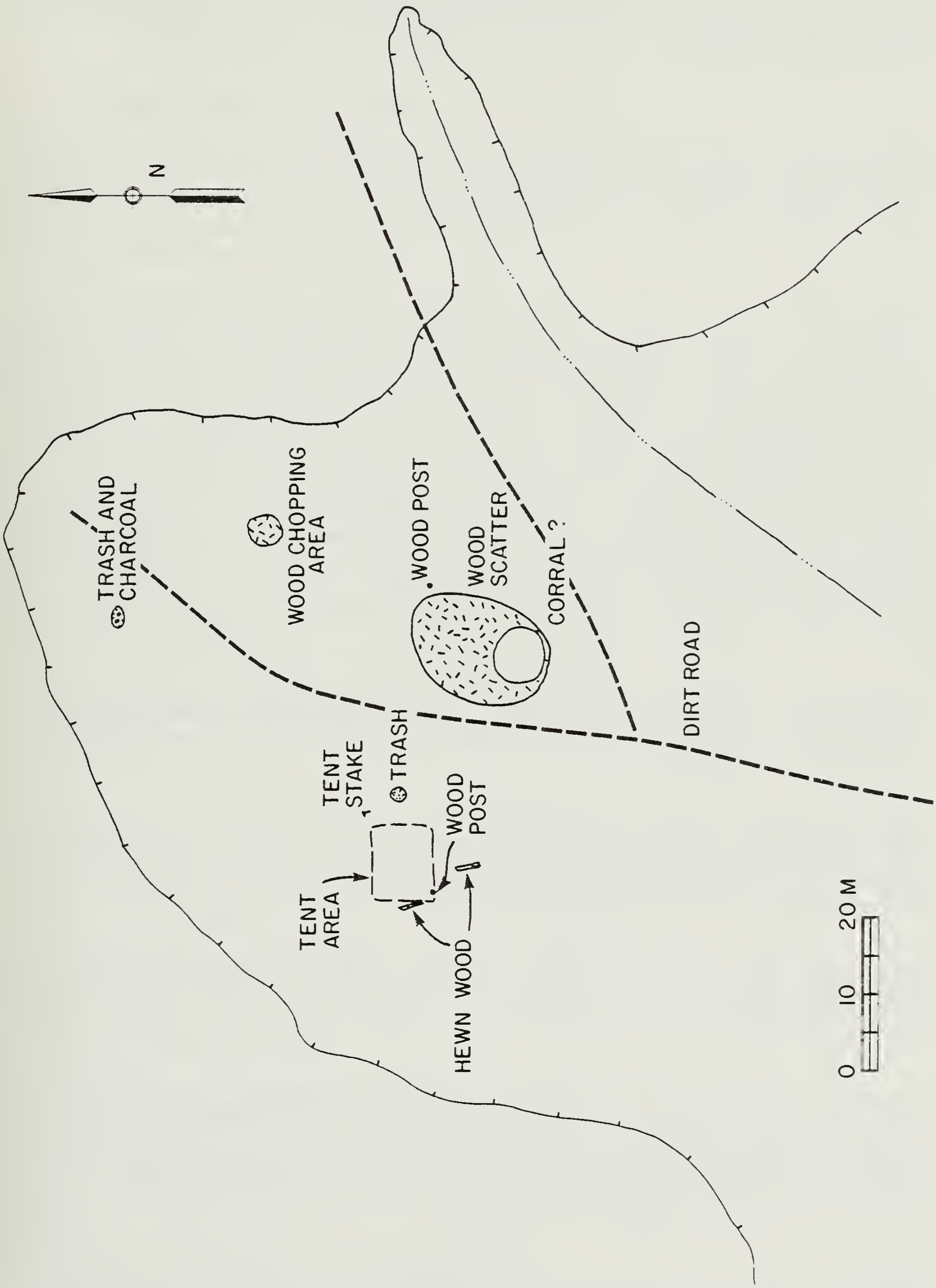


Figure 16. Site 54-22-1, a Navajo Temporary Camp Recorded by this Survey

Provided that future studies maintain the quality of those cited here, significant advances in understanding the process of cultural change in the Historic Period in the San Juan Basin can be anticipated.

4.0 METHODS AND PROCEDURES

4.1 CULTURAL RESOURCES DATA BASE by Mark Ganas

The archaeological data for initial model development were compiled from previous surveys conducted within and immediately adjacent to the PRLA study area (Figure 17). Since these data were to be used to model variability in site location and density within the study area, only tract type survey data were collected.

Six studies were chosen on the basis of areal extent, comparability of archaeological data, proximity to the PRLA study area, and environmental content. Several nearby tract surveys were not incorporated into the archaeological data base principally for two reasons: the archaeological data were not comparable to the bulk of the studies in the region, or the data were not made accessible for this study. The six study areas selected are representative of the environmental zones found within the PRLA area. This archaeological information therefore constitutes an appropriate data base for the development of a model of site/environmental relationships within the region. Two authors of this report have directed (Sessions 1979; Ganas 1979, 1980) and/or performed fieldwork (Powers 1979) on four of the six projects. This familiarity facilitated data manipulation and the discovery of comparability among the data. The six studies are discussed below.

1. Bisti-Star Lake Phase I (Huse, et al. 1978): This is a survey of 37,610 acres of BLM-held parcels surrounding the PRLA study area. The work was supported by the Bureau of Land Management, Albuquerque District.

2. Alamito (Wilson 1979): This is a survey of the proposed Alamito Coal Company mine lands (16,640 acres, 26 square miles) adjacent to the south-central portion of the PRLA study area. The work was funded by the Alamito Coal Company, which plans to establish a surface coal mine in the area.

3. El Paso Coal Company (EPCC) (Sessions 1979): This is a survey of 15, 273 acres (23.9 square miles) located west of the northernmost PRLA area. This survey was supported by the El Paso Coal Company which plans to mine the area.

4. Public Service Company of New Mexico (PNM) (Powers 1979): This is a survey of 2400 acres (3.75 square miles) of land situated in the northwestern portion of the PRLA study area. The work was funded by Public Service Comany of New Mexico, which plans to construct the New Mexico Generating Station, a coal-fired generating plant, on the parcel.

5. Western Coal Federal Parcel (Ganas 1980): This is a survey of 2160 acres (3.4 square miles) of land, in the northwestern portion of the PRLA area. The work was supported by Western Coal Co., which plans to strip mine the area.

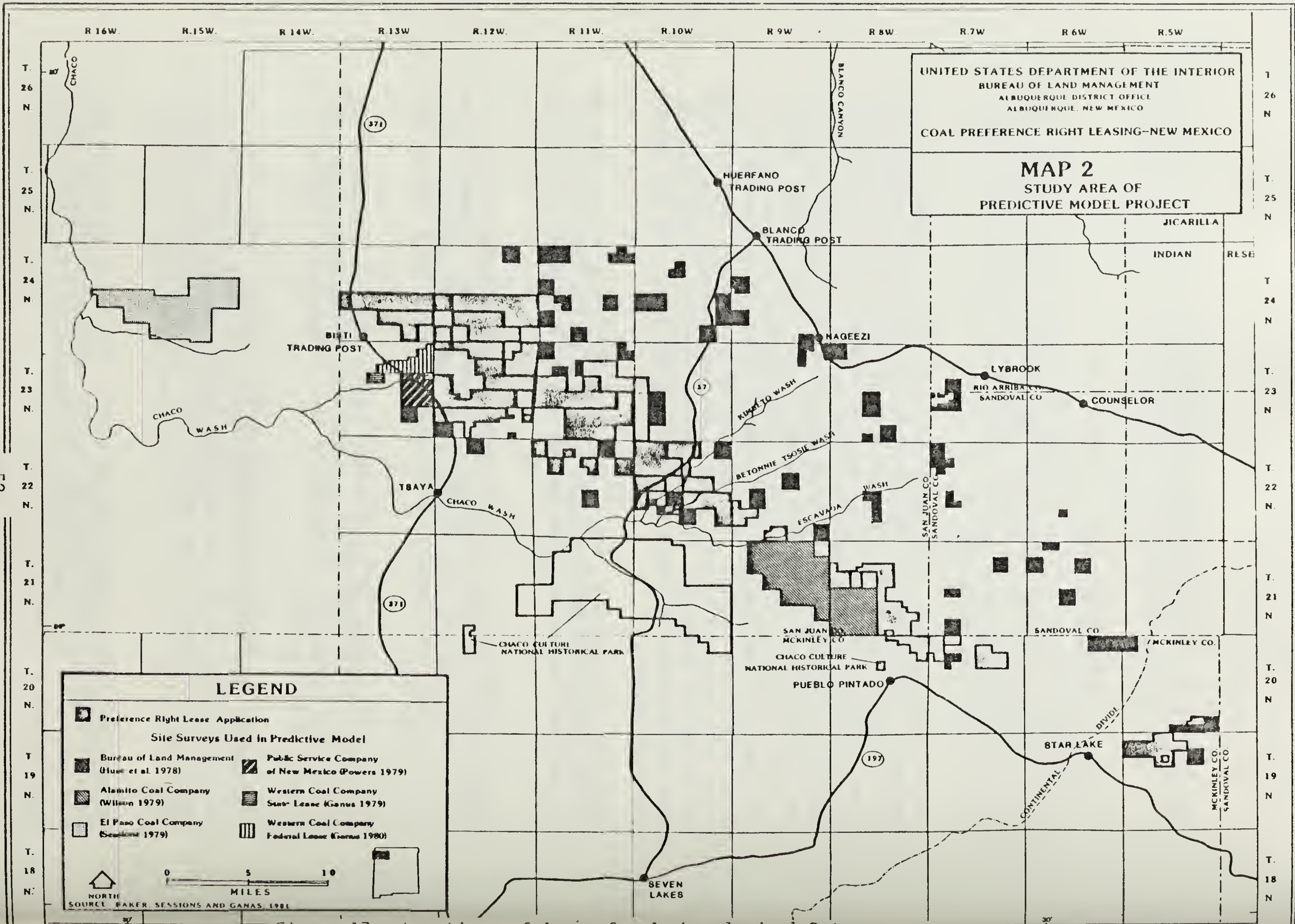


Figure 17. Locations of Areas for Archaeological Data

6. Western Coal State Parcel (Ganas 1979): This is a survey of 320 acres (0.5 square miles) of land in the northwestern portion of the PRLA study area. The work was supported by Western Coal Co., which plans to perform strip mining.

Site data from these previous surveys were collected from site forms on file at the appropriate agencies with the exception of the EPCC data, which were available on magnetic tape. In the interests of time and ease of manipulation, the site data were coded onto optical scanning sheets from which a computerized file could be formed immediately upon reading without intermediate steps such as keypunching.

For multiple component sites, each component was coded as a separate site, since each occupation represents an independent event. Thus, the term "site" was operationally defined to mean site component for purposes of this study.

The cultural resources were subdivided into three basic categories for data coding purposes: lithic, Anasazi, and Historic site components.

Sites incorporated into the lithic category were those which included exclusively flaked and ground stone lithic artifacts. Three subcategories are included in this class of sites:

Undiagnostic lithic sites have lithic artifacts, but lack temporally/culturally diagnostic projectile points or other artifacts which would permit accurate dating or cultural assignment.

PaleoIndian sites include one or more projectile points which are attributable to the PaleoIndian Period (8000-5500 BC).

Archaic sites include lithic artifacts and one or more projectile points which are attributable to the Archaic Period (5500-800 BC) as well as to the Basketmaker II period (800 BC-AD 400).

Although it is likely, on the basis of temporal duration, that most lithic sites without diagnostic artifacts were produced during the Archaic Period, some may represent limited activity loci produced during the PaleoIndian Period, Anasazi Period or by Native American groups during the Historic Period.

Anasazi sites are those which, by virtue of ceramics or architectural styles, could be ascertained to date from the Anasazi Period, from Basketmaker III (AD 400-750) through Pueblo III (AD 1150-1300). Most of the ceramics involve the San Juan/Mesa Verde wares, Cibola wares, and Chuska wares, but Anasazi sites also include intrusive traditions such as the White Mountain redwares. To some extent, inclusion in this category was also determined by the occurrence of certain types of ground stone (such as trough metates), but usually this factor required corroborative evidence such as associated architectural, ceramic, or projectile point styles.

Historic sites include features of obvious non-Anasazi origin, such as houses, hogans, or corrals, or items of historic manufacture. Also included are protohistoric Navajo sites, which often contain pottery such as Dinetah Utility. Included in the historic category are Navajo, Jicarilla Apache, and possible Ute sites, as well as Euro-American sites, both Spanish and Anglo.

Data coding forms (Figures 18, 19 and 20) were devised to accommodate differences in data content among each of these three site categories. The three site forms share certain data categories:

Columns 1-3: SITE. Each site component was given a unique, arbitrary inventory number for the purposes of internal record keeping. Inventory numbers were correlated separately with the site numbers assigned by a particular research or agency.

Columns 4-10: UTM NORTHING, and Columns 11-16: UTM EASTING. Locations were recorded utilizing UTM coordinates. This permitted accurate placement of the sites within a coordinate system, and correlation with the environmental data.

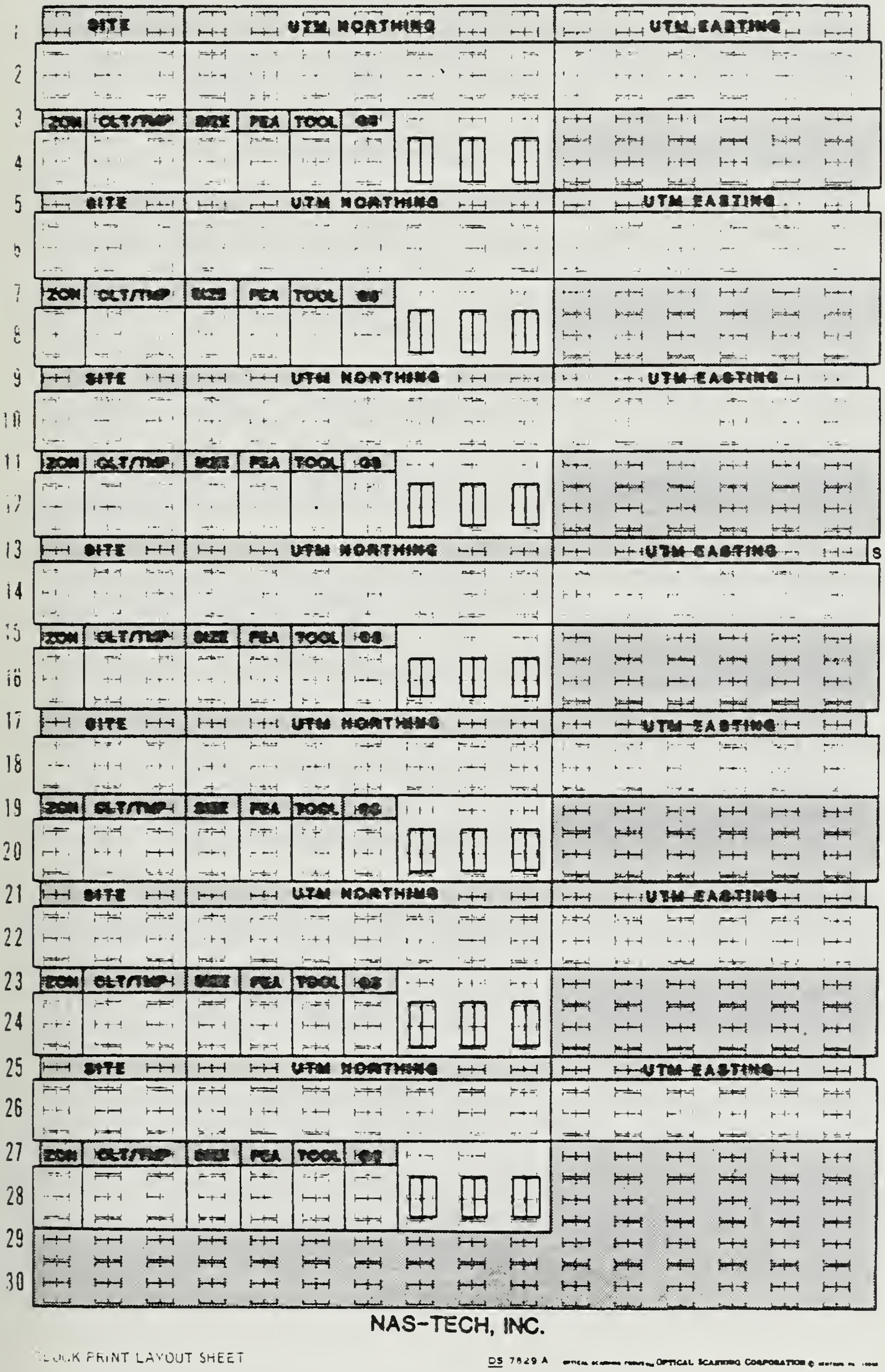
Column 17: UTM ZONE. Sites were located in both zone 12 and zone 13. In the former case, "2" was entered, in the latter, "3".

A number of the data categories and the values coded into them which are unique to lithic sites are listed along the margin of the lithic site data form (Figure 18). The various cultural/temporal phases are those described by Irwin-Williams (1973), which the authors of all six studies utilzed The sizes of lithic sites were grouped into intervals which appeared to be meaningful based on a preliminary analysis of the site data from several of the studies. Number of features (FEA in Figure 18) for lithic sites is the number of hearths, fire-cracked rock concentrations, and artifact clusters. Tools include knives, bifaces, projectile points, drills, scrapers and other end products of flaked tool manufacture. The number of pieces of ground stone (GS in Figure 18) is the number of manos, metates, and other ground implements.

Two of the data categories and their coded values appropriate for Anasazi sites are described along the margin of the Anasazi data form (Figure 19). The Pecos Classification system for cultural/temporal assignment was utilized by all authors. It includes the Basketmaker III (BM-III) through the Pueblo III (P-III) Phases. As a measure of site size and complexity, the number of structures (STRUC in Figure 19) was recorded. The number of nonhabitation features (FEA) such as hearths, storage cists, and artifact concentrations was also coded. Ceramic (CER), ground stone (GS) and lithic (LITH) densities were rated as none, low, medium and high (Figure 19).

Relative rather than absolute values were employed so that usage intensity could be evaluated separately from site size and complexity. For example, Anasazi one- or two-room farmsteads can exhibit the outcomes of use periods ranging from a single season to multiple generations, yet sherd, lithic and ground stone frequencies from any given farmstead are small when compared with those from a village.

LITHIC SITES



CULTURAL/ TEMPORAL	
UNDIAGNOSTIC	10
PALEO-INDIAN	20
ARCHAIC: UNKNOWN OR MULTI-COMPONENT	30
JAY	31
BAJADA	32
SAN JOSE	33
ARMIJO	34
EN MEDIO	35
BM II	36

SIZE (SQ. METERS)	
0-499	1
500-799	2
800-999	3
100-1499	4
1500-9999	5
10,000-	6

TOOLS	
0	0
1-5	1
6-10	2
11-15	3
16-20	4
21-	5

GROUNDSTONE PCS.	
0	0
1-3	1
4-10	2
11-20	3
21-	4

Figure 18. Data Recording Form for Lithic Sites

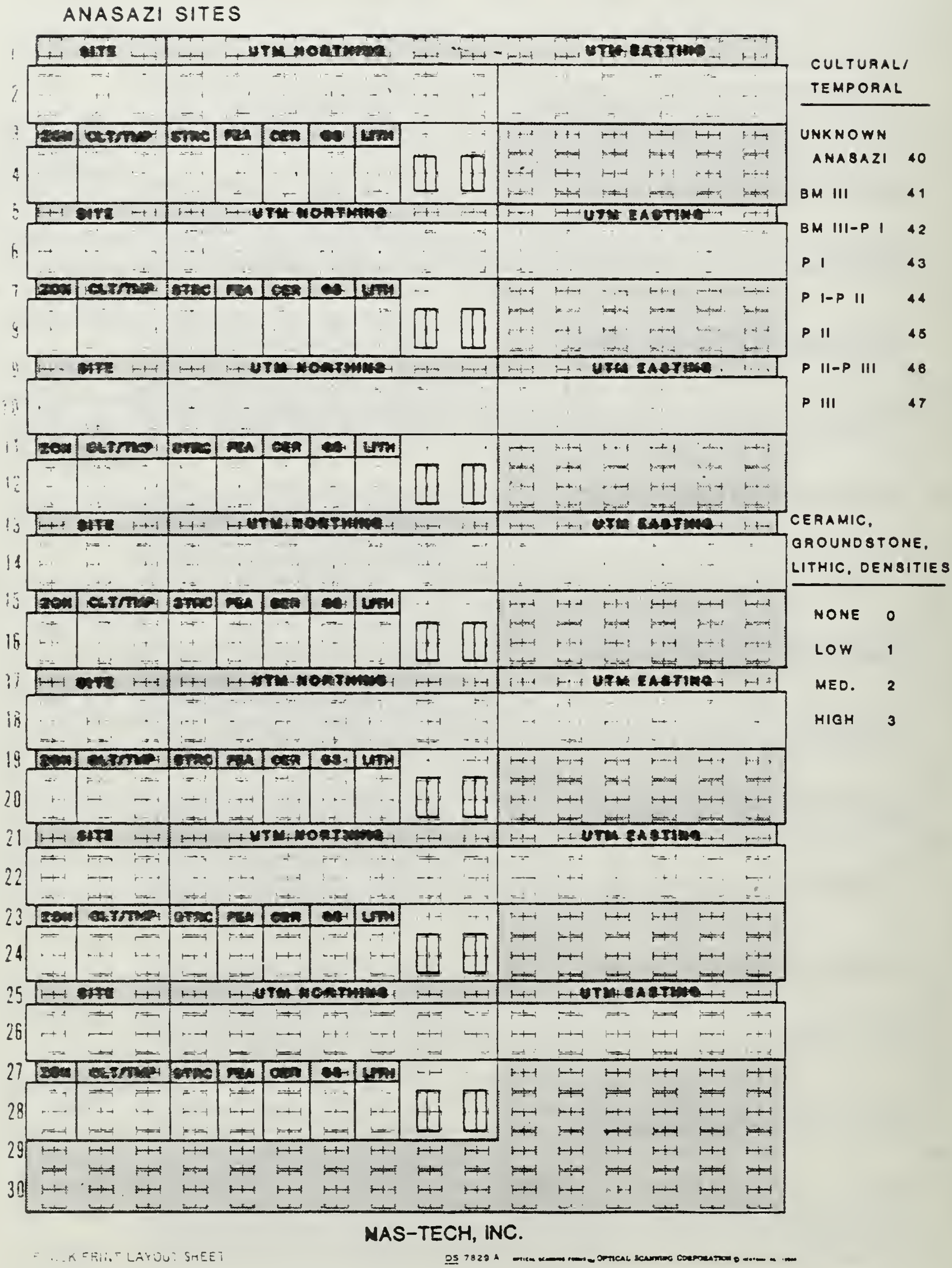


Figure 19. Data Recording Form for Anasazi Sites

HISTORIC SITES

SITE | UTM NORTHING | UTM EASTING

CON | CLT/TMP | NAV. | H/A | FIRE | TRASH | OTHER

CULTURAL/TEMPORAL

UNKNOWN NAV	50
A. PRE-1680	51
B. 1680-1800	52
C. 1800-1868	53
D. 1868-1880	54
E. 1880-1907	55
F. 1907-1933	56
G. 1933-1940	57
H. 1940-1950	58
I. 1950-	59
A-B	61
B-C	62
C-D	63
D-E-F	64
E-F-G-H	65
G-H-I	66
F-G	67
H-I	68

UNKNOWN ANGLO-SPANISH

ANGLO-SPANISH 70 (SAME AS FOR NAVAJO BUT 71-88)

UNKNOWN HISTORIC 90

H/A: HERDING/AGRICULTURAL

NEITHER	0
HERDING	1
AGRIC.	2
BOTH	3

TRASH

NONE	0
SCATTER	1
1 DUMP	2
MULTIPLE DUMPS	
DUMP(S)	3
& SCATTER	4

OTHER

(SEE OVER)

NAS-TECH. INC.

SCREEN PRINT LAYOUT SHEET

DS 7529 A OPTICAL SCANNING CORPORATION

Figure 20. Data Recording Form for Historic Sites

Historic period sites include Navajo, Spanish and Anglo cultural remains. Several of the more complex variables coded are listed on the margin of the historic site form (Figure 20). Cultural/temporal affiliations for all historic sites were subdivided into the time periods which are often detectable in survey data. These periods correspond to major socioeconomic changes which occurred in northwestern New Mexico (cf. Bailey and Bailey 1978; York 1979).

The category HAB (Figure 20) refers to the number of dwellings. This includes Navajo hogans, Anglo ranch houses and homestead dwellings, trading posts and Spanish homesteads. The presence of herding or agricultural features on a site (category H/A) was also recorded, as were number of external fire features (FIRE) such as hearths or hornos; and the presence and complexity of trash associated with a given Historic Period site (TRSH category). Examples of other types of features (OTHER category) were printed onto the reverse side of the form; these are presented in Table 4.

Table 4. Examples of OTHER Class Memberships and Code Values for Historic Period Sites

Type of Feature	Code Value
Temporary habitation: tent, tent base, ramada, wind break, etc.	1
Ash pile	2
Coal or wood pile, wood chopping area	3
Sweat lodge	4
Burial	5
Non-habitation structure: storage, root cellar, etc.	6
Stone/coal quarry, stone stockpile	7
Petroglyph	8
Other	9

Listings of all information in the archaeological data base, which include the raw data, frequency distributions for each coded variable, and two-way interactions among all variables have been submitted to the Bureau of Land Management, Albuquerque District Office (cf. Baker, Sessions and Ganas 1981). This information is also on file at the Laboratory of Anthropology, Santa Fe.

The cultural resources data base was analyzed to assess its suitability for use in predictive modeling. Since data from six different reports produced by five different researchers were to be considered analytically equivalent, some test of comparability among these data was necessary.

A fundamental concept requiring evaluation was the definition of a site. Criteria for defining sites can vary with research bias, levels of funding, and personal bias. This variability could affect site density distributions, which is the most critical variable in the predictive model. For example, several cultural loci within a given area might be recorded by some researchers as separate sites, but others would consider them to be activity areas within a single site. As a first test of this source of error within the data base, mean lithic, Anasazi, historic, and total site densities from each of the reports were compared. Means were derived from densities computed for each section of land within each project area in order to render the various studies comparable by reducing the effects of project area size on these density values.

The Western Coal state parcel was eliminated from the calculations because of its small size (320 acres) and anomalous site densities (12 lithic sites and 18 historic sites per square mile). This parcel does not exhibit the range of environmental variability seen in the other survey areas, and its location on the banks of a major wash is probably a causal factor in the unusually high site densities. The parcel was included in the correlations of archaeological data with environmental variables, but was excluded from this particular comparison since its values would unjustifiably inflate the statistics.

The mean site densities are shown in Table 5.

Table 5. Regional Site Densities
(Site Components/Square Mile)

	Lithic	Anasazi	Historic	Total
Bisti-Star Lake Phase I				
mean	2.48	0.77	5.54	8.79
range	0-30	0-6	0-36	1-66
Alamito				
mean	3.12	1.35	3.96	8.42
range	0-12	0-13	0-14	1-38
EPCC				
mean	5.09	1.72	4.68	11.49
range	0-24	0-15	0-19	0-34
PNM				
mean	7.00	1.25	2.33	10.25
range	2-12	0-3	1-5	3-16
Western Coal Federal				
mean	10.46	0.20	8.08	18.76
range	1-31	0-1	4-12	9-40
Total				
mean	3.62	1.13	5.19	9.97
standard deviation	4.62	2.38	5.47	8.52
range	0-31	0-15	0-36	0-66

The data in Table 5 show that the inter-project variation in mean site density is considerable in all site categories, and is especially pronounced for the lithic sites. The site frequency ranges for each project indicate that intra-project variation is also high.

A series of one-way analyses of variance was conducted to compare inter- and intra-project variation in site densities. The null hypothesis tested in these analyses was that the mean site density values from each project area represented a sample of means from a universe to which each study area belonged. The purpose of these analyses was not to reject the null hypothesis, but rather to evaluate its credibility at a formally specifiable level of confidence. The confidence level was set at 95% with F-score values of 2.45 or less. Thus confirmation of the null hypothesis would indicate that site definition biases had not significantly affected site densities between projects and the density values in the data base were reliable for predictive modeling. The results of the analyses of variance are presented in Table 6.

Table 6. One-Way Analysis of Variance in Mean Site Type Densities

LITHIC SITE DENSITIES

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Inter-project	4	411.39	102.85	6.14
Intra-project	124	2077.08	16.75	
Total	128	2488.47		

Reject H_0 at $\alpha = 0.95$

ANASAZI SITE DENSITIES

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Inter-project	4	21.09	5.27	1.05
Intra-project	124	688.08	5.55	
Total	128	709.17		

Accept H_0 at $\alpha = 0.95$

HISTORIC SITE DENSITIES

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Inter-project	4	125.26	31.32	1.13
Intra-project	124	3448.32	27.81	
Total	128	3573.58		

Accept H_0 at $\alpha = 0.95$

TOTAL SITE DENSITIES

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F Value
Inter-project	4	605.28	151.32	2.32
Intra-project	124	8073.43	65.11	
Total	128	8678.71		

Accept H_0 at $\alpha = 0.95$

The analyses show that inter- and intra-project site densities are significantly similar except for lithic sites. This is shown in Table 6 where the inter- and intra-project mean square values are more similar for Anasazi, historic, and total site densities than for lithic site densities.

Inter-project variation is significantly higher than intra-project variation for lithic site densities. Two possible explanations for this are the the following. First, researcher bias in defining lithic sites may have significantly influenced site density values. Second, there may be more variation in lithic site densities between project areas, perhaps at a scale which cannot be appreciated without further data.

At least some portion of the high inter-project variability in lithic size was caused by observer bias. During the compilation of data from these reports, it was noted that the lithic sites recorded in some of the reports (notably Powers 1979 and Ganas 1980) were, on the average smaller than the sites from the other reports. This indicates differences in perception of site boundaries. Conversely, several authors have noted that lithic site densities can be highly variable between project areas separated by distances ranging no more than 30 miles within this portion of the San Juan Basin (cf. Baker and Sessions 1979:288; Ganas 1980:30). Therefore extremely high inter-project variation in actual lithic site densities cannot be dismissed.

In summary, this evaluation of the cultural resources data base indicates that the site density values are sufficiently reliable for predictive modeling, particularly the Anasazi, historic, and total site data. There is probably some error in lithic site density estimates within the data base because of lack of comparability in site definition. However, as documented by the statistical properties of the predictive model (section 5.0), reasonably reliable predictions can be made for this class of sites.

The data base was analyzed to determine how it could be partitioned into culturally/temporally meaningful sets which would contain sufficiently high data frequencies to meet statistical requirements for predictive modeling. Those data categories which specified site type in terms of cultural content/site complexity were examined first. Unfortunately, each combination of values for these variables was generally represented by only one or two sites. One exception, the class of small lithic and sherd scatters, included 39 sites. For historic sites, however, each site was essentially unique. Thus predictions by cultural content/site complexity versus environmental variables were not feasible, since correlations based on small data samples could not be reliably extrapolated over an area as large as the PRLA study area.

A similar analysis was conducted with the data partitioned by cultural/temporal period. Within the most narrowly defined categories, e.g., Basketmaker III Phase, Jay Phase, etc., the data frequencies were too low for modeling purposes. Within the broader categories, however, data content was sufficiently high for meaningful interaction with environmental variables.

Eight site classes were developed:

1. Lithic (n = 410 sites): This class includes PaleoIndian, Archaic and culturally/temporally uncategorized lithic sites.

2. Anasazi (n = 178 sites): This set includes Basketmaker III through Pueblo III Phase sites, as well as Anasazi sites which could not be assigned with certainty to a particular phase.

3. Pre-1933 Navajo (n = 146 sites): This class includes Navajo sites dating from as early as the late 1600's to 1933, as well as those sites which could only be assessed as having been built or occupied earlier than 1933.

4. Post-1933 Navajo (n = 358 sites): This class includes those sites which date between 1934 and 1980.

5. Total Navajo (n = 569 sites): This class combines the data from categories 3 and 4 as well as data from sites which could not be assigned with certainty to either category 3 or 4.

6. Anglo/Spanish (n = 3 sites): The sites in this category could have been generated by participants in the Hispanic or Anglo cultural traditions and could date from the eighteenth to the twentieth centuries.

7. Unknown Historic (n = 14 sites): The sites within this category could not be assigned to any cultural tradition and could date from the eighteenth to the twentieth centuries.

8. Total Sites (n = 1174 sites): This class includes those sites from categories 1 through 7. It was selected for predictive modeling purposes as a separate dependent variable.

4.2 ENVIRONMENTAL DATA BASE by Craig Baker and Steven Sessions

4.2.1 Environmental Variability and Methods

Studies of the distribution of sites generated by subsistence-based cultures usually reveal that site locational patterning is strongly related to the location of critical environmental resources (cf. Gumerman 1971; Jochim 1976). As demonstrated in section 4.1, it is clear that site densities are not homogeneous in the vicinity of the PRLA study area. Equally apparent is the fact that plant, animal, and water resources which are critical for human subsistence are not uniformly distributed in this region. It is likely that site frequencies and environmental resources are directly related. With the premise that site frequencies vary directly with relative critical resource potential, an environmental data base was created for correlation with the archaeological data to produce a site prediction model.

Soils and washes were selected for use as environmental variables for several reasons. First, the spatial distribution of soils and major drainages are the least altered aspects of the regional environment from the prehistoric era to the present (cf. Reher and Witter 1977). This is clearly not the case for the plants and animals (cf. Mayfield 1980) or climate (cf. Robinson and Dean 1969; Irwin-Williams and Haynes 1970). Second, soils and the major drainages are important regulators of regional biotic potential. Soils are the substrate for plant life. Chemical and nutrient content and other characteristics of soils regulate the types and numbers of plant species which can grow. Major drainages regulate, to a large extent, the water delivery and availability which is essential for life within the region. Variability in soils and surface hydrology therefore should be important predictors of site locations and densities.

The Soil Conservation Service (SCS) soil classes within this region which served as variables are the Blancot-Notal association (BT), the Huerfano-Muff-Uffens complex (HU), the Doak-Sheppard-Shiprock association (DS), the Avalon-Sheppard-Shiprock association (AZ), the Stumble-Notal complex (SX), and two subclasses of the Doak-Avalon loam (DN1 and DN2) soils, explained below. A surface runoff variable, termed WASH, was also incorporated into the environmental data base. These variables and the general criteria for selection are described in section 2.0 of this report.

SCS (Keetch 1980) and remote sensing analysis techniques were utilized to recognize and extrapolate the occurrences of the eight environmental variables throughout the PRLA study area and its environs. Aerial and satellite remote sensing techniques provide efficient, accurate, and economical means of obtaining environmental data for archaeological studies particularly when the study area is large (cf. Crawford and Keiller 1928; Crawford 1929; Gumerman and Lyons 1971; Gumerman and Johnson 1971; Gumerman and Neely 1972; Tandarich 1975; Lyons and Avery 1977; Ebert and Hitchcock 1977; Drager and Ireland 1979; Fanale and Drager 1979; Camilli 1979; Baker and Gumerman, in press).

There are many types of remote sensors and sensing systems. These may be broadly classified as either image-oriented systems or numerically oriented systems. Image-oriented analyses involve visual interpretation of remotely sensed images such as aerial or satellite photographs. Numerically based analyses rely on mathematical argument for the interpretation of remotely sensed numerical data such as spectral or densitometric values. Both methods have their advantages and drawbacks, depending upon their application to a particular task. Numerically based remote sensing analysis was judged to be most appropriate for this study because:

1. The study area is very large. Computer-assisted analyses of numerical remotely sensed data can accomplish environmental classification of the area in less time and at significantly less cost than visual interpretation techniques.

2. The numerically based environmental classification is developed from explicit, replicable mathematically based argument. Thus classificatory error is quantifiable, whereas observational error in visual analyses is often difficult to quantify.

3. The environmental variables are generated in numerical form, immediately suitable for correlation with the archaeological site frequency data, whereas visually classified environmental data would require cumbersome and costly transformation procedures to produce quantitative variables.

LANDSAT multispectral satellite data were used to classify pedologic and hydrologic variation within the region containing the PRLA study area. LANDSAT II satellite data from an orbital passage over the study area on October 15, 1977 were utilized. The October satellite scene of the study area is highly suitable for examining soil variability, for the annual vegetation is sparse and ground visibility is high, probably ranging between 50-60% during this season. A copy of the computer tape, available at the Technology Applications Center (TAC), University of New Mexico, was utilized for these analyses. The satellite is equipped with a multiple spectral scanner which collects light reflected from the earth's surface in four wavelength bands. Two of the bands are in the visible portion and two are in the near-infrared portion of the electromagnetic spectrum. Reflectance values for each of these four bands are recorded for each pixel, a land surface unit measuring about 50 by 70 meters and containing 0.5 hectares of land. The pixel is the basic observational unit that was used in compiling the environmental data base.

Several analytic steps were necessary to create the environmental data base. First, SCS soil mapping units superimposed on aerial photos of the study area (Keetch 1980) were used as training samples. For each soil class, two to four examples were selected from the photographs which were relatively large in areal extent and which were situated in a distinctive physiographic setting that could be identified and accurately located on the LANDSAT image. The same procedure was followed for the WASH variable. This provided a sample of pixels which represented known soil classes and drainages. The number of pixels sampled for each environmental class ranges from 28 to 106 (Table 7). Second, the spectral values for pixels reflecting soil class were analyzed to derive the signature (the unique spectral characteristics) for each class. A discriminate function analysis, available at TAC in an image processing software package termed STANSORT II (Inglis and Budge 1980), was utilized to derive signatures for each soil class. The same procedures were employed for the spectral characteristics of major washes in the study area. During the course of this analysis, it became apparent that one soil class, the Doak-Avalon association (DN), exhibited two distinctive spectral signatures among the various training samples from the region. This class was therefore subdivided into two soil categories labelled DN1 and DN2.

The discriminate analysis defined, on a statistical basis, the spectral ranges which most strongly differentiated the environmental classes from each other. This does not mean, however, that these spectral ranges for a given class mutually exclude the ranges of others. A test was therefore performed to evaluate the relative accuracy of the discriminate functions in correctly reclassifying spectral values into the appropriate soil or WASH class. The spectral values of each pixel within a series of the training samples were classified according to the discriminate functions and compared with the SCS classifications. The results of this analysis are presented in Table 7.

Table 7. Correspondence between Spectral-based and SCS-based Classifications*

Reflectance Analysis		SCS Classifications: BT	DN2	DS	HU	SX	WASH	Total
BT	Pixels	93	15	6	1	5	0	120
	Percent	77.50	12.50	5.00	0.83	4.17	0.00	100.00
DN2	Pixels	5	22	1	0	0	0	28
	Percent	17.86	78.57	3.57	0.00	0.00	0.00	100.00
DS	Pixels	4	0	60	0	0	0	64
	Percent	6.25	0.00	93.75	0.00	0.00	0.00	100.00
HU	Pixels	0	0	0	51	5	0	56
	Percent	0.00	0.00	0.00	91.07	8.93	0.00	100.00
SX	Pixels	4	0	0	10	30	0	44
	Percent	9.09	0.00	0.00	22.73	68.18	0.00	100.00
WASH	Pixels	0	0	0	0	0	28	28
	Percent	0.00	0.00	0.00	0.00	0.00	100.00	100.00
Total		106	37	67	62	40	28	340
Percent		31.18	10.88	19.71	18.24	11.76	8.24	100.00

*AZ and DN1 were inadvertently omitted when this table was generated.

The results show that agreement between the two classifications ranges between 68 and 100 percent. This range of accuracy is probably conservative, since soil variability is usually not as homogeneous as the SCS map units indicate. In other words, the spectral-value-based measurements are probably sensitive to soil variation within each of the SCS mapping units. On the basis of this evaluation, the spectrally defined classification of the eight environmental types was considered adequate for predictive modeling purposes.

The area incorporated into the environmental data base (approximately 1621 square miles) includes some zones that have not been classified by the SCS. This fact constitutes another reason for using remotely sensed data for environmental classification and analysis. The most recent SCS report (Keech 1980) includes only San Juan County, New Mexico, and excludes that portion of the county within the Navajo Reservation. The PRLA study area, however, extends south into McKinley County, and a portion of the archaeological data base is within the Navajo Reservation (Figure 17). The boundaries of the area spectrally classified and compiled into the environmental data base are shown in Figure 21 as the study area boundary.

4.2.2 Definition of Variables for Modeling

An analytic framework was devised to correlate the archaeological and environmental variables. The procedures utilized here and the subsequent section of this report (5.0) are similar to those devised by Baker and Sessions (1979) in the EPCC study. This study represents a methodological refinement of their approach to site prediction modeling.

In order to perform correlation analyses, a portion of the region defined by the study area boundary and the bulk of the archaeological data as shown in Figure 21 was partitioned into a 2 by 2 kilometer grid system. The grids served as units of observation for measuring the archaeological variables (number of sites/unit) and the environmental variables (number of spectrally classified pixels/unit). The grid system was also necessary to provide units for which site frequency predictors could be modeled.

The 2 x 2 km spatial unit size was selected for several reasons. First, the unit is sufficiently large to capture both on-site and extra-site environmental relationships. As a hypothetical example, Anasazi farmsteads may often be located on aeolian dunes, but always within one kilometer of arable alluvial soils along major washes. In this example, site selection strategies include a fairly complex set of environmental considerations for which on-site criteria (presence of dunes) are not as important as extrasite conditions (presence of arable alluvium and a water supply). If the spatial unit is not sufficiently large, the strong extra-site relationships and the relative numbers of the on-site relationships might not be accounted for in the correlations and thus would weaken the predictive strength of the model. In their previous study, Baker and Sessions (1979) used a 1 x 1 km spatial unit which produced significant but relatively low correlations. An assessment of these results indicates that the methodology yielded valid estimates of site frequencies, but the estimates were based almost entirely upon on-site environmental relationships. These previous findings therefore underlie the selection of the 2 x 2 km unit.

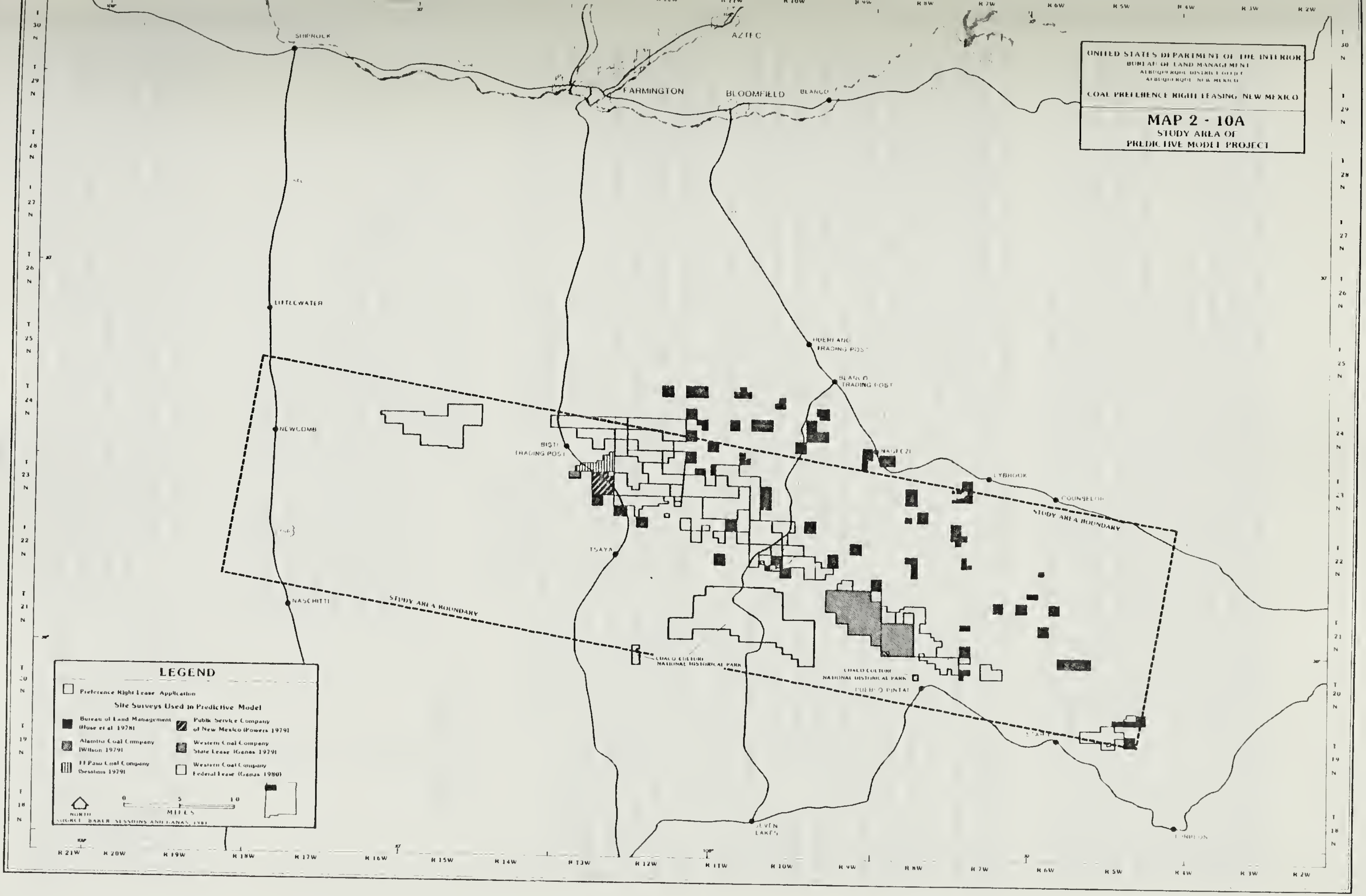


Figure 21. Location of the Classified Environmental Data Base
(courtesy of the Bureau of Land Management, Albuquerque)

Another reason for selecting units of uniform size was for comparability purposes so that the values exhibited by the site and environmental variables would be derived from spatial units of equivalent size. Thus the correlations would not be biased by spatial differences.

The point of origin for the grid system is located in its northwest corner and was referenced on the terrain by a distinctive bend in New Mexico Highway 666, near Bennett Peak. The grid system is aligned with the exterior boundaries of all USGS topographic maps and extends eastward for 1820 kilometers and southward for 1820 kilometers.

The locations of the environmental and archaeological data were registered with each other within the 2 x 2 km grid system. A trigonometric formula was derived to reference accurately the locations of all data within the grids. Data within both sets were spatially defined by the UTM coordinate system. However, these data fell within two UTM zones (12 and 13). The formula served two purposes. First, it re-aligned the UTM coordinate system and eliminated potential locational error caused by interzonal geometric differences resulting from the UTM projection. Second, the formula rotated the UTM grid coordinates to parallel those for the 2 x 2 km grid system. The result of this mathematical function was the production of an undistorted analytical surface on which the environmental and archaeological data are accurately superimposed, and where new data can be entered into the data bases via the UTM coordinate system.

The 2 x 2 km grid also provided the analytical unit to which environmental variables were assigned. The eight original environmental classes which form the basis of these environmental variables were numbered and are listed in Table 8. Four different sets of variables were developed and assigned to the 2 x 2 km grid units.

Table 8. Numerically Ordered Listing of the Environmental Classes as Derived from LANDSAT Data

Class Number	Class Description
1	Avalon-Sheppard-Shiprock Association (AZ)
2	Doak-Avalon Association, Type 1 (DN1)
3	Doak-Avalon Association, Type 2 (DN2)
4	Huerfano-Muff-Uffens Complex (HU)
5	Stumble-Notal Complex (SX)
6	Blancot-Notal Association (BT)
7	Doak-Sheppard-Shiprock Association (DS)
8	Major Washes (WASH)

The first set of variables is based directly upon the eight environmental classes listed in Table 8. The values assigned to each of the variables in this set (Class 1 through Class 8) are specified by the number of pixels spectrally classified into each environmental class within each 2 x 2 km grid unit. The second set of eight variables (Class 1X through Class 8X) were assigned values based on the proportion of pixels per grid unit that were classified into each class. The third set contains

28 variables that represent all unique two-way interactions between the environmental classes (Class 12 through Class 78). The values for each of these variables were derived by multiplying the number of pixels classified into each member of each twoclass set within each grid unit. The fourth set also contains 28 variables and represents all unique two-way interactions between the eight environmental classes (Class CX12 through Class CX78), where the proportional number of pixels classified into each member of each two-class set within each grid unit was multiplied to derive values for these variables. In all, 72 environmental variables were available for correlation with the archaeological data.

There were a number of reasons for developing these four different sets of environmental variables. First, it should be kept in mind that the soil and WASH variables selected for use in this study account for approximately 63% of the land area (see section 2.0). Consequently, a considerable number of pixels were not classified into any of the eight soil and WASH variables, and thus classified pixel frequencies vary among the 2 x 2 km units. Since this was a potential source of error in correlating site and environmental variation, both absolute and proportional classified pixel frequencies were given the opportunity to interact with site frequencies. Second, there are both cultural and environmental reasons for examining two-way interactions among these eight variables. On cultural grounds, it was not known whether site frequencies varied by the absolute or proportional incidence of each variable considered separately, or whether sites were preferentially located in settings where more than one environmental factor had been taken into consideration. In terms of environmental content, very few 2 x 2 km grid units contain only one of the eight classes. The occurrence of two classes is the most common, and the number of grid units containing three or more classes occurs less frequently. Thus the use of two-member sets as environmental variables was chosen as the means by which intra-grid unit environmental variability and its relationship to site frequencies could be taken into account.

4.3 SURVEY SAMPLING METHODS by Mark Ganas and Meade Kemrer

Within the PRLA study area, a new sample survey was conducted which was designed to test and refine the site prediction model. The work is classified as a Class II cultural resources survey by the Bureau of Land Management. A Class II survey is defined as a sample cultural resources inventory designed to provide an objective estimate of the kinds and distributions of sites within a particular study area. Such surveys generate sufficient data to serve as a management and planning tool for predicting cultural resource content of the study area.

Both geographical and methodological criteria were utilized in selecting sample units for the Class II survey. While the Bureau of Land Management permitted flexibility in selecting the placement of samples, the sampling universe was restricted to PRLA areas. There were two reasons for this restriction. First, the archaeological data base from which the initial predictive model was derived contained relatively little information from the PRLA areas. Thus it was deemed essential to improve the quantity of data from the study area for refining the site prediction model. Second, time and budgetary constraints did not permit expansion of the sample universe to any appreciable extent beyond the PRLA areas.

Since a Class II survey (as defined by BLM) required at least a 10% fraction, sampling was proportional to the size of various portions of the PRLA areas. As shown in Figure 1, the lease areas form three spatial clusters, with approximately 70% of the leases located between townships 22 and 24 north, 20% situated between townships 20 and 21 north, and approximately 10% located in the extreme southeastern portion of the study area, between townships 19 and 20 north. The leases collectively contain 75,510 acres of land. The Class II survey covered 11,360 acres or approximately 15% of the leases, with 8320 acres (73.2%) sampled within the northernmost area, 2080 acres (18.3%) surveyed in the central area, and 960 acres (8.5%) sampled from the southernmost PRLA area.

Land jurisdiction also regulated the selection of sample units. Only those areas within the leases where the Bureau of Land Management holds surface ownership were sampled. Indian-alloted lands are also included within the PRLA tracts since the Federal government holds subsurface mineral rights; however, alloted lands were not sampled in order to remain within the time and budgetary constraints allocated for administrative tasks and to avoid project delays related to allottee, agency and tribal permitting procedures.

The 2 x 2 km grid system, which was used as the analytical framework for interacting the archaeological and environmental variables (section 4.2), also served to define sample units and regulate the selection of suitable areas for survey. Based upon the regressions performed in the model development phase, it was clear that each survey sample would have to fill at least 60% of a 2 x 2 km cell (at least 570 acres) in order to provide reliable data for inclusion in model testing and refinement analyses, although it was hoped that smaller fractions would prove to be sufficient for modeling purposes.

The 2 x 2 km cell boundaries did not correspond to those generated by the township-range-section land partitioning system. Wherever possible, whole sections of land which fell entirely within a 2 x 2 km grid unit were selected as sample units, for one square mile (640 acres) would fill approximately 66% of a grid unit. In several instances, sample units containing various combinations of half and quarter sections were constructed in order to meet the necessary spatial requirements. In all cases, however, regular parcels of land as defined by the township-range-section system were utilized as sample units. This resulted in survey boundaries which could be accurately located in the field by section and quarter section brass caps, and the survey units could be easily expresed in terms of land unit systems utilized by the Bureau of Land Management. The application of these sample unit size and boundary criteria, however, reduced the number of areas suitable for sampling within the PRLA tracts.

Another criterion applied to the selection of sample units for survey was based upon the results of the initial predictive model. Since the primary objective of the Class II survey was to evaluate and refine an existing model, it was considered essential to sample predicted cultural resource variability within the PRLA study area. Thus sample units which were predicted to contain relatively high and low frequencies of lithic, Anasazi, and Historic sites, and meeting all the previously described criteria were selected for survey. In several cases within the PRLA tracts, no predictions were made by the initial predictive model because of insufficient archaeological or environmental data. Two sample units were therefore selected within these no-prediction areas in an attempt to increase the number of predictions in the final model.

The selection of grid units for survey was not random for two principal reasons. First, the application of the criteria pertaining to (1) PRLA lease cluster fraction, (2) land jurisdiction, (3) size and location of sample units within the 2 x 2 km grid system, and (4) sampling the range of predicted cultural resource variability, greatly reduced the number of parcels within the PRLA study area eligible as sample units. Moreover, these suitable units were not randomly distributed and therefore were not areally representative of the entire PRLA study area. Second, a large majority of the site-environmental observations compiled into the data bases for predictive modeling purposes came from areas which cannot be considered randomly distributed vis-à-vis the PRLA study area. Rather, the reliability of the model is based, in part, on the fact that the predictions are derived from a large number of observations within the region. Since the samples from the study area could not substantially offset sampling bias, random sampling was considered irrelevant. Therefore, the primary objective was to collect additional reliable site-environmental observations from an area where relatively few tract-type surveys had been conducted and thus refine predictions of archaeological variability and content within the PRLA study area. As a consequence of this approach to sampling, access could be taken into consideration in the final selection of sample units. Time constraints required that all sample units be within one mile of a road. However, this criterion was applied in very few instances, since the study area is almost entirely accessible by the numerous roads which traverse this region.

Eighteen sample units were selected and are listed below in Table 9. The paired sample unit numbers refer to their row and column location within the 2 x 2 km grid system. As discussed in section 4.2, the origin of the grid system is its northwest corner, near Bennett Peak northwest of the PRLA study area. Row numbers thus increase to the south and column numbers increase to the east. For each sample unit, the first number refers to its column location and the second refers to its row location. Figure 22 shows the locations of these sample units.

Table 9. Sample Units and Sizes Selected for Survey

Sample Unit Number	Size (in acres)	Sample Unit Number	Size (in acres)
30-10	640	40-10	640
31-10	640	40-11	640
37-10	640	40-14	640
37-11	640	50-19	800
38-10	640	52-19	640
38-11	640	54-22	640
39-9	640	57-23	640
39-13	640	65-31	480
40-9	640	66-31	480

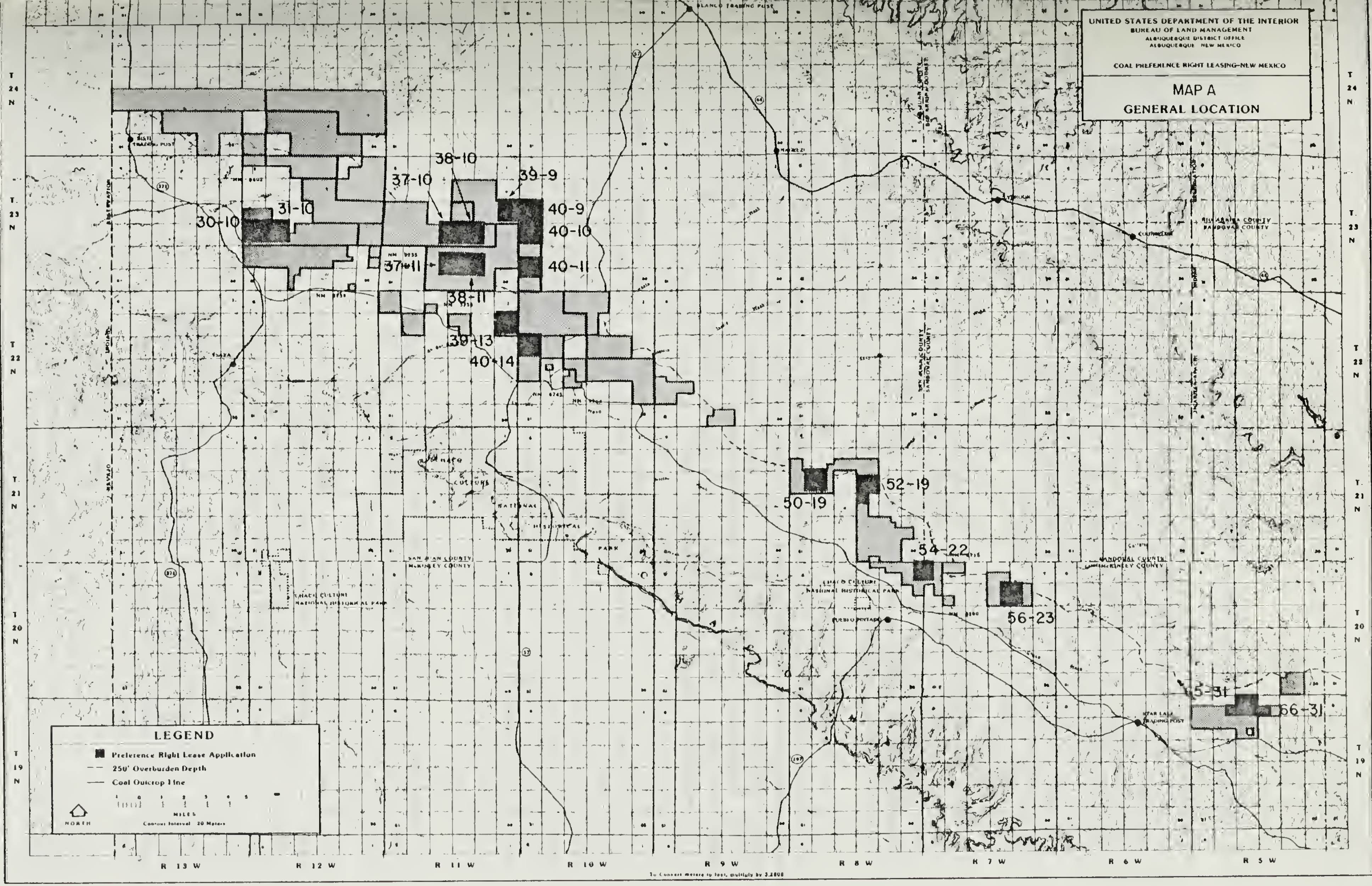


Figure 22. Locations of Survey Sample Units in the PRLA Study Area (courtesy of the Bureau of Land Management, Albuquerque)

4.4 FIELD METHODS by Nancy Hewett Cella

Two crews of four surveyors each performed the cultural resources inventory survey. During the initial field session, several days were devoted to surveying as one crew in order to standardize field methods and thus achieve comparable results. Individuals having specific skills in identifying ceramics, lithics, or historic artifacts were assigned crew membership so that both crews possessed equivalent in-field analysis capabilities. For the majority of the survey parcels, the two crews worked separately; on occasion crews surveyed together on particular units, or recorded large sites together.

An intensive 100% coverage of all parcels was conducted. Each crew walked parallel transects across the parcels; spacing between individuals varied from 15 to 30 meters according to terrain and ground visibility. Complete coverage was assured by placing pin flags on the outermost edge of each transect. The flags were then recovered on the return transect.

Upon encountering a site, the crew inspected the area in the immediate vicinity to ensure that all features were recorded. Features and artifacts were marked with blue and red pin flags respectively, until the sketch map was prepared and the site photograph taken. For mapping purposes, distances were paced, and Brunton or Silva compasses were used to take bearings. Sample transects, when utilized, were marked with red flags and noted on the site maps.

The locations of sites and isolated occurrences were marked on a set of USGS 7.5' quadrangle maps upon which the sample unit boundaries had been drawn. Portions of the site and isolated occurrence data were recorded in the field on BLM Cultural Resource Inventory Record (CRIR) forms. A separate Laboratory of Anthropology form was also completed in the field for each site. Steno notebooks were provided to each crew member for recording environmental and any other pertinent information encountered during the survey. Other data were recorded on the CRIR forms in the laboratory.

As requested by the BLM, unique artifacts or materials requiring further laboratory identification were collected. These items are stored at the BLM District Office in Albuquerque.

Field identifications of ceramics were performed by Daisy Levine and Mark Ganas. Their ceramic classification system is consistent with that described in section 3.3. Lithic material types were identified during the first field session by Richard Loose, and his typology was followed in subsequent field sessions. He also analyzed those projectile points collected during the course of the survey. In-field lithic technological analyses were performed by Alexa Roberts, William Brancard, and David Simons. A file search was conducted prior to the survey, and copies of reports documenting previous surveys in adjacent areas were available to the field crews.

Field work on one sample unit was terminated shortly after commencement because of problems with a grazing leaseholder. Several sites were recorded (see Appendix 1) and were submitted to BLM separately from the

Sample Unit Reports. Another suitable sample unit was selected and inventoried.

The following information was submitted to the BLM District Office in Albuquerque:

1. Site forms including sketch maps of each site

2. Description of each sample unit including an enlargement of that portion of the quadrangle map showing the location of all sites and isolated occurrences

3. Set of 7.5' quadrangle maps showing the location of all sites and isolated occurrences

4. Photographs of each site and two of the isolated occurrences

5. All collected artifacts

Sites were differentiated from isolated cultural occurrences on the basis of information potential. A site was defined as a locus manifesting the outcomes of past human behavior which contained more identifiable or potential scientific data values than could be effectively extracted at the time of survey. Isolated occurrences were defined as those cultural manifestations whose scientific data values could be adequately documented by the survey. These cultural resources are described in detail in Appendix 1 of this report.

4.5 SYNOPTIC SURVEY RESULTS by Nancy Hewett Cella and Meade Kemrer

This section summarizes the survey data by site and component counts, and temporal and functional classifications of the cultural resources. Appendix 1 presents a more detailed discussion of the resources within each sample unit.

The area surveyed covered 17.75 square miles (45.97 square km) and is located generally northwest, north and northeast of Chaco Canyon. The crews began surveying parcels near Tsaya Trading Post (near New Mexico Highway 371) and moved eastward. The distribution of sample units within the PRLA lease areas is shown in Figure 1.

Sample units were numbered by their column and row membership within the 2 x 2 km grid system. For example, Sample Unit 30-10 is located within the 2 x 2 km cell specified by the intersection of column 30 and row 10. Individual sites were numbered sequentially in the order in which they were discovered. Site 30-10-1 is the first site recorded during the survey of Sample Unit 30-10. Base maps showing the 2 x 2 km grid system are found in Appendix 4.

Ninety-two sites and 213 isolated occurrences were recorded within the sample units. Three additional sites and six isolated occurrences were recorded in an incomplete survey of another sample unit (44-15). The number of sites and isolates found within each sample unit is shown in Table 10. The data from Sample Unit 44-15 are omitted from the subsequent summary of the resources since they do not constitute tract-type information.

The distribution of component densities recorded by the sample survey by major cultural/temporal periods (section 3.0) is presented in Table 11. Both sites and isolated occurrences are combined in this summary. Sites containing stone artifacts but lacking sherds or identifiable projectile points have been included in the lithic category. The Archaic and PaleoIndian classifications have been applied to sites where culturally/temporally diagnostic projectile points were found in association with chipped and/or ground stone artifacts.

In order to make appropriate comparisons with other surveys in the area, Table 12 presents the cultural density figures using only site components, excluding isolated occurrences.

Eleven of the 92 sites have multiple components. Table 13 gives a breakdown of component associations for these sites.

PaleoIndian

One probable PaleoIndian site (40-14-2) was found in a setting similar to other lithic scatters dated to later periods. The artifacts at this limited activity site indicate initial testing of local materials, some primary lithic reduction, and biface and tool manufacture. The base of a silicified wood projectile point has been identified as Midland (or Belen) which dates to the 8000-6000 BC interval (Cordell 1979:15). Lithic material diversity is high in the moderately dense chipped stone assemblage. This site is probably a hunting camp.

Table 10. Site and Isolated Cultural Occurrence Distributions in the Sample Units

Sample Unit Number	Acres	Sites	IOs
30-10	640	9	41
31-10	640	6	16
37-10	640	5	10
37-11	640	5	7
38-10	640	2	6
38-11	640	0	10
39-9	640	6	13
39-13	640	15	15
40-9	640	8	11
40-10	640	10	13
40-11	640	0	4
40-14	640	10	23
50-19	800	0	7
52-19	640	4	5
54-22	640	3	10
57-23	640	3	8
65-31	480	2	6
66-31	480	4	8
Totals	11,360	92	213

Table 11. Total Component Density by Time Period

	Components	Density/mi^2	Density/km^2
PaleoIndian	1	.06	.02
Archaic (all phases)	10	.56	.22
Lithic	131	7.38	2.85
Anasazi	75	4.23	1.63
Navajo/Historic	102	5.75	2.21
Totals	319	17.97	6.93

Table 12. Site Component Density by Time Period

	Components	Density/mi^2	Density/km^2
PaleoIndian	1	.06	.02
Archaic	8	.45	.17
Lithic	34	1.91	.74
Anasazi	31	1.75	.67
Navajo/Historic	29	1.63	.63
Totals	103	5.80	2.24

Table 13. Multiple Component Sites

Site Number	Earlier Component(s)	Later Component(s)
31-10-5	P-II sherd and lithic scatter	Historic trash
30-10-1	En Medio point and artifact scatter	Historic trash
37-11-4	Unknown lithic scatter	Coal pile and tire tracks
39-13-1	En Medio point and lithics	P-II/III sherds
39-13-3	Unknown lithic scatter	Late 19th century Navajo homestead
39-13-4	Lithic scatter with En Medio point	P-II/III sherds, cairn
39-13-6	Unknown lithic scatter	bottles
39-13-8	Late Archaic lithics	P-II/III sherds
39-13-12	P-II/III sherds and lithics	cairn
40-14-5	P-II sherds and three two-hand manos	Navajo sheepherder's camp
54-22-2	P-II field house and artifacts	Three cairns

Other evidence of PaleoIndian occupation within the surveyed parcels was found at 39-13-1 in the form of a reworked point tentatively identified as Belen or a Cody Complex variety. It was found near Cluster 1, which has been defined as a probable activity area where tool maintenance and final manufacture took place. The greyish brown chalcedonic petrified wood point has clearly been modified; shallow notches have been added and the proximal edges have been retouched. It appears that it may have been used as a hafted knife of some form. This artifact is in ambiguous context; spatially it was found at the edge of Cluster 1, but "the artifact may have eroded out of the edge of the dune formation east of the blowout" (field notes). The cluster contained principally lithics and a small number of sherds, one of which was identified as Gallup B/W (P-II). The site has been included in both Anasazi and Archaic categories by virtue of a projectile point (En Medio) and ceramics (P-II/III) in other clusters.

The sample survey data essentially document minimal use of the PRLA area during the PaleoIndian Period. This is consistent with the findings of previous surveys in the San Juan Basin (section 3.1).

Archaic and Unknown Lithic

Forty-two site components were placed in the lithic category (Table 14). Eight sites were assigned to the Archaic Period (5500 BC-AD 400) on the basis of diagnostic projectile points. Thirty-four sites were classified as unknown lithic sites since they contained no ceramics or identifiable projectile points. Fifteen of these scatters contain ground stone and therefore probably postdate the PaleoIndian period. One site has been tentatively assigned to the late Archaic/early Basketmaker Period on the basis of a slab metate and biscuit mano.

Table 14. Lithic Site Components (excludes PaleoIndian site)

	Components	Density/mi2	Density/km2
Bajada, Bajada/San Jose	2	.11	.02
Armijo	1	.05	.02
En Medio	5	.28	.11
Unknown Lithic	34	1.97	.76
Totals	42	2.31	.89

The proportional distribution of site frequencies by phase within the Archaic Period differs somewhat from previous survey coverage in the region (section 3.2). No Jay phase (5500-4800 BC) sites were recorded, while only one possible San Jose phase (3200-1800 BC) site was identified in this survey. The San Jose phase has normally been the most populous class of Archaic sites in other surveys. The proportionally high incidence of En Medio phase (800 BC-AD 400) sites, however, is consistent with previous studies.

A number of factors could account for these discrepancies. The overall low incidence of datable Archaic sites could introduce sampling error into these apparently biased site frequencies. That is, the number of datable sites may be too small to be meaningful when comparing proportional site incidence by phase with other surveys.

Cultural ecology could have created sampling error. Sites were assigned to a particular phase of the Archaic Period on the basis of diagnostic projectile points. These artifacts are related to large game hunting activities. The environment within the PRLA area consists largely of badlands and soils unsuitable for sustaining high quantities of plant life, and probably exhibits a lower large game carrying capacity than the surrounding areas. Consequently, the intensity with which hunting activites were conducted or supported by hunter-gatherer groups utilizing the PRLA survey area would have been lower than adjacent areas.

This contention is supported by the functional distribution of Archaic and unknown lithic site components presented in Table 15.

Table 15. Functional/Temporal Correlation for Archaic and Unknown Lithic Site Components

Site Function	Number	Temporal Period
Large camp	1	possible Bajada or San Jose
Small camps	6	3 unknown lithic, 1 Armijo, 2 En Medio
Plant processing	13	12 unknown lithic, 1 Late Archaic/Early Basketmaker
Plant procurement	6	unknown lithic
Lithic procurement	9	1 En Medio, 8 unknown lithic
Hunting camps	7	2 En Medio, 1 Bajada, 4 unknown lithic

As shown in this list, plant procurement and processing sites are the most numerous functional classes and the least culturally/temporally diagnostic. Only one Archaic multiple function large base camp was identified in this survey, and the number of sites related exclusively to hunting is small. A discussion of the criteria for these functional assignments is presented in section 3.2

Anasazi

Thirty-one Anasazi site components were inventoried during the Class II survey. A cultural/temporal density distribution is presented in Table 16. For a discussion of these phases, see section 3.3. Assignment to a particular phase is based on ceramics associated with these sites.

Table 16. Anasazi Site Component Density by Phase

	Components	Density/mi^2	Density/km^2
Basketmaker III	1	.04	.02
Pueblo I-II	2	.11	.04
Pueblo II	18	1.01	.39
Pueblo II-III	10	.56	.22
Pueblo III	0	-	-
Total	31	1.75	.67

The proportional incidence of Anasazi sites by phase is consistent with previous studies in the region (section 3.3). The Anasazi sites were placed in the same functional categories defined for Archaic and unknown lithic sites as well as other functional classes. This distribution is shown in Table 17.

Table 17. Functional/Temporal Anasazi Site Component Distribution

Site Function	Number	Temporal Period
Main camp	1	BM-III through P-III
Small camps	3	1 P-II; 2 possible P-II
Plant processing	6	5 P-II; 1 Late P-II
Plant procurement	3	P-II
Lithic procurement	1	P-II
Hunting camp	1	P-II/III
Field houses	2	P-II; 1 possible P-II
Sherd scatters on the Chacoan North Road	8	3 P-II; 1 P-I/II; 4 P-II/III
Sherd scatters not on the Chacoan North Road	3	P-II
Pithouse (?)	1	BM-III
Small sherd scatter	1	Near small camp with lithics, En Medio point and reworked PaleoIndian point
Ten room pueblo	1	P-II

The Anasazi period displays a greater variety of site types in the survey area than other cultural periods.

Many of the Anasazi sites are spatially associated with the Chacoan North Road which traverses two of the sample units. All of these fall within the Pueblo II-early Pueblo III phases (AD 1000-1150). The sherd scatters exhibit a few general patterns. Except for 39-9-2, the number of utility sherds (both plain graywares and corrugated types) equal or exceed the number of plain and decorated whiteware sherds. At 39-9-2, there are about twice as many plain and decorated whitewares as utility sherds. At four sites, there is an unusually high diversity of decorated types vis-a-vis the number of sherds at the site or in a grab sample. Except for two sites, lithics are absent or very sparse. These two sites exhibit lithic assemblages which could be functionally classified as plant processing locales. One of these (39-13-1) is a multiple component site. One cluster at this site has sherds and ground stone in association, but at the other (39-13-8), the sherds are spatially separated from the chipped and ground stone artifacts. It is therefore uncertain that these two road-associated sites functioned as plant processing locales. No features were found at any of the road-associated Anasazi sites. All of these characteristics contrast with those exhibited by Anasazi resources identified during the course of the survey which are not associated with roads. It is likely, therefore, that the road-associated sites represent a functionally and behaviorally unique resource class which warrant additional archaeological attention, particularly in terms of understanding how this prehistoric road network was used by Anasazi groups.

Structural remains at Anasazi sites were rarely found, and when present, are adjacent to water sources and arable soils. The ten room pueblo (39-9-5) is near Pierre's Chacoan community, an outlier associated with the North Road.

Historic Period

All the Historic Period sites inventoried during the survey appear to be Navajo. As shown in Table 18, the sites were generally occupied in the twentieth century, and none predate the late nineteenth century.

Table 18. Temporal Distribution of Historic Navajo Site Components

Time Interval	Components
1880-1950	2
1907-1940	1
1933-1940	1
1940-1950	1
Post-1933	3
Post-1940	3
Post-1950	10
20th century	8
Total	29

The proportionally high frequencies of Navajo sites dating to 1933 or later are consistent with data from other surveys in the off-reservation portion of the San Juan Basin (section 3.4). The absence of pre-1868 Navajo sites is also explicable. None of the sample units have pre-Fort Sumner Navajo site selection criteria, particularly landforms which provide seclusion and high visibility of the surrounding terrain (section 3.4). The functional distribution of the Navajo sites, presented in Table 19, shows that sites are largely related to herding activities.

Table 19. Navajo Site Component Types

Type of Site	Components
Large habitations	5
Small habitations	6
Sheep herders' camps	6
Summer camps or shelters	3
Corral	1
Cornfield	1
Trash dumps	3
Cairns	3
Roadside party	1
Coal pile and tire tracks	1
Total	29

General Observations

Site and isolated occurrence frequencies are interrelated among the sample units. Pearson's r correlation coefficient values were obtained between two variables, site component frequency (x) and isolated occurrence frequency (y), within each of the 18 sample units. Three separate site and isolated occurrence component classes were evaluated: prehistoric components, historic components, and all components. The two variables were analyzed on a component basis since there were a number of multiple component sites. The data and the results of these analyses are presented in Table 20 (next page).

As shown in Table 20, the highest correlation coefficient value was obtained for the prehistoric components. This value is significant beyond the .01 level of confidence (Young and Veldman 1965:420), while the coefficient values for all components and historic components are not significant at the .05 level of confidence.

This analysis suggests that variability in prehistoric usage intensity among the 18 sample units is measurable by both site and isolated occurrence frequencies. This study also suggests that prehistoric sites and isolated occurrences are behaviorally and spatially related. It is likely that the extremely limited activities which produced the isolated occurrences were performed by occupants of nearby sites.

Conversely, neither of these interpretations appear to apply to Historic Period resources. Historic site and isolated occurrence component frequencies vary more independently of each other in the sample units. This may be due to a land use system that differs markedly from that utilized by prehistoric groups. Navajo livestock herding and some farming constitute the major historic land use activites identified among the isolated occurrences in the survey data. The distances from the occurrence of these activities to the nearest habitation site varied considerably. Intensity of performance of these activities within any particular sample unit also varied greatly.

Table 20. Co-variation between Site and Isolated Occurrence Component Frequencies

	Prehistoric		Historic		All Components	
SU Number	Sites	IOs	Sites	IOs	Sites	IOs
30-10	8	33	2	8	10	41
31-10	6	10	1	6	7	16
37-10	5	9	0	1	5	10
37-11	5	7	1	0	6	7
38-10	2	5	0	1	2	6
38-11	0	6	0	4	0	10
39-9	3	10	3	3	6	13
39-13	18	13	4	2	22	15
40-9	5	5	3	6	8	11
40-10	10	13	0	1	10	14
40-11	0	1	0	3	0	4
40-14	9	15	2	9	11	24
50-19	0	5	0	2	0	7
52-19	0	1	4	4	4	5
54-22	1	3	2	7	3	10
57-23	0	4	3	5	3	9
65-31	0	3	2	3	2	6
66-31	2	0	2	8	4	8
Totals	74	143	29	73	103	216
	(r = 0.624)		(r = 0.327)		(r = 0.480)	

5.0 PREDICTIVE MODEL DEVELOPMENT AND EVALUATION

5.1 DEVELOPMENT OF THE INITIAL MODEL by Craig Baker and Steven Sessions

The primary focus of this study was to develop and refine methods which formally predict archaeological site component densities across the landscape of a large study area. The formula used here for modeling site component densities is the linear equation:

$$Y = C + B_1X_1 + B_2X_2 + \ldots \quad B_nX_n + E$$

The formula means that the various observed site densities (the dependent or Y variable) are the direct result of summing a set of weighted (B_1,B_2 etc.) independent environmental variables (X_1,X_2 etc.). The line of the equation which the B_nX_n variables best fit is established by a constant (C) and an adjustment for observational error (E).

The B weights adjust for two factors at work among the environmental variables; differences in the methods by which values for the environmental variables were calculated, and differences in the nature and relative importance in accounting for variability in site frequencies. As discussed in section 4.2, the classified pixels were calculated on the basis of actual as well as proportional frequencies within the grid units. Values for absolute pixel frequencies range from 0 to 1143, while the value of proportional frequencies must be between 0 and 1. Clearly the unadjusted values are not comparable to one another. Therefore, one function of the B values was to standardize both types of variables and render them comparable for interaction with the archaeological data. The B values also reflect the relationship of the variables to site frequencies. Some variables correlate positively and others are negatively correlated with site frequencies. Therefore B values were assigned positive or negative signs, depending upon their direct or inverse relationship with site frequencies. Finally, the magnitude of the B values reflect the relative importance of the variables as predictors of site frequencies. The B values and constant C were derived through regression, which specified values which best fit the observed site frequencies.

The E term of the equation is a variable derived from residual variation in site frequencies that could not be accounted for by the environmental variables which entered the equation. To derive values for this variable, the differences between predicted and observed site frequencies were compiled. Another set of regressions which included this error variable was then computed. This variable served two purposes. It provided a formal measure of the collective strength of site-environmental relationships, for the value of E in the equation decreases as the amount of variance explained by the environmental variables increases. Second, E was also considered to be part of the model, since it represented a portion of the unexplained variability in site frequencies that, when summed together with the constant C and the weighted environmental variables B_nX_n, would improve the predictive characteristics of the model.

An important property of this model requires explication. As indicated by the variable weights (B), the constant (C) and error value (E), this model does not explain in a cultural ecological sense the relationship between site location and environmental content. The sociocultural reasons for locating sites in certain settings are, strictly speaking, beyond the scope of this project and will undoubtedly continue to be an important topic for future archaeological and historical research within the San Juan Basin. Rather, this model is an attempt to identify the degree to which environmental variability (as defined here) accounts for site density variability within and adjacent to the project area, and based upon these results, the degree to which it can generate reasonably accurate site frequency predictions.

The 72 independent (X) environmental variables have been described in section 4.2. The eight dependent (Y) site component variables have been described in section 4.1 and are listed in Table 21.

Table 21. Archaeological Variables

Site Type Number	Brief Description
1	Lithic Sites
2	Anasazi Sites
3	Pre-1933 Navajo Sites
4	Post-1933 Navajo Sites
5	Anglo/Spanish Sites
6	Unknown Historic Sites
7	Total Navajo Sites
8	Total Sites

The 2 x 2 km grid unit was utilized to assign values to the eight archaeological variables. For each site type, the number of site components within each grid unit was used as a dependent variable value. A unique set of values within the equation was derived for each of the eight archaeological variables.

The first problem addressed in the model-building procedure was to reduce the large number of environmental variables. This was necessary for statistical reasons stemming from the characteristics of the archaeological and environmental data bases. In multiple regression analysis, it is imperative that the independent variables accepted for membership within the equation truly covary with the dependent variable rather than covarying by chance alone. The odds of selecting false variables are high when the number of independent variables is large and the number of observations for each of the dependent variables is relatively small. The principal reason for this is sampling error in the archaeological data, where there may be too few observations to accurately estimate site density variation within each of a large number of environmental conditions. Such conditions clearly obtained here, for the number of 2 x 2 km cells containing 100% archaeological survey coverage was small, and the number of environmental variables (72) was extremely large. The risk of accepting false independent variables was therefore extremely high. The number of environmental variables was reduced to a statistically acceptable number by allowing all 72 variables an opportunity to correlate with the largest number of observations possible within each of the eight archaeological variables. For this initial analysis, 2 x 2 km grid squares containing 20% or more archaeological coverage were utilized. The number of observations (i.e., grid units) was 122, a sufficiently high number for this initial regression. In order to utilize this number of observations, however, a certain amount of observational error had to be accepted. For those grid units where survey coverage was less than 100%, the archaeological content of the entire unit was estimated based on proportion surveyed. For example, if a grid unit contained 20% actual survey coverage and one lithic site was recorded, the estimated number of lithic sites for the entire unit would be five. Since the underlying assumption that site frequencies are homogeneously distributed within all grid squares is almost certainly untrue, there is some error in these weighted site estimates. The amount of error is not the same for all 122 units, since accuracy would increase with increased unit coverage. However, it is likely that these estimates are reasonably correct in terms of relative site density per grid unit and can be used as crude, but not completely accurate, set of observations.

Backward stepwise multiple regressions were conducted for each of the eight archaeological dependent variables. This procedure starts with all 72 environmental independent variables initially in the equation and eliminates one variable at each succeeding step until only those variables that are significant at the 0.1 level (i.e., a 90% probability that the variable truly covaries with site frequencies) are retained within the equation. Thirty-eight environmental variables were eliminated, leaving 34 variables which had entered at least one of the eight regression equations at the 0.1 level of significance.

The resulting equations varied in terms of the relative strength of site-environmental relationships. The basic measure of covariation between the dependent and independent variables is Pearson's _r_ correlation coefficient, which ranges between -1.00 (a perfect inverse correlation) to 1.00 (a perfect direct correlation). The measure utilized here, termed _explained variance_, is derived from Pearson's _r_, and represents the degree to which variation in Y accounts for the variation in X and vice versa. This measure is calculated by the value of _r_ squared, is expressed as a percentage, and is assigned the symbol R^2. For example, if the _r_ correlation between lithic site frequencies and a set of environmental values is .90, the explained variance is 81%, an extremely strong relationship. A synoptic listing of the results of this initial set of regressions is presented in Table 22.

The next step in the model-building procedure was to utilize the 34 environmental variables remaining after the initial regressions, and the archaeological data from 2 x 2 km grid units which contained 40% or more survey coverage. The objectives in this second set of regressions were to evaluate not only the predictive strength of the environmental variables but also the extent to which error within the site estimates for partially surveyed grid units had lowered explained variance values. A total of 87 grid units within the archaeological data base contained at least 40% survey coverage. Again the backward stepwise multiple regression procedure was employed. The results of these regressions are presented in Table 23.

Table 22. Backward Stepwise Regression Against 2 x 2 km Cells Containing More Than 20% Survey Coverage

Site Type	Environmental Variables Significant at 0.1	Explained Variance (R^2)
1. Lithic	28	33%
2. Anasazi	29	34%
3. Pre-1933 Navajo	34	76%
4. Post-1933 Navajo	6	5%
5. Anglo/Spanish	3	2%
6. Unknown Historic	28	51%
7. Total Navajo	25	21%
8. Total Sites	30	34%

Table 23. Backward Stepwise Regression Against 2 x 2 km Cells Containing More Than 40% Survey Coverage using 34 Environmental Variables

Site Type	Environmental Variables Significant at 0.1	Explained Variance (R^2)
1. Lithic	16	31%
2. Anasazi	13	36%
3. Pre-1933 Navajo	19	38%
4. Post-1933 Navajo	11	43%
5. Historic Anglo/Spanish	3	17%
6. Unknown Historic	19	48%
7. Total Navajo	17	42%
8. Total Sites	18	48%

A comparison of the results in Table 23 with those presented in Table 22 reveals a number of important findings. First, the R^2 values are generally higher in the second set of regressions, indicating that weighted site estimates for cells containing 20 to 39% coverage contain more error than those with more than 40% coverage. Second, the number of variables entering each of the eight equations at the 0.1 level of signficance generally drops in the second set of regressions, indicating that error in the archaeological variables caused the inclusion of some irrelevant environmental variables into the initial equations.

Another set of multiple regression analyses was performed with the archaeological data from grid units containing 40% or more survey coverage. In this series of analyses, all 72 environmental variables were again utilized. The purpose of this procedure was to evaluate the effectiveness of the first set of regressions in eliminating the bulk of those environmental variables which do not truly contribute to site-environmental covariation by using the maximum possible number of archaeological observations (grid units). The results were dramatically clear, for the R^2 values for all eight regressions were 100%. Again, only those environmental variables which correlated at the 0.1 level of significance were incorporated into these regressions. Clearly this set of analyses produced inflated correlation values caused by the use of too few archaeological observations which allowed some environmental variables in the regression equations to covary with the archaeological variables strictly by chance.

These results demonstrate that the larger number of observations utilized in the first set of regressions, although they contained more observational error, successfully eliminated unimportant environmental variables.

Based on the findings from the first two sets of regressions, another set of analyses was performed to derive the initial model (termed Model I). Since R^2 values increase with increased survey coverage within the cells (Tables 22 and 23), this set of regressions utilized only those 2 x 2 km grid units containing 60% or more coverage. A total of 54 observations (grid units) met this criterion. Again the 34 environmental variables selected by the first regressions were utilized. A synopsis of the results is presented in Table 24. Again, only those variables which correlate at the 0.1 level of significance were accepted in the regression equations.

Table 24. Backward Stepwise Regression Against 2 x 2 km Cells Containing More Than 60% Survey Coverage

Site Type	Environmental Variables Significant at 0.1	Explained Variance (R^2)
1. Lithic	20	71%
2. Anasazi	19	62%
3. Pre-1933 Navajo	26	86%
4. Post-1933 Navajo	21	71%
5. Historic Anglo/Spanish	19	64%
6. Unknown Historic	17	52%
7. Total Navajo	18	75%
8. Total Sites	26	79%

As shown in this table, R^2 values increase over the previous analyses (Tables 22 and 23). However, more environmental variables generally enter each of the eight equations than for those shown in Tables 22 and 23, indicating that the R^2 values in Table 24 may be inflated somewhat by variables which covary by chance alone due to a decrease in the number of archaeological observations (grid units).

The statistical characteristics of this set of regressions are, however, empirically acceptable for using these equations to predict site frequencies in the region. More than half of the variance in all eight equations is accounted for by the weights (B values) generated by the environmental variables, which means that less weighting was assigned to the constant (C) and the error (E) terms of the equation. Thus the site-environmental relationships are stronger components in regulating site density variation than the C and E components which adjust the environmental values to fit the archaeological data. The variables entering each of the eight equations, as well as the C and E values are listed in Appendix 2.

5.2 MODEL REFINEMENT AND EVALUATION by Craig Baker, Steven Sessions and Meade Kemrer

The set of regressions derived from the model development phase (Appendix 2) was utilized to generate site frequency predictions within and adjacent to the PRLA study area. Predictions were made for each of the eight archaeological variables (Table 21). The predicted values were calculated separately for each 2 x 2 km grid unit containing classified pixels. For each of the eight equations, the observed value of each environmental variable which entered the equation was multiplied by its weighting value (B) and summed with the appropriate error (E) weight and constant (C) values to produce a predicted site frequency value. No predictions were therefore made for those grid units containing only environmental variables which did not enter any of the equations, or for grid units located beyond the boundaries of the environmentally classified zone (Figure 21), or units which contained only unclassified pixels. These predicted site frequencies are therefore derived strictly from environmental content within each grid unit with no direct reference made to any archaeological survey data.

Site predictions were made for 813 grid units. Eight maps showing the predicted site frequencies within and adjacent to the PRLA study area were developed, one for each of the eight archaeological variables. These maps served as guides for the selection of survey parcels designed to test and refine the predictive equations (section 4.3). Another set of multiple regressions was produced following the field session. The archaeological data from the Class II survey were added to the cultural resources data base and were regressed against the 34 environmental variables. The procedures utilized were identical to those described in section 5.1 of this report. A listing of the number of variables entering the predictive equations and the explained variance (R^2) values are presented in Table 25.

Table 25. Backward Stepwise Regressions Against 2 x 2 km Cells Containing More Than 60% Survey Coverage including the PRLA Class II Data

Site Type	Environmental Variables Significant at 0.1	Explained Variance (R^2)
1. Lithic	22	64%
2. Anasazi	23	65%
3. Pre-1933 Navajo	24	68%
4. Post-1933 Navajo	15	46%
5. Unknown Historic	20	53%
6. Total Navajo	18	57%
7. Historic Anglo/Spanish	21	52%
8. Total Sites	21	60%

The environmental variables entering each of the eight equations, their B weights, and the vålues assigned to the constant (C) and error (E) values are presented in Appendix 3.

A comparison of Tables 24 (Model I) and 25 (Model II) shows that the R^2 values are generally lower for Model II. This may well support the notion that the Model I R^2 values may have been artifically inflated by variables which entered into the regressions by chance alone, because there were too few grid units containing 60% or more survey coverage (section 5.1). The Class II survey data added 15 observations, raising the total number of grid units from 54 to 69, an increase of approximately 22%. The new archaeological data provided more site density observations for the archaeological variables, and thus decreased the odds of accepting false environmental variables.

Three of the 18 sample units could not be used as effective observations because they were located in areas containing environmental variation exceeding that utilized in this study. As discussed in section 4.3, four sample units were selected in areas where Model I could not make predictions. Two conditions could cause this: lack of environmental data, or lack of archaeological observations within particular classified environmental data. It was impossible to determine prior to fieldwork which of the two conditions applied to the no-prediction areas. However, in order to maximize the number of predictions within the PRLA study area, one of the two conditions could be fulfilled by inventorying grid units in which Model I had not made predictions. The archaeological data from from one of the four sample units interacted with the environmental data base, indicating that this unit had supplied the requisite archaeological information for model building purposes.

There appears to be no overwhelming trend with regard to the number of environmental variables entering the equations of Model II. A comparison of Tables 24 and 25 shows that the number of variables increases for five archaeological categories, and decreases for three site types.

Despite the fact that the Model II R^2 values are lower, its predictive characteristics are somewhat better than those of Model I. One proposition evaluated was whether or not the low number of archaeological and environmental observations within the PRLA study constituted a serious deficiency in the development of Model I. A comparison of Model I and Model II predictive error described as the sum of the differences in observed from predicted site frequencies for the 15 Class II sample units is presented in Table 26. These results clearly show that data from the PRLA study area were essential for adequate modeling, for the predictive error is substantially lower in the Model II data.

The reader may wonder why there is any predictive error in the Model II values shown in Table 26, since archaeological and environmental data from these 15 sample units were utilized in developing the second model. Although these data were indeed used, along with data from 54 other grid units to generate the regression equations, the predictions were derived from the eight Model II regression equations which utilized the environmental content of each of the 15 sample units to estimate site frequencies within each unit.

Table 26. Model I and Model II Site Prediction Error within the 15 Class II Sample Units

Archaeological Variable	Total Error Model I	Total Error Model II	Mean Error Model I	Mean Error Model II
1. Lithic Sites	89	33	5.93	2.20
2. Anasazi Sites	79	14	5.27	0.93
3. Pre-1933 Navajo Sites	29	13	1.93	0.87
4. Post-1933 Navajo Sites	54	29	3.60	1.93
5. Anglo/Spanish Sites	7	4	0.47	0.27
6. Unknown Historic Sites	15	5	1.00	0.33
7. Total Navajo Sites	64	28	4.27	1.87
8. Total Sites	176	66	11.73	4.40

The second model also possesses more evenly distributed prediction characteristics than Model I. Based on the sums of over- and underpredicted differences between actual and predicted site frequencies for grid units containing 60% or more archaeological survey data, Table 27 shows that both Model I and II tended to overestimate site content. However, Model II's overpredictions are less extreme. Both models are approximately equivalent in terms of the incidence of accurate predictions. The percentages within Table 27 have been adjusted to reconcile site frequencies in the "underestimated" and "overestimated" categories with the number of instances (i.e., number of grid units) where "accurate predictions" were made.

Comparative site prediction characteristics for both models were developed and are presented in Table 28. Predictions from the 15 Class II sample units were included into the Model I data to make the number of observations equivalent. As shown in this table, mean error is generally lower for Model II, but the standard deviations are generally lower for Model I. The larger standard deviations in Model II are also reflected in the lower R^2 values for this model (Tables 24 and 25). This is the result of rejecting, for several equations, environmental variables that had entered by chance alone, and for others, a reduction in their correlational strength. Therefore, Model II is a more conservative, but also a more statistically reliable model.

A ratio between mean error and mean number of sites was developed to evaluate how well both models were predicting site frequencies for each of the eight archaeological variables (columns 4 and 5 in Table 28). Mean predictive accuracy increases inversely with these ratio values. Values less than 1.00 indicate that on the average, the number of sites erroneously predicted for each grid unit does not exceed the average number of sites actually present within each unit, and ratios greater than 1.00 indicate that the average error exceeds the average number of sites within each 2 x 2 km grid unit. Table 28 shows that Model II ratio values are generally lower for the eight archaeological variables and illustrates that its predictive accuracy is generally better than Model I. The ratios for both models, however, strongly covary and thus they generally agree as to which archaeological variables have been modeled with a relatively high or low degree of accuracy.

Table 27. Comparative Predictive Characteristics of Models I and II

Archaeological Variable	Underpredictions Model I No.*	%	Underpredictions Model II No.*	%	Overpredictions Model I No.*	%	Overpredictions Model II No.*	%	Accurate Predictions Model I No.+	%	Accurate Predictions Model II No.+	%
1. Lithic Sites	90	38%	74	40%	109	46%	75	40%	11	16%	14	20%
2. Anasazi Sites	49	22%	44	30%	125	56%	74	45%	14	20%	17	25%
3. Pre-1933 Navajo Sites	13	10%	22	21%	45	36%	27	33%	37	54%	32	46%
4. Post-1933 Navajo Sites	46	24%	66	37%	92	48%	77	44%	19	28%	13	19%
5. Anglo/Spanish Sites	11	15%	16	28%	5	7%	0	0%	54	78%	50	72%
6. Unknown Historic Sites	13	12%	9	13%	26	24%	14	19%	44	67%	47	68%
7. Total Navajo Sites	65	33%	71	37%	99	51%	82	43%	11	16%	14	20%
8. Total Sites	149	40%	154	40%	180	48%	148	45%	8	12%	6	9%

* number of sites + number of grid units

Table 28. Predictive Error and Site Frequency Relationships, Models I and II

Archaeo-logical Variable	1 Mean Number of Sites	2 Model I Error Mean	Std. Dev.	3 Model II Error Mean	Std. Dev.	4 Model I Mean Error Mean No. of Sites	5 Model II Mean Error Mean No. of Sites	6 Total Sites I	II
Lithic	4.26	2.97	1.57	2.20	2.03	.70 (5)	0.52 (5)	120 (3)	135
Anasazi	1.72	2.62	1.96	1.72	1.80	1.52 (8)	1.00 (7)	88 (5)	99
Pre-1933 Navajo	1.56	0.83	0.77	0.73	1.08	0.53 (4)	0.47 (3)	49 (6)	49
Post-1933 Navajo	4.09	2.04	1.50	2.09	1.90	0.50 (3)	0.51 (4)	93 (4)	107
Anglo/Spanish	0.19	0.22	0.36	0.23	0.60	1.16 (7)	1.21 (8)	13 (8)	14
Unknown Historic	0.62	0.57	0.74	0.33	0.67	0.92 (6)	0.53 (6)	43 (7)	47
Total Navajo	5.65	2.49	1.60	2.22	2.31	0.44 (2)	0.39 (2)	189 (2)	214
Total Sites	12.44	5.04	2.79	4.43	3.60	0.41 (1)	0.36 (1)	453 (1)	511

( ) indicates rank value

Another analysis conducted with these data shows that predictive accuracy is strongly correlated with the number of sites utilized for model development. The number of sites for each of the eight archaeological variables which were located in the grid units containing 60% or more survey coverage and which were utilized in the Models I and II regressions are listed in column 6 in Table 28. The total site frequencies were then ranked, as shown in Table 28, according to population size within each of the eight categories. The mean error:site ratios were also ranked on the basis of relative accuracy (see columns 4 and 5, Table 28). A Spearman's rho rank-order correlation coefficient was calculated for both models to measure covariation between site frequency and predictive accuracy. The rho value for Model I is 0.76 and for Model II, 0.79, both of which are significant at the 0.05 level. Visual inspection of the ratios and rankings in Table 28 shows that the most accurate predictions are made for the most populous variables, total Navajo sites and total sites. The least accurate predictions tend to be associated with the least populous class--Anglo/Spanish sites. Departures from the relationship between site frequency and predictive accuracy are interesting. Both models agree that predictive accuracy is strong despite the relatively few sites within the pre-1933 Navajo category, and surprisingly weak despite the relatively large number of Anasazi sites. This probably indicates that site-environmental relationships are particularly strong for pre-1933 Navajo sites, and markedly weak for Anasazi sites. Additional discussion and interpretations of these patterns are described in section 6.0 of this report. Another departure from the site frequency-predictive accuracy rankings is for lithic sites. The rankings and the predictive accuracy ratio indicate that Model I is especially poor at modeling lithic site frequencies. The Model II accuracy ratio is substantially lower than Model I for lithic sites and is not appreciably greater than the ratios for pre-1933 and post-1933 Navajo sites. The ranking departure for Model II lithic sites is therefore probably not significant.

In summary, the net results from these evaluations consistently show that additional archaeological data, particularly from the PRLA study area, were both useful and necessary for adequately modeling site frequency variation in this region. All the evaluations show that many of the prediction properties of Model II are better than those for Model I. Although site prediction error is more varied in Model II, the average predictive error is lower. It appears likely, therefore, that the higher R^2 values for Model I do indeed reflect the incorporation of environmental variables which did not enhance the predictive strength of this model. Conversely, the additional archaeological observations from the PRLA area appear to have improved predictive accuracy and the R^2 values reflect more accurate estimates of predictive strength among the archaeological variables. Model II was therefore selected as being the more reasonable model for site prediction purposes.

This predictive modeling study is not the first such attempt within the San Juan Basin. Camilli (1980), for example, performed a remote-sensing based environmental stratification of the 340-square-mile Navajo Indian Irrigation Project (NIIP) area, located approximately 25 miles north of the PRLA study area. Archaeological site content was projected for each environmental stratum within the NIIP area, based upon survey information from several parcels within and adjacent to the project area. Unlike this present study, Camilli's projections were strictly informal forecasts. No formal probability based estimates of intra-stratum archaeological variability, predictive strength or any other measures of reliability were utilized to develop, test, or refine these estimates.

Two virtually identical studies which share the same basic methodology and hence the same problems as those in the Camilli (1980) analysis have also been conducted in the San Juan Basin. The first of these, produced by Drager (in press), included large portions of the Basin in an attempt to estimate archaeological content for assessing uranium mining suitability. The second, developed by Drager and Ireland (in press), projected archaeological content by environmental stratum for each major land parcel (blocks) for the entire NIIP area. Their informal estimates for total site frequency proved to be accurate within 2% for Blocks VI and VII (Reynolds 1980). However, since intra-stratum variability was not formally measured in a statistical, probabilistic sense, nor were inter-stratum relationships with site frequencies considered, nor was any measure of the predictive strength of site-stratum relationships developed for any of these forecasting-type models, there is no method by which these models can be indepedently assessed on an a priori basis. For example, Drager and Ireland's (in press) model proved to be 98% accurate for Blocks VI and VII, but there is no reason, and there never will be, for dismissing the notion that future forecasts will be totally inaccurate. Thus the utility of forecast-type models is perpetually realized only in a post facto sense, unless accepted strictly on blind faith.

Baker and Sessions (1979) modeled archaeological variability in the El Paso Coal Company (EPCC) lease area, located several miles west of the northernmost PRLA tract. Their methodology was basically the same as that utilized here, with the exception that 1 x 1 km grid units and vegetative as well as soil variables were employed in the EPCC study. Consequently, the results of this study and the EPCC study can be directly compared. As indicated in Table 29, Model II compares favorably with the EPCC model.

Table 29 shows that R^2 scores from Model II are higher than those from the EPCC tract, except for Anasazi sites. The possible reason for this discrepancy may well be cultural and will be discussed in section 6.1.

Table 29. Comparison of Explained Variance (R^2) EPCC and Model II Site Density Prediction Models

Site Type	EPCC	Model II
Lithic Sites	34%	64%
Anasazi Sites	74%	65%
Total Navajo Sites	43%	57%
Total Sites	59%	60%

6.0 INTERPRETATIONS AND APPLICATIONS OF THE PREDICTIVE MODEL

6.1 ARCHAEOLOGICAL APPRAISAL OF THE MODEL by Mark Ganas and Meade Kemrer

The site prediction model developed in this report may contain information of significance for studies of cultural resources. It should be stressed that the degree to which site location correlates to environmental variation is constrained by the structure of sociocultural systems. Certainly anthropologists have learned this lesson long ago and have largely abandoned environmental determinist theory (cf. Boas 1911). Therefore it is highly unlikely that site prediction models based on site-environmental relationships could ever reach the 100% level of explanation. In this regard there are several interesting patterns among the R^2 values for the various types of sites that persist between Models I and II (Table 30).

Table 30. Comparison of R-square Values, Models I and II

Site Type	Model I	Model II
1. Lithic Sites	75%	64%
2. Anasazi Sites	62%	65%
3. Pre-1933 Navajo Sites	86%	68%
4. Post-1933 Navajo Sites	71%	46%
5. Anglo/Spanish Sites	64%	52%
6. Unknown Historic Sites	52%	53%
7. Total Navajo Sites	74%	57%
8. Total Sites	78%	60%

The highest R^2 values are achieved for pre-1933 Navajo sites. Since Navajo dependence on a subsistence economy was extremely high during this period, it is reasonable to expect strong site-environmental relationships. The sharp drop in explained variance for the post-1933 Navajo sites is consistent with this interpretation. As discussed in section 3.4, overgrazing and the livestock reduction program reduced the viability of a strictly subsistence based economy for Navajos, with wage labor becoming increasingly important in Navajo economy since 1933. A number of factors undoubtedly have altered Navajo site locational strategies in the context of socioeconomic change. These include restricted access to critical livestock resources through fencing and enforcement of land use policies, preferential location of sites near roads to facilitate access to jobs and shopping in towns, and reduced need for seasonal transhumance for livestock pasturage.

The fact that the R^2 values for Anasazi sites are lower than for pre-1933 Navajo sites may also have cultural connotations. At least a portion of the Anasazi sites may not have been located using environmental criteria, but rather in relation to the Chacoan roadway system. The majority of the Anasazi sites in the archaeological data base are attributable to the Pueblo II/Pueblo III phases. As discussed in section 3.3, the region-wide Chacoan sociocultural system flourished within this interval and is archaeologically manifested by a network of roads which provided intercommunity connectivity. Certainly the roads are not highly correlated with the environmental variables examined here, but rather the roads cross-cut a wide variety of environmental zones. Similarly, road-associated sites such as those documented in this Class II survey are probably located in a variety of environmental settings. It is likely that the primary determinant for locating these sites was the road, not the environment *per se*. The conclusion is that the complexity of the Chacoan sociocultural system reduced the strength of site-environmental relationships. This may be further supported by the higher predictive values for Anasazi sites achieved in the EPCC survey area (Table 29). The Anasazi site inventory for the EPCC tract is restricted to small farmsteads and campsites, for which environmental setting would have been a likely criterion for site location.

The R^2 values for the lithic sites may be constrained somewhat by the fact that a wide variety of functional site types is included in this category. Although this model accounts for a good deal of variability in environmental settings which contain lithic sites, some types of site locations may be difficult to model. Lithic procurement sites, for example, are characteristically located at or near lithic resources, an environmental variable which was not employed in this model. Certain types of sites may have been located somewhat more randomly with respect to environmental content than others. Hunting expeditionary camps, for example, may be located in a wide variety of settings, for they may well represent loci where hunter groups temporarily rested on their way to or from a specific resource area.

The lower R^2 values for Anglo/Spanish and unknown historic sites are probably due to the low frequency of these types in the archaeological data base. Additional data are necessary to evaluate the cultural component in predictability levels.

Another analysis was performed to evaluate the effects of archaeological survey behavior on data reliability. The Class II survey data from the PRLA area were used for this study. Table 31 lists the R^2 scores for three sets of regressions: those developed from the original data base (Model I), another set utilizing the original data base plus the data generated by one crew in the PRLA survey, and the third from the original data base plus the two-crew generated data utilized to develop Model II.

Table 31. Comparison of Explained Variance with Differing Archaeological Data Content

Site Type	Model I	Model I Plus Crew #1	Plus Both Crews (= Model II)
1. Lithic Sites	71%	67%	64%
2. Anasazi Sites	82%	74%	65%
3. Pre-1933 Navajo Sites	86%	71%	68%
4. Post-1933 Navajo Sites	71%	50%	46%
5. Anglo/Spanish Sites	64%	65%	52%
6. Unknown Historic Sites	52%	60%	53%
7. Total Navajo Sites	74%	58%	57%
8. Total Sites	68%	60%	60%

The primary purpose of this analysis was to evaluate recorder bias and its effects on predictive reliability. Biases can and do play a role in recording information. Although the data categories devised for the archaeological data base were constructed to maximize data comparability between surveys, the decisions that archaeologists make as to which cultural resources will be accorded site status vary from project to project and from crew to crew. The data in Table 31 probably reflect this aspect of bias to a certain extent.

Some of the differences in R^2 scores between the two crews, shown in Table 31, are undoubtedly related to recorder bias. Based on site data and information from the two crew leaders, it is evident that crew #1 utilized more conservative criteria for assigning site status to the resources. The conservative crew, accepting a narrower range of criteria for assigning isolated occurrence status, may have classified more loci as sites. The converse is true for crew #2, assuming equal motivation not to miss sites for both crews.

Extrapolating these results to the entire cultural resources data base, it is likely that the predictive strength of the model is adversely affected by recorder bias. The magnitude of R^2 differences between the two crews, shown in Table 31, varies between 0 to 13% among the eight site type categories. Three factors contribute to this range of differences: recorder bias, cultural effects on site-environmental relationships, and statistical properties of the data base. The range of differences between the two crews is probably inflated within the Anglo/Spanish and the unknown historic categories by sampling error, since the amount of data for modeling purposes is extremely small. The 9% difference between the crews for Anasazi sites is probably inflated by cultural factors, for the second crew recorded all of the Chacoan road-associated sites which, as discussed previously, are probably not strongly correlated with environmental variables. With these factors taken into account on an informal basis, the amount of predictive error related to recorder bias from the Class II survey probably does not exceed 4%.

There is some evidence which suggests that recorder bias becomes less significant in affecting predictive modeling as the size of the cultural resources data base increases. The least difference in R^2 scores between the two crews is within the total Navajo and total sites categories--the most populous classes. It is likely, therefore, that increasing the size of the data base would reduce the magnitude of this source of error in predictive models.

6.2 APPRAISAL OF SITE-ENVIRONMENTAL RELATIONSHIPS by Meade Kemrer

The environmental variables which entered each of the eight regression equations are highly patterned. Interpretations of these patterns (discussed in this section) indicate that the predictive model is sensitive to site-environmental relationships which have cultural/ecological significance.

A comparison of the environmental variables which entered the Model I and Model II equations at the 0.1 level of significance (Table 32) shows a high degree of consistency between the two sets of regressions. These data are taken from Appendices 2 and 3. The purpose of this analysis is to assess the effects of the additional Class II archaeological survey data on the selection of the environmental variables which significantly account for site frequency variation and to evaluate the degree of consistency in variable selection between the two models. The amount of correspondence between the two sets of regressions provides an informal measure of model reliability in terms of site-environmental relationships. If the variables selected were radically different between the two models, then it would be reasonable to suspect deficiencies in the environmental or the archaeological variables.

In particular, two possible reasons which could underlie strong disparities between the two models are:

1. Neither model contained sufficient amounts of archaeological data to adequately account for site frequency variability. If this were the case, the addition of the Class II survey data would have produced significant changes in site frequency distribution characteristics resulting in the selection of a markedly different set of environmental variables.

2. The environmental variables utilized in this study were relatively poor indicators of site frequency variation. Thus if the variables selected in the two sets of equations had been radically different, it would be reasonable to suspect that the variable selection process was largely random.

As shown in Table 32, however, the correspondence in variables selected between Models I and II is high. Over-all agreement in terms of all 34 environmental variables is 65% for lithic sites, 76% for Anasazi sites, 82% for both pre-1933 and post-1933 Navajo sites, 76% for Anglo/Spanish sites, 59% for unknown historic sites, 68% for total Navajo sites, and 59% for total sites. Also, within those variables shared by both models, there are only three instances among the eight archaeological categories where the positive or negative loadings differ. Therefore it is highly likely that the environmental variables are sensitive indicators of site frequency variations.

The principal source of difference in variables selected between the two models appears to be related to the characteristics of the archaeological data from the Class II survey. It should be reiterated that the survey was conducted within the PRLA area, whereas the remainder of the archaeological data base was derived largely from areas surrounding the PRLA zone.

Table 32. Comparison of Environmental Variables Entering the Model I and Model II Regression Equations at the 0.1 Significance Level

Environmental Variable	Lithic I	Lithic II	Anasazi I	Anasazi II	Pre-1933 Navajo I	Pre-1933 Navajo II	Post-1933 Navajo I	Post-1933 Navajo II	Anglo/ Spanish I	Anglo/ Spanish II	Unknown Historic I	Unknown Historic II	Total Navajo I	Total Navajo II	Total Sites I	Total Sites II
DN1	-	-	+	+	+	+	+	+	-	0	+	+	+	+	+	+
ON2	0	-	-	-	0	0	-	0	+	+	+	+	-	0	-	-
BT	+	+	0	-	-	0	+	0	0	0	+	0	0	0	+	0
DS	0	+	-	-	-	-	-	-	0	-	-	-	-	-	-	-
xAZ	-	-	-	-	0	-	-	-	0	0	+	+	-	-	-	-
xDN1	+	+	-	-	-	0	-	-	0	0	0	0	-	0	-	0
xSX	0	0	-	-	-	-	0	0	0	+	+	+	0	0	-	0
xOS	0	-	+	+	0	0	+	0	0	+	+	+	0	0	+	0
DN1ON2	0	0	+	+	-	-	+	0	-	-	0	-	0	-	+	0
ON1HU	-	+	0	-	+	+	-	0	+	+	0	0	0	+	0	0
ON1SX	+	+	0	0	+	+	+	+	+	+	0	+	+	+	0	+
DN1BT	0	0	-	-	-	-	-	-	0	0	0	0	-	-	-	-
DN1WSH	0	0	-	-	-	-	-	-	0	0	0	0	-	-	-	-
UN2SX	-	-	0	0	-	-	-	-	-	-	0	-	-	-	-	-
ON2BT	0	+	0	0	+	+	0	0	+	+	-	0	+	+	0	+
HUBT	+	0	+	+	-	-	+	+	-	-	-	-	0	0	+	+
HUOS	-	0	0	0	+	+	-	-	0	0	0	0	-	0	-	0
HUWSH	-	-	-	0	-	-	0	0	+	+	0	+	0	-	-	0
SXWSH	+	0	0	0	+	+	0	0	0	-	+	0	0	0	+	0
BTOS	0	-	+	+	+	+	0	0	-	0	+	+	0	+	+	+
OSWSH	+	0	+	+	0	0	+	+	0	+	0	0	+	+	+	+
xAZHU	0	0	0	-	0	0	-	-	0	0	0	-	-	0	-	-
xAZSX	0	0	0	+	0	0	0	0	0	0	0	-	0	0	0	0
xAZWSH	+	+	0	0	-	0	0	0	+	+	+	+	0	0	0	+
xON1HU	+	0	0	0	+	-	+	+	-	-	+	0	0	-	+	0
xDN1SX	-	-	0	+	-	-	-	-	0	0	-	-	-	-	-	-
xDN1BTT	-	-	+	+	+	+	0	0	0	0	0	0	+	+	+	+
xDN1WSH	-	-	+	+	+	0	0	0	+	+	0	+	0	0	+	+
xON2SX	+	+	0	0	+	+	0	0	+	0	0	0	+	+	0	+
xUN2BT	0	-	0	0	-	-	0	0	-	-	+	-	-	-	0	-
xHUBT	-	-	-	0	+	+	-	-	+	+	+	+	0	0	-	-
xBTOS	0	+	-	-	0	-	0	0	+	+	-	0	0	0	-	0
xBTWSH	+	+	0	-	-	-	0	0	-	-	0	0	0	0	0	0
xDSWSH	0	0	-	-	0	0	-	0	-	-	0	-	-	0	-	-

+ = direct positive correlation
- = inverse correlation
0 = variable did not enter equation
xON1 = variable calculated on a proportional basis
UN1 = variable calculated directly from pixel counts

DN1 = Doak-Avalon Type 1
UN2 = Ooak-Avalon Type 2
BT = Blancot Notal
DS = Doak-Sheppard-Shiprock
SX = Stumble-Notal
HU = Huerfano-Muff-Uffens
WSH = major washes

Moreover, the Class II survey added 22% more grid units containing archaeological data to that portion of the archaeological data base utilized for model development purposes. It is expected, therefore, that some adjustments in the variables entering the equations would be necessary to adequately account for site frequency and environmental variation within the PRLA area. In this regard, the amount of change in variables entering the Anasazi, pre-1933 and post-1933 Navajo, and Anglo/Spanish equations is reasonably low.

The degree of difference between Models I and II variables for the lithic and unknown historic site categories is somewhat higher. As discussed in section 4.1, the density distribution characteristics of lithic sites as a single, coherent regional population may not have been adequately represented in the original archaeological data base. It is possible that the Class II data may have provided a more accurate estimate of frequency variation for the lithic site population resulting in a substantial change in the model. The relatively low correspondence between the two models for unknown historic sites is understandable because this is a residual category which probably contains a cultural and temporal admixture of sites, and also the number of sites falling within this category is low. These factors undoubtedly caused difficulties in attempting to adequately model environmental relationships for this class of sites.

The number of Anglo/Spanish sites in the archaeological data base is also extremely low. The Class II survey did not add any additional sites to this category. The fact that there is a 24% lack of agreement between the two models indicates that the additional 15 negative observations from the Class II survey resulted in a discrepancy that is perhaps over-inflated by insufficient Spanish/Anglo site data. The relatively poor predictive characteristics of both Models I and II for this class of sites, discussed in section 5.2, is consistent with this interpretation.

The underlying reasons for the relatively low agreement between Models I and II for the total Navajo and total site categories are probably similar. Both are categories which combine culturally and temporally distinct site classes. Each of the component classes exhibits a somewhat different set of site-environmental relationships, and each of the classes differ as to the variables entering the Models I and II equations. Although equations were derived separately and independently for all eight archaeological variables, the Models I and II differences are, in effect, somewhat cumulative among the particular set of classes which were combined to form the total Navajo and total site categories. Consequently, there is less disparity between Models I and II for total Navajo sites than for total sites. An inspection of Table 32 reveals how the cumulative effect type of pattern operates. Note, for example, that agreements in variables entering both the Models I and II equations which are shared by both pre-1933 and post-1933 Navajo sites are also shared without disagreement within the total Navajo site category. Note also that disagreements between Models I and II for total Navajo sites are either shared by at least one of the two component categories or correspond to disagreements between the pre-1933 and post-1933 Navajo site categories. A similar set of patterns obtains for comparisons between the total site category and the lithic, Anasazi, pre-1933 and post-1933 Navajo, Spanish/Anglo, and unknown historic site categories. These results are encouraging, for they indicate that the addition of the Class II survey data produced adjustments in the Model II equations for the total Navajo and the total sites variables which are consistent with those independently derived for the particular set of site types which comprise those two comprehensive categories. It is highly likely, therefore, that real site-environmental relationships are expressed in the regression equations, and that Model II represents a refinement of these relationships.

An analysis of the eight regression equations and the characteristics of the environmental variables provides insights regarding the nature of site-environmental relationships generated by Model II. How the regression equations actually function requires further explication. As indicated in Table 32, the positive and negative loadings describe the relationship between each variable entering an equation and site frequencies. If the sign is positive ("+"), the relationship is direct, meaning that as the amount of that particular environmental variable increases, the number of sites also increases. If the sign is negative ("-"), this relationship is reversed--as the incidence of a particular environmental variable increases, the number of sites decreases. If a variable does not enter an equation ("0"), then it can be said that there is no relationship and thus site frequencies are random with regard to that variable.

It must be kept in mind that each of the regression equations is multivariate, and the variables interact not only with site frequencies but also with each other to produce an over-all quantitative statement regarding environmental relationships with a particular site type. Interactions among variables within each equation are in the form of adjusting the strength of a particular relationship. Numerous examples of inter-variable adjustments can be seen in Table 32. To illustrate, note in the table that for lithic sites, the variable DN1SX enters both equations as a positive direct relationship. Further down the table, however, the variable xDN1SX also enters the equations, but as a negative, inverse relationship. Within each of the eight site categories in Table 32, pairs of identical variables with opposite sign representing quantitative inter-variable adjustments frequently occur.

In order to ascertain which environmental variable within a particular pair was adjusted, the correlational strengths of the variables must be compared. If the variables had all been quantified in the same manner and normalized to render them comparable, then the B weighting values (Appendix 3) for a particular pair could be summed. The residual positive or negative values would represent the actual direct or inverse relationship and the quantitative relationship with site frequencies for a particular variable. However, the class n and the class nn variables represent raw pixel counts and the class nx and the CXnn variables were calculated on a proportional basis, and thus the B values cannot be directly compared utilizing only the data in Appendix 3.

The F-scores in Appendix 3 collectively provide an alternative measure of relative correlational strength among the variables which also renders the variables comparable to each other. The F-score is a statistical measure of the relative importance of each variable within the multiple correlations. The F-score also served as the statistical basis for selecting variables which contributed significantly to correlation with site frequencies (cf. Blalock 1960:354-5). Basically, the higher the F-score for a particular environmental variable entering the equation, the greater the proportional amount of variation in site frequencies is explained by that variable relative to the remainder of the environmental variables. Returning to the example from Table 32, the Model II positive or negative loading, combined with the F-score for the variable DN1SX is +9.38 and that for variable xDN1SX is -16.21 (see Appendix 3 for F-scores). The sum of the two is -6.83, indicating that the actual relationship between this environmental variable and lithic site frequencies is inverse, and the DN1SX variable adjusted the magnitude of the correlational strength of the xDN1SX variable.

Analyses of the Model II positive or negative loadings and the corresponding F-scores served as the basis for assessing how the equations weighted and correlated site-environmental relationships. Rather than expressing these relationships in terms of soil types, a typology of those environmental characteristics likely to be of importance to human groups occupying and utilizing the resources of the region was devised for the six soil types employed as environmental variables. This is presented in Table 33.

Table 33. Environmental Characteristics of the Soil Types Utilized as Variables

Soil Type	Grasses	Seed Grasses	Salt-Tolerant Plant Species	Aeolian Derived	Alluvially Derived
Blancot-Notal (BT)	+	+/-	+/-	-	+
Avalon-Sheppard-Shiprock (AZ)	-	+	+/-	+	+/-
Doak-Sheppard-Shiprock (DS)	+/-	+/-	+/-	+/-	+/-
Huerfano-Muff-Uffens (HU)	-	-	+	-	+
Stumble-Notal (SX)	+/-	+/-	+	+/-	+/-
Doak-Avalon (DN1, DN2)	-	+	-	-	+

+ = homogeneously distributed
+/- = differentially distributed
- = absent or minimally represented

The biotic content supported by the various soil types is characterized on the basis of relatively undisturbed and non-overgrazed conditions as presented in the SCS report (Keetch 1980). The <u>grasses</u> category refers to the various grass species (grama, galleta, wheatgrass, etc.) which would be of importance to domestic and non-domestic mammals exploited by human groups. <u>Seed grasses</u> refer to those species (Indian rice grass, sand dropseed, etc.) which could be utilized directly by humans as food or as a food source for a wide range of exploitable birds and mammals.

The salt-tolerant plant species class refers to species such as four-wing saltbush, shadscale, and alkali sacaton which could be utilized by humans directly, or which serve as food for exploitable birds and mammals. This class also indicates the presence of soils with moderately high salt content and thus low agrarian potential. The two classes aeolian derived and alluvially derived were utilized to assess preferences in site location vis-à-vis soil texture and other properties. For example, aeolian soils are generally loosely consolidated and manifested as dunes or playas in this region, and thus tend to retain heat and provide wind shelter properties which might be of importance in locating open camp campsites. Alluvial soils are generally associated with surface runoff systems, are generally more compacted, and contain a higher proportion of humus. This set of characteristics may have been important for agrarian site selection.

The typology also takes into account environmental variability within each soil class. For example, the plus and minus signs in Table 33 for Blancot-Notal soils means that both Blancot and Notal soils support a number of grass species and both are predominately alluvially derived. Seed grasses and salt-tolerant species are differentially distributed, with seed grasses more populous on Blancot soils and salt-tolerant plants occurring with higher frequencies on the more saline Notal soils. Table 33 shows that the six soil types collectively represent a sizable range of environmental conditions which are of potential significance for a wide variety of site locational strategies.

The F-score values and their distributions among the environmental classes were analyzed to discern how Model II generally characterized site-environmental relationships within the eight archaeological categories. For this analysis, the F-score, combined with its positive or negative loading for each environmental variable, was assigned to each of the environmental characteristics which applied to that variable. For example, if the F-score and loading for DN1 was -6.45, then this value was assigned to the seed grasses and alluvially derived environmental categories which apply to this soil type (Table 33). A series of analyses were conducted that were designed to eliminate over-inflated values. The method which proved to produce the least distortion was to take the F-scores for those variables representing two-way interactions among the soil and wash classes, reduce them by one-half, and assign these reduced values to the environmental categories applicable to each soil type. For each site type the positive and negative F-scores for all environmental variables entering the equation were each summed. The two sets of scores were then summed to determine whether the over-all relationship for a particular environmental characteristic was direct or inverse. The results are presented in Table 34.

Lithic sites show an over-all slight positive correlation with soils that support largely grasses, and with zones where seed grasses are differentially distributed. Lithic sites are also strongly inversely correlated with alluvial soils and zones which contain mostly seed grasses, and also tend not to be found in settings in which salt-tolerant plant species are either homogeneously or differentially distributed. The differences in the magnitude of the summed F-scores also indicates that lithic sites are more likely to be located in settings which contain mixtures of alluvial and aeolian soils than with those which are either strictly aeolian or

Table 34. F-Score Loadings and Environmental Relationships with each of the Eight Archaeological Variables

Distribution Characteristic (see Table 33)	Environmental Characteristic				
	Grasses	Seed Grasses	Salt-Tolerant	Aeolian	Alluvial
LITHIC SITES					
Homogeneous or Uniform	+25.28(4)	+62.41(6)	+22.07(3)	+ 8.92(1)	+ 83.40(9)
	-23.12(4)	-75.16(8)	-29.55(4)	-13.53(1)	-115.64(14)
Sum	+ 2.16	-13.35	- 7.48	- 4.61	- 32.24
Heterogeneous or Differential	+29.77(4)	+54.03(9)	+40.85(7)	+29.67(4)	+ 34.13(5)
	-33.15(4)	-50.49(7)	-50.29(7)	-33.15(4)	- 39.91(5)
Sum	- 3.48	+ 3.54	- 9.44	- 3.48	- 5.78
ANASAZI SITES					
Homogeneous or Uniform	+ 7.84(2)	+48.48(7)	+23.12(3)	+ 4.04(1)	+ 47.58(8)
	-29.64(4)	-67.93(7)	-37.12(3)	-15.26(2)	-103.60(11)
Sum	-21.80	-19.45	-14.00	-11.22	- 56.02
Heterogeneous or Differential	+35.46(2)	+40.95(8)	+24.22(6)	+35.43(6)	+ 41.95(8)
	-18.65(4)	-37.39(7)	-42.72(9)	-18.79(4)	- 29.58(5)
Sum	+16.81	+ 3.56	-18.50	+16.64	+ 12.37
PRE-1933 NAVAJO SITES					
Homogeneous or Uniform	+30.92(4)	+44.73(6)	+35.94(7)	+ 0.00(0)	+ 84.22(13)
	-31.97(5)	-89.67(8)	-44.45(5)	-26.01(1)	-122.56(14)
Sum	- 1.05	-44.94	- 8.51	-26.01	- 38.34
Heterogeneous or Differential	+26.54(5)	+57.46(9)	+24.94(6)	+26.54(5)	+ 26.54(5)
	-26.72(5)	-56.44(10)	-57.20(8)	-26.72(5)	- 41.96(7)
Sum	- 0.18	+1.02	-32.26	- 0.18	- 15.42

(n) = number of positive or negative variables entering the equation

Table 34 (continued)

Distribution Characteristic (see Table 33)	Grasses	Seed Grasses	Salt-Tolerant	Aeolian	Alluvial
			Environmental Characteristic		
POST-1933 NAVAJO SITES					
Homogeneous	+ 2.13(1)	+10.27(3)	+ 7.43(3)	+ 0.00(0)	+ 16.65(6)
or Uniform	- 5.28(2)	-35.85(7)	-15.94(5)	- 9.57(2)	- 38.15(10)
Sum	- 3.15	-25.58	- 8.51	- 9.57	- 21.50
Heterogeneous	+ 6.75(2)	+ 8.88(3)	+ 5.70(2)	+ 6.75(2)	+ 6.75(2)
or Differential	-14.84(4)	-20.12(6)	-15.94(6)	-14.84(4)	- 20.54(6)
Sum	- 8.09	-11.24	-10.24	- 8.09	- 13.79
ANGLO/SPANISH SITES					
Homogeneous	+12.65(3)	+53.06(6)	+31.52(5)	+13.26(1)	+ 68.10(11)
or Uniform	-16.12(3)	-19.40(4)	-17.84(4)	- 0.00(0)	- 41.08(9)
Sum	- 3.47	+33.66	+13.68	+13.26	- 27.02
Heterogeneous	+20.71(5)	+33.86(8)	+31.59(7)	+21.21(5)	+ 27.84(6)
or Differential	-27.00(4)	-28.16(7)	-24.35(5)	-18.81(4)	- 18.81(4)
Sum	- 6.29	+ 5.70	+ 7.24	+ 2.40	+ 9.03
UNKNOWN HISTORIC SITES					
Homogeneous	+17.91(2)	+71.54(6)	+61.08(4)	+28.82(2)	+ 94.05(8)
or Uniform	-14.47(2)	-47.80(6)	-35.80(5)	- 8.84(2)	- 67.55(8)
Sum	+ 3.44	+23.74	+25.28	+19.98	+ 26.46
Heterogeneous	+38.40(4)	+56.71(6)	+54.10(6)	+38.80(4)	+ 53.21(6)
or Uniform	-32.84(5)	-47.32(7)	-34.50(6)	-32.85(5)	- 41.69(7)
Sum	+ 5.95	+ 9.39	+19.60	- 5.95	+ 11.52

(n) = number of positive or negative variables entering the equation.

Table 34 (continued)

Distribution Characteristic (see Table 33)	Environmental Characteristic Grasses	Seed Grasses	Salt-Tolerant	Aeolian	Alluvial
TOTAL NAVAJO SITES					
Homogeneous	+ 8.43(3)	+30.57(6)	+10.92(3)	+ 0.00(0)	+43.09(10)
or Uniform	- 8.68(2)	-68.16(8)	-23.61(4)	-20.79(1)	-73.74(11)
Sum	- 0.25	-37.59	-15.40	-20.79	-30.65
Heterogeneous	+16.56(4)	+24.99(7)	+18.17(5)	+16.56(4)	+16.56(4)
or Uniform	-15.59(3)	-24.27(5)	-26.09(4)	-15.59(3)	-25.99(4)
Sum	+ 0.97	+ 0.72	- 7.92	+ 0.97	- 9.43
TOTAL SITES					
Homogeneous	+14.47(4)	+57.69(7)	+19.51(3)	+17.54(1)	+50.46(10)
or Uniform	-16.50(3)	-76.79(7)	-28.16(4)	-24.18(2)	-92.21(11)
Sum	- 2.03	-19.10	- 8.65	- 6.64	-41.75
Heterogeneous	+28.97(4)	+43.44(8)	+34.55(7)	+28.97(4)	+43.75(6)
or Uniform	-25.52(4)	-54.76(8)	-40.59(7)	-25.52(4)	-41.86(6)
Sum	+ 3.45	-11.32	- 6.04	+ 3.45	+ 1.89

(n) = number of positive or negative variables entering the equation alluvially derived. These general preferences are not inconsistent with previous findings which suggest that hunter-gatherer site locations are associated with local biotic diversity (cf. Reher 1977).

The over-all patterning for Anasazi sites appears to be extremely clear. This class of sites shows a consistently inverse relationship with zones where botanical content is homogeneously distributed and also with homogeneous aeolian or alluvial soil zones. They are positively correlated, with one exception, to settings where plants and soils are differentially distributed. The one exception is interesting, for Anasazi sites generally are absent from all settings where salt-tolerant plant species are present. It appears that Anasazi groups generally selected settings which contain both soil and botanical diversity in order to maximize local biotic exploitation, but avoided saline soils because of their poor agrarian potential.

Pre-1933 Navajo sites appear to exhibit a more generalized distribution vis à vis soil and botanical characteristics. The principal pattern appears to be one of strong inverse relationships with settings where seed grasses, aeolian and alluvial soils are uniformly distributed, and where salt-tolerant plants are differentially distributed. This class of sites is nearly randomly distributed with respect to grasslands and settings where grasses, seed grasses, and aeolian soils are differentially distributed. In general, the pre-1933 Navajos selected a wide variety of environmental settings for their sites, with a tendency towards zones which exhibit biotic diversity. Given the fact that the archaeological data base contains summer and winter homesteads and temporary sheep camps, this generalized site-environmental characterization is probably as specific as could be adequately modeled.

Post-1933 Navajo sites appear to exhibit an even more generalized distribution than the Navajo sites dating prior to 1933. The number of environmental variables entering this equation is the lowest for any of the archaeological variables (Table 32). Thus post-1933 sites are randomly distributed with regard to most soil and wash variables. The over-all patterns for the environmental variables entering the post-1933 Navajo equation are similar to those for the pre-1933 Navajo sites. Based upon the data in Table 34, both pre- and post-1933 Navajo sites tend to show strong inverse relationships with uniform distributions of seed grasses and alluvial soils, and a stronger inverse relationship with differentially distributed salt-tolerant plant species. The principal fact is that post-1933 sites are more randomly distributed with regard to a wider range of environmental settings than pre-1933 Navajo sites. This is consistent with the likelihood that post-1933 Navajos were collectively less dependent upon pastoralism and more reliant upon the cash-based economic system. Consequently, the post-1933 Navajos were probably utilizing criteria for locating locating sites (existing roads, for example) which are probably unrelated to environmental context.

The analyses of the Model II predictive characteristics for Anglo/Spanish and unknown historic sites (presented in section 5.2) indicate that the low number of sites in these two categories resulted in models which should not be given a great deal of credence. The data in Table 34, however, indicate that both Anglo/Spanish and unknown historic sites are generally more positively associated with soil and biotic characteristics which are uniformly distributed than with differentially distributed environmental characteristics. Models of both site types also show weak or slightly negative relationships with grassland or mixed grassland settings. Since both site types are probably temporally and culturally mixed, it is difficult to ascertain whether these relationships are meaningful cultural/ecological terms.

The general site-environmental characteristics for total Navajo sites are, as could be expected, similar to those which are shared by both the pre-1933 and post-1933 Navajo sites (Table 34). Navajo sites are less likely to be located in zones where seed grasses, salt-tolerant plants, aeolian and alluvial soils are uniformly distributed or where grasses, seed grasses and soils are differentially distributed. Navajo sites in general are therefore distributed among a wide variety of environmental settings, with a tendency toward locales which provide immediate access to multiple biotic resources.

The over-all environmental pattern within the total sites category is relatively clear. In general, sites are inversely correlated with environmental characteristics which are homogeneously distributed and either positively or less strongly negatively correlated with differentially distributed soil and botanical resources. Thus sites of all temporal/cultural periods tend to be located in settings which provide immediate access to a number of resources. This suggests that the prehistoric and historic human occupants generally shared a multiple use strategy vis-à-vis the surface land resources in this portion of the San Juan Basin.

Another environmental class that has not been discussed is major washes. As shown in Table 32, only eight of the 34 variables include this class, and they are all two-way interactions with soils. This means that major washes as a single variable and as a component in at least six other two-way interactions with the soil variables were eliminated from further consideration prior to the formulation of Models I and II. Thus washes are apparently not of overwhelming importance to site location. Since the eight variables including washes are always combined with particular soil types, meaningful analyses of site/wash relationships must take soil characteristics into account.

A listing of the F-scores for all wash-related variables which entered the Model II equations at the 0.1 level of significance is presented in Table 35.

The combined F-scores for lithic sites show a net inverse relationship with washes. All four of the variables are different, and thus no inter-variable adjustments are apparent. The environmental characteristics of the soils associated with the washes appear to regulate the positive and negative relationships with lithic sites. The DN1 and HU soil types are both predominately alluvial soils which are inversely related with lithic sites (Table 34). DN1 soils also support mostly seed grasses, and BT soils tend to support salt-tolerant plants. Both of these characteristics are also negatively correlated with lithic sites. BT and AZ soils exhibit characteristics which are generally positively associated with lithic sites. BT soils exhibit homogeneous distributions of grasses

Table 35. F-Scores of Wash-related Variables Entering the Model II Equations at the 0.1 Level of Significance

Variable	Lithic	Anasazi	Pre-1933 Navajo	Post-1933 Navajo	Anglo/ Spanish	Unknown Historic	Total Navajo	Total Sites
DN1WSH	0	- 6.46	-12.25	-8.23	0	0	-15.56	-20.22
xDN1WSH	-12.88	+ 7.03	0	0	+13.07	+ 7.31	0	+ 6.43
xBTSH	+ 5.44	-12.89	- 4.49	0	- 7.40	0	0	0
DSWSH	0	+ 6.17	0	+7.15	+ 5.76	0	+15.06	+18.46
xDSWSH	0	- 7.19	0	0	- 5.98	- 4.56	0	- 6.29
xAZWSH	+ 8.92	0	0	0	+13.26	+12.94	0	-17.54
SXWSH	0	0	+ 4.89	0	-10.40	0	0	0
HUWSH	- 9.00	0	-22.20	0	+ 9.08	+26.18	-12.52	0
TOTAL +	+14.36	+13.20	-38.94	+7.15	+41.17	+46.43	-28.08	+42.43
TOTAL -	-21.88	-26.54	+ 4.89	-8.23	-23.78	- 4.56	+15.06	-26.51
SUM	- 7.52	-13.34	-34.05	-1.08	+17.39	+41.87	-13.02	+15.92

and differential distributions of seed grasses. Both these characteristics are positively correlated with lithic sites (Tables 33 and 34). AZ soils are partially alluvial and are less negatively associated with lithic sites than homogeneous alluvial soils. The remainder of the AZ characteristics (Table 33) are more likely to be negatively associated with lithic sites, and thus the positive relationship with this soil type is not fully consistent with the general pattern shown in Table 34. As shown in Table 33, however, both BT and AZ soils provide a wider variety of locally available plant species than DN1 and HU soils, and this factor, along with the presence of major washes, may have been significant for the preferential location of lithic sites.

Inter-variable adjustments must be considered before site/soil/wash relationships can be assessed for Anasazi sites. Table 35 shows that the pairs DN1, xDN1 and DS, xDS entered the equation for Anasazi sites and the members of each pair are opposite in loading sign. The sum of the F-scores for the DN1 pair is +0.57 and the sum for the DS pair is -1.02. Both of these sums are so low that the DN1WSH and DSWSH variables probably mean little in terms of Anasazi site distributions. The remaining soil/wash variable shown in Table 35, BTWSH, is strongly negative. Anasazi sites are therefore significantly inversely correlated with this variable. The environmental characteristics of BT soils are also inversely correlated with Anasazi sites. These soils are alluvially derived, are partially saline, and support mostly grasses, partially mixed with seed grasses. As shown in Table 34, all these characteristics, except for the differentially distributed seed grasses, are inversely correlated with Anasazi sites. Thus Anasazi groups avoided locating sites on the agriculturally poor Blancot-Notal soils situated adjacent to major washes. Otherwise, Anasazi sites are randomly associated with major washes.

All four of the soil/wash variables entering the pre-1933 Navajo sites equation are unique and thus inter-variable adjustments do not have to be considered (Table 35). The positive relationship between the environmental characteristics of SXWSH and pre-1933 Navajo sites is completely consistent with the general site locational preferences shown in Table 34. SX soils contain differentially distributed grasses, seed grasses, and mixtures of aeolian and alluvially derived soils. Salt-tolerant species are also homogeneously distributed. All these characteristics are either positively or less negatively associated with pre-1933 Navajo sites.

The remaining three soil/wash variables entering the pre-1933 Navajo sites equation are all negatively associated with site frequencies. All three of these soil classes have uniform distributions of alluvium, which is strongly negatively correlated with pre-1933 Navajo sites (Table 34). The three soil types exhibit other characteristics which are inversely related to this class of sites. For example, seed grasses are homogeneously distributed on DN1 soils, and salt-tolerant plants are differentially distributed on BT soils but homogeneously distributed on HU soils. The remaining characteristics of these soils are either less negatively related or randomly associated with pre-1933 Navajo sites (Tables 33 and 34).

As shown in Table 35, two unique soil/wash variables entered the equation for post-1933 Navajo sites. The DSWSH variable is positively correlated with site frequencies. The DS soil class exhibits heterogeneous distributions of all soil and plant characteristics which tend to be less negatively associated with post-1933 Navajo sites (Tables 33 and 34). This site class is inversely correlated with the DN1WSH variable. DN1 soils are alluvially derived and exhibit a homogeneous distribution of seed grasses. Both these characteristics are strongly negatively associated with post-1933 sites.

Three soil/wash variables entered the total Navajo sites equation. The positive DSWSH relationship with Navajo site frequencies is consistent with the environmental characteristics which Navajo groups tended to prefer for all plant and soil derivation characteristics. These are either positively correlated or less negatively correlated with Navajo sites than uniform distributions (Table 34).

The net positive correlations of soil with variables for Anglo/Spanish and unknown historic sites are consistent with the generally positive association with all environmental characteristics (Table 34). Since there are problems regarding the adequacy of the archaeological data and the predictive model for these two site categories, the significance of the soil/wash interactions with site frequencies is difficult to ascertain.

The five soil/wash variables within the total sites category actually represent only three unique variables. As illustrated in Table 35, there are two sets of paired variables: DN1WSH, xDN1WSH and DSWSH, xDSWSH. The sum of F-scores for the DN1WSH pair is -13.79, which is strongly negative, and the sum for the DSWSH pair is +12.17, a strongly positive value. The negative correlation with DN1WSH, when the environmental characteristics of DN1 soils are taken into account, is consistent with the general preferences for site locations shown in Table 34. DN1 soils contain homogeneously distributed seed grasses and alluvium, both of which are strongly negatively correlated with total sites. DS soils are heterogeneous for all soil and plant characteristics which are either positively or less negatively associated with total site frequencies than the homogeneously distributed environmental classes. Thus the positive correlation between DN1WSH and total site frequencies is consistent with site-environmental patterns shown in Table 34.

Salt-tolerant plants and alluvially derived soils are differentially distributed within AZ soils; these are characteristics which are generally preferred settings for total sites. AZ soils also exhibit uniform distributions of seed grasses and are mostly aeolian, factors that are not as strongly inversely correlated with total sites as other homogeneously distributed environmental characteristics (Table 34). The positive correlation between total sites and AZWSH is therefore consistent with general site locational preferences.

In summary, the relationships between major washes and site frequencies are highly correlated with the environmental characteristics of the various soil types which are associated with major washes. If the soil/wash variables correlated more independently of site locational preferences associated with soil characteristics, then the role of washes in regulating site frequencies could be considered significant. Since this is not the case, it is concluded that soils are the controlling variables, and washes play contributory roles.

The results of these analyses indicate that site frequencies and environmental content are highly patterned. These patterns, moreover, appear to have potential cultural/ecological significance which warrants additional research in this portion of the San Juan Basin.

6.3 APPLICATIONS OF THE MODEL by Meade Kemrer, Craig Baker, Steven Sessions and Mark Ganas

6.3.1 Site Prediction Maps

Based on the Model II equations, mean site frequency predictions were generated for 833 grid units for each of the eight archaeological variables. Eight maps showing these predictions within and adjacent to the PRLA study area are presented in Appendix 4. Predicted site frequency ranges for the eight archaeological variables are listed in Table 36. The highest frequency within each category represents the largest number observed within the 2 x 2 km grid units utilized for the development of Model II. Although the model predicted frequencies that exceed the observed range, it is impossible to ascertain the amount of predictive error without additional archaeological data. Consequently, predicted frequencies shown on the maps in Appendix 4 which fall beyond the observed range were assigned the highest observed frequency and a "+" symbol. This symbol means that the number of sites predicted for a particular grid unit is at least as high as the maximum number observed in the data base.

Table 36. Predicted Site Frequency Ranges for the Eight Archaeological Variables

Archaeological Variable	Frequency Range
1. Lithic sites	0 - 19+
2. Anasazi sites	0 - 29+
3. Pre-1933 Navajo sites	0 - 17+
4. Post-1933 Navajo sites	0 - 16+
5. Anglo/Spanish sites	0 - 5+
6. Unknown historic sites	0 - 9+
7. Total Navajo sites	0 - 24+
8. Total sites	0 - 35+

Approximately 560 of the 833 grid units for which there were site frequency predictions fell within the boundaries of the maps in Appendix 4. Site prediction data for all grid units are on file at the Bureau of Land Management, Albuquerque, and the Laboratory of Anthropology, Santa Fe. The total number of sites predicted within each of the eight categories for all 833 grid units are summarized in Table 37.

Table 37. Total Number of Sites Predicted for the Eight Archaeological Variables within 833 Grid Units

Archaeological Variable	Total Sites Predicted	Mean Number of Sites	Standard Deviation
Lithic sites	4,746	5.70	2.03
Anasazi sites	2,978	3.57	1.80
Pre-1933 Navajo sites	3,211	3.85	1.08
Post-1933 Navajo sites	3,086	3.79	1.90
Anglo/Spanish sites	222	0.27	0.60
Unknown historic sites	1,035	1.24	0.67
Total Navajo sites	5,782	6.94	2.31
Total sites	11,163	13.40	3.60

6.3.2 Management Applications of the Model

The site frequency predictions collectively provide a valuable tool for current and future cultural resource management needs within a large portion of the San Juan Basin. The site predictions can serve a number of specific management purposes. For example, they can be utilized in planning to gauge the potential suitability of lands located within and adjacent to the PRLA study area which are being considered for land disturbance development. Specifically, this information provides a useful supplement to existing archaeological data for the development of comprehensive and pertinent cultural resource overviews and assessments within this region. These data may also greatly reduce the need for additional Class II sample surveys within those areas for which there are predictions. The site predictions can also serve compliance management needs. For example, they can be used in combination with the predictive error standard deviations presented in Table 28 to evaluate the adequacy of tract-type cultural resource inventory surveys conducted at the 100% level of coverage.

It must be stressed that the predicted site frequencies should not be considered or used as a substitute for Class III inventory data, or applied directly to the archaeological clearance determination process as mandated in the National Historic Preservation Act. The frequencies shown in the maps in Appendix 4 are mean predicted values, not absolute numbers. The standard deviations shown in Table 37 represent the dispersion ($S_{y.x}$) from the line of the regression equations which can be used to set levels of confidence and thus the range in actual site frequencies that could be expected to occur in the grid units. For example, if the level of confidence was set at 95% (two standard deviation units) and the mean number of lithic sites predicted for a particular grid unit was 0, then the actual number of sites that could be expected to occur at 95% probability within the unit (2 x 2.03 sites, see Table 37) could range from 0 to four sites. Certainly the presence of as many as four sites, all potentially eligible for nomination to the National Register of Historic Places, is not a "no effect" situation vis-à-vis proposed land disturbance activities within that grid unit. Moreover, assessment of cultural resources, obtainable only through actual survey data, is required to identify unique scientific, heritage, and educational values for National Register eligibility determination as well as for mitigation plan development purposes.

A few additional comments regarding the appropriate use of the site frequency predictions are warranted. It must be kept in mind that the predictive unit is the 2 x 2 km grid square. All the statistics describing the strength of site-environmental relationships and predictive error characteristics presented in this report are defined strictly in terms of this grid system. No reliability statistics have been developed for estimating site frequencies within portions of grid units or for extrapolating site frequencies into squares adjacent to those for which there are predictions. There is evidence which supports the probability that estimates such as these may be unreliable. First, the reason for the absence of predictions for some grid units located within the zones for which there is environmental data is that the environmental variation in these units is beyond the ranges for the environmental variables utilized for developing the predictive model. The number of sites within these environmentally distinctive non-prediction units is therefore unpredictable at this time, and may differ significantly from extrapolated estimates. Second, estimation error of site content for portions of grid units containing predictions probably varies inversely with tract size. The findings from the model building process discussed in section 5.1 support this postulated inverse relationship, for error in estimating the number of sites within an entire grid unit decreased with increasing survey coverage. This study suggests that estimation error is acceptably small for parcels comprising 60% or more of a grid unit, with error increasing as the grid unit fraction drops below 60%. In terms of the township-range-section land partitioning system, acceptably reliable estimates could be made for parcels of land within a grid unit equal to or larger than a section. It should be stressed, however, that the most appropriate use of the site predictions should be restricted to the 2 x 2 km grid units. The size of the grid unit was selected not only for capturing on-site and extra-site environmental relationships, but also to capture sufficiently large mean site frequencies. Thus the predictions shown on the maps in Appendix 4 were made in terms of unambiguous and empirically meaningful whole numbers. If smaller grid units are used and the mean number of sites drops below 1.00 for virtually all site types, the predictions would consist of ambiguous fractional numbers. For example, it is unclear what a prediction of 0.25 sites would really mean. On the pragmatic level there are several possible meanings: either one site or no sites were predicted for that tract of land, or that one site is predicted in every four units. But, since each observation is an independent event, which four units? Thus, the problem of ambiguity would also arise when attempting to estimate the number of sites for a portion of a grid unit where the predicted frequency is very low.

6.3.3 Archaeological Applications of the Model

Archaeologists working within the San Juan Basin may find this model and the site predictions useful for various research purposes. The predicted site frequencies represent a geographically and numerically large body of data available for use. In numerical terms, the total number of sites predicted within each of the eight archaeological categories represents approximately a tenfold increase over the number of sites compiled into the archaeological data base. In terms of geographic extent, the archaeological data base contains survey coverage from 197 grid units. Site predictions have been generated for 833 units, which represent a fourfold increase. Given the fact that only 69 of the grid units contain at least 60% survey coverage, the actual increase in grid units containing prediction data is approximately 12 times the archaeological data base. Also, the grid units for which there are predicted site frequencies are contiguous and cover a zone within the San Juan Basin which is largely unsurveyed.

The fact that the grid units for which there are predictions are not dispersed provides the opportunity to make comparative analyses of site population density variability, geographic shifts, and other spatial analyses which may have cultural/ecological, demographic, and other connotations.

The predicted site frequencies not only serve as data, but also stand as a complex set of testable propositions regarding the archaeological content and variability within this portion of the San Juan Basin. In this regard, the predictions can be of heuristic value to archaeologists who are actively performing studies in this region, and should have direct applications in formulating sophisticated research strategies.

The analytic outcomes derived in the context of producing, evaluating, and interpreting this model also merit further archaeological exploration. It should be reiterated that the methods employed in producing the model are designed to identify that portion of site frequency variation which is accounted for by the variability in the occurrence of a set of environmental classes. The regression equations are not, strictly speaking, cultural/ecological statements. Dean correctly states, "Although site distributions may be accounted for by a variable, they are not necessarily explained by the traits that define the variable" (1978:10).

The model appears to adequately meet pragmatic needs concerning archaeological content and variability in site frequencies, but the underlying cultural and ecological bases for why and how the model works are largely unknown and deserve additional attention. The data generated by the modeling process produced several patterns which indicate that cultural factors have influenced the relative strength of the site-environmental correlations (section 6.1). Precisely how these cultural factors serve to regulate site distributions and how cultural relationships could be incorporated into future site frequency predictive models is a worthwhile research topic.

Similarly, there are patterns in the relationships between site frequencies and the environmental variables which suggest that they are of cultural/ecological significance (section 6.2). Certainly the cultural ecology of the prehistoric and historic groups who occupied and used this portion of the San Juan Basin is a topic of on-going research. The identification and use of cultural-environmental relationships in predictive models would undoubtedly enhance the quality of such predictions.

6.3.4 Future Applications of this Study and Concluding Remarks

The products of this study can be upgraded and refined to meet the future cultural resources management needs of the Bureau of Land Management as well as the research needs of the archaeological community. The computerized archaeological data base can accept all the current and future cultural resources inventory data on file with BLM. These data could thus be available in an efficient storage and retrieval system for use in planning unit resource analyses and other routine management-related activities. Similarly, archaeologists, historians, and cultural anthropologists could apply these data to a wide variety of research endeavors.

The predictive model can also be periodically refined. With the addition of more tract-type archaeological survey information, new regressions can be performed. Similarly, environmental and cultural variables can also be added to the environmental data base to model an increasingly wide range of site-environmental relationships. Model refinement would be useful from a number of perspectives; new archaeological and environmental data could increase the predictive strength of the model, and could increase the number of predictions within the grid system. As discussed previously, the 2 x 2 km grid system is designed to be spatially expanded. Thus other areas can be added to meet future needs. Furthermore, as the amount of information in the archaeological data base increases, the number of archaeological variables can be increased. For example, the generalized Anasazi variable could be subdivided into more useful variables such as Basketmaker III, Pueblo I, Pueblo II, and so on.

All pertinent information regarding the model and its development is on file at the Bureau of Land Management, Albuquerque District Office, and the Laboratory of Anthropology, Santa Fe. This includes the regressions which were employed in constructing and refining the model and the computer runstreams used in compiling and manipulating the environmental and the archaeological data bases. Data listings for the cultural resources data base, including a number of cross-tabulations, are also on file.

In assessing this study, it is most important that attention not be directed solely toward the completion of a series of site-predicting end products. Rather, the study should be regarded as having generated a set of "beginning products." There is every reason to believe that future use of and expansion upon this study could yield fruitful results both for archaeologists and the Bureau of Land Management.

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APPENDIX 1

SAMPLE UNIT AND SITE DESCRIPTIONS

By Kurt Anschuetz, Nancy Hewett Cella and Meade Kemrer

Sample Unit 30-10

Both topographic and physiographic variation are relatively low within this sample unit. Total relief is approximately 100 feet with elevations increasing to the south and ranging between 5900 and 6000 feet. Two small washes drain the western edge and the southeastern portion of the unit. These flow north to the De-na-zin Wash located approximately one mile north of the sample unit. The sample unit contains 640 acres.

The landscape is principally rolling terrain produced by a series of longitudinal dunes, interdunal playas and blowouts. The northeastern portion of the unit is relatively flat. The ground surface is mantled by erosional detritus from a series of baked shale and clay badland hillocks beyond the eastern boundary of the parcel.

Soils vary with the physiographic features. Alluvial sandy silts border the two minor washes. Sand and sandy loams cover the dunes. A thin alkaline clay loam soil has developed on the badlands outwash in the northeast corner of the sample unit.

Vegetation also co-varies with soil and physiographic characteristics.

Russian thistle and rabbitbrush are abundant on the alluvial sites adjacent to the two minor washes, although grasses and annuals are also present. Indian ricegrass, galleta grass, sand dropseed, wolfberry and narrow-leaf yucca are the most predominant species in the dunal zones. The sodic soils derived from the Kirtland-Fruitland shales support sparse plant populations. Salt-tolerant species such as shadscale and fourwing saltbush are common. Grasses and annuals also occur, but in lesser amounts.

Nine sites and 41 isolated cultural occurrences were recorded within the sample unit. Eight of the sites are prehistoric lithic scatters. The ninth is an historic Navajo sheep herders' camp. All sites are in aeolian dunal or interdunal settings.

Site 30-10-1 (LA 34678)

The site is in a dunal setting and is manifested in two artifact clusters located north and south of an interdunal playa. The site measures 30 by 40 meters. In the larger cluster, the remains of two sandstone cobble hearths and a scatter of sandstone fragments were found. The smaller cluster also contains a sandstone cobble hearth.

Other artifacts assotiated with the smaller cluster include lithic debitage composed of mostly secondary and tertiary flakes and a chert biface.

The larger cluster contains several sandstone slab metates associated with one of the hearths, two hammerstones, a cobble chopper, and lithic debitage representing secondary and tertiary reduction. Most of the artifacts are petrified wood; other materials include translucent chert, fine-grained tan orthoquartzite, quartzite, oolitic chert and chalcedony.

Two projectile points were found in the larger artifact cluster. One is undamaged and exhibits shape characterists of the En Medio style, datable to the 800 BC to AD 400 interval (Basketmaker II Period). A projectile point midsection was also found. Although its shape characteristics are also consistent with En Medio Phase points, the artifact is too incomplete to make an accurate classification.

Functionally, the site appears to be a camp site where a fairly wide range of activities, including hunting, plant processing, and tool manufacture/repair was conducted.

A scatter of historic trash, which may have been deposited by the Navajo residents of a structure 150 meters west beyond the sample unit boundary, was also noted on the site. Artifacts fall within the following functional categories: food, medicinal and cosmetic. Datable items include a KC baking powder lid "48 years same price" (AD 1938-39) and an "AH" bottle bottom (AD 1927-1964). The dump was utilized in the late 1930's or 1940's.

Site 30-10-2 (LA 34679)

This site is on a semistabilized dune adjacent to and south of an interdunal playa. Approximately 50 artifacts are distributed over an area measuring 130 by 25 meters. A dispersed scatter of fire-cracked rocks indicates that a hearth was present. Several sandstone ground stone fragments were also observed. Other than lithic debitage, no additional tools were noted. Functionally, the site appears to be a plant processing locus.

Although no temporally/culturally diagnostic artifacts were found, the assemblage indicates that the site is prehistoric. The presence of ground stone implements suggests that the site postdates the Middle to Late Archaic Period.

Site 30-10-3 (LA 34680)

This site is within a series of blowouts on a semistabilized dune. Two interdunal playas are located immediately northeast and southeast of the site. The site is large, covering an area 200 by 240 meters in extent. Ten artifact clusters were recorded (see also Figure 4).

Cluster 1 contains lithic debitage consisting of secondary and tertiary reduction and biface thinning flakes, several slab metate and mano fragments and the base of a Bajada or San Jose style projectile point made from gray Jemez obsidian. The predominant material type is petrified wood. A transect representing a 20-25% fraction of the cluster was recorded.

Cluster 2 contains the dispersed remains of a sandstone-lined hearth, metate and mano fragments, a biface fragment, cores, tested cobbles, as well as secondary and tertiary reduction flakes, and angular debris. A 25% sample of Cluster 2 was subjected to field analysis. A 45% sample of the artifacts in Cluster 3 yielded ground stone artifacts, several hammerstones, and lithic debitage which represents secondary and tertiary reduction activities. Petrified wood is the principal material type, with lesser amounts of chalcedony.

Cluster 4 contains secondary and tertiary reduction flakes, a hammerstone, and a slab metate fragment. The material type is principally chalcedony, with some quartzite as well. A 60% sample was analyzed in situ.

Cluster 5 contains a unifacial flake tool and a sandstone mano. Lithic debitage is mostly secondary flakes of petrified wood. A 40% sample of the assemblage was analyzed.

Cluster 6 contains only secondary and tertiary lithic debris of petrified wood and a small amount of chert. All artifacts were inspected.

Cluster 7 consists of four metate fragments, a mano, a hammerstone, and a soil stain which indicates the location of a hearth. The lithic debitage is principally angular debris of chalcedony, silty chert, petrified wood and chert. All artifacts were analyzed.

Cluster 8 contains approximately 60 artifacts including secondary flakes of petrified wood, chalcedony, quartzite, purple banded rhyolite or silicified argillite, two chalcedony cores/hammerstones, orthoquartzite shatter, and a quartzite hammerstone.

Cluster 9 contains a few primary flakes and abundant secondary, tertiary and biface thinning flakes, a chert core, a pink San Juan granite mano and a rhyolite knife or projectile point tip. Lithic materials include petrified wood, chalcedony and quartzite. The sample represented 30% of the artifacts in a 5 by 6 meter transect.

Cluster 10 is entirely lithic debitage. The majority of the assemblage are is secondary and tertiary flakes of petrified wood. A 40% sample was analyzed.

The Bajada or San Jose projectile point base in Cluster 1 is datable to the 4800 to 1800 BC interval of the early Middle Archaic Period. The site is functionally complex, containing equipment related to both plant and animal procurement, processing, and tool manufacture. Assuming that all clusters are contemporaneous, the site represents an Archaic base camp.

Site 30-10-4 (LA 34681)

This site is manifested in a blowout on the south slope of a dune and measures 20 by 60 meters. Downslope erosion has dispersed the 40 to 50 artifacts contained within the site.

A scatter of fire-cracked rock at the western portion of the site indicates the presence of a hearth. A unifacial cobble mano and lithic debitage consisting of primary, secondary and tertiary flakes were found. Petrified wood and chalcedony are the primary lithic materials.

Functionally, the site appears to represent a limited plant processing locus. No temporally or culturally diagnostic artifacts were found. However, the assemblage appears to be prehistoric and the presence of milling equipment would suggest that the occupation of the site falls within the 3800 BC to AD 1300 interval.

Site 30-10-5 (LA 34682)

The site is located within a blowout on the southwestern slope of a dune. Approximately 50 stone artifacts are within a 30 by 30 meter area.

Tools found within the site include four ground stone fragments and the tip of a projectile point or knife. The remainder of the assemblage is lithic debitage consisting of primary, secondary and tertiary flakes as well as angular debris in roughly equal proportions. Lithic materials include petrified wood, chert, Jemez obsidian and Brushy Basin chert.

The site is probably a limited plant processing locus. The absence of diagnostic artifacts makes temporal/cultural assignment difficult; however, the assemblage appears to be prehistoric. The presence of grinding equipment suggests that the occupation of the site falls within the 3800 BC to AD 1300 interval.

Site 30-10-6 (LA 34683)

This site has four artifact concentrations along the margin of an interdunal playa in an area measuring 35 by 80 meters. In all, approximately 200 artifacts are on the surface.

The first cluster has the remains of a hearth identified by a concentration of fire-cracked rock. The second cluster contains secondary and tertiary flakes, a drill tip, and a portion of a point/knife. The third cluster contains a knife tip, a ground stone fragment and lithic debitage consisting mostly of secondary and tertiary flakes. The fourth cluster contains the basal portion of a serrated knife/projectile point which articulates with the fragment found in the second concentration. If the artifact is a projectile point, it appears to represent the Armijo style. Other artifacts in this concentration include a flake end scraper, an exhausted core, as well as secondary and tertiary reduction flakes. The principal lithic material is petrified wood with lesser amounts of chert, quartzite and chalcedony.

Contemporaneity between at least two of the artifact clusters is denoted by the articulating artifact fragments. The probable Armijo point is assignable to the 1800-800 BC interval within the Late Archaic Period. The site is a small multiple function camp where plant and animal procurement, processing and tool manufacturing occurred.

Site 30-10-7 (LA 34684)

This site is along the margin of an interdunal playa at the base of a stabilized dune and measures 22 by 6 meters. Two features are represented on the surface of the site. The first is a hearth manifested by oxidized sandstone fragments, including two slab metate fragments. The second is a lithic scatter in two clusters containing approximately 50 artifacts. A 20% sample of the lithic debitage consists mainly of secondary and tertiary flakes, including several biface thinning flakes. Other artifacts found within the cluster include an exhausted core, a hammerstone, two slab metate fragments, and an En Medio projectile point. Most of the chipped stone is petrified wood. The En Medio point places the occupation of the site within the 800 BC to AD 400 interval of the Late Archaic (Basketmaker II) Period. Although the site is small, plant processing and hunting activities are represented in the artifact assemblage and it is probably a small camp site.

Site 30-10-8 (LA 34685)

This site contains approximately 500 surface artifacts within a 40 by 25 meter area. The artifacts are exposed in a blowout on a semistabilized dune.

One diagnostic artifact, an En Medio point, was found on the site. Other tools include three knife tips and a cobble mano fragment.

The lithic debitage is primarily secondary, tertiary, and biface thinning flakes and the principal material is petrified wood. A 40% inventory of the assemblage was analyzed in the field.

The En Medio point places the site within the 800 BC to AD 400 interval of the Late Archaic (Basketmaker II) Period. Activities identified by the artifact assemblage include plant processing and hunting. The site represents a small multiple function camp site.

Site 30-10-9 (LA 34686)

This site is in a blowout at the base of a semistabilized dune and adjacent to a playa. The site measures 60 by 30 meters.

It is a Historic Period site manifested by two hearths and associated coal ash piles. The artifacts include condensed milk cans and a Vick's Vapo-Rub™ bottle. One hearth is masonry-lined and may have served as a cooking area associated with a tent.

A date of 1955 was obtained from the bottle bottom. The site appears to be a Navajo sheep herding camp.

Isolated Occurrences

Forty one isolated cultural occurrences were recorded within this sample unit and are listed in Table 1-1. These items provide additional information concerning the use of the area. Extremely limited short-term usage, probably related to food procurement in the prehistoric era, is represented by the isolated flakes, flaked tools, and milling equipment. Interestingly, only two Anasazi Puebloan ceramic fragments (IO-33, 36) were found within this parcel, suggesting that Puebloan Period (AD 900 - 1300) usage was extremely minimal. Several historic loci show limited usage, probably relating to seasonal sheepherding activities by twentieth century Navajo groups.

Table 1-1. Isolated Occurrences in Sample Unit 30-10

IO Number	Brief Description
1	Washington Pass chert flake
2	2 flakes, 1 core; petrified wood and Washington Pass chert
3	chalcedony angular debris
4	chert secondary flake
5	petrified wood secondary flake
6	chert secondary flake
7	number not used
8	oolitic chert biface
9	chalcedony core
10	chert primary flake
11	petrified wood primary flake
12	sandstone slab metate
13	petrified wood secondary flake
14	petrified wood secondary flake
15	petrified wood end scraper
16	2 petrified wood flakes, chert end scraper
17	1 secondary, 3 tertiary flakes, quartzite and petrified wood
18	chert primary flake
19	secondary chert flake, petrified wood primary flake
20	Lysol bottle
21	petrified wood primary flake
22	quartzite pebbles, ground stone, shoe, rusted metal
23	retouched quartzite flake, petrified wood flake
24	retouched flake, 10 petrified wood flakes, chert core, chert flake, quartzite primary flake
25	2 petrified wood cores, chert core, hammerstone
26	number not used
27	30 food cans, glass, nails, bottles
28	chert testing flake
29	food cans, oil cans, glass, china, medicine tube
30	chert testing flake, chert angular debris
31	petrified wood secondary flake

IO Number	Brief Description
32	retouched window glass fragment
33	biface, core, petrified wood
34	Cibola whiteware ladle sherd
35	2 chert secondary flakes
36	Cibola whiteware ladle sherd
37	chert secondary flake
38	dump: crockery, china
39	2 condensed milk cans
40	chert core fragment
41	chert secondary fragment
42	11 petrified wood and quartzite tertiary flakes
50	dump: food cans, glass, stoneware, shoe sole, metal strip

Sample Unit 31-10

Topographic variablity in this unit is low, with elevations ranging from 5910 to 6000 feet. Two minor washes drain the area and flow into the De-na-zin Wash located approximately one mile to the north. These tributaries are dammed one half mile north of the unit boundary and form Tanner Lake.

The sample unit is one square mile (640 acres) in extent.

The terrain is a rolling plain. A gravel-covered playa is in the northeastern portion of the unit and several baked shale hills are on the northwestern edge of the sample parcel. A series of stablized dunes covers the surface of the tract.

Soils consist of dunal sands, alluvial silts along the washes and clay loams adjacent to the badlands outcrops. Vegetation co-varies with the soil types. Salt-tolerant species such as shadscale and fourwing saltbush predominate in the badlands and playa areas. Indian ricegrass and galleta grass are the dominant species on the dunes. Russian thistle and other annuals are most numerous in the alluvial soils.

Six sites and 15 isolated occurrences were recorded in this sample unit.

All the sites are lithic scatters which may range from early Archaic (ca. 5000 BC) to Anasazi (AD 1300). Functionally, lithic scatters indicate hunting/foraging usage of the sample tract. The isolated occurrences indicate extremely temporary or transient usage of the sample unit by Archaic and Anasazi prehistoric groups and Navajo sheep herders within the Historic Period. Almost all of the sites are situated in dunal settings. One site is adjacent to a small playa in the southeastern portion of the site.

Site 31-10-1 (LA 34687)

This site consists of a 26 by 20 meter scatter of lithics on the north slope of a semistablized dune overlooking a playa. The majority of the lithic debitage are tertiary flakes and angular debris manufactured principally from chalcedony, petrified wood, and quartzite. Other artifacts recorded include a biface fragment, a one-hand sandstone mano, and a slab metate fragment. An Olivella shell bead was also found.

The artifact assemblage indicates that the site represents a short-term plant processing locus. Cultural and temporal assignment is difficult. The assemblage indicates that the site is prehistoric and the presence of milling equipment places the site after 3800 BC. The Olivella shell bead also suggests that the site may fall within the Basketmaker II to Pueblo III Periods datable to the 800 BC to AD 1300 interval.

Site 31-10-2 (LA 34688)

The site is manifested in a 40 by 50 meter blowout on a dune. The number of surface artifacts is estimated to range between 50 and 100 items. A transect sample of the lithic debitage indicates that primary reduction and cobble testing were the dominant flaking activities. Lag gravels containing several lithic material types are in the vicinity of the site. A sandstone slab metate fragment was also found. A sandstone outcrop 100 meters east of the site may indicate that milling equipment was also being manufactured. Other artifacts recorded include two quartzite hammerstones. The principal activities at this site appear to be lithic resource allocation and equipment manufacturing.

No temporally or culturally diagnostic artifacts were found. The site appears to be prehistoric and the presence of ground stone places the site after 3800 BC.

Site 31-10-3 (LA 34689)

This site is in a blowout basin within a semistabilized dune, and measures 35 by 24 meters. Approximately 40 lithic artifacts and a deflated sandstone hearth were observed on the surface. Two historic artifacts, a metal lid and a strip of metal, were also found within the basin.

The lithic assemblage is predominately secondary and tertiary petrified wood and quartzite flakes. Other artifacts include four cores, a bifacial quartzite knife, a unifacial sandstone cobble mano, two slab metate fragments, and a quartzite hammerstone. Functionally, the site probably represents a plant food processing locus.

The historic artifacts probably represent transient usage of the location in recent times. The remainder of the assemblage is undoubtedly prehistoric. Although culturally/temporally diagnostic artifacts are absent, the presence of milling equipment places the site within the 3800 BC to AD 1300 interval.

Site 31-10-4 (LA 34690)

The site is manifested within several blowout areas on top of a semi-stabilized longitudinal dune and measures 60 by 70 meters in extent.

Artifact content includes lithic debitage, stone tools and a concentration of fire-cracked rock on the eastern edge of the site. The entire artifact assemblage consists of approximately 40 items. The lithic debitage is mostly secondary and tertiary flakes, although several primary flakes and a few tested cobbles were also recorded. Several biface thinning flakes were also observed. The tool assemblage consists of an orthoquartzite biface fragment, a silicified wood bifacially flaked knife fragment, and two unifacially retouched flakes of quartzite and petrified wood. No grinding equipment was found. The activities represented at the site include plant procurement, tool manufacture and repair.

Although diagnostic artifacts were not found, the site is undoubtedly prehistoric. Since the tool and flaking characteristics are inconsistent with PaleoIndian techniques, the site is datable from early Archaic to late Anasazi times.

Site 31-10-5 (LA 20078)

This is a multiple component site located on the western edge of a semi-stabilized longitudinal dune. The site is in a blowout basin and measures 25 by 50 meters.

The site contains an historic component and at least one prehistoric component. The historic materials include three food cans, a fork handle, machinery parts and a soda bottle. The prehistoric materials include one redware sherd and two corrugated sherds, lithic debitage, two sandstone grinding slab fragments (one basin metate), two one-hand manos, three cores, a large bifacially flaked cobble, five tested cobbles and one hammerstone. Most of the debitage represents secondary and tertiary reduction.

Based on the data from the soda bottle bottom, the historic component dates to the 1940's, and probably represents transient usage of the blowout by Navajo sheep herders.

The sherds are datable to the late Pueblo II phase (ca. AD 1000 to 1100). Assuming that the ceramics are associated with the stone artifacts, the prehistoric component probably represents a late P-II Anasazi plant processing locus.

Site 31-10-6 (LA 34692)

This site is manifested within several dune blowout basins on a semistabilized sand dune and measures 65 by 70 meters.

A hearth and over 400 lithic artifacts are present on the site. The lithics are composed mainly of secondary, tertiary and biface thinning flakes. One sandstone slab metate fragment was also recorded. No formal flaked tools were noted. The principal lithic material is petrified wood.

The artifact assemblage indicates that the site is prehistoric. The slab metate suggests that the site dates to the Middle to Late Archaic interval. The site is probably a small camp where several activities relating to plant processing and tool manufacture took place.

Isolated Occurrences

Seventeen isolated cultural occurrences were recorded within this sample unit. This assemblage provides additional information concerning the use history of the parcel. As shown in Table 1-2, the Bennett Gray sherds are datable to Basketmaker III times (AD 700 to 850). The Escavada B/W sherds date to the Pueblo II interval (AD 925-1125). The horno base and the sandstone cairns were probably associated with Navajo sheep herding activities in the sample unit. The resharpened Bajada point found with historic artifacts probably represents curation and perhaps reuse.

Table 1-2. Isolated Occurrences in Sample Unit 31-10

IO Number	Brief Description
43	white chert testing flake
44	white chert angular debris
45	Bajada point with sheep rattle, glass fragments
46	wood chopping area
47	sandstone horno base
48	Escavada B/W sherd
49	sandstone rock alignment
50	historic trash scatter
51	3 sandstone cairns
52	3 Escavada B/W bowl sherds
53	chalcedony drill
54	2 sandstone cairns
55	2 flakes, core, four purple glass fragments
56	9 flakes, hammerstone, 3 cores
57	3 Bennett Gray sherds
58	basalt biface fragment

Sample Unit 37-10

The terrain varies throughout the parcel. Ephemeral arroyos drain northwest into the headwaters of Coal Creek; some are entrenched, suggesting heavy runoff following storms. The northern three-quarters of the section consists primarily of an eroded and somewhat dissected sand/shale floodplain with occasional sand and shale hills. In the south fairly high steep shale badlands rise from the floodplain.

Atop these shale strata to the south are relatively uneroded dunal deposits which extend out of the unit for a number of miles south. The elevational range is 6200 to 6300 feet. The highest elevation is in the extreme southeastern portion of the sample unit, with slope gradients higher to the west (100 feet/0.5 mile) than to the northwest (100 feet/mile).

The sample unit contains 640 acres. The soils vary with physiographic zone. On the floodplain the soils are silty clays mixed with shale detritus; the upper deposits on badland surfaces are heavy clays and the dunal deposits in the extreme south are unconsolidated sands and sandy loams.

On the alluvial plains and flat areas near drainages, the vegetation is mixed grasses and low shrubs. Shadscale, muhly and galleta grasses predominate. Russian thistle grows in large patches in these areas also. Typical shrubs and grasses in the higher rolling terrain include fourwing saltbush, rabbitbrush, wolfberry drifts, snakeweed, narrow-leaf yucca, dropseeds, Indian ricegrass, spike muhly, a variety of annuals, and in the moister areas, greasewood and tamarisk.

The cultural resources are almost exclusively prehistoric. The sites include lithic scatters of various sizes located on semistabilized dunes on knolls and overlooking badlands and water sources. There are three lithic sites, two sites with sherd and lithic artifacts, various prehistoric isolated occurrences of sherds and lithics, and one historic isolated occurrence consisting of a tent stake and three rusted cans.

Site 37-10-1 (LA 34693)

The four clusters of artifacts within this site are on the tops and sides of low dunal ridges which are bounded by several tributaries of Coal Creek. The site size is 450 by 225 meters.

No distinct features were discernible, but there are six probable hearth locations marked by concentrations of fire cracked rock. Artifacts cluster in erosional areas within stabilized dunes and in many cases probably represent downslope erosion from activity areas located on dunal ridges.

The artifact assemblage within each of the clusters is somewhat similar in lithic content, but ceramic variability is high among the four clusters. A 20% lithic sample in Cluster 1 yielded angular debris, secondary and primary flakes of petrified wood, and two cores. Tools found within and outside the sample included utilized flakes, slab metate fragments, mano fragments, unidentified ground stone fragments, a biface fragment and a hammerstone/tested cobble. The ceramics included mostly Chuska whiteware, Bennett grayware, early Cibola corrugated, and one piece of possible White Mountain redware.

There were no ceramics in Cluster 2, but an in-field analysis of a 30% lithic sample produced angular debris, tertiary flakes and cores, as well as basin and slab metate fragments, manos, an intact slab metate, a biface tip and utilized flakes. Lithic materials are principally petrified wood palmwood, chert, sandstone, and quartzite.

In Cluster 3 a 30% sample was analyzed, and the following items were noted: tertiary flakes, angular debris, secondary flakes, core fragments, a hammerstone, a handstone, slab metate fragments, retouched angular debris, and a Jemez obsidian drill tip. The dense scatter of ceramic sherds in this cluster included one Gallup B/W, one Escavada B/W, one P-II Chuska series B/W, and P-I and P-II Cibola corrugated sherds.

The highest density and diversity of artifacts were noted in Cluster 4. There is a wide variety of Cibola and Chuska wares including twelve distinct painted and corrugated types, representing a temporal range of AD 500 to 1300. The lithic assemblage likewise contained more tools (23) relative to chipped stone items. A 15% sample produced tertiary flakes, angular debris, retouching and thinning flakes, core fragments, and secondary flakes. The tools found within the transect and in the general artifact scatter include utilized flakes, biface fragments, basin and slab metate fragments, handstone fragments, and a hammerstone.

The historic component of this site consists of two stock dams, one of which has been breached and abandoned and one which is intact and located south of the first. In Cluster 4 there is a Coca-Cola bottle and a half-buried pail with a handle.

The historic component of the site represents Navajo pastoralist usage in the twentieth century. Prehistoric site usage is both functionally and occupationally complex.

The ceramic assemblage indicates Anasazi usage from BM-III through P-III periods. Conclusive evidence for earlier occupation is absent. The lack of structural features suggests that all Anasazi usage of the site was restricted to short-term encampments.

The remainder of the artifact assemblage indicates that plant procurement and processing were the dominant activities. The site setting, overlooking two tributaries of Coal Creek, suggests a suitable locus for agriculture and/or noncultigen plant procurement.

Site 37-10-2 (LA 34694)

The site is on the west slope of a large semistabilized dune. The lithic artifacts occur on a bench of the dune which is deflated in places, and are probably derived from upslope. The dimensions of the site are 22 by 10 meters.

No features were visible at this locus. The lithic assemblage consists of petrified wood, chert, palmwood, and metaquartzite material types. Tertiary flakes of petrified wood were most abundant, with lesser amounts of thinning flakes, core fragments and retouching flakes. Two one-hand manos were found. No specifically diagnostic artifacts were found which could date the occupation of the site. Based on the content of the lithic assemblage, functions of tool manufacturing and plant processing may be surmised. The site is heavily eroded by wind and water activities and there is some probability of intact subsurface deposits in the dunal areas above the artifacts.

Site 37-10-3 (LA 34695)

The site is at the edge of dunal sands above a shale badlands area and continues to the east and south along a playa area. The scatter of lithics extends longitudinally along the ridge. The site measures 190 by 15 meters.

No visible features were noted at this site. The artifact assemblage includes 50 to 60 flakes and four ceramic sherds. The identification of the sherds is not certain, but they appear to be Cibola series P-II plain grayware. A 33% sample of the surface lithics included primary, secondary, tertiary and biface thinning flakes, angular debris, core fragments and tested rock. The materials are principally petrified wood with lesser quantities of quartzite and chert. The tool assemblage includes one marginally retouched chert flake and two small pieces of metaquartzite ground stone. An Olivella shell bead was also found.

The site appears to have functioned as a short-term plant processing and tool manufacturing locus occupied during the P-II phase of the Anasazi Period. The artifacts are located on loose sand; there may be some subsurface material.

Site 37-10-4 (LA 34696)

This site is on a semistabilized dunal area above the shale badlands. The lithic artifacts are scattered on loose sand. The dimensions of the site are 50 by 38 meters.

This site has no visible features on the surface of the loose sand. No ceramics were noted, but there is a light scatter of lithics, mostly flakes, including petrified wood, chert, obsidian, and orthoquartzite. There is a small amount of burned rock. A 33% lithic sample shows that almost all of the artifacts are tertiary and secondary flakes. Two core fragments (one utilized), one thinning flake and one utilized flake were recorded. This site may have functioned as a plant procurement locus where tools for extracting plant resources were manufactured.

No temporally/culturally diagnostic materials were found. All of the artifacts were found on the surface of loose sand and there is a possibility that intact subsurface features or deposits are present.

Site 37-10-5 (LA 34697)

The site is on a semistabilized dune above the shale badlands. The artifacts lie on the dune top and extend slightly down the south slope towards toward badlands exposures. The artifact scatter measures 17.5 by 12 meters.

The site is a sparse, small lithic scatter consisting of a hammerstone and 17 flakes. Most of the flakes are tertiary and secondary flakes of petrified wood. There are also flakes and angular debris of chert, palmwood, oolitic chert, Brushy Basin chert, and orthoquartzite. The diversity of materials at such a small site suggests that the site function may be more complex than apparent from the surface artifacts. No diagnostic features or artifacts were found, and it is surmised that the function of the site was limited tool manufacture related to plant procurement activities.

Isolated Occurrences

Ten isolated occurrences were recorded and listed in Table 1-3. The sherds date the use of the area in the P-II phase, while the lithic artifacts are entirely non-diagnostic. The historic component probably under-represents the amount of grazing use of the parcel.

In general, the prehistoric use of this parcel appears to have been seasonal in character. Tool manufacture, procurement, and initial processing of plant materials seem to constitute the major activities of these limited activitity sites.

Table 1-3. Isolated Occurrences in Sample Unit 37-10

IO Number	Brief Description
68	secondary flake
70	P-II corrugated sherd
72	retouched tertiary flake
74	tertiary flake
76	sherd, 2 flakes, 1 piece of angular debris
78	flake (possible scraper)
80	Red Mesa B/W sherd
82	P-II corrugatd sherd
84	3 cans, tent stake
86	tertiary flake

Sample Unit 37-11

Elevational differences within the sample unit are quite small, ranging between 6200 and 6260 feet. The general slope is to the southwest and the very shallow drainages are unentrenched. Many areas within the parcel are flat, with very gently rolling hills. Toward the south of the unit there are local dunal ridges produced by small outcrops of erosion resistant sandstone which are covered by unconsolidated sands. Small blowouts occur within and at the base of these dunes and there are larger deflation areas near the dunes.

Soils within the parcel vary from heavy clay soils which are quite saline in places within the drainage bottoms to loose sands on the dunal ridges. Where vegetation has stabilized higher terrain, the sandy soils are more loamy.

Floodplain areas support a vegetative community of mixed grasses, Russian thistle and small shadscale shrubs. A greater diversity of shrubs occurs on the sandy dunal areas, including wolfberry drifts, fourwing saltbush, snakeweed and rabbitbrush. Indian ricegrass sometimes occurs in dense stands in these areas, but more frequently there is a mixture of dropseed, galleta and ricegrass in the more sandy, hilly areas.

In general, there is little environmental variability in the sample unit. Its current use for grazing of cattle and horses is an appropriate contemporary land use activity.

The cultural resources also reflect this relative homogeniety. There are four prehistoric lithic scatters and a small sherd scatter associated with a possible pithouse depression. The isolated occurrences are exclusively chipped and ground stone. A scattered pile of coal and tire tracks at 37-11-4 mark post-1900 historic usage.

Site 37-11-1 (LA 34698)

The site is on the south side of a low ridge formation and around the edges of a dune blowout. There may be buried cultural deposits within the semistabilized sands. The site contains two artifact clusters and measures 70 by 35 meters.

There are no visible features, but the artifacts are clustered in two areas at about the same elevation on a gentle south-facing slope. One cluster is within a larger deflation zone. The artifact assemblage is exclusively chipped stone of four different material types. The most frequently occurring material type in both clusters is locally available petrified wood. Found most frequently were pieces of angular debris, but there are also tertiary, secondary, and primary flakes. Small numbers of cores, thinning flakes, and retouch flakes were also found. In various parts of the site, three tools were noted: a Washington Pass chert biface which may be a midsection of a knife, an crude orthoquartzite biface and a chalcedonic petrified wood Archaic point, Bajada Phase. An estimated date for this site is 4500 to 3500 BC (Irwin-Williams 1973: Figure 7).

The site appears to be a very limited-use hunting camp where tool manufacture and repair took place. Since the artifacts seem to be relatively undisturbed, additional artifacts and/or features may be buried in the unconsolidated sands elsewhere on the rise.

Site 37-11-2 (LA 34699)

This artifacts were found within the confines of a large blowout on the northwest side of a low, semistabilized dune. The physiographic setting is very similar to 37-11-1, but the direction of the exposure differs; however, exposure may be an artifact of erosional processes rather than site placement. The artifacts are in two clusters within a 70 by 30 meter area (see also Figure 5).

There are no clearly definable features visible, but there is a possible hearth in Cluster 1 which is suggested by several fire-oxidized rocks. The chipped stone assemblage features a relatively large proportion of tertiary reduction flakes and pieces of angular debris. Four kinds of lithic materials were utilized, and all, except two Jemez obsidian biface thinning flakes, can be obtained locally. Petrified wood is the most commonly used material, and there are tertiary, secondary, thinning and retouch flakes as well as angular debris, a tested rock and two biface fragments of this material. In Cluster 2 there is also a variety of chipped stone materials and flake types, as well as two sandstone mano fragments. The fragments are too small to indicate mano style. No specific diagnostics were found, but the presence of ground stone suggests either Archaic or Anasazi use of the site.

The locus appears to be a plant processing site. Since the site is on sandy dunes, there is a high probability that there may be additional features and/or artifacts buried in the unconsolidated deposits.

Site 37-11-3 (LA 34700)

This site is on a flat plain where there are both alluvial and aeolian deposits of sandy loam soils. The vegetation consists of galleta grass and Russian thistle. The overall dimensions of the site are 18 by 5 meters.

The site has a small scatter of sherds located twelve meters southwest of a five-meter diameter depression that may be a pithouse. The sherds are all grayware with fugitve red paint, and have been identified as Lino style, Cibola Series plainware. No lithic artifacts or other features were found. These sherds are probably Anasazi BM-III in age.

If the depression is indeed a pithouse, it probably served as a seasonally occupied habitation unit for activities centering on both the agricultural soils of the bottomlands and ephemeral water supplies within the drainage to the southeast, as well as floral resources on the sandy dunes to the south.

Site 37-11-4 (LA 34701)

This site overlooks a small drainage to the south and is on the south side of semistabilized dune. There is a playa 100 meters north. The sands are unconsolidated and there may be some subsurface cultural material present. The site measures 110 by 75 meters.

There are two clusters of stone artifacts in a large blowout in a dunal area. This clustering is probably the result of weathering rather than cultural processes. A 35% sample transect within one of the clusters was analyzed in the field. Most of the flakes are tertiary, with lesser quantities of secondary and primary flakes. Cores, a heavily used hammerstone, a biface tip, and angular debris were also found within the sample area.

Other items noted in the general scatter included a utilized petrified wood flake, a unifacially retouched flake fragment, one quartzite mano fragment, two sandstone manos and a shallow basin metate. No features were visible. Based on the presence of ground stone, the site probably dates within the 3800 BC-AD 1300 interval. The locus is probably a plant processing area.

Site 37-11-5 (LA 34702)

This lithic site is located within a blowout on the southwest side of a sandy dune that surrounds a small playa. The artifact scatter measures 40 by 35 meters (see also Figure 7).

The site contains of a light scatter of chipped stone materials of petrified wood, chert, chalcedony, palmwood, two types of obsidian, and orthoquartzite. Most of the lithic items are tertiary flakes, angular debris, and secondary and primary flakes. No cores, thinning flakes or ground stone were found and there were no discernible features. The only apparent tool is a unifacially retouched orthoquartzite primary flake. No diagnostic artifacts were found. A 40% fraction of the lithics was subjected to in-field analysis.

The function of this site appears to be plant procurement and tool manufacture. Since it is located in a generally sandy area, there is a possibility of subsurface artifacts and/or features.

Isolated Occurrences

The isolated occurrences are listed in Table 1-4. In general, the parcel appears to have been occupied during the Middle to Late Archaic, and BM-II and III phases (3500 BC to AD 700). The historic component at 37-11-4 is probably an under-representative sample of the grazing use of the grasslands. These isolated occurrences are entirely prehistoric in origin and reflect seasonal use of the area for plant processing and limited tool manufacture.

Table 1-4. Isolated Occurrences in Sample Unit 37-11

IO Number	Brief Description
59	ground stone fragment
60	small metate fragment (basin or slab)
62	basin metate fragment
64	exhausted petrified wood core
65	2 flakes
69	En Medio (BM-II) point base, 4 pieces angular debris, all petrified wood
71	Chuska sandstone one-hand mano

Sample Unit 38-10

This sample unit contains 640 acres. The northwestern half of the sample unit is a gently sloping and rolling colluvial plain. Numerous small erosional channels traverse the plain, and they drain from southeast to northwest toward the upper tributaries of Coal Creek. The terrain within the southeastern half of the parcel is dominated by a low, broad ridge formation. Zones of clay/shale are found on the steeper slopes on the northwestern side of the ridge. Cobbles of petrified wood, red quartzite and other raw lithic materials were found within these settings. These dispersed outcrops may have been used as quarry loci for materials needed in chipped stone tool manufacture. The northern edge of the sample unit is marked by steeply rising slopes which feature semistabilized, longitudinal dune ridges. Topographic relief ranges from 6240 feet at the northwestern corner of the sample unit to 6340 feet on the crest of the low ridge to the southeast.

There are three major soil/plant associations. First, within the gently sloping colluvial plain, sandy soils predominate. These soils support a mixed shrub-grassland plant association. The shrubs include shadscale and fourwing saltbush, and the grasses consist of various dropseeds, ring and spike muhly, Indian ricegrass, and galleta. The second association is on the crests and upper slopes of the low ridge formation and the longitudinal dune ridges. The vegetation found growing in these sandy soils includes the mixed grasses described above, but the more salt tolerant shrubs are replaced by rabbitbrush and wolfberry drifts. Snakeweed is another common plant. The third soil/plant association consists of hard-packed clayey soils which are found within the badlands. The plants growing in this setting include a few widely scattered shadscale, fourwing saltbush and bud sagebrush.

The cultural resources recorded within this sample unit are relatively limited. Two archeological sites were located, both of which date to the Anasazi Period. These sites lack any definable features and they are thought to represent the loci of limited, short-term activities during the P-II phase.

The six isolated artifact occurrences date almost exclusively to the prehistoric period. Both chipped and ground stone artifacts were recorded, all of which were within zones of sandy soils and relatively greater vegetational cover. The only historic artifact, IO-88, is a homemade shovel blade. The large expanses of mixed grasses noted within much of the survey parcel undoubtedly have been utilized in the Historic Period for grazing livestock. This activity, however, does not always produce archaeologically visible remains.

Site 38-10-1 (LA 34703)

This light sherd and chipped stone scatter is within a shallow, broad valley which is bordered by two longitudinal dune ridges. The maximal dimensions of the site area are 40 meters by 10 meters. There are fewer than 100 artifacts, and no features could be defined.

A 50% sample of the ceramic artifact assemblage revealed the following types and frequencies: five plain gray sherds, 21 sand-tempered P-II corrugated sherds, two Escavada B/W sherds and four sand-tempered, undifferentiated utility ware sherds. Only three chipped stone artifacts made of petrified wood were encountered. These include one secondary and two tertiary reduction flakes.

The ceramic assemblage indicates that the site was occupied during the AD 900-1100 interval. The small number of artifacts and the limited range of debris suggests that the site was occupied only for a brief time. Site function could not be ascertained, but the high proportion of sherds to lithics is similar to sites in Sample Units 39-9 and 39-13 which are associated with the Great North Road. No Chacoan roads have been identified in this area, however.

Site 38-10-2 (LA 34704)

This lithic scatter is on the south side of a longitudinal dune ridge. A tributary wash of Coal Creek lies about 15 meters south. The artifacts were found within a series of dune blowouts. Some cultural debris is thought to be eroding out of the semistabilized dune deposits, particularly at the west end of the site. The site dimensions are 90 meters by 20 meters.

There are fewer than 100 artifacts within this area. The distribution of artifactual remains is not homogeneous: very little debris was found on the ground surface between the blowouts. A cluster of fire-cracked rock was found at the east end of the site. These cobbles may mark the location of a former hearth area; however, no charcoal or ash was found in association with the cobbles.

The chipped stone lithic assemblage is composed of 37 artifacts. Of these, 16 are pieces of angular debris, 19 are tertiary reduction flakes and two are secondary reduction flakes. One tertiary flake and one piece of angular debris display edge damage suggestive of their use as tools. With the exception of one piece of Jemez obsidian, all of the debitage is made of locally available petrified wood. Three core fragments, one with possible edge damage, were also noted.

The ground stone assemblage is composed of two quartzite manos, one of which has two grinding surfaces. The only other formal tool on the site is a quartzite hammerstone. One P-I corrugated vessel fragment was found. On the basis of this evidence, the site may date between AD 900 and 1100. The sherd, however, may be intrusive on an Archaic site.

The artifact assemblage indicates that some tool blank manufacture from previously prepared cores and some plant processing were the primary activities at this site.

The small number of artifacts and limited range of cultural remains suggests that the site was briefly occupied.

Isolated Occurrences

Six isolated occurrences were located within the sample unit. All but one of these are thought to date to the prehistoric period, probably between Late Archaic and P-III times (800 BC to AD 1300). The remaining isolated occurrence is related to the Navajo use of the area in the past century. These cultural remains are listed in Table 1-5.

Table 1-5. Isolated Occurrences in Sample Unit 38-10

IO Number	Brief Description
87	basin metate fragment
88	tertiary flake
89	obsidian knife
90	homemade shovel blade
91	ground stone fragment
93	2 ground stone fragments, 2 flakes

Sample Unit 38-11

This unit contains 640 acres. Elevations range between 6320 and 6260 feet and increase to the east within the unit. Several minor washes drain the parcel to the west to enter the Tsun-je-zhin system. A few moderately large sand dunes are located in the southwestern portion of the unit. The northwestern section is mostly flatlands containing outwash gravels composed of petrified wood, shale and quartzite. The eastern half of the unit is a flat, elevated plateau.

Soils are generally sandy loams throughout the unit. Vegetation is predominately mixed grasses. Galleta and dropseeds with lesser amounts of muhly grasses were observed. On dunal surfaces rabbitbrush, fourwing saltbush, wolfberry, eriogonum, narrow-leaf yucca, and sagebrush occur. Annuals include Russian thistle, globe mallow, penstemon and other unidentified species. Wild onion was found in heavy clay soils.

The area is overgrazed by cattle, and numerous livestock trails traverse the unit.

Evidence for human usage of this sample unit is minimal. No sites were found. Only one of the five isolated cultural occurrences listed in Table 16 is attributable to the prehistoric era (IO-75). The remainder are probably associated with Navajo sheep or cattle herding activities.

Table 1-6. Isolated Occurrences in Sample Unit 38-11

IO Number	Brief Description
61	Red Mesa B/W sherd
63	mano fragment
65	ground stone fragment and core
67	3 pieces of angular debris
75	core, chert tertiary flake
77	2 baking powder cans, no dates
79	oil(?) can
81	sandstone circle, dog/coyote burial (?)
83	noisemaker

Sample Unit 39-9

Physiographic variability is relatively high within this sample unit. Total relief is 140 feet and elevations range between 6320 and 6460 feet. A major tributary of Coal Creek is present along the northern edge of the unit. Broad alluvial floodplains are associated with this drainage. Elevations increase sharply in the northeastern and east central portions of the unit where several mesas are present. High elevation flatlands are located in the southeastern quarter of this 640 acre sample unit. Badlands clay shale outcrops form small hillocks in the central portion of the parcel.

Soils range from alluvial silts along the major wash to clay loams on the slopes below the mesas and sandy clay loams in the high flatlands. Vegetation is varied. Sagebrush is present on the uplands and is mixed with Indian ricegrass, grama, galleta and muhly grasses. In the lower elevations fourwing saltbush, rabbitbrush, narrow-leaf yucca and snakeweed predominate. A few stunted juniper are present on the mesa located in the northeast portion of the unit.

Cultural resources within the unit are two types: Anasazi Puebloan and twentieth century Navajo. Six sites and 13 isolated occurrences were found. The Anasazi Great North Road, which begins at Chaco Canyon to the south and passes near Pierre's Site one-half mile north of the sample unit, traverses the eastern portion of the unit. Several sherd scatters and isolated artifacts appear to be directly associated with the road. A ten-room pueblo adjacent to the major wash may be associated with Pierre's Site community.

The historic Navajo sites and isolated occurrences indicate habitation and sheep herding activities. These cultural manifestations occur at moderate to high elevations and are frequently associated with ephemeral drainages within the sample unit.

Site 39-9-1 (LA 34297)

This historic Navajo habitation site is on a relatively flat sagebrush uplands zone. A dirt road aligned north-south bisects the site. The site measures 20 by 30 meters.

The site contains two features: the remains of a cribbed or many-legged hogan and an ash/trash dump. Datable artifacts include a KC baking powder can lid ("same price today ... 44 years ago"). Manufacturer's marks on several other lids indicate that the site falls within the AD 1900-1940 interval. Several Navajo Utility and Navajo Polychrome sherds were also found. Domestic activities are represented in the artifact array. The only evidence for sheep herding is bone fragments found within the dump.

Site 39-9-2 (LA 34298)

This sherd scatter is located on top of a small mesa and measures 150 by 40 meters. Artifacts have eroded downslope both north and south of the mesa.

There are 61 sherds in the artifact assemblage. All sherds were inspected in the field. Ceramic types identified within the assemblage include Gallup B/W, Cibola corrugated and whiteware, Chaco B/W, Escavada B/W, Wingate B/R and an unidentified B/W. The average date range for this ceramic collection is AD 1050-1125, placing the site within the Puebloan Period.

The specific function of this site could not be determined. No features or non-ceramic artifacts were found. The site, however, is on or adjacent to the Great North Road. IO-109, a 1.5 meter circle of unshaped sandstone and petrified wood, is about 150 feet west, and may also be associated with the Chacoan road.

Site 39-9-3 (LA 34707)

This Navajo habitation site is on the edge of an elevated plain and has a southern exposure. The site is 105 by 65 meters in areal extent. A north-south road is 10 meters west of the site.

Four features were recorded: a hogan ring, a wood chopping area, an ash/trash dump, and a corral. A hearth is just inside the doorway of the hogan ring. Datable artifacts included a True Height baking powder can lid, an AH bottle bottom, and Depression Period china which dates the site to the AD 1930-1940 interval. Both domestic and sheep herding activities are represented in this site.

Site 39-9-4 (LA 34708)

This Navajo sheep herders' camp is on a relatively flat area adjacent to a small arroyo and measures 35 by 25 meters in extent. Two features are present: an ash/trash dump and a brush corral. It is likely that the site represents a summer tent camp. However, no traces of a tent base could be found. The deteriorated condition of the metal cans and the manufacturer's mark on the base of a Jergens bottle indicate that the site dates to the 1930-1940 interval.

Site 39-9-5 (LA 34709)

This ten-room pueblo is on the north side of a major tributary of Coal Creek wash adjacent to the alluvial floodplain. The wash is deeply entrenched. The site measures 60 by 100 meters in areal extent. A dirt road bisects the rubble mound.

The ten rooms are contiguous and constructed of sandstone and shale masonry. Only the foundation walls are visible, and dividing walls are somewhat dispersed. Three features were noted adjacent to the structure. An ash stain was noted outside the southwestern wall, another hearth area was recorded outside the northern wall, and a midden deposit was noted 30 to 40 meters southeast of the site.

Ceramics recorded from the site include Red Mesa B/W, Escavada B/W, Gallup B/W, Cibola whiteware, and Chuska corrugated. The average dates of these ceramics place occupation of the site within the AD 900-1100 (P-II) interval of the Anasazi Period.

Functionally, the site's setting indicates that farming was probably a vital activity. The site's proximity to Pierre's Site, which is about three quarters of a mile northeast, suggests that the inhabitants may have been members of this Anasazi community.

Site 39-9-6 (LA 34710)

This sherd scatter is located at the base and lower slopes of a small clay shale hill and measures 10 by 15 meters. The site is also adjacent to the Great North Road. If any features were present on the hill top, they have now been completely eroded downslope.

The ceramic assemblage dates to the AD 900-1100 interval of the Anasazi Period. Identified ceramics include Gallup B/W, Chaco B/W, Cibola whiteware, and P-II corrugated utility wares. Non-ceramic artifacts are absent.

The function of the site is unknown, but the site is similar to site 39-9-2 in size, artifact content, and spatial association with the Chacoan Great North Road.

Isolated Occurrences

Thirteen isolated occurrences were found within this sample unit. The majority are Anasazi sherds datable to the AD 900-1100 interval and are spatially associated with the Great North Road or the ten-room pueblo. The remainder are historic artifacts or features apparently associated with twentieth century Navajo sheep herding activities. These cultural manifestations are listed in Table 1-7.

Table 1-7. Isolated Occurrences in Sample Unit 39-9

IO Number	Brief Description
95	3 Escavada B/W, 1 Chuska series, 2 Cibola corrugated sherds
97	2x1 m. circular sandstone slab feature (hearth?) associated with Anasazi road
99	Cibola corrugated sherd
101	noisemaker
103	Cibola whiteware sherd
105	assigned site status (39-9-6)
107	2 Cibola corrugated sherds

IO Number	Brief Description
109	sandstone and petrified wood circle, corrugated P-II sherd, Chuska whiteware sherd; possibly associated with 39-9-2 or Great North Road
111	corrugated P-II sherd
113	1 m. sandstone circle, charcoal and glass fragments
115	Cibola corrugated sherd
117	2 Cibola corrugated sherds
119	Cibola corrugated sherd
121	3 Cibola grayware P-I sherds

Sample Unit 39-13

The terrain within the sample unit is best characterized as a cross-section of the Ah-shi-sle-pah Valley. There is relatively high mesa land in the northwestern and southeastern portions of the parcel. One zone of high ground consists of the southern slopes and a small portion of the crest of Tsun-je-zhin Mesa, and another is the edge and the northern slopes of a smaller mesa formation which is bordered to the north by the Ah-shi-sle-pah Wash and to the south by the Kimbeto Wash. Topographic relief within the sample unit ranges from 6120 feet along the Ah-shi-sle-pah Wash to 6300 feet on the crest of Tsun-je-zhin Mesa. The sample unit contains 640 acres.

The mesa slopes are semistabilized, longitudinal dunes. There are many small deflated areas within these deposits, many of which have been eroded down to a hard-packed clayey surface. Both isolated playas and blowouts with exterior drainage were noted. The dune ridges are separated by small washes which increase in width as they approach the Ah-shi-sle-pah Wash.

A number of eroded badland areas were also noted within and immediately adjacent to this parcel.

The vegetation throughout the sample unit manifests two basic patterns. First, in the sandy areas on the crests of the mesas and the longitudinal dune ridges, there is a moderate to heavy cover of vegetation consisting of a variety of shrubs, grasses, and annuals. The dominant plant species in these settings include rabbitbrush, small drifts of wolfberry, some fourwing saltbush, Indian ricegrass, muhly, galleta, dropseed grasses, snakeweed, a few widely scattered narrow-leaf yucca, and prickly pear cactus. The zones of the clayey hardpan flats have sparse and scattered fourwing saltbush, shadscale and Russian thistle.

Throughout the survey parcel there is an extremely sparse but nearly continuous scatter of chipped stone debitage. Various kinds of petrified wood are locally available as well as quartzite, white to gray chert, palmwood oolitic chert and Brushy Basin chert. Many of these materials could have been obtained from any one of the three major outcrops of water-worn pebbles which occur within this parcel. The density of raw lithic materials is very light within these settings and many of the nodules contain impurities and fissure lines which make them useless for chipped stone tool manufacturing. Some broken nodules, a few widely scattered core fragments and a small number of primary reduction flakes were encountered in these locales. It appears that these outcrops were occasionally used for lithic material procurement.

Fifteen sites containing 22 components were recorded within this unit. Six of the nine Anasazi components are aligned with and adjacent to the Great North Road which traverses the sample unit. Two lithic scatters containing late Archaic/Basketmaker II projectile points were also found. The remainder of the site components discovered in this unit includes three late Historic Navajo components and eight non-diagnostic lithic sites.

All but one of the lithic site components are located within or on the margins of semistabilized dunes. With the exception of the road-associated Anasazi sites, the prehistoric components were apparently produced in the context of collecting and processing indigenous biotic resources. Similarly, the Navajo components were generated during the course of exploiting the pasturage and water resources within and adjacent to the sample unit.

Site 39-13-1 (LA 34711)

This sherd and lithic scatter is at the western edge of an elongated mesa formation which forms the southeastern edge of the survey parcel. The site overlooks Ah-shi-sle-pah Wash to the north and an area of badlands to the west. An unimproved dirt road cuts across the northern portion of the site. Since artifactual debris is found almost exclusively within deflated and/or sheet washed dune deposits along the western edge of the mesa, it is possible that cultural debris remains buried within zones of semistabilized dunes to the east. The maximal site dimensions are 210 by 50 meters.

No distinct features or activity areas could be defined; however, three artifact clusters coincide with areas that have been most heavily eroded. Cluster 2 is thought to date to Archaic times, while Clusters 1 and 3 are Anasazi in origin.

The Archaic component, as manifested within Cluster 2, consists of a very light scatter of chipped stone tools and pieces of lithic debitage which measures 61 by 10 meters. No ceramic artifacts were encountered. The chipped stone tool assemblage includes an En Medio phase projectile point fragment, two biface fragments, a hammerstone, and a cobble uniface chopper.

Cluster 2 overlooks a broad area of badlands to the west-southwest and the lower portion of the Ah-shi-sle-pah Wash. This cluster is thought to be the remains of multiple short-term occupations. The major activities appear to have been related to hunting rather than plant processing. The presence of the En Medio projectile point indicates that the cluster was occupied between 800 BC and AD 400.

The Anasazi component, which is evident within Clusters 1 and 3, may be related to the Great North Road.

Cluster 1 is approximately at the center of the site, and it measures 30 by 20 meters. Substantial quantities of chipped stone debris, a reworked PaleoIndian point, one hammerstone, two pieces of fire-cracked rock, and several Gallup B/W decorated sherds were noted. Because of the large proportion of tertiary reduction flakes and small pressure flakes within the chipped stone artifact assemblage, tool maintenance and/or the final manufacture of tools from previously prepared cores may have been the primary activites within the cluster.

The projectile point appears to be either a Belen or Cody type (9500 to 7500 BC) that has been modified; shallow side notches have been added and the proximal edges have been retouched. The artifact was found at the edge of the cluster in an active erosional zone. Thus, spatial and temporal association with the Anasazi component cannot be made with certainty.

Cluster 3 consists of a moderately dense scatter of sherds, a few chipped stone flakes and two ground stone artifacts. This cluster, which is located at the northwestern end of the site, measures 50 by 25 meters. The following ceramic types were identified: Mancos B/W, Nava B/W, McElmo B/W, Mancos B/W, Chaco B/W, Gallup B/W and unidentified Cibola series whiteware. Plainware and corrugated sherds were also noted, but could not be typed. The chipped stone assemblage is composed of secondary and tertiary reduction flakes, pieces of angular debris and four core fragments. The ground stone artifacts include portion of one sandstone mano and one tabular metate. Secondary core reduction and some food processing activities are suggested by the above artifact assemblages.

The ceramic artifacts recorded from Clusters 1 and 3 indicate that the Anasazi component of this site dates between AD 1100 and 1200. Some functional variability was noted between the two clusters. It is suggested that several short-term occupations are represented.

Site 39-13-2 (LA 34712)

This light scatter of chipped stone assemblage is located within a series of three major dune blowouts which overlook the Ah-shi-sle-pah Wash to the north. The site measures 60 by 55 meters.

The artifact density within the blowouts ranges from very light to moderate; the artifact density within the intervening zones of semistabilized dune is extremely sparse. Some debitage was found eroding downslope to the edge of the Ah-shi-sle-pah Wash. No features could be identified. Each of the dune blowouts was designated as an artifact cluster for recording purposes.

Cluster 1 is a light scatter of chipped stone debris which is situated in a small dune blowout at the southeastern margin of the site. The maximal dimensions of the cluster are approximately 25 by 8 meters.

Cluster 2 was found approximately 12 meters west-northwest of Cluster 1. The maximal dimensions of the cluster are 24 x 6 meters. The lithic debitage consists of secondary and tertiary flakes.

Cluster 3 was found in a large dune blowout in the northwest portion of the site, and it contains the majority of the artifacts. This cluster measures 35 by 25 meters. The chipped stone assemblage is dominated by tertiary reduction flakes and angular debris. Four core fragments, several thinning and pressure flakes, and a small number of secondary reduction flakes were also noted. One stylistically unidentifiable projectile point, which appears to be made from a previously broken point, and one core with evident edge battering, are the only utilized tools.

No definite date may be assigned to this site due to the absence of diagnostic artifacts. The primary activities appear to include secondary core reduction, some tool manufacture, and the maintenance of previously manufactured tools. The artifact assemblage indicates that either animal processing or plant procurement were the major activities at this site.

Site 39-13-3 (LA 34713)

This small Navajo habitation site is on the lower southern slopes of Tsun-je-zhin Mesa and it is sheltered to the west by a low, elongated spur which extends from north to south. The Ah-shi-sle-pah Wash is 800 meters to the south. The site measures 150 by 70 meters.

The main component of the site is a Navajo hogan complex which features a stone ring, a possible corral enclosure, a possible stone horno or sweat lodge, and a sparse trash scatter. A light scatter of chipped stone debris, which may be a prehistoric component, was also noted.

The hogan ring, which is made of unshaped sandstone blocks, measures about five meters in diameter. The doorway faces east. Cultural debris found within the vicinity of the hogan includes the iron legs of an animal trough or salt lick, strap iron, a metal pipe, clear glass fragments, a piece of historic decorated Pueblo ceramics, and the lid to a tin of black blasting powder.

The remains of a possible corral were found 150 meters south of the hogan ring. The feature is marked by a dense thicket of wolfberry and a distinct soil change. This feature measures 14 by 8 meters. The possible horno or sweat lodge is at the western edge of the large dune blowout which separates the hogan from the possible corral. The horno is composed of a low pile of unshaped, fire-oxidized sandstone blocks. The feature measures less than two meters in diameter.

Within the large dune blowout to the west of the horno or sweat lodge there is a sparse scatter of green and clear bottle glass, including a portion of a Sloan's™ liniment bottle.

The chipped stone artifact assemblage includes five flakes and three cores. A two-sided mano fragment was also noted. These artifacts were found scattered among the historic trash within the large dune blowout.

The Navajo component is thought to date between 1880 and 1920 on the basis of the liniment bottle, hogan ring morphology and the historic Pueblo sherd. The liniment bottle is iron cast and the product's name is present on a raised, lettered panel. Iron casting was practiced between 1867 and 1917. The Pueblo sherd appears to be a late nineteenth century ware which was probably manufactured at one of the middle Rio Grande Pueblos. No cultural/temporal affiliation could be assigned to the chipped stone assemblage.

The paucity of cultural debris suggests that the hogan complex was occupied for only a short period of time, perhaps on a seasonal basis. Because the site occupies a sheltered location with a southern exposure, it is probable that the complex was inhabited during the cool seasons of the annual cycle.

Site 39-13-4 (LA 34714)

This site is within an extensive and heavily sheet-washed and deflated dune blowout approximately 100 meters south of Ah-shi-sle-pah Wash. The site is exposed to the north and east, and the density of artifactual remains ranges from light to moderate. The maximal dimensions of the scatter are 250 by 200 meters. No features could be defined; however, three major artifact clusters were noted. The site contains Basketmaker, Pueblo and contemporary Navajo components.

The Basketmaker component is the dominant assemblage on the site. This component consists of an extensive scatter of chipped stone debitage and artifacts, including one projectile point fragment, 15 cores and core fragments, four faceted hammerstones, three cobble hammerstones, two choppers, and seven biface fragments. The debitage is largely composed of secondary and tertiary reduction flakes. Primary reduction flakes, thinning flakes, and pieces of angular debris were noted only in very low quantities. Six ground stone artifacts were also encountered, including two mano fragments and portions of four metates. One of the metates was shaped by pecking, and another appears to be burned. The above cultural/temporal affiliation is based on diagnostic projectile point morphology. The point size and the presence of two side notches, among other characteristics, suggests that this artifact dates to Basketmaker III times. The site appears to have been used during the transition from Archaic to Anasazi subsistence strategies. Furthermore, all of the raw lithic materials are locally available petrified woods, palmwoods, cherts and quartzites; no non-local exotic materials chacteristic of earlier adaptations were observed.

The chipped stone assemblage indicates that tool manufacture and tool maintenance activities were important pursuits. The nearly complete absence of primary reduction flakes suggests that the cores were prepared off the site. The broken projectile point is indicative of tool maintenance and hunting activities. The ground stone artifacts represent plant processing tasks. The site appears to be a multiple function camp.

The Anasazi component is composed of a small, dispersed ceramic scatter which measures 15 meters in diameter. Six sherds were counted. All the sherds are from plainware vessels, and all appear to be slipped with a white clay wash. At least two vessels, perhaps three, are represented. The date and function of this scatter is not known. The sherd scatter was found at the southern edge of the site at the base of a low knoll.

The Navajo component consists of an isolated rock cairn on the crest of the low knoll bordering the southern edge of the site. The cairn has collapsed, and it appears to be fairly recent in origin. The cairn may mark a grazing boundary.

Site 39-13-5 (LA 34715)

This site is located on the crest of a ridge near the northern boundary of the survey parcel. This edge is an erosional remnant of the Tsun-je-zhin Mesa. The site overlooks the Ah-shi-sle-pah valley to the south. The maximal dimensions of the scatter are 110 by 10 meters.

The site has a light scatter of chipped stone debitage and one possible fragment of a sandstone basin metate. One plainware body sherd was also encountered at the northern edge of the site. The greatest concentration of lithic debris occurs in dune blowouts. There are more than 100 artifacts within the defined site boundaries. In addition, a very sparse scatter of lithic debitage was found extending to the northeast along the crest of the ridge and beyond the boundary of the survey parcel. No definite features could be defined.

The lithic assemblage is largely composed of secondary and tertiary reduction flakes, and pieces of angular debris. Two core fragments were also recorded. Therefore, the preparation of tools from previously prepared cores appears to have been a major activity. A light but extensive scatter of water-worn cobbles of various siliceous materials was found 500 meters west-northwest of this site on the crest of Tsun-je-zhin Mesa. Numerous cobbles which were broken open to assess their fracturing properties were encountered within the scatter. It is possible that much of the raw lithic material at the site was obtained at this location.

The basin metate and the plainware sherd indicates that the site is Anasazi, attributable to the B-III/P-III phases and dating within the AD 400-1300 interval. Functionally, the site appears to represent a plant processing locus.

Site 39-13-6 (LA 34716)

This small scatter of prehistoric and historic debris is located within a badlands setting about 150 meters south of Ah-shi-sle-pah Wash. The site is located on the western edge of two low shale knolls. The site measures 40 by 20 meters.

The prehistoric component may date to Archaic times. This cultural/temporal designation is based on the characteristics of the chipped stone assemblage. This component consists of a light scatter of chipped stone debitage, most of which contains secondary and tertiary reduction flakes and pieces of angular debris. Six cores and two tested cobbles were also noted. Only one formal tool, a biface fragment, was observed. All these artifacts are made of locally available petrified wood and chert. The activities indicated by this assemblage include the testing and initial reduction of lithic raw materials and the limited manufacture of tool blanks. The site appears to be a plant procurement locus.

The historic component is represented by a light scatter of thick, brown bottle glass. One complete bottle was encountered. Two episodes of historic occupation may have occurred: one dating to the turn of the century and the other dating perhaps as late as the 1950's. These tentative dates are based on the morphology of the two bottles, the thickness and eveness of the vessel walls, and differential glass patination.

Site 39-13-7 (LA 34717)

This lithic scatter is within a major dune blowout in an area 40 meters north of the Ah-shi-sle-pah Wash. The site is at the nose of a semistabilized longitudinal ridge formation. The distribution of cultural debris is almost exclusively restricted to zones of deflation. The maximal site dimensions are 75 by 50 meters.

The lithic assemblage is composed of several hundred artifacts. Secondary and tertiary reduction flakes and pieces of angular debris predominate. Small numbers of primary reduction flakes and thinning flakes were also noted. The only formal tool encountered at the site was a biface fragment. Locally available petrified wood and palmwood were the raw lithic materials found within the assemblage.

The above lithic assemblage indicates tool manufacturing activities. Because very few primary reduction flakes are present, it is likely that most cores were initially reduced elsewhere.

The site appears to be a plant procurement locus. The site is probably prehistoric.

Site 39-13-8 (LA 34718)

This dispersed sherd and lithic scatter is within a series of dune blowouts along the northern edge of a large, semistabilized dune. The site is about 100 meters south of the Ah-shi-sle-pah Wash. The maximal site dimensions are 200 by 40 meters.

The site may have both late Archaic and Anasazi components. The possible Archaic component is largely confined to a large dune blowout near the center of the site, and consists of several hundred secondary and tertiary flakes and pieces of angular debris.

One core and only a few thinning flakes were observed within the sample lithic transect which included approximately 10% of all lithic artifacts. Within the whole site, two biface fragments, one hammerstone fragment and one projectile point midsection were encountered. The only piece of ground stone, a one-hand mano, was found at the northern edge of the main blowout in which the chipped stone debitage is located.

The tentative designation of a late Archaic component is based on the morphological characteristics of the projectile point midsection. The chipped stone assemblage suggests that the secondary reduction of cores and some final tool manufacture and maintenance may have been important activities. The mano indicates that some food preparation also may have been undertaken. This component represents a temporary camp datable to the 1900 BC - 400 AD interval.

The Anasazi component is a very dispersed scatter of about 20 sherds. Most of the ceramics were found within the eastern portion of the site in a small wash area. The majority of the sherds are from either plainware or corrugated vessels. A grab sample of four black-on-white decorated sherds was identified as Gallup B/W, a possible Chaco B/W, and an unidentifiable Cibola series. This ceramic assemblage dates the component to the AD 1000 - 1150 interval. This component is probably related to the Chacoan Great North Road which passes within the general vicinity of the site.

Site 39-13-9 (LA 34719)

This highly dispersed sherd and chipped stone scatter was found along the crest and the western slopes of a semistabilized longitudinal dune ridge. The ridge is oriented north-south, and it is bordered to the east and west by small arroyos. The site is about 400 meters north of the Ah-shi-sle-pah Wash. The distribution of cultural debris is almost exclusively restricted to zones of deflation and water erosion. Some debris may lie buried beneath semistabilized dunes adjacent to the eroded areas. The site dimensions are 160 by 45 meters.

Most of the ceramics were found clustered in the center of the site, and dominate the artifact assemblage. This 15 meter diameter cluster includes 25 to 30 sherds. The corrugated wares appear to date to P-II and P-III times, and the decorated wares may include Gallup B/W and possibly Chaco B/W. Three sherds were collected and subsequently identified as McElmo B/W, Cibola series corrugated, and Cibola whiteware.

The chipped stone assemblage is composed of mostly secondary reduction flakes and angular debris. A few primary and secondary reduction flakes and one hammerstone were also noted. All of the lithics are made of locally available petrified wood. Fewer than 50 pieces of debitage were scattered widely across the site area.

This site appears to be a limited activity locus, perhaps related to food procurement. The ceramic assemblage dates this site between AD 1000 and 1100.

Site 39-13-10 (LA 34720)

This discontinuous sherd scatter is on a hard-packed clay flat immediately north of the Ah-shi-sle-pah Wash. The site is adjacent to the Chacoan Great North Road. The density of ceramic debris ranges from sparse to moderate. No features could be defined; however, two artifact clusters were recorded. These clusters are separated by a gap of about 30 meters in which few sherds were found. No lithic materials were encountered. The dimensions of the site are 100 meters by 70 meters.

Cluster 1 consists of a concentration of 25 to 30 sherds, all of which are either plain gray utility or P-III corrugated wares. This cluster measures 10 to 15 meters in diameter. A grab sample included two Cibola series corrugated sherds and one undifferentiated Cibola series whiteware sherd. Cluster 2 is composed of 75 to 100 sherds, and it measures between 20 and 25 meters in diameter. Plain gray utility wares comprise about 90% of the assemblage. A few corrugated and black-on-white wares were also noted. A grab sample included three Cibola series corrugated P-III sherds and two possible Puerco B/W sherds. Some Escavada B/W was also noted but not included in the grab sample.

On the basis of the ceramic assemblage, this site dates between AD 1050 and 1200. It is typical of the road-associated sites recorded during the course of this survey. Ceramics from a relatively large number of vessels are represented, but non-ceramic artifacts are rare or absent. The function of this class of sites is presently unknown.

Site 39-13-11 (LA 34691)

This large scatter of chipped and ground stone is situated within a major dune blowout on the north slope of a large knoll. The blowout forms a bench which overlooks the Ah-shi-sle-pah Wash immediately north of the site. No clearly definable features were encountered, but three dense artifact concentrations were recorded. A possible hearth marked by a concentration of fire-cracked rock was noted within Cluster 2. The dimensions of the scatter are about 170 by 13 meters.

The chipped stone assemblage is largely composed of locally available petrified wood, Brushy Basin chert and orthoquartzite. The densest concentrations of debitage were found along the southern edge of the main dune blowout in the center of the site. Deflation and sheet wash erosion have uncovered hundreds of small tertiary reduction, thinning, and retouch flakes, particularly within Cluster 1.

In contrast, the more heavily eroded portions of the site contain the majority of the cores, most of the primary and secondary reduction flakes and pieces of angular debris, eight of the nine biface fragments, ten faceted hammer/pecking stones, and eight unmodified cobbles which reveal some use as hammerstones. One of the bifaces may be a projectile point fragment. All seven of the ground stone artifacts, including both tabular and basin metate fragments, are also present within this zone.

Cluster 1 is within the center of the main dune blowout, and it measures 40 by 30 meters. In addition to the chipped stone lithic debitage, a small number of eroded sandstone cobbles, two basin metate fragments, three biface fragments, and two faceted hammer/pecking stones were noted.

Cluster 2 is about 45 meters southeast of Cluster 1. This concentration of artifacts measures 15 meters in diameter, and it consists of lithic debitage, three cores, and approximately twelve fire-cracked quartzite cobbles. Although no ash or charcoal was observed, these cobbles may be a hearth area.

Cluster 3 is about 50 meters southwest of Cluster 1; it is approximately 20 by 15 meters. It has two basin metate fragments, two hammerstones, six cores, and approximately 25 primary, secondary and tertiary reduction flakes. Several dozen pieces of badly eroded sandstone were also noted. These small pieces are not fire-oxidized, and it is unlikely that they represent a hearth.

The possible projectile point fragment found 15 meters north of Cluster 2 is not diagnostic. Three coarse sand-tempered corrugated sherds were found about 35 meters northeast of Cluster 1. The presence of exclusively basin metates and the corrugated sherds indicates that the occupation of the site is P-II/III Anasazi, dating within the AD 900-1300 interval.

Functionally, the site represents the outcomes of a diverse set of food procurement, processing and preparation behaviors. The locus is probably a base camp which may have been reoccupied on a seasonal basis.

A Navajo rock cairn was also noted on the crest of the knoll bordering the site to the southwest. It probably marks a grazing boundary.

Site 39-13-12 (LA 34721)

This small site is on a low dunal ridge. Areas of badlands are found to the east and west of the ridge. The site is approximately 400 meters north of Ah-shi-sle-pah Wash, and adjacent to the Chacoan Great North Road. The dimensions of the site are 20 by 10 meters.

The site has 27 sherds, three orthoquartzite flakes and one petrified wood flake. The ceramics include seven black-on-white decorated sherds, two black-on-red decorated sherds, and 18 plain and corrugated utility ware sherds. Five collected sherds were identified as Mancos B/W, Puerco B/R, Tohatchi Banded (a Cibola series grayware) and McElmo B/W (possibly a Chaco variety). On the basis of this ceramic data, the site falls within the Anasazi late P-II and early P-III phases, and dates to the AD 1000 to 1200 interval.

This appears to be a typical Anasazi road-associated site containing ceramics from a relatively large number of vessels and few non-ceramic artifacts. The function of this site type cannot be determined at this time.

Site 39-13-13 (LA 34722)

This sherd and lithic scatter is within two deflated areas separated by a low ridge of semistabilized dune deposits. The site overlooks an extensive area of badlands the south and east. The Chacoan Great North Road passes within the immediate vicinity.

No definite activity areas could be defined but three major sherd concentrations were identified. Clusters 1 and 2 have decorated and utility wares. Cluster 3 is composed exclusively of plainwares and corrugated sherds. In all, there are hundreds of sherds within the site area.

Cluster 1 is located along the southern edge of a low dune, and it overlooks the area of badlands. The cluster measures roughly 30 by 15 meters.

There are approximately 25 to 30 decorated and plainware sherds within the cluster. A grab sample of three decorated sherds were identified as McElmo B/W (San Juan variety) and Puerco B/W.

Cluster 2 is about 25 meters north of Cluster 1 on the opposite side of the dune. The cluster measures 35 by 20 meters and has 150 and 200 sherds. Black-on-white decorated and utility wares are equally represented. Five decorated sherds in a grab sample were identified as Chaco B/W, McElmo B/W, Gallup B/W and an unknown Cibola series whiteware.

Cluster 3 is 15 to 20 meters west of Cluster 2, and measures seven meters in diameter. It has 75 to 100 plainware and corrugated sherds. Two collected sherds were identified as Cibola series corrugated ware.

The quantity of chipped stone debitage is very low. There are 10 and 20 artifacts across the site as a whole. Secondary reduction flakes and pieces of angular debris predominate. Two core fragments and one Anazasi Pueblo style side-notched projectile point were also recorded. With the exception of the point, all of the raw lithic material is very low quality and locally available.

The site is typical of those associated with the Great North Road. Some functional variability is suggested when Cluster 1 and 2 are compared with Cluster 3. The site falls within the late P-II to early P-III phases and dates to the AD 1000 - 1200 interval.

Site 39-13-14 (LA 34723)

The site is on a low erosional remnant in a badlands area. Semistabilized dunes are 50 meters northwest. Numerous small washes surround the site area, which measures about 30 feet in diameter. The Chacoan North Road is in the immediate vicinity of the site.

The site has about 20 sherds, almost all of which are various plain and corrugated wares. One eroded decorated sherd, which may possibly be Cibola series Chaco B/W, was also noted. No features or activity areas could be defined within the scatter. One undifferentiated orangeware body sherd was encountered about 60 meters northeast of the main site area.

The purpose of this typical road-associated site is not known. The site falls within the late P-II and early P-III phases, and dates to the AD 1000 - 1200 interval.

Site 39-13-15 (LA 34724)

This lithic scatter is on the northwestern edge of a low dune ridge within a deflated area about 300 meters north of Ah-shi-sle-pah Wash.

The site consists of a sparse to light scatter of about 25 pieces of chipped stone debitage, one biface, and six cores. The biface may be a projectile point preform, and one of the cores has been used as a hammerstone. All stages of core reduction are represented among the flakes.

The lithic materials are locally available petrified wood, chert, palmwood, and quartzite.

One Anasazi plainware body sherd was found at the northeastern end of the site area, and may date the site between AD 450 and 1300.

The primary activities at the site appear to have been the secondary reduction of cores in the preparation of tool blanks, perhaps related to plant procurement.

Isolated Occurrences

Fifteen isolated occurrences were found in the sample unit. All but one of the occurrences (IO-216) probably date to the prehistoric period, between Archaic and Anasazi P-III times. IO-216 is related to Navajo use of the area during the present century.

Table 1-8. Isolated Occurrences in Sample Unit 39-13

IO Number	Brief Description
211	plainware body sherd
212	2 flakes
213	4 unpainted body sherds
214	deleted number
215	core, 3 flakes
216	collapsed sandstone cairn
217	core, 3 flakes
218	3 cores, 3 flakes, small biface
219	biface fragment
220	core, 5 flakes
221	plainware body sherd, 2 flakes
222	15 flakes, a few pieces of angular debris
223	core, a few flakes
224	thinning flake
225	rusty shovel blade
226	rim sherd, 3 B/W sherds

Sample Unit 40-9

This sample unit covers 640 acres. The northwestern two-thirds of the sample unit are characterized by severely broken terrain in which steep and barren slopes and eroded hills form an extensive area of badlands. The change in elevation from the highest point in the center of the badlands (6600 feet) to the hardpan flats in the northwest corner of Section 18 (6380 feet), is about 220 feet. The southwestern third of the parcel is dominated by the rolling crest of the Tsun-je-zhin Mesa. In this setting longitudinal dunes are separated by shallow washes. The soils within the badlands and the hardpan flats in the northern third of the parcel are composed of clays and sandy clays.

The vegetation in this zone is relatively sparse but varied. Juniper was observed growing on hill tops and in the bottoms of shallow valleys where there is more moisture. In the scattered pockets of deeper, loamy soils, sagebrush, fourwing saltbush and various bunch grasses were noted. Within the southwestern third of the parcel where soils are relatively deep and sandy, sagebrush increases greatly in frequency. Rabbitbrush, snakeweed, bushy eriogonum, prickly pear, muhly, and Indian ricegrass are the other common species in this shrub-grassland association.

The eight archaeological sites encountered during the survey of the sample unit include five artifact scatters of probable prehistoric origin, three of which are composed of lithics with no definable features. Two sites are the remains of temporary camps relating to Navajo sheep herding activities. The last site is the recent remains of a possible Squaw Dance location.

The eleven isolated occurrences also reflect the prehistoric and historic use of the sample unit. Except for one P-II sherd, the five prehistoric isolated manifestations are undiagnostic. The six historic items are recent in origin and represent transient usage by Navajo sheep herders.

Site 40-9-1 (LA 34725)

This Historic Period camp is in a zone of semistabilized dune deposits at the extreme northern end of the survey parcel. An extensive area of badlands is found south of the site. Within the immediate vicinity of the site there are low sandy knolls and hardpan flats. The dimensions are 70 by 60 meters.

The site consists of four posts which have been set into the ground, and scattered notched branches which define a rectangle (ramada?) measuring 2.5 by 2.0 meters. A wood chopping area is 15 meters south-southwest of the four posts.

Food cans, a condensed milk can, broken bottle glass, window glass, an enamelware pot, and a piece of a leather shoe were scattered across the site area. One small cluster of debris was found in the center of the site area approximately 20 meters southwest of the ramada (?).

The site appears to be a temporary camp. No diagnostic artifacts were found to allow an exact dating of the site. On basis of tin can morphology the camp may have been used between 1935 and 1970.

Site 40-9-2 (LA 34726)

This chipped and ground stone scatter is within a dune blowout on the crest of the broad, gently rolling ridge formation which characterizes the southern third of the survey parcel. There are fewer than 100 artifacts within an area measuring 55 by 37 meters.

The chipped stone assemblage is composed of 20 flakes and pieces of angular debris. All stages of core reduction are present; however, tertiary reduction flakes constitute the majority of the assemblage. One core fragment and four thinning flakes were recorded. The raw lithic materials are varieties of locally available petrified wood.

One petrified wood hammerstone and one mano fragment with two grinding surfaces were the only formal tools encountered.

Two possible hearth areas, one 25 meters north of the main scatter and the other five meters west, were also recorded. Both of the hearths contained fragments of burned bone, and both are situated on top of the semi-stabilized dune. However, the lithic artifacts were found only within deflated areas; therefore, it is probable that the hearths represent a later, perhaps Navajo, occupation of the site area.

The prehistoric component cannot be dated because of the absence of diagnostic artifacts. Functionally, the site is probably a plant processing locus.

Site 40-9-3 (LA 34727)

This temporary Navajo camp is immediately north of the Black Lake Road. It is on a sandy slope just below and south of a sandstone outcrop on the edge of an area of badlands. A small wash cuts through the center of the site. The maximal dimensions of the site are 35 by 10 meters.

The site contains the remains of two structures, three hearths, and an associated trash scatter. The first structure consists of a four meter diameter cribbed log windbreak. A hearth, marked by a surficial lens of ash and charcoal, is immediately south of the structure. Two Navajo Utility sherds were found near the windbreak.

The second structure, a probable hogan base, is about 22 meters northeast and is marked by a rectangular stone alignment which measures 3.25 by 2.5 meters. Two hearths were found north and northeast of the structure. One is marked by a concentration of charcoal and ash, the other contains charcoal, ash, and burnt bone. Beverage bottles and cans have been deposited along the roadside, probably subsequent to site abandonment.

The presence of Navajo Utility ware and the scarcity of trade goods indicate that this site dates to the 1880-1930 interval. The windbreak indicates that the site was occupied during the spring-summer season.

Site 40-9-4 (LA 34728)

This chipped stone scatter was found within highly dissected badlands which extend north, east and west of the site. The surrounding terrain dips steeply toward the north. The scatter of cultural debris is unevenly distributed across the site area; two artifact clusters were recorded. There are fewer than 100 pieces of lithic debitage within a 80 by 40 meter area.

Cluster 1 is at the western end of the site and covers a 40 by 10 meter area. A small wash cuts through the center of the concentration, and many of the artifacts appear to have eroded downslope for some distance. Secondary and tertiary flakes and pieces of angular debris are all equally represented. Two core fragments were also noted. All of the raw lithic materials are made from locally available petrified wood.

Cluster 2 is 40 meters east of Cluster 1, and measures five meters in diameter. A small erosional channel cuts through this concentration, although the degree of disturbance does not appear severe. The chipped stone assemblage is composed exclusively of locally available palmwood. There is a high percentage of angular debris, core fragments, and secondary reduction flakes. Relatively few primary or tertiary flakes were observed. The site cannot be assigned a cultural/temporal affiliation because no diagnostic artifacts were found. The primary activities appear to have been the secondary reduction of cores, although some tertiary reduction is also indicated within Cluster 1. The variability between the artifact clusters in the two concentrations in addition to their spatial separation suggests discrete activity areas and/or two occupational occurrences.

Site 40-9-5 (LA 34729)

This lithic scatter is located on the crest of the broad, gently rolling dunal ridge which dominates the topography of the southeastern portion of the sample unit. The site has about 100 artifacts and a possible hearth area. The dimensions of the site are 110 by 60 meters.

All stages of core reduction are represented within the chipped stone assemblage, although tertiary flakes and pieces of angular debris compose nearly 75% of the artifacts. In addition to the core reduction debris, several thinning and reduction flakes, suggestive of final tool manufacturing activities, were also recorded. With the exception of two orthoquartzite secondary flakes, and one tertiary flake of imported Washington Pass chert, all of the chipped stone is made of locally available raw materials. The only formal tools encountered were two quartzite hammerstones.

The probable hearth area is at the extreme eastern end of the site. This feature is marked by a surficial scatter of charcoal and fire-oxidized rock.

Although culturally/temporally non-diagnostic, the site is probably prehistoric.

Site 40-9-6 (LA 34730)

This small lithic scatter is along the northeastern edge of a small drainage on a clay-sand plain. The slope drops moderately to the south.

The site has about 70 pieces of chipped stone debris within an area measuring 40 by 10 meters. No features could be defined.

The lithic assemblage is dominated by angular debris which comprises nearly 60% of all artifacts. The next most frequent artifact type is secondary reduction flakes. Very few tertiary flakes and no primary flakes were observed. Four core fragments were recorded. Three locally available petrified wood material types were present.

The cultural/temporal affiliation of this scatter cannot be determined due to the lack of diagnostic artifacts, although the site is undoubtedly prehistoric. The chipped stone assemblage is indicative of secondary and tertiary reduction activities, perhaps for the manufacture of tool blanks which were then finished elsewhere. The site appears to have been occupied for a short period of time.

Site 40-9-7 (LA 34731)

The site is on a low clay knoll within a rolling hardpan colluvial plain. The site is bordered on the west and south by low hills. A small wash borders the eastern edge of the site. The site is composed of a scatter of approximately 75 pieces of chipped stone debitage within an area measuring 75 by 30 meters.

The chipped stone assemblage is composed of six varieties of locally available petrified wood. All stages of core reduction are represented. Tertiary reduction flakes comprise more than 50% of the assemblage. Three core fragments were noted. No formal tools were observed. It is likely that the raw lithic materials were obtained from among the gravel and cobble outcrops within the immediate vicinity of the site.

Because no diagnostic artifacts were found, the site cannot be assigned a cultural/temporal affiliation. However, the site is undoubtedly prehistoric. The chipped stone lithic assemblage indicates that primary, secondary, and tertiary core reduction activities, probably related to the manufacture of tool blanks, were important activities.

Site 40-9-8 (LA 34732)

This recent Navajo site is immediately south of the Black Lake Road, on the crest of the broad, gently rolling ridge which dominates the topography of the southeastern portion of the sample unit. The maximal site dimensions are 110 by 100 meters.

The site may be a possible Squaw Dance location. A cluster of twelve hearths was found within the western half of the site area. The hearths range in size from two to four meters. A small trash dump and a concentration of corn cobs and burnt and unburnt sheep bones were found along the southern margin of the hearth cluster. Large trash dumps were found at 35 meters north and 40 meters east of the hearths.

The debris found within the trash dumps is varied. Liquor and soft drink bottles and cans are most common. Several tobacco tins, a hairclip and a toy motorcycle were also noted. The dates of 1978 and 1979 were observed on the bottoms of several beverage bottles, and probably date the utilization of the site.

Isolated Occurrences

Eleven isolated cultural occurrences were recorded during the survey of the sample unit. Both prehistoric and historic activities are represented.

Table 1-9. Isolated Occurrences in Sample Unit 40-9

IO Number	Brief Description
92	noisemaker
94	3 pieces dinnerware, axe-cut juniper branches
96	2 secondary flakes
98	6 pieces silicified wood
100	cairn
102	hearth
104	cairn
106	Gallup B/W sherd
108	4 angular debris
110	2 angular debris
112	historic trash

Sample Unit 40-10

The physiographic features of this sample unit are principally a continuous sandy shale/sandstone ridge through the southern half of the section, a series of hills in the northern half, and an arroyo through the center. Ephemeral washes flow through the section from east to west, and in some areas the main arroyo is deeply entrenched. Side drainages enter the main arroyo from the east, north and south. Sandstone outcrops are exposed in some areas, producing hills and colluviated slopes. Semistabilized dunes occur frequently on hilltops and and slopes throughout the western and southern portions of the unit. The elevation ranges from 6400 feet in the central drainage to 6500 feet in the extreme southeast corner. The sample unit contains 640 acres.

Local lithic materials are eroding from exposed strata, and include sandstone, petrified wood of several varieties, palmwood, cherts and quartzite.

The soils of the sample unit are sandy loams, sands, and sandy clay loams. There are varying amounts of aeolian deposits on top of the more level areas on sandstone/shale outcrops. The more level and rolling plains have sandy loam soils and there are saline clays and silts on the floodplain and in the drainage bottoms.

A variety of shrubs and grasses occur throughout the sample unit. On higher hilltops there are scattered juniper and a few antelope bitterbrush. Predominately, however, there is a mixture of sagebrush, rabbitbrush, bushy eriogonum, narrow-leaf yucca, muhly, and Indian ricegrass. Sandy areas support moderately dense stands of ricegrass and annuals.

Ten sites were found in the survey area. All are lithic scatters, and two also have a few P-II sherds. The dating on these sites is problematic because of the general lack of diagnostic tools. Three of the thirteen isolated occurrences contained P-II pottery, but it is improbable that all of the lithic sites can be attributed to the Anasazi Period.

The small amount of historic trash in the sample area indicates that the intensity of Navajo sheep herding and occupational usage was low. The sample unit land is currently being used to graze cattle, and there is a dry stock dam near the southern center of the tract.

Site 40-10-1 (LA 34733)

The site is a sparse scatter of lithics on the top and south side of a low dunal ridge. The loose soils have been partially stabilized by various shrubs and grasses. The dimensions of the scatter are 70 by 40 meters.

No features were noted. The artifacts were found primarily in deflation zones, although some were found in loose sand, indicating the possibility of subsurface materials. No diagnostic artifacts were encountered. The site has angular debris, secondary and tertiary flakes, retouching flakes, and one tested rock, all of petrified wood. In addition there is one handstone fragment of quartzitic sandstone. Two pieces of chipped stone were fire-crazed and there is evidence of some use of soft hammer technique. Most of the chipped stone pieces are angular debris. All the lithics were analyzed in the field.

Primary reduction and limited tool manufacture are implied by the lithic assemblage. The site is probably a plant processing locus. Additional artifacts and/or features may lie beneath the surface of the unconsolidated sands. The site is probably prehistoric.

Site 40-10-2 (LA 34734)

This site is a lithic scatter of several hundred artifacts. It is on the top and the southeast-facing slope of a semistabilized dune. The artifact scatter measures 65 by 30 meters.

No features were noted with the lithic materials. There are two concentrations of lithic artifacts. Fire-cracked rock occurs throughout the site area, and there is a fragment of a sandstone metate which may have been basin-shaped. The chipped stone assemblage is almost exclusively petrified wood and includes mostly tertiary flakes. Angular debris, secondary and thinning flakes were also found. A tertiary chert flake and a quartzite hammerstone were also recorded in a 50% sample of the artifacts. Lithic materials are somewhat diverse; four types of petrified wood were noted, the most common being opaque white. Plant processing and tool maintenance appear to constitute the principal activities. The site is undoubtedly prehistoric.

Site 40-10-3 (LA 34735)

This lithic scatter was found on top of a semistabilized dune. The dimensions of the scatter are 36 by 28 meters.

No features were noted within the scatter of approximately 60 artifacts. A 50% sample was inspected, and the petrified wood chipped stone assemblage consists of secondary, tertiary and thinning flakes, angular debris, a core fragment, and a few retouching flakes. In addition there were one primary and two secondary palmwood flakes. A quartzitic sandstone handstone was also found. Five different types of petrified wood were noted, although the thinning flakes were exclusively butterscotch and dark brown petrified wood. A few pieces of fire-cracked rock were noted, but no hearth was found. The site appears to represent a plant processing locus.

No diagnostic tools or ceramics were found. The site is undoubtedly prehistoric.

Site 40-10-4 (LA 34736)

The site is a large, dense lithic scatter on a low, semistabilized dune above a large arroyo. There are two clusters of artifacts, and the entire scatter measures 160 by 70 meters.

Two possible hearths lie between the two clusters.

Cluster 1 contains several hundred artifacts and is at the southern point of the dune where the terrain drops off quickly; Cluster 2 also contains several hundred artifacts and is at the crest of the southern edge. A sample transect of four by five meters included approximately 50% of the artifacts in Cluster 1. Numerous types of petrified wood debitage were found. There are tertiary, thinning, primary and secondary flakes, retouching flakes, angular debris and one core. Two flakes of palmwood were also noted in this transect. One Red Mesa B/W sherd was also found in Cluster 1.

Cluster 2 is somewhat smaller but the lithics are more dense. A sample transect of four by five meters, which constitutes 20 to 30% of the surface artifacts, was analyzed. Petrified wood of many types was noted, and the pieces included tertiary, secondary, thinning, retouching and primary flakes, angular debris, one core fragment and four biface fragments. In addition there are tertiary, secondary and thinning flakes of palmwood, one quartzite teriary flake and one oolitic chert flake. Some of the pieces of angular debris are fire-crazed. A metaquartzite bifacial handstone was recorded.

There is a wide variety of lithic materials and the quality of workmanship is high at this site. Biface manufacturing and all levels of lithic reduction probably occurred at Cluster 2 of this site. The probability that additional subsurface cultural materials are present is high.

Assuming that the single sherd is not intrusive, the site can be dated to the P-II phase, approximately AD 950 - 1100.

Site 40-10-5 (LA 34737)

This site consists of a sparse lithic scatter over the north slope of a sandy hill. There are two light concentrations of artifacts on each edge of the 135 by 30 meter scatter.

No features were found within the scatter of chipped and ground stone. Petrified wood was the principal lithic material found within the 50% sample of about 50 artifacts. Angular debris, secondary, tertiary and primary flakes, two cores, an exhausted core, and a core fragment were recorded. Two quartzite hammerstones, a split quartzite cobble with utilized acute edges, and a metaquartzite one-hand mano were found in the assemblage. The material diversity is low.

No temporally diagnostic tools were found in the chipped stone assemblage, but the presence of the one-hand mano may indicate Archaic utilization. There is evidence of downslope and some channel erosion, but there is a possibility that subsurface materials are present in the sandier areas of the site. Plant processing and primary lithic reduction activities are inferred from the artifacts and site setting on the dune.

Site 40-10-6 (LA 34705)

The site is a sparse lithic scatter found on the north slope of a sandy hill. The scatter measures 80 by 40 meters.

Two possible hearths were found near the top of the hill; one is near the center of the artifact scatter and the other is slightly downslope and towards the northeast.

Analysis of approximately 50 artifacts, a 50% sample, indicates that the site served as a plant processing locus. Primary and secondary lithic reduction took place, as well as perhaps initial plant processing. Artifacts sampled include angular debris, secondary, tertiary and thinning flakes, two tested rocks, and three core fragments. All are made from petrified wood. Tested rocks of both chert and palmwood were also found along with a biface fragment of quartzite and a sandstone basin metate fragment. An orthoquartzite core and an oolitic chert primary flake were also found in the sample.

Two Cibola series P-II corrugated sherds were found in the scatter of lithics. The sherds indicate that the site is Anasazi, and date the occupation to the AD 950 - 1150 period.

Site 40-10-7 (LA 34738)

This site is a light to medium density lithic and sherd scatter of about 150 items, and is on the north and east slopes of a semistabilized dune. The slope has been eroded by natural weathering, and the artifacts cover an area of 40 by 45 meters on the slope. A small amount of lithic debris is on the top of the ridge. On the north side of the ridge there is a possible hearth area.

The lithic assemblage is almost entirely chipped stone. Tertiary, secondary and thinning flakes, angular debris, three cores, two bifaces, a tested rock, and a pressure flake of petrified wood were recorded. There are two flakes of Jemez obsidian, and one of oolitic chert, a piece of ground siltstone and an unidentified projectile point fragment of Jemez obsidian. The lithics were sampled at a 50% level.

The ceramics consist of three Cibola series plain grayware sherds.

The variety of lithic tools and materials and the presence of a possible hearth suggests a small multiple function camp.

Based on the presumed association of the sherds and lithics, the occupation of the site is estimated at AD 950 to 1150. The sandy loam soil is probably less than one meter in depth in the non-eroded areas, and there is a possibility of subsurface material near the hilltop where the slope is gentle.

Site 40-10-8 (LA 34739)

The site consists of a large lithic scatter with materials occurring in three clusters on the tops and on the southern slopes of the series of sandy hills. The extent of the site is 110 by 60 meters. The site overlooks an area of flatlands, and the degree of relief from the hill crests to the flats is approximately ten meters.

No features were noted within these three clusters of lithics. Cluster 1 has 30 to 40 artifacts predominately of five different types of petrified wood (secondary, tertiary, thinning, and pressure flakes), one tested rock of petrified wood and the midsection of a quartzite projectile point. It is just below the crest of a hill, on a south-facing slope.

Cluster 2 is on a flat bench of the hill below Cluster 1, and has 60 to 70 pieces of chipped stone. A four by five meter transect sampled approximately 50% of the surface artifacts and included tertiary, secondary, thinning and pressure flakes, angular debris, and two cores of petrified wood. One core of quartzite was also found in the sample. One tertiary petrified wood flake located outside the transect had two retouched lateral edges.

Cluster 3 is a small, sparse scatter of flakes about 100 meters west of Cluster 1. A 50% sample of the artifacts in this cluster includes secondary, tertiary, thinning and reduction flakes, and angular debris of petrified wood, a discoidal scraper or chopper, and a utilized split cobble of quartzite. Some items were fire-crazed. There are approximately 20 items in this cluster.

Based on the projectile point fragment and the absence of ground stone, the site appears to be a hunting camp. The projectile point appears to be a spear or dart point and probably dates to the Archaic Period.

Site 40-10-9 (LA 34740)

The site is a very small lithic scatter containing 30 to 40 artifacts eroding out of a low dunal ridge into a small drainage basin. The exposure is toward the south. Site dimensions are 35 by 45 meters.

No features were noted, but there is the possibility that the loose sand on the ridge top may conceal features and/or additional artifacts. A 2 by 10 meter transect, about 60% of the lithic assemblage, included tertiary, secondary, primary, and thinning flakes, angular debris, and a chopper, all made of petrified wood. In addition, there were two quartzite hammerstones, a quartzite one-hand mano (bifacial) and a quartzite hammerstone/core.

Based on the presence of the one-hand mano and the chopper, the occupation of the site may have occurred during the Archaic Period. The site appears to be a plant processing locus.

Site 40-10-10 (LA 34741)

The site is a sparse lithic scatter containing 30 to 40 items eroding down the north slope of a sandy hill. Natural rock outcrops occur throughout the site. Lithic artifacts occur within a 65 by 25 meter area, but much of the extent of the site has probably been produced by erosion.

No features are visible on the surface, and analysis of a 50% sample of lithic materials indicates that primary reduction and testing of local rocks took place. Flakes include primary, secondary, tertiary and thinning, as well as angular debris of petrified wood. Two types of petrifed wood are also represented in one core fragment, one core and one tested rock. The predominant material type is a white, opaque petrified wood. Two concentrations of artifacts occur, but these concentrations may have resulted from erosional processes rather than prehistoric activity. Subsurface materials and features could be present.

No diagnostic artifacts or features were noted; the time of occupation of this site is unknown. The site appears to be a lithic procurement and processing locus.

Isolated Occurrences

Thirteen isolated occurrences were recorded throughout the sample unit, and are listed in Table 1-10. They are similar in character to the items found at the sites and reflect prehistoric use over the areas on both sides of the main arroyo. Evidence of Historic Period usage of the sample unit is minimal, although there are cattle presently grazing in the unit.

In general, the sites occur on the semistabilized sandy dune areas on both sides of the central arroyo where outcrops of local rock are exposed and where the greatest concentration of seed grasses grow. The cultural resources of the sample unit document seasonal wild plant food procurement and its initial processing. Another major activity involves the procurement of local rock.

Table 1-10. Isolated Occurrences at Sample Unit 40-10

IO Number	Brief Description
114	Cibola grayware sherd
116	3 tertiary flakes
118	2 secondary and 2 tertiary flakes
120	utilized tertiary flake
122	probable point preform
124	tested rock, core
126	biface
128	primary flake, secondary flake, tertiary flake, two sherds
131	7 flakes/angular debris, evaporated milk can, rebar stake
133	core
135	2 Cibola sherds, 2 flakes, one-hand mano fragment
137	exhausted core
139	full-grooved axe of grayish green basalt

Sample Unit 40-11

The physiography within the sample unit has two principal features: badlands hills and a sagebrush covered uplands plain. Three washes flow from the higher terrain in the northeast to the southwest. These drainages are unentrenched on the plain, but create deep channels as the elevation drops in the exposed clay/shale strata which underlie the mantle of sandy/clay loam soil. The elevation ranges from 6480 feet in the northeast corner to 6320 feet in the southeast part of the sample unit. The break in the plain and change of vegetation and character of the terrain occurs between the 6420 foot and 6380 foot relief lines. The sample unit contains 640 acres.

The badlands portion of the survey area is composed of clay/shale hills of varying slope and height. The area extends westward out of the sample unit. The hills are varicolored, mostly grays, black, purple and green from the lichens growing near the tops of most hills. There are numerous outcrops of intact petrified logs, silicified wood fragments, sandstone/shale detritus, and fossil bone eroding down slopes. The principal soil constituent is clay, which is baked hard and cracked. Small sandy drainages occur at the base of the hills.

The eastern half of the sample unit and portions of the northern areas have gently rolling uplands and some shallow, broad swales. The soils are deep sandy clay loams and support large, dense stands of sagebrush. Occurring with the sagebrush is snakeweed, prickly pear cactus and various grasses. In shallow swales there is a greater abundance of galleta and dropseed grasses.

Vegetation in the badlands is sparse but quite diverse. In drainages and near the top of exposures there are scattered occurrences of sagebrush, snakeweed, rabbitbrush, fourwing saltbush, greasewood, eriogonum and narrow-leaf yucca. Grasses include galleta, sparse grama, dropseeds and Indian ricegrass. Annuals include various composites, Indian paint brush, penstemon, and Astragulus spp. In areas receiving more effective moisture there are small juniper trees.

The cultural resources in this survey area are very sparse; no sites were recorded. The four isolated occurrences listed in Table 1-11 represent minimal use by prehistoric populations and historic activities related to stock raising.

Table 1-11. Isolated Occurrences in Sample Unit 40-11

IO Number	Brief Description
123	Chuska series whiteware bowl sherd
125	corn cob
127	rusted can, pint jar, wood and glass fragments
129	400 x 400 foot corral

The single sherd may be associated with a Chacoan road located immediately west of the survey parcel. The corn cob is undoubtedly modern. It is not carbonized and its small size is probably the result of stressful growing conditions. It was found in a very exposed location on a badlands slope.

IO-127 is a rusted Dinty Moore™ stew can opened with a knife, a pint Mason jar, six to eight short pieces of axe-cut juniper branches, and a few pieces of clear glass. These were found in a small grassy swale on the sagebrush plain. This may indicate a single-use camp for a herder.

Near the head of a deeply entrenched principal drainage is a large square corral (IO-129) made of upright juniper posts and barbed wire. No features or artifacts were found in the vicinity of the corral. Bisecting the corral is a 15' deep arroyo channel, and the terrain within and outside of the corral is quite broken. The structure must have functioned as a temporary holding pen for large stock since the vegetation on the clay/shale hills is sparse and suitable only for supporting stock for a very limited period.

The lack of water and the small amount of suitable plant foods appear to be the chief reasons that this area was little utilized by prehistoric and historic peoples. While the badlands vegetation is quite diverse, it is not plentiful.

Sample Unit 40-14

The physiographic features of this sample unit of 640 acres are varied. In the southeastern corner the land is nearly flat to gently rolling with a slope to the southwest. The relief becomes greater towards the southwestern corner. A major topographic feature is a broad, unentrenched drainage which enters the parcel from the northeast and flows southwest into the Kimbeto Wash. The terrain in the northern third is more broken. Low shale/sandstone outcrops occur in some areas, and there is a combination of badlands terrain and soil-covered hills. Smaller oxidized shale hills occur on the floodplain slopes. The elevation ranges between 6220 feet in the southwest quarter to 6300 feet in the southeast quarter.

The soils in the parcel are principally unconsolidated sands, sandy loams, and heavy clays. There are varying amounts of aeolian deposits on top of the more level areas on sandstone/shale outcrops. The more level and rolling plains have sandy loamy soils, and there are saline clays and silts on the floodplain and drainage bottoms.

The hill tops and slopes in the southern portion support a mixed vegetation of snakeweed, fourwing saltbush, Russian thistle, ricegrass, dropseed and grama grasses. The alluvial floodplain has principally mixed grasses, annuals, low rabbitbrush and fourwing saltbush.

The high number of sites and their spatial distribution within the sample unit suggests that the relatively abundant amount of edible plants and the water supply provided by the wash were features that were attractive to both prehistoric and historic human groups.

Ten sites were found in the survey area. They represent a lengthy occupation from the Late PaleoIndian(?) through recent Navajo. The majority of the sites are sherd and lithic scatters, all dating to the P-II phase of the Anasazi Period. In contrast to the high diversity of lithic material at the non-ceramic sites, the Anasazi sites generally have a low diversity of materials. The principal activities at the latter sites, however, appear to be similar to those at the non-ceramic sites. Two historic Navajo sites indicate sheep herding activities in the 1940's and 1950's.

Site 40-14-1 (LA 34742)

The site is within the confines of a small deflation area on gently rolling terrain. The soil in the vicinity is sandy loam which supports a mixture of plant species including snakeweed, fourwing saltbush, rabbitbrush, as well as Indian ricegrass, dropseed, and grama grasses. The diameter of the artifact scatter is 20 meters.

A hearth area is marked by three stones which are probably fire-oxidized. The lithic assemblage has 25 flakes, angular debris and one tested rock. Most of the flakes are petrified wood with lesser quantities of chert, palwood, chalcedony, and obsidian. A Gallup B/W sherd was found in the deflation area. Secondary flakes predominate, but there are also a few primary and tertiary flakes. No cores were found, but there is one tested palmwood rock. No ground stone materials were found. There are no formal tools. Plant procurement may have occurred at this site.

The Gallup B/W sherd may date the site to the AD 1080-1150 interval, the late P-II phase of the Anasazi Period, although the artifact may be intrusive. The fact that the artifacts are eroding into the blowout indicates that some cultural deposits are buried.

Site 40-14-2 (LA 34743)

The site is on the crest of a small shale outcrop downslope of a semi-stabilized dunal area. The artifacts are exposed in a deflation area, and artifacts and/or features may be obscured by sandy soils upslope. The dimensions of the lithic scatter are 16 by 8 meters (see also Figure 3).

No features or ground stone were found with the chipped stone scatter.

Lithic materials include four kinds of petrified wood and two kinds of quartzite. A 100% sample of the 31 artifacts includes the following: secondary, tertiary and thinning flakes, angular debris, a core, tested rocks, biface fragments, and one projectile point base. The petrified wood point base may belong to the Midland Complex dating to the 8000 - 6600 BC interval. The site probably functioned as a biface manufacturing and lithic reduction locus which related to hunting.

Site 40-14-3 (LA 34744)

This historic Navajo site is on a fairly level area near the edge of the elevated plain in the southeastern corner of the parcel. The principal structures are on a low hill, with ancillary features distributed downslope near the edge of the plain. The site extends for 500 by 250 meters (see also Figure 15).

This large Navajo complex has two concentrations of features. The western area of the site has one octagonal concrete hogan foundation slab, one square storage/work shed, the remains of a wood foundation, five corral enclosures, three coal ash piles, a possible hogan with a boulder foundation, a sweat lodge, a horno, and a scarecrow. Most of the usable materials have been removed and the scatter of trash is fairly widespread over the site. Trash dumps and scarecrows line the gullies and crest towards the east, where there is a another habitation complex with standing structures. These include a house, shed, woodpile, two hornos, an outhouse, a coal ash dump, and a storage shed/summer shelter. To the northwest near the edge of the crest is a large corral complex and manure dump.

Datable artifacts include two New Mexico license plates (1956 in the western area and 1958 in the eastern area) and two KC baking powder cans in the western area which date to the 1950's and 1970's. Dates written inside the outhouse are 1976, 1978 and 1979.

The persistence of the corral and habitation features throughout the site indicates that the principal functions of the site were sheep herding and habitation from at least the 1950's to the late 1970's.

Site 40-14-4 (LA 34745)

The site is on the flats in a sandy shaley area. The artifacts are exposed in a deflation zone and probably have been moved by considerable sheet erosion. The dimensions of the the artifact scatter are 10 by 6 meters.

The site is a sherd and chipped stone scatter consisting of 34 sherds and four lithics. The chipped stone assemblage includes two tested nodules, a petrified wood tertiary flake, and a quartzite primary flake. Ceramics include sand-tempered plain gray utility wares, sand-tempered P-II corrugated sherds, several trachyte-tempered P-II corrugated, unknown Cibola whitewares, and Escavada and Gallup B/W sherds. No features or ground stone materials were noted. The Gallup B/W sherds date the occupation from AD 1080 to 1150. Since the artifacts have been moved or mixed by erosional processes, and the lithic assemblage is so small, it is difficult to speculate upon the function of this site.

Site 40-14-5 (LA 34746)

This site is the northern slopes of the broad floodplain drainage near the west central portion of the sample unit. Grasslands extend in all directions from this probable sheep herders' camp. The site measures 200 by 150 meters.

There are several features associated with this camp. They include sandstone foundation stones which probably mark a tent base, a coal ash pit, a rock cairn which may mark a burial, two scarecrows, and a light scatter of associated trash. There are no artifacts which indicate firm dates, but the general scatter suggests a 1940's to 1950's occupation. Included in the assemblage are a part of a metal stove (?), cans of various sizes and contents, porcelain fragments, and pieces of jar and bottle glass. The location on the south-facing slope suggests a winter or early spring use for a few seasons.

This site may be contemporaneous with the earlier occupation of the larger habitation complex (40-14-3) southeast, and represents a temporary camp occupied in conjunction with herding activities.

Northwest of the historic items is a small scatter of painted sherds and ground stone on a slope of a sandstone/shale outcrop. Escavada B/W, Red Mesa B/W and Cibola whiteware sherds are associated with three sandstone two-hand manos. These artifacts may have been collected and redeposited.

Site 40-14-6 (LA 34747)

The site is on a hilltop of oxidized shale in a relatively level area on the main floodplain valley. Artifacts are also exposed in a deflated area to the northwest of the hilltop. Site dimensions are 20 by 30 meters.

The site is a moderately dense scatter of chipped stone and ceramics. The lithic assemblage (17 pieces) features a large proportion of secondary and tertiary reduction flakes and pieces of angular debris. One core was found, and there are three tested rocks. The only formal tool observed was a petrified wood biface. No features or ground stone materials were noted.

A sample transect which represented approximately 30-50% of the surface sherds included mostly corrugated and plain gray wares, a Gallup B/W, a Red Mesa B/W and two Escavada B/W sherds. A minimum of twelve vessels are represented. Outside of the transect one Chaco B/W sherd was found. Although no building stone materials or structural foundations were noted, the site's location on a hill top near arable soils within the drainage, and the diversity of ceramics within the sample suggests that a field house may have been present. The time range indicated by the ceramic assemblage is Pueblo II. Site function is probably related to seasonal plant procurement activities and horticulture because of its location in a large grassy drainage.

Site 40-14-7 (LA 34706)

The site is on the north-facing slope of a shale/sandstone exposure in the floodplain bottomlands. Artifacts are eroding downslope from a sandy area and also appear in a collector's pile on the loose sandy soil on top of the knoll. The artifacts appear in an area 60 by 40 meters.

The site consists 59 ceramic sherds and four lithics. A 100% sample of the surface scatter of sherds includes mostly P-II corrugated (Cibola series), with lesser amounts of Cibola whiteware, Chuska series corrugated, a few Cibola corrugated, one Gallup B/W, and two Lino gray sherds.

The sparse lithics include three secondary flakes and one core.

The ceramic assemblage indicates a time range of AD 800-1100, but over half of the sherds cluster in the P-II Phase. No features were found, and there is a possibility that the artifacts may have been collected from more than one site and redeposited.

Site 40-14-8 (LA 34748)

The site is within a blowout on the sandy soils near the edge of a badlands outcrop. Artifacts are exposed in eroded areas downslope from higher terrain. The dimensions of the scatter of sherds and lithics are 170 by 20 meters.

The site is a light chipped stone and sherd scatter. The main part of the site is composed exclusively of lithics, most of which are tertiary reduction flakes and pressure flakes. Several sherds, P-II corrugated and plain gray, were found approximately 150 meters west of the main scatter and represent two vessels. Approximately 35 artifacts were noted. All lithics are made of locally available petrified wood. No features or ground stone were noted. A small cluster of ceramics and lithic debitage to the west may not be associated.

All the artifacts on the surface are in deflated and eroded areas, so there is a possibility that features and/or artifacts may be located upslope in the sandy stabilized dunal areas. The site appears to represent tool manufacturing activities related to plant procurement because of the vegetative diversity on sandy soils.

Site 40-14-9 (LA 34749)

This site is in a relatively flat deflated area adjacent to a semistabilized sandy dunal area in the center of a floodplain. Ceramics and lithics are scattered in a 75 by 70 meter area.

The site is a light sherd scatter and has a few dispersed pieces of chipped stone debitage. There are approximately 43 sherds including P-I corrugated (Cibola), P-II corrugated (Cibola), Chuska corrugated, miscellaneous Cibola whitewares, Escavada B/W, Gallup B/W, and Newcomb corrugated.

One core, two flakes, and four pieces of angular debris comprise the lithic assemblage. The few scattered pieces of oxidized sandstone may represent a hearth area.

The large number of sherds and the number of vessels they represent as well as the low number of lithics makes functional assignment of this Anasazi site difficult. The ceramic assemblage dates the site at AD 1075-1125.

Site 40-14-10 (LA 34750)

The site is in a series of deflations on a large, semistabilized dune. Artifacts appear to be eroding from the sandy soils onto hardpacked surfaces. Overall site dimensions are 30 by 20 meters (see also Figure 6).

The site has a scatter of lithic debitage and a one-hand mano. Several pieces of fire-cracked rock indicate an eroding hearth feature. The lithic assemblage is composed of a few primary, secondary and tertiary reduction flakes, pieces of angular debris, two core fragments, and a tested rock. Lithic diversity is moderate. The most frequently used material is petrified wood, with considerably less chert, palmwood, quartzite and Jemez obsidian.

The site may have functioned as a short-term camp during plant processing. The one-hand mano and lack of ceramics indicates a probable Archaic occupation.

Isolated Occurrences

Twenty three isolated occurrences were recorded in the sample unit and are listed in Table 1-12. They reflect a variety of prehistoric and historic groups who used the land in this sample unit. Sherds date to the P-II phase, while the lithic artifacts are not temporally diagnostic. Historic items are contemporaneous with Navajo sites 40-14-3 and 40-14-5 and relate to herding activities.

Table 1-12. Isolated Occurrences in Sample Unit 40-14

IO Number	Brief Description
130	cairn
132	2 tertiary flakes
134	2 sherds

IO Number	Brief Description
136	3 angular debris
138	cairn
140	2 tested rocks
141	noisemaker, 2 soda bottle fragments
142	tertiary flake, sherd
143	2 sherds
144	3 sherds
145	historic trash dump
146	3 sherds
147	5 flakes, broken cobble; historic trash
148	sherd
149	historic trash
150	biface fragment
151	5 sherds
152	cairn
153	cairn
155	sherd
157	3 sherds
159	historic trash
161	3 sherds

The cultural resources found in this sample unit appear to span a lengthy time period, and represent slightly different placement in relation to various topographic features. The two Archaic/PaleoIndian sites and isolated lithic artifacts occur principally in the higher elevations (6280 feet) and at least one-half mile north of the main drainage channel. The terrain is more broken in these areas. The Anasazi occurrences are closer closer to the floodplain and at a slightly lower elevation (6200 to 6260 feet). The Navajo habitation is at 6300 feet in an area of mixed vegetation and overlooking the broad flood plain, while the sheep herders' camp, trash dumps and cairns are at slightly lower elevations and on all sides of the wide floodplain valley.

Sample Unit 50-19

The physiography of the sample unit is relatively uniform and is chiefly gently rolling upland flats. Along the eastern border erosion has carved steep slopes from the underlying shale and sandstone strata. A broad shallow wash flows generally westward across the northern portion of the parcel, and has exposed shale bedrock to form a badlands landscape. In the southwestern portions there are broad shallow swales with unentrenched drainages. The elevation throughout the sample unit ranges between 6600 feet in the northeastern corner and 6540 feet in the southwestern portion. In general, relief is gentle across the entire parcel, but in the northwestern corner the slope is greater. The sample unit encompasses 960 acres--the eastern half of one section, together with the western three fourths of the adjacent section.

Sagebrush is the dominant vegetation throughout most of the sample unit. It occurs in dense stands above the 6580 foot contour line, and is mixed with snakeweed, prickly pear cactus and mixed grasses in the more broken terrain. The broad swales are principally zones of grasses; sagebrush is scattered in these areas. The steep eastern slopes and clay-shale exposures in the northwestern drainage have a very light vegetative cover of shadscale and annuals.

The soils in the parcel consist of sandy clay loam on the gently rolling uplands, hard packed clay in the badlands, and sandy loam in the wash bottoms.

In general, environmental variability is low throughout the unit. No sites were recorded in the sample unit. Seven isolated occurrences were recorded which reflect both prehistoric and historic use of the land. Table 1-13 is a list of these occurrences.

Table 1-13. Isolated Occurrences in Sample Unit 50-19

IO Number	Brief Description
162	1 tertiary and 2 secondary flakes, angular debris of silicified wood
164	concrete and cinder block check dam
166	retouched secondary flake
167	3 silicified wood tertiary flakes
168	Escavada B/W (?) sherd, Cibola series plain gray sherd, 2 tertiary flakes of opaque white silicified wood
169	historic trash: one-quart Mason jar, lard bucket, 2 tobacco cans, wooden stake, several pieces of axe-cut sagebrush wood
170	Armijo projectile point

The lithic artifacts in IO-167 and IO-162 were found in the shale bedrock badlands where local rock outcrops provide source materials. The sherds in IO-168 are dated to the P-II phase, and the projectile point has been identified as an Armijo style which dates to the Late Archaic period. The point was found on a dirt road next to the graded road and is probably out of place. Given the limited variability of economic resources, prehistoric use is predictably light and probably limited to exploitation of small game and a few wild plant foods.

IO-169 may represent a temporary Navajo campsite, although no hearth remains were found near the artifacts. Artifacts were found in a small open grassy area on the sagebrush uplands, and suggest a single meal.

The cans are rusted though not badly deteriorated; no temporally diagnostic marks were noted. The locus probably dates to the latter half of the twentieth century.

The concrete-rebar-cinder block check dam (IO-164) is in a small wash in the badlands. Many rebars and spikes are in the ground near the two meter long feature. Its function may be related to livestock watering.

Sample Unit 52-19

Several dirt roads provide access into this 640 acre parcel from the south. The Canada Alemita drainage cuts across the center of the survey parcel as it flows from northeast to southwest. The topography of the sample unit may be characterized as a cross-section of the Canada Alemita Valley. The northwestern half of the survey parcel is dominated by the modern floodplain and the valley bottom of the drainage. The extreme southeastern portions of the survey parcel are composed of slightly higher, rolling terrain which forms the crest of a major plateau. The land between these two settings consists of the broken colluvial slopes which dip from southeast to northwest. The maximum elevation on the crest of the plateau is 6560 feet. The minimum elevation along the modern floodplain of the Canada Alemita is 6480 feet.

The soils within the floodplain and the hardpan flats to the north of the drainage are saline sandy clays and clays. The soils on the slopes south of the drainage are generally sandy. Semistabilized sand dunes, which are separated by small erosional gullies, are common within this setting. The rolling plain forming the crest of the plateau features relatively deep, sandy clay loam soils.

Each of the topographic settings discussed above has a distinct plant community. First, the alluvial floodplain and the hardpan flats adjacent to the primary drainage channel are characterized by a greasewood riverine association. In the valley bottom some scattered rabbitbrush, snakeweed and miscellaneous low grasses were noted. On the sandy colluvial slopes south of the drainages, there are a few scattered shrubs and pockets of grasses. Dominant plant species include rabbitbrush, snakeweed, a few sagebrush and miscellaneous grasses. The rolling plateau features a relatively dense shrub-grassland community in which sagebrush is the predominant species. Russian thistle, snakeweed and mixed grasses were observed in the few open areas.

There are three currently inhabited Navajo residential compounds within and near the survey parcel. During the course of the survey, recent tire tracks were noted on the floodplain of the Canada Alemita and along the secondary access roads. Modern trash was frequently found along these routes. Sheep were also grazing in the area.

Four archaeological sites and five isolated occurrences were recorded, and with the exception of one isolated occurrence, all are a result of Navajo use of the area during the twentieth century. The four sites are in the rolling sagebrush uplands zone, and each is near the principal dirt road which provides access into the area.

Site 52-19-1 (LA 34753)

This large Navajo habitation complex is immediately south of the primary access road into this parcel. The site is on the crest of the sagebrush-covered plateau which overlooks the broad valley of the Canada Alemita. The maximum dimensions of this site are 375 by 150 meters.

The site has 33 features, including the remains of four hogans. Feature 1 is near the northeastern end of the site, and is a collapsed many-legged hogan. The walls of the structure were made of juniper logs. Nails, steel cable and milled lumber were used to fasten the logs and to hold them in place. Pieces of scrap metal, metal hinges and milled lumber were also noted among the scatter, and a metal bedspring was within the structure. The doorway was placed on the southeast side of the hogan. Of the four hogans recorded, only this one is almost completely intact; the other three structures have been dismantled and their building materials have been removed. It is possible that a human burial is located within the structure.

Found immediately adjacent to the hogan were two wood chop areas, a depression which may represent a borrow pit, two collapsed sandstone hornos, and a surficial ash dump.

Three coal ash/trash dumps were also found north of the many-legged hogan. In addition, an ash/trash pile and a cluster of fire-cracked rock, which may mark the remains of a horno or sweatlodge, were found west-southwest of Feature 1.

The second hogan (Feature 11) is about 25 meters south-southwest of Feature 1 and is composed of the very incomplete and eroded remains of a structure. The only architectural components observed consist of a scatter of axe-cut juniper branches; the remainder of the building mateterials have been scavenged. Feature 11 was tentatively identified as a hogan because of the types and distribution of its associated features.

Four non-structural features which form a semicircle enclosing an area south of Feature 11. They include three ash/trash dumps and a circular depression which may be a borrow pit. A second semicircular ring of features was found approximately 75 meters south and southwest of Feature 11. These include three ash/trash dumps, a mixed wood chopping/trash area and the remains of a possible corral enclosure. The probable corral measures 22 meters in diameter, and is marked by an open space in which large quantities of old sheep, cow, and horse dung were found.

The remaining habitation area is at the southwestern end of the site. The remains of two hogans were found in the center of a cluster of associated features. One of the hogans consists of a low circular earthen ring which measures about five meters in diameter. Only a few juniper chips were observed. A four meter diameter hogan also has a low mound of dirt and a light scatter of wood. Its associated features include a corral enclosure marked by a 15 meter diameter soil stain, two collapsed sandstone hornos, a wood chopping area, and three ash/trash dumps.

The final two features are about 200 meters north of the main site area. Feature 29 is a small trash dump found in an arroyo. Cultural debris includes various auto parts, coffee cans, an enamelware bowl, and KC baking powder cans, which date the dump to 1950. A simple hearth consisting of a few pieces of fire-oxidized rock is located 70 meters west of the dump.

This large and complex Navajo habitation locus was probably occupied between 1940 and 1960 based on tin can morphology and several temporally diagnostic artifacts. In addition to the KC baking powder cans dating from 1950, a 1957 license plate and a bottle bottom with an imprinted date of 1959 were noted. The steel beverage cans are key opened.

Site 52-19-2 (LA 34754)

This small site is 150 meters north of the main dirt road which provides access into the survey parcel. The site is at the upper edge of the Canada Alemita Valley. The site dimensions are 20 by 8 meters.

The site has two features. Feature 1 is a recently disturbed area where a possible infant or animal burial is marked by a shallow depression measuring 67 by 46 cm. An upright slab of petrified wood has been placed in the center of the depression. Feature 2 consists of an L-shaped alignment of three upright juniper posts protruding above the present ground surface. Two of the posts are found within 7.5 meters of each other, and the third post is 16 meters southeast. A few axe-cut juniper boughs was noted adjacent to the third post. This feature may be the remains of a brush corral or ramada.

The site may be the locus of two periods of activity. The possible burial is fairly recent, probably dating to the last couple of years based on its general appearance and condition. Feature 2 is older, but no date of use can be assigned since no temporally diagnostic artifacts were found.

Site 52-19-3 (LA 34755)

This Navajo habitation complex is south of the main dirt road. A secondary road bisects the site area, which measures 200 by 175 meters. The site is within a rolling, sage-covered plain which forms the crest of a low plateau.

The site is the remains of three possible habitation structures and a scatter of associated features. The best preserved hogan is at the western edge of the site area. Most of the building materials have been scavenged. The other two hogans were found on the east side of the secondary access road. These features are so poorly preserved that their identification as hogans is tentative.

The scatter of associated features includes two small sandstone hornos, one possible storage cellar, two or three surficial soil stains which may mark the locations of old corrals, one wood chopping area with a related coal pile, one brush pile, three ash/trash dumps, and two pits. Both pits appear to be related to automotive maintenance and repair. This portion of the site appears to have been occupied during the 1950's.

A small trash dump was encountered 30 meters northwest of the main site area on the opposite side of the primary access road. The temporally diagnostic characteristics of the cultural debris indicates two major periods of discard. The earlier episode of dumping activity dates to the 1950's and includes various food cans, an KC baking powder can, oil cans, various automobile parts, broken beverage bottles, dish fragments, key-opened beverage cans, coal ash, and several sherds from a broken Acoma-style decorated bowl. The later episode dates to the 1970's and is represented by aluminum pull tab beverage cans, one KC baking powder can, and miscellaneous food cans.

Site 52-19-4 (LA 34756)

This large Navajo habitation complex is on the north side of the primary road. The site is within a rolling, sagebrush-covered plain which forms the crest of a low plateau. Site size is 300 by 200 meters.

The site consists of the remains of 37 features including four old hogans. The first hogan's associated features comprise the western portion of the site. The hogan consists of a low earthen mound which marks the location of the dismantled structure. Milled lumber is scattered around the earthen ring which has an five meter inside diameter. Southeast of the structure is a large quantity of household and building trash, including a inner tube, various pieces of enamelware, a 1954 New Mexico license plate, partially burned wooden beams, parts of a wooden barrel, parts of a wood-burning stove, a man's rubber boot, and bedsprings. Other associated features include the remains of a possible ramada, three collapsed sandstone hornos, two wood chopping areas, a pile of chopped wood, several pieces of butchered cow bone, one nine meter circle of small sagebrush branches, and a light scatter of milled lumber, window glass, metal fragments, hardware and automotive parts, and two ash/trash piles. In these piles are key-opened beverage cans, miscellaneous household items, hardware, and automotive parts. The trash dates this part of the site to the 1950's.

A large ash/trash pile was also encountered approximately 100 meters north-northwest of the hogan. Included are numerous key-opened beverage cans, a KC baking powder can, condensed milk cans, oil cans, coffee cans, lard buckets and cans including Hammond Packing Peerless Lard Compound, St. Joseph, Mo., 1951 and 1953 New Mexico license plates, large animal bone, miscellaneous automobile parts, red-glazed pottery, and a metal belt buckle.

The central portion of the site contains the remains of two dismantled hogans and a cluster of associated features. This complex is spatially distinct from the other habitation loci. The hogans are in the center of the cluster. One is a five meter diameter hogan ring marked by a sparse scatter of wood debris. The other hogan is represented by a low five meter diameter earthen ring. Several sandstone slabs were noted on the southeastern side of the structure. Associated trash includes pieces of wood, segments of a cable and chain, tin can lids, and scrap metal from old barrels.

The features in the immediate vicinity of the two hogans include a large wood chopping area, a concentration of fire-oxidized sandstone which may be the remains of a collapsed horno, a five meter cleared depression, and four ash/trash piles. The function of the cleared depression is unknown, but it may be a third hogan. The ash/trash dumps have a variety of food and beverage cans, broken household utensils, bone fragments, and one 1956 New Mexico license plate.

Four additional features were found at the plateau edge a short distance north of the primary cluster. These features include a collapsed sandstone horno, a possible hearth, a trash dump, a small scatter of wood, rusted cans and broken glass. In addition, a small trash pile having leather scraps, pieces of rubber, a Mason jar, burned bone and charcoal was found east-northeast of the habitation area.

At the eastern end of the site there are several features which may be associated with each other. A one-meter diameter mound has a scatter of wood, a piece of fire-oxidized sandstone, several can lids and bone nearby. The other features include three scattered sandstone hornos, a possible hogan represented by an earthen depression measuring about five meters in diameter, a wood chopping area, a pile of wood chips, and three ash/trash dumps.

The site may have been occupied between the late 1940's through the 1950's and is one of the largest Navajo habitation complexes recorded in this survey.

Isolated Occurrences

Five isolated occurrences were recorded in this sample unit, and are listed in Table 1-14.

Table 1-14. Isolated Occurrences in Sample Unit 52-19.

IO Number	Brief Description
171	historic trash dump
172	historic trash dump
173	scarecrow
174	historic trash dump
175	secondary flake

Sample Unit 54-22

The sample unit contains 640 acres and is topographically varied. A broad valley produced by several tributaries of the Chaco Wash extends through the western half of the unit. The Chaco Wash is about three quarters of a mile northeast. The valley is surrounded by rolling sagebrush-covered hills and stabilized dunes. A steeply rising shale and sandstone uplift is present in the northwestern corner of the unit. Soils consist of aeolian sands, sandy clay loams in the hilly areas, and baked clayey loams in the broad floodplains. Elevations range between 6500 and 6600 feet.

Grasses predominate in the valley, and include galleta, dropseeds, and Indian ricegrass. Sagebrush dominates the hill slopes along with prickly pear, wolfberry, and minor occurrences of grasses and annuals. The floodplain areas support Russian thistle and one cottonwood tree. A single pinyon pine was observed on a hillside in the north-central part of the unit.

The entire unit is heavily overgrazed by sheep, cattle and horses. A stock tank is near the western boundary and numerous stock trails leading to the tank traverse the sample unit. Several Navajo pastoralist homesteads are adjacent to the unit.

Site density within the unit is low. Three sites and nine isolated occurrences were recorded. Documented usage is restricted to twentieth century Navajo seasonal stock raising activities and P-I/II Anasazi agriculturally related activities.

Site 54-22-1 (LA 34757)

This site is a Navajo sheep herders' camp dating to the 1950's. Features include a tent site, an ash/trash dump, a wood chopping area, a wood storage area, and a possible corral area measuring approximately 9 meters in diameter. The areal extent of the site is 60 by 60 meters (see also Figure 16).

The site is in the bottom of a broad shallow swale on the south side of a series of hills, and near the head of a small wash which is dammed approximately 500 meters to the west.

Temporally diagnostic artifacts include key opened soda cans and a tire. The high incidence of handmade artifacts, recycled items, and the absence of purchased materials associated with grooming and recreational activities are consistent with a 1950's placement for the site.

Site 54-22-2 (LA 34758)

Ceramics and masonry indicate a small Anasazi farmhouse dating to the AD 900-1150 interval. The site is adjacent to a sandstone knoll. Several shallow basins at the base of the knoll may contain prehistoric water control devices designed to trap both soil and water runoff for farming purposes. Sandstone fragments which delineate these basins may also result from the degradation of an outcrop which underlies the shallow drainage basins and gullies. Site features include three ceramic and lithic scatters, and sandstone masonry, some of which was utilized to construct three cairns. Next to one cairn is a metal stake to which a metal tag is attached. Printed on the tag is BM-17; this may designate a site number given to the locus by another archaeological (?) surveyor.

Diagnostic artifacts include Gallup B/W, Cibola whiteware, Cibola corrugated, and Newcomb exuberant corrugated, and an Anasazi style obsidian projectile point midsection. Other artifacts recorded include chalcedony and petrified wood lithic debitage and a quartzite hammerstone fragment.

The site is an apparent field house occupied during P-II (AD 950 - 1150) times.

Site 54-22-3 (LA 34759)

This site is a temporary Navajo sheep herders' camp, probably dating to the 1940's or 1950's. Features include a deteriorated tent base or windbreak made from tree branches, a flat, stained soil area which probably represents a corral, a wood chopping area, and an ash/trash dump. The site measures 30 by 45 meters. The site is on a hillslope overlooking a tributary wash. The exposure is southeast.

No temporally diagnostic artifacts were found. However, a slightly patinated liniment bottle and the very rusted condition of the fuel cans in the dump suggests that the site dates to the 1940's or 1950's.

Isolated Occurrences

Nine isolated occurrences were found and are listed in Table 1-15. The assemblage reflects twentieth century pastoralist activities and limited Puebloan Anasazi usage of this sample unit.

Table 1-15. Isolated Occurrences in Sample Unit 54-22

IO Number	Brief Description
177	scarecrow
179	8 Cibola corrugated and banded sherds, P-I/II
181	60-70 sherds from 2 Cibola banded jars, P-I
183	can and wire noisemaker
185	sandstone cairn
187	sandstone and shale cairn
189	food cans, bottles, sheep bones
191	intact ramada, 2 dead animals on top
193	ground control masonry cairn and metal stake with tag; soda cans
196	tertiary flake

Sample Unit 57-23

The physiographic setting of the parcel is a cross-section of the shallow valley drained by the Canada Corrales. Slopes rise moderately from the northwestern quarter and the southeastern half of the parcel. The floodplain of the Canada Corrales, which drains from the northeast to the southwest toward the Chaco Wash, forms the central portion of the survey unit. The low mesa at the northwestern end of the unit separates the Canada Corrales from Cottonwood Flats; the low, rolling mesa land to the southeast divides the Canada Corrales from the Arroyo Pueblo Alto. Portions of the southern slopes of the mesa are also included within the sample unit boundaries. Topographic relief varies from 6590 feet along the

Canada Corrales floodplain to 6650 feet on the crests of the mesa. The sample unit contains 640 acres.

The soils on the mesa slopes and crests are characterized by semistabilized dunal deposits, while soils on the Canada Corrales alluvial plain are more clayey.

Sagebrush dominates the crests of the mesa, whereas higher frequencies of rabbitbrush and mixed grasses were noted on the mesa slopes. The soils on the alluvial plain support more salt-tolerant species such as fourwing saltbush, although some grasses and miscellaneous annuals were also noted. Greasewood was observed in the moister parts of the floodplain.

A highly visible shale/clay outcrop is the dominant topographic feature within the sample unit. This outcrop is in the southwestern portion of the parcel near the Canada Corrales arroyo. Several gravel outcrops are adjacent to this topographic feature. Quartzite and chert nodules were observed within these gravel deposits; however, the materials are generally poor quality and not well suited for stone tool manufacture. Nevertheless, several isolated occurrences (IO-188, IO-190 and IO-192) were noted nearby. These gravel outcrops may have been occasionally exploited as quarry loci for raw lithic materials.

The three sites in this sample unit are all twentieth century Navajo manifestations representing herding and agricultural activities.

The eight isolated cultural occurrences found in the parcel result from both prehistoric and historic activity. The prehistoric loci are probably related to plant procurment and processing. The historic isolated occurrences represent habitation, maintenance, and pastoralist activities.

Site 57-23-1 (LA 34760)

This Navajo herding site is located east of the shale/clay badlands in the southwestern portion of the sample unit. Several small dirt roads cross the site area, which measures 160 by 60 meters. The site is 250 meters south of Canada Corrales. The site contains the remains of two corral enclosures and associated trash scatter.

The first corral is relatively intact. This feature is about 12 meters in diameter, and opens to the east. The corral walls are juniper posts and wire. Adjacent to the eastern side of the this corral are remnants of a larger enclosure which measures approximately 30 by 72 meters. This second corral was also constructed of juniper posts and wire, but the posts are now fallen and it appears that some materials were scavenged for use elsewhere, perhaps in the construction of the standing corral.

The trash scatter associated with the corrals extends generally east up to 85 meters. The cultural debris includes condensed milk, meat, and beverage cans, enamelware pots, two manos, various metal automotive parts, five 50-gallon drums converted to feeding troughs, and one tin can and a pebble noisemaker. There are fewer than 100 artifacts in all. Because the beverage cans are key-opened, the site may date to the 1950's.

Site 57-23-2 (LA 34761)

This site is on an alluvial plain about 275 meters north of the Canada Corrales, and measures 17 by 6.5 meters.

One of the site's features is an earthen mound measuring 6.5 meters in diameter and 40 cm high at the center. A piece of milled lumber has been set upright in the middle of the mound. The purpose of this feature cannot be determined precisely, but it may represent a shelter, possibly a hogan.

A small scatter of wood chips was encountered three meters southeast of the mound. This may be a wood chopping area, perhaps related to dismantling activities. The only other debris found in the vicinity of the mound consists of two galvanized buckets. Most of the durable building materials have been scavenged for use elsewhere.

Because no diagnostic trash was found in direct association with the mound, no date can be assigned. However, this feature probably was occupied during the twentieth century.

Site 57-23-3, a recent cornfield, was found approximately 275 meters northeast of the site.

Site 57-23-3 (LA 34762)

The cornfield is in an alluvial plain about 225 meters north of the Canada Corrales, and measures 125 by 100 meters.

A large, rectangular cornfield is enclosed by a post and barbed wire fence. The field has been in use until recently since plowed furrows and the weathered remains of old corn stalks are still visible. The fence, however, is in disrepair.

The remains of five to ten scarecrows were noted within the fenced area, and another dozen were found scattered along the fence line bordering the field. Very little trash was observed within and adjacent to the field. The little debris that was seen includes two KC baking powder cans which date to 1970, and a small number of food and beverage cans a short distance to the northeast. A burned fence post, which may mark a possible hearth area, was encountered in the center of the field.

Isolated Occurrences

Eight isolated occurrences were recorded in this sample unit. Both prehistoric and historic activities are represented.

Table 1-16. Isolated Occurrences in Sample Unit 57-23

IO Number	Brief Description
180	historic trash dump
182	historic trash dump
184	historic trash dump

IO Number	Brief Description
186	flake, 2 angular debris
188	7 flakes, possible core
190	mano fragment
192	flake, bottle rim
194	4 coffee cans and pebbles (noisemaker materials)

Sample Unit 65-31

The physiographic features in the sample unit are relatively uniform and consist of low rolling hills and broad floodplains. There is little topographic relief throughout the survey area. The elevation ranges between 6660 feet and 6630 feet. Low sandy semistabilized dunal areas border the washes. The sample unit contains 480 acres.

Soils on the low hills are chiefly sandy loams and unconsolidated aeolian deposits. On the floodplain are hard-packed clays, silts, and gravels. The washes are unentrenched.

The vegetation is fairly uniform, and consists principally of a mixture of grasses, annuals, and low shrubs. Sagebrush occurs in the sandy loams on the higher, more level areas above the drainages. The more saline soils on the floodplain support fourwing saltbush, and there are large areas of Russian thistle throughout the sample unit.

During an earlier survey of 4.75 sections near Star Lake performed by New Mexico State University (NMSU), two prehistoric quarry sites were found in the sample unit (Preslar, et. al 1977). This report was reviewed by ESCA-Tech in the BLM Albuquerque office, and the sites had been previously plotted on the BLM maps. Both sites (NM-01-4065 and NM-01-4066) were designated by NMSU as "insignificant lithic sites" (ibid:7). They were temporally assigned to the Archaic Period, and the site assemblage consisted of flakes, debitage, and a few tools (cores, choppers, a hammerstone) near naturally occurring outcrops of petrified wood, cobbles and gravels on hard clay surfaces.

These loci were not re-located during the present survey. The presence of persistent orthoquartzite outcrops along the edges of the broad floodplain, as well as the trampling activities of cattle, sheep, goats and horses, make the identification of specific locales as quarries tenuous. Erosion and other weathering processes also affect the distribution and visibility of stone materials from year to year.

Two sites and six isolated occurrences were found in the sample unit during the current survey. Both sites are small Navajo habitations which were occupied in the middle twentieth century. Three of the isolates are Navajo, datable to the 1940's, and may be associated with the habitation sites. The other isolates are lithic artifacts which are probably related to prehistoric lithic and plant procurement activities.

Site 65-31-1 (LA 34763)

The cultural remains at this site include a seven meter diameter circle of wood fragments which is probably a hogan, a small trash dump, an ash dump, and a rock pile of undetermined function. A 1950's pickup cab is west of the hogan area. The site is located on top of a low hill and covers an area of 100 by 30 meters.

In the hogan area there is a very light scatter of cans, various car parts, some sandstone and bone. No mound or depression was noted with the circular scatter of chipped wood. One of the trash piles is in a small arroyo to the north-northeast of the hogan area, and includes a few cans, bottle glass, wood chips, rubber fragments, milled lumber, and a few can lids. The possible horno is a one-meter diameter area of sandstone slabs. Most of the items are food and beverage containers, car parts and wood fragments. The occupation of the hogan may have occurred in the 1940's.

The 1950's pickup cab bears a 1959 license plate and may be intrusive to the site area. It is on a high point and is visible from some distance. It has been stripped of parts, some of which are now scattered over a wide area. Graffiti consists of names of local residents, dates from the the early 1960's to the late 1970's, and pictures of cowboys, a horse, an oil well, an Indian, a six-shooter, a house, and a pornographic drawing. The cab is wired down to the four stakes of an aerial photo marker and apparently was used as an aerial reference point. A powerline runs between the habitation features and the pickup cab.

Although the features and artifacts have been subjected to erosion and salvage activities, the site was identified as a sheep herding camp or small habitation used seasonally by a small group engaged in stock raising.

Site 65-31-2 (LA 34764)

The site is in a semistabilized, partially deflated dunal area on the south side of a large deflated flat. The site area is 100 by 60 meters.

There is a probable hogan represented by a roughly circular arrangement of wood fragments, two small wood chopping areas, a probable horno, and scattered trash. A 60 cm square sandstone-lined pit which may have been an outhouse or storage shed is 60 meters south. Southeast of the probable dwelling is more scattered trash.

At the edge of a deflated flat to the northwest is another roughly three meter circular scatter of branches which may have been a second dwelling. A sparse woodchopping area is located to the north. A general scatter of trash extends for a quarter of a mile to the east, and includes cans, lard buckets, bottles, broken glass, and milled lumber fragments.

The sheep herders' camp probably had temporary shelter such as brush hogans or tents. Weathering action and historic recycling of usable artifacts have reduced all features. No diagnostic artifacts were found in the site area, but occupation is judged to have occurred in the 1940's based on the kind and condition of features and artifacts.

Isolated Occurrences

Six isolated occurrences were recorded in the sample unit, and are listed below.

Table 1-17. Isolated Occurrences in Sample 65-31

IO Number	Brief Description
199	palmwood core
200	4 tested rocks; orthoquartsite primary, tertiary and 3 secondary flakes; hammerstone
201	4 upright posts, milled lumber
202	core, 2 orthoquartzite flakes
209	historic trash dump
210	historic trash dump

These occurrences include both historic items and prehistoric lithic materials. The lithics are all of local materials derived from the few low sandstone exposures and from gravels in some of the broad floodplain channels.

The artifacts reflect initial testing of these local rocks. The palmwood core shows evidence of possible utilization along one edge. The quartzite hammerstone associated with the orthoquartzite tested rocks and flakes shows little use.

Historic materials are dated to the same general time span as the two sites.

Two occurrences are single episode trash dumps containing food and beverage cans and bottles. The third historic occurrence may represent a ramada and corral area. The structures have been dismantled and scattered, and identification is difficult.

The survey area is now heavily grazed by cattle, horses, sheep and goats and is part of a large grazing range. An operating windmill and stock tank is east along a main wash.

The cultural resources largely represent seasonal use of the area, especially in prehistoric times. The relative homogeneity of terrain and soils provides a limited diversity of plant foods. The grasses include mostly galleta, with lesser amounts of muhly and dropseed which are more suitable for grazing animals than for human exploitation.

Sample Unit 66-31

Total relief in this sample unit varies by only 40 feet (6600-6640 feet). The terrain is generally flat to gently sloping. An unentrenched tributary drainage of Torreon Wash traverses the central portion of the unit from west to east. A small mesa of resistant sandstone is in the southwestern corner of the unit. Large flat pans containing coal and gravel are adjacent to this mesa. Stabilized low dunes occur north and east of the mesa. Major physiographic features located in the vicinity of this unit include Ojo Encino Mesa located one to one and a half miles north, and Little Blue Mesa, situated one half mile to the southeast. The sample unit contains 480 acres.

Soils range from thin alkaline clay loams in the southwest to sandy loams in the remainder of the unit.

Vegetation is uniformly distributed in the unit. Although the area is overgrazed, grasses include galleta, dropseeds, and muhly. Shrubs include sagebrush, shadscale, fourwing saltbush, and wolfberry. Russian thistle is abundant in areas disturbed by livestock. Several Russian olive trees were observed adjacent to a currently utilized Navajo homestead.

During an earlier survey of 4.75 sections near Star Lake performed by New Mexico State University, five sites were recorded in this sample unit (Preslar et al. 1977). Three of these sites (NM-01-4073, NM-01-4072, and NM-01-4054) were recorded again, and two prehistoric sites (NM-01-4056 and NM-01-4068) were not found because they are very close to a Navajo homestead. A wide area around this homestead was avoided by ESCA-Tech surveyors because the owners were present at the time of the survey.

Four sites and eight isolated occurrences were found in this sample unit. The resources fall into two groups: post-1930 Navajo and lithic loci of probable prehistoric age. The lithic sites are in dunal settings and the two Navajo habitation sites are associated with adjacent grasslands and water sources.

Site 66-31-1 (NM-01-4073, LA 34765)

This historic Navajo habitation site is located in a dunal setting adjacent to a small wash and is 225 by 250 meters in areal extent. The site is bisected by a dirt road.

Twenty five features were recorded. Structural features include three habitation structures, a horno, four corrals, an outhouse foundation, and a fenceline. Non-structural remains include nine ash/trash dumps, three wood chopping loci, two lumber piles, and a hearth.

Datable artifacts and informant data indicate that this Navajo homestead was established in the 1940's and is still in occasional usage. Sheep herding was the primary activity at this homestead until the 1970's when cattle raising was initiated.

Site 66-31-2 (LA 34766)

This Navajo homestead is in a relatively flat grassland adjacent to a small wash. The site measures approximately 150 by 140 meters.

Features recorded within the site include a collapsed cribbed log hogan, three hornos, a coal ash pile, a wood chopping locus, several trash dumps and a corral.

Datable artifacts include a KC baking powder lid ("60 years the same price") and aluminum cans attributable to the 1950's and early 1960's.

Functionally, sheep herding and domestic activities are represented on this Navajo habitation site.

Site 66-31-3 (NM-01-4072, LA 34767)

This site is on a sagebrush-covered dune and and a several blowout areas at the edge of the broad, shallow floodplain.

It measures 270 by 90 meters. The site is a large lithic scatter with no visible features.

Three sample transects were placed in areas of lithic concentration. No formal tools were found either in these transects or over the entire site area. The lithic assemblage consists mainly of secondary and tertiary flakes as well as angular debris. Several retouch flakes and biface thinning flakes were also noted. Exotic material types include Washington Pass chert and Jemez obsidian. Several hundred artifacts are present at the site. It is estimated that approximately 40% of the artifacts were examined.

The site is probably prehistoric, and the principal activity represented is the manufacture of tools from previously prepared cores. Because of its setting in the dunes at the edge of the floodplain, the activities of the site may have included plant procurement.

Site 66-31-4 (NM-01-4054, LA 34768)

This site is at the base of a dune in a blowout basin and is 150 by 25 meters in areal extent.

Approximately 150 artifacts were found on the surface. Lithic resource procurement and primary reduction appear to have been the principal activities. Most of the artifacts are primary flakes and tested cobbles. One unifacially flaked cobble tool was found. Approximately 80% of the lithics are orthoquartzite which outcrops several hundred meters north of the site.

During the earlier survey of the sample unit, two clusters of lithic artifacts were recorded as NM-01-4054. A 350 x 15 meter cluster is near a pond, road, windmill and a tank on the floodplain; the other is 175 meters north at the edge of the dunes. The artifacts in both clusters include flakes, debitage, cores, preforms, and a knife fragment (collected). The entire site was designated a cobble quarry area occupied during the Archaic Period (Preslar et. al 1977:22). The second cluster was recorded as 66-31-4 during the present survey. The knife fragment was collected in this second scatter.

The artifact assemblage indicates that the site is prehistoric. The cobble chipping tool, knife fragment and site location suggest the site represents activities related to plant procurement.

NM-01-4056 and NM-01-4068

These two sites were not re-located during the present survey because they are close to a currently-occupied Navajo homestead.

NM-01-4056 is a 400 x 800 meter thin lithic scatter on and adjacent to a ridge. Two concentrations of lithics were found, and include flakes, debitage, cores, a hammerstone and a knife fragment (collected). "The area is presently occupied by Navajo dwellings, storage buildings, corrals, three roads and a waterline (Preslar, et al. 1977:30).

NM-01-4068 is a 20 by 20 meter lithic work area on a secondary ridge. Approximately 50 small lithic flakes were recorded. It may be part of the larger, similar site (NM-01-4056) (Preslar, et al. 1977:42)

Isolated Occurrences

Eight isolated cultural occurrences were found within the sample unit and are listed below. All of these are attributable to Navajo domestic and sheep herding activities. The datable isolated loci fall within the 1950-1970 interval.

Table 1-18. Isolated Occurrences in Sample Unit 66-31

IO Number	Brief Description
195	historic trash dump (1950's)
197	sandstone cairn
203	historic trash dump (1960's)
204	6 sandstone cairns
205	cairn
206	sandstone slab walkway/ erosional control device(?)
207	historic hearth (1970's)
208	historic trash dump (1950's)

Additional Sites Recorded

During the course of the field work, the crews were asked by a grazing leaseholder to leave one of the parcels selected in the original sample. Three sites and six isolated occurrences had been recorded in this sample unit, however. Another sample unit (39-13) was selected to replace sample unit 44-15.

Site 44-15-1 (LA 34769)

The site is a probable Navajo sheep herding camp which may have been occupied during the early part of the twentieth century. The main portion of the site occupies an area of 55 by 20 meters. It is on a small rise in the shale badlands.

The site features include a three meter diameter circular alignment of sandstone, a possible structure represented by several upright sandstone slabs set against a shale outcrop, two ash piles, a sparse wood chopping area, and scattered trash. At the western portion of the site is a quantity of deteriorated cow and sheep bone. One bone shows possible butchering marks. Scattered in the area are fragments of wood; two may be tent stakes. Also found was a 3-in-1 Oil™ can with a lead top, barbed wire, and round nails.

Several wine bottles, probably not associated with the site, were found in an arroyo in the badlands. Two small coal quarries were found about 50 meters east of the site.

The date of the occupation of the site is difficult to estimate because of the eroded nature of the features and artifact scarcity. The cultural remains probably indicate a sheep herders' camp with a tent or small temporary shelter, a possible lamb pen or storage area, and perhaps temporary wood structures. The lack of artifacts can be attributed to one or a combination of factors including early occupation, salvage of useful articles, heavy erosional activity, and short-term use.

Site 44-15-2 (LA 34751)

The site is on top of a oxidized shale hill in an area of shale/sandstone badlands. It is probably a two-component site and covers an area of 60 by 50 meters.

The Anasazi component consists of a squarish depression and a quantity of building stone on top of a small hill. No definite walls or corners were found within the depression. Within the depression is a two-hand mano fragment and many ceramic sherds. Hundreds of sherds are in the depression and especially in a fan-shaped scatter down the south-facing slope. Chipped stone is very scarce; only two pieces of chalcedony were found on the hill slope.

The ceramic types are extremely varied for a small site. Both Cibola and Chuska series painted and corrugated wares were found as well as several sherds of possible Mesa Verde style B/W. A 33% sample of the ceramics was analyzed (approximately 100 sherds) in the field; most were painted types, rim, and large sherds. The sherds are dated to AD 950-1250 (P-II/III).

The second component appears to represent a Navajo sacred/religious site. Two features are present: a slab masonry cairn, and a rectangular box constructed of upright sandstone slabs. The cairn stands one meter high and is on the highest point of the hill. The upright slab feature is at the bottom of the rectangular depression.

The upright slab feature contains two Navajo anthropomorphic figurines representing both sexes, and four sharpened prayer sticks. The figurines are armless; the legs are represented by a split, and the feet may have been painted. A feather remnant is attached to the larger male figurine. Another figurine and two prayer sticks were also found within the depression. The sticks still contain bark. The bark was removed from one stick, the wooden surface was painted turquoise, and human facial features were portrayed in black paint.

Variability in the condition of these wooden artifacts indicate that they were deposited at different times.

The Anasazi component is probably a field house on a high point adjacent to an ephemeral wash. The temporal and stylistic variety of ceramic types is unusual for such a small site, and it is likely that painted types were collected elsewhere and brought to the site in connection with Navajo curing ceremonies which use anthropormorphic figures. The cairn may mark the location of this sacred/religious site.

Site 44-15-3 (LA 34752)

The site is on the southern slope of a sandy hill and an area of upland flats. The artifact scatter covers an area of 100 by 100 meters.

The site may be a Navajo sheep herding camp. The features include a large coal ash/trash dump and an area of scattered, cut sagebrush branches. An associated scatter of trash covers a large area and includes many condensed milk cans, a small clear glass jar, a five gallon bucket, coffee and lard cans, and a possible tent stake. Dating the occupation of this site is difficult, but the size of the ash dump and scarcity of features indicates multiple short-term occupations consistent with the needs of seasonal herding activities. The site may have been used in the 1940's.

Isolated Occurrences

Six isolated occurrences were recorded, and are listed below. These occurrences principally document dumping episodes for the last 30 years, as well as Anasazi Puebloan usage. Within the trash dumps typical items include twentieth century food and beverage containers, car parts, household articles and coal ash. These dumps are near roads in various places in the badlands and upland sagebrush flats (arroyos, on hills, on the flats). There are a number of inhabited dwellings in the vicinity of this survey parcel, and trash is a fairly common occurrence.

Table 1-19. Isolated Occurrences in Sample Unit 44-15

IO Number	Brief Description
154	historic trash dump
156	historic trash dump
158	historic trash dump
160	plain gray Cibola sherd
163	historic trash dump
165	historic trash dump

APPENDIX 2

PREDICTIVE MODEL STUDY
OBSERVED INCLUDES ONLY THOSE 2 x 2 KM UNITS WITH MORE THAN SIXTY PERCENT SURVEY COVERAGE

Model I

Backward Elimination Procedure for Dependent Variable Type 1 (Lithic Sites)

$R^2 = 0.712$ C = 13.108

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	20	925.08443553	46.25422178	4.08	0.0022
Error	33	373.65924859	11.32300753		
Total	53	1298.74368411			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	-616.77715402				
Class 2	- 0.42162354	0.19436455	53.28161614	4.71	0.0374
Class 6	0.46926300	0.21837089	52.28835036	4.62	0.0391
Class 1X	1235.66768047	414.24689003	100.75037197	8.90	0.0053
Class 2X	8395.24707817	2238.95515142	159.19813371	14.06	0.0007
Class 24	-0.00044183	0.00015931	87.09021075	7.69	0.0091
Class 25	0.00055649	0.00018851	98.67576075	8.71	0.0058
Class 35	-0.00061003	0.00016238	159.80496444	14.11	0.0007
Class 46	0.00027277	0.00015599	34.62463066	3.06	0.0896
Class 47	-0.00023298	0.00012369	40.17641645	3.55	0.0694
Class 48	-0.00024679	0.00006490	163.72800447	14.46	0.0006
Class 58	0.00045196	0.00008306	335.26624824	29.61	0.0001
Class 78	0.00023474	0.00007208	120.09777075	10.61	0.0036
CX 18	1003.06583414	237.02113617	202.78999335	17.91	0.0002
CX 24	3468.20997651	807.68077217	208.78201003	18.44	0.0001
CX 25	-3326.72932194	741.38260897	227.98797428	20.13	0.0001
CX 26	-2342.56963182	750.10755982	110.43321843	9.75	0.0037
CX 28	-2508.51561534	582.85518132	209.73653597	18.52	0.0001
CX 35	2070.97779051	540.23587929	166.39712987	14.70	0.0095
CX 46	-1009.25817525	427.19027521	63.20095387	5.58	0.0242
CX 68	710.21216670	227.92597347	109.93864387	9.71	0.0038

All variables in the model are significant at the 0.1000 level.

Backward Elimination Procedure for Dependent Variable Type 2
(Anasazi Sites)

$R^2 = 0.623$ $C = 25.136$

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	19	796.45725494	41.91880289	2.96	0.0029
Error	34	482.20992725	14.18264492		
Total	53	1278.66718219			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	1191.86195755				
Class 2	7.52385201	2.88177638	96.67566412	6.82	0.0133
Class 3	-0.38686138	0.14159859	105.86444330	7.46	0.0099
Class 7	-06.84576755	2.74103262	88.46533363	6.24	0.0175
Class 1X	-1425.89195591	632.79355904	72.01224790	5.08	0.0308
Class 2X	-37107.57122041	15209.87028337	84.41726331	5.95	0.0201
Class 5X	-1557.78652326	603.49668682	94.49815607	6.66	0.0143
Class 7X	32006.75504109	14444.20278284	69.63913504	4.91	0.0335
Class 23	0.00016284	0.00007979	59.06708368	4.16	0.0491
Class 26	-0.00356338	0.00139509	92.52897822	6.52	0.0153
Class 28	-0.00317757	0.00128996	86.05809665	6.07	0.0190
Class 46	0.00058195	0.00019624	124.72016759	8.79	0.0055
Class 48	-0.00025913	0.00009821	98.74487015	6.96	0.0125
Class 67	0.00310098	0.00130196	80.45688832	5.67	0.0230
Class 78	0.00300096	0.00121321	86.77751762	6.12	0.0185
CX 26	8615.10269153	4655.49239663	48.56762915	3.42	0.0729
CX 28	6924.97481338	3492.47200124	55.76064132	3.93	0.0555
CX 46	-2018.25389729	784.77747500	93.80279326	6.61	0.0147
CX 67	-8252.41795392	4341.65342230	51.24002766	3.61	0.0658
CX 78	-7178.36114776	3245.33496818	69.38870458	4.89	0.0338

All variables in the model are significant at the 0.1000 level.

Backward Elimination Procedure for Dependent Variable Type 3
(Pre-1933 Navajo Sites)

$R^2 = 0.860$ C = 22.398

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	26	305.05530880	11.73289649	6.38	0.0001
Error	27	49.65109111	1.83892930		
Total	53	354.70639991			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	476.96244738				
Class 2	0.88393207	0.16366026	53.64340582	29.17	0.0001
Class 6	-0.45849228	0.11422002	29.63088413	16.11	0.0004
Class 7	-0.43859848	0.07864294	57.19786310	31.10	0.0001
Class 2X	-3381.46484372	1172.92034758	15.28402519	8.31	0.0076
Class 5X	-1376.06301019	381.72129316	23.89730362	13.00	0.0013
Class 23	-0.00017338	0.00007189	10.69543516	5.82	0.0229
Class 24	0.00055259	0.00014251	27.64896681	15.04	0.0006
Class 25	0.00044110	0.00019892	9.04232029	4.92	0.0352
Class 26	-0.00156047	0.00026790	62.39072084	33.93	0.0001
Class 28	-0.00027589	0.00004179	80.12949902	43.57	0.0001
Class 35	-0.00065994	0.00020813	18.82635099	10.24	0.0035
Class 36	0.00140198	0.00035617	28.49190034	15.49	0.0005
Class 46	-0.00034864	0.00016898	7.82809164	4.26	0.0488
Class 47	0.00020629	0.00005757	23.60958221	12.84	0.0013
Class 48	-0.00013770	0.00004416	17.87842531	9.72	0.0043
Class 58	0.00016585	0.00005625	15.98784511	8.69	0.0065
Class 67	0.00039906	0.00011041	24.02091574	13.06	0.0012
CX 18	-242.75850202	93.23176865	12.46769256	6.78	0.0148
CX 24	3051.29415383	589.62987812	49.24636980	26.78	0.0001
CX 25	-1183.14489093	593.23950659	7.31443472	3.98	0.0563
CX 26	4693.11083161	715.92831259	79.02192016	42.97	0.0001
CX 28	1088.69774357	179.20282887	67.87189205	36.91	0.0001
CX 35	2034.20549268	600.03333188	21.13508144	11.49	0.0022
CX 36	-4204.65513872	874.58463510	42.50324696	23.11	0.0001
CX 46	2036.81683775	498.04058860	30.75668397	16.73	0.0004
CX 68	-373.17740872	134.72684395	14.10871463	7.67	0.0100

All variables in the model are significant at the 0.1000 level

Backward Elimination Procedure for Dependent Variable Type 4
(Post-1933 Navajo Sites)

$R^2 = 0.7111$ C = 13.071

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	21	678.17292790	32.29394895	3.75	0.0004
Error	32	275.53131928	8.61035373		
Total	53	953.70424718			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	1127.50390829				
Class 2	1.99253174	0.60016226	94.90610060	11.02	0.0023
Class 3	-0.41679602	0.09647320	160.71438474	18.67	0.0001
Class 6	0.23081366	0.10700416	40.06293099	4.65	0.0386
Class 7	-1.64908695	0.56503195	73.34357786	8.52	0.0064
Class 1X	-898.90992230	260.85671047	102.24670356	11.87	0.0016
Class 2X	-9135.75393514	2727.00833026	96.63553414	11.22	0.0021
Class 7X	5843.86716342	2559.41011727	44.88920350	5.21	0.0292
Class 23	0.00030602	0.00009502	89.31313825	10.37	0.0029
Class 24	-0.00050396	0.00020898	50.07174310	5.82	0.0218
Class 25	0.00063784	0.00021823	73.55852852	8.54	0.0063
Class 26	-0.00051165	0.00011753	163.19676505	18.95	0.0001
Class 28	-0.00094469	0.00018769	218.12241940	25.33	0.0001
Class 35	-0.00032411	0.00009005	111.54614628	12.95	0.0011
Class 46	0.00058068	0.00014937	130.12190339	15.11	0.0005
Class 47	-0.00032359	0.00011853	64.16993894	7.45	0.0102
Class 78	0.00102449	0.00022619	176.64647335	20.52	0.0001
CX 14	-1082.48542690	258.70730155	150.74667365	17.51	0.0002
CX 24	2862.61492271	800.75649498	110.03881765	12.78	0.0011
CX 25	-2294.77969103	711.20358826	89.64273750	10.41	0.0029
CX 46	-2435.46713586	555.64293583	165.42225849	19.21	0.0001
CX 78	-1389.54486844	430.70716285	89.61938393	10.41	0.0029

All variables in the model are significant at the 0.1000 level

Backward Elimination Procedures For Dependent Variable Type 5
(Anglo/Spanish Sites)

$R^2 = 0.638$ C = 11.058

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	19	16.18832139	0.85201692	3.15	0.0017
Error	34	9.20181753	0.27064169		
Total	53	25.39013892			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	-38.80133811				
Class 2	-0.04412349	0.02047933	1.25632821	4.64	0.0384
Class 3	0.05071362	0.01707391	2.38768907	8.82	0.0054
Class 23	-0.00003041	0.00001128	1.96667715	7.27	0.0108
Class 24	0.00010243	0.00002787	3.65591260	13.51	0.0008
Class 25	0.00002686	0.00001126	1.54078056	5.69	0.0227
Class 35	-0.00006346	0.00001928	2.93328049	10.84	0.0023
Class 36	0.00016418	0.00004373	3.81540070	14.10	0.0007
Class 46	-0.00010827	0.00003125	3.24804180	12.00	0.0015
Class 48	0.00000948	0.00000522	0.89156025	3.29	0.0784
Class 67	-0.00011266	0.00003388	2.99212237	11.06	0.0021
CX 18	37.54621003	21.27740037	0.84273257	3.11	0.0866
CX 24	-387.14777772	104.08832451	3.74407212	13.83	0.0007
CX 28	268.57221962	85.91630006	2.64463502	9.77	0.0036
CX 35	175.79301414	56.97588067	2.57641507	9.52	0.0040
CX 36	-580.82291953	150.78606488	4.01568627	14.84	0.0005
CX 46	430.40585451	100.01571745	5.01204003	18.52	0.0001
CX 67	588.27541965	141.49057152	4.67844042	17.29	0.0002
CX 68	-166.87093379	42.42474495	4.18714125	15.47	0.0004
CX 78	-109.78574995	49.59739726	1.32607740	4.90	0.0337

All variables in the model are significant at the 0.1000 level.

Backward Elimination Procedures For Dependent Variable Type 7
(Unknown Historic Sites)

$R^2 = 0.525$ C = 10.697

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	17	44.80106023	2.63535648	2.34	0.0160
Error	36	40.61360284	1.12815563		
Total	53	85.41466308			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	-464.66997531				
Class 2	0.12324712	0.02991671	19.14674680	16.97	0.0002
Class 3	0.18626489	0.04999225	15.66122539	13.88	0.0007
Class 6	0.12910131	0.03746122	13.39881374	11.88	0.0015
Class 7	-0.40817424	0.10493298	17.07010390	15.13	0.0004
Class 1X	147.94970144	70.21626991	5.00866163	4.44	0.0421
Class 5X	698.69845754	170.07749360	19.03947161	16.88	0.0002
Class 7X	2478.68105388	670.33291369	15.42514386	13.67	0.0007
Class 36	-0.00026771	0.00006913	16.91604476	14.99	0.0004
Class 46	-0.00007260	0.00003443	5.01462329	4.44	0.0420
Class 58	0.00006168	0.00001932	11.49366927	10.19	0.0029
Class 67	0.00026584	0.00007096	15.83378184	14.04	0.0006
CX 18	256.67036958	75.59632721	13.00526172	11.53	0.0017
CX 24	240.66851968	65.53801066	15.21321773	13.49	0.0008
CX 25	-368.96760716	85.34904652	21.08376412	18.69	0.0001
CX 36	320.38246208	169.42256563	4.03426087	3.58	0.0667
CX 46	364.76553643	169.43537412	5.22863641	4.63	0.0381
CX 67	-597.71213264	233.46512897	7.39450514	6.55	0.0148

All variables in the model are significant at the 0.1000 level.

Backward Elimination Procedures For Dependent Variable Navs
(Total Navajo Sites)

$R^2 = 0.7452$ $C = 12.754$

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	18	1103.76182238	61.32010124	5.69	0.0001
Error	35	377.47534784	10.78500994		
Total	53	1481.23717022			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	1367.00024472				
Class 2	0.72506674	0.18432075	166.88913419	15.47	0.0004
Class 3	-0.19401953	0.07273856	76.73298033	7.11	0.0115
Class 7	-0.56650774	0.12137617	234.94456404	21.78	0.0001
Class 1X	-1240.80226636	238.34335109	292.29381343	27.10	0.0001
Class 2X	-1140.65348686	510.01455595	53.94645017	5.00	0.0318
Class 25	0.00172148	0.00034837	263.35781184	24.42	0.0001
Class 26	-0.00178766	0.00039809	217.48218369	20.17	0.0001
Class 28	-0.00076379	0.00014825	286.26406098	26.54	0.0001
Class 35	-0.00133633	0.00029906	215.34602550	19.97	0.0001
Class 36	0.00173724	0.00038306	221.82007906	20.57	0.0001
Class 47	-0.00013257	0.00003202	184.87452702	17.14	0.0002
Class 78	0.00064571	0.00014784	205.74287352	19.08	0.0001
CX 14	-1391.09613698	245.95550424	345.00210640	31.99	0.0001
CX 25	-5721.35900644	1065.50613429	310.96179945	28.83	0.0001
CX 26	4366.98540087	1117.60685495	164.66675074	15.27	0.0004
CX 35	2735.07114991	769.01135012	136.42448002	12.65	0.0011
CX 36	-5751.98275521	1187.38634498	253.08802683	23.47	0.0001
CX 78	-1132.07190620	314.59964965	139.65359062	12.95	0.0010

All variables in the model are significant at the 0.1000 level.

Backward Elimination Procedures For Dependent Variable Total
(Total Sites)

$R^2 = 0.786$ C = 21.452

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	26	3570.32690103	137.32026542	3.82	0.0004
Error	27	969.40034404	35.90371645		
Total	53	4539.72724506			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	4109.39150280				
Class 2	35.71635401	7.06033245	918.80498000	25.59	0.0001
Class 3	-1.58442361	0.33241179	815.69760987	22.72	0.0001
Class 6	1.23640011	0.51736075	205.05507073	5.71	0.0241
Class 7	-33.93360085	6.82958019	886.36231418	24.69	0.0001
Class 1X	-4914.11171742	1683.30900805	305.98614444	8.52	0.0070
Class 2X	-173167.51717856	36498.76185867	808.19470611	22.51	0.0001
Class 5X	-8707.87791251	2117.40025431	607.23688876	16.91	0.0003
Class 7X	164344.77800353	35823.25379414	755.65083008	21.05	0.0001
Class 23	0.00082146	0.00021326	532.70649156	14.84	0.0007
Class 26	-0.01355423	0.00276909	860.23081261	23.96	0.0001
Class 28	-0.01402998	0.00312012	725.95929689	20.22	0.0001
Class 35	-0.00049299	0.00014944	390.75536105	10.88	0.0027
Class 46	0.00097565	0.00037898	237.96166633	6.63	0.0158
Class 47	-0.00058531	0.00024426	206.15917546	5.74	0.0238
Class 48	-0.00099770	0.00031594	358.04201519	9.97	0.0039
Class 58	0.00127738	0.00034418	494.54421995	13.77	0.0010
Class 67	0.01221981	0.00260401	790.64760298	22.02	0.0001
Class 78	0.01344288	0.00294449	748.34787829	20.84	0.0001
CX 14	-1338.68568204	692.08895213	134.32993633	3.74	0.0636
CX 24	3271.15618646	975.31662310	403.87848093	11.25	0.0024
CX 25	-1162.85066716	538.98625187	167.12134526	4.65	0.0400
CX 26	30411.27620929	8882.35652966	420.87419042	11.72	0.0020
CX 28	27188.40569403	8288.33483228	386.34234709	10.76	0.0029
CX 46	-4629.22571152	1790.38216639	240.02950637	6.69	0.0154
CX 67	-34511.26298940	8897.29131079	540.18869522	15.05	0.0006
CX 78	-30906.94399637	7996.45389560	536.36034385	14.94	0.0006

All variables in the model are significant at the 0.1000 level.

APPENDIX 3

PREDICTIVE MODEL STUDY
OBSERVED INCLUDES ONLY THOSE 2 x 2 KM UNITS WITH MORE THAN SIXTY PERCENT SURVEY COVERAGE

REGRESSIONS INCLUDE ALL SITES IN DATA BASE Model II

Backward Elimination Procedure for Dependent Variable Type 1
Lithic Sites

$R^2 = 0.640$ $C = 13.357$

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	22	1111.24015296	50.51091604	3.80	0.0001
Error	47	625.47655817	13.30801188		
Total	69	1736.71671113			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	411.48108703				
Class 2	-3.13072800	0.65339035	305.53320533	22.96	0.0001
Class 3	-0.34524099	0.09910954	161.48307191	12.13	0.0011
Class 6	0.37886510	0.13263920	108.57718226	8.16	0.0064
Class 7	3.13026794	0.63286622	325.57599309	24.46	0.0001
Class 1X	-1623.94831136	441.57224064	179.99235375	13.53	0.0006
Class 2X	20335.81529044	4033.47541330	338.28094014	25.42	0.0001
Class 7X	-17643.95926977	3405.74435641	357.17510544	26.84	0.0001
Class 24	0.00022900	0.00005042	274.55771102	20.63	0.0001
Class 25	0.00112891	0.00036868	124.77936419	9.38	0.0036
Class 35	-0.00109896	0.00036076	123.49313863	9.28	0.0038
Class 36	0.00155944	0.00045021	159.66817968	12.00	0.0011
Class 48	-0.00013718	0.00004572	119.79508556	9.00	0.0043
Class 67	-0.00167807	0.00044901	185.87261700	13.97	0.0005
CX 18	483.78208593	161.94196979	118.76648688	8.92	0.0045
CX 25	-4732.55561661	1175.42298070	215.73284855	16.21	0.0002
CX 26	-1417.37931681	629.76966201	67.40962184	5.07	0.0291
CX 28	-1240.86322080	345.81028622	171.35042644	12.88	0.0008
CX 35	4013.36835295	1067.06471802	188.25637962	14.15	0.0005
CX 36	-4440.39655118	1305.58338935	153.93857467	11.57	0.0014
CS 46	-1351.06349023	341.70446547	208.04792449	15.63	0.0003
CX 67	4454.21954241	1322.10356442	151.05164721	11.35	0.0015
CX 68	576.75912545	247.30315607	72.38403874	5.44	0.0240

All variables in the model are significant at the 0.1000 level

Backward Elimination Procedure for Dependent Variable Type 2 (Anasazi Sites)

$R^2 = 0.651 \quad C = 22.560$

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	23	887.20105400	38.57395887	3.73	0.0001
Error	46	476.33111944	10.35502434		
Total	69	1363.53217345			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	1158.49700229				
Class 2	8.28786426	2.51428150	112.51452277	10.87	0.0019
Class 3	-0.31672542	0.07034419	209.92320510	20.27	0.0001
Class 6	-0.34353640	0.11331825	95.16930765	9.19	0.0040
Class 7	-7.37206276	2.36993097	100.19770639	9.68	0.0032
Class 1X	-649.44955530	323.64569208	41.69676001	4.03	0.0507
Class 2X	-4447.70729222	13542.65528571	111.54296993	10.77	0.0020
Class 5X	0335.22385883	838.39850406	163.87024847	15.83	0.0002
Class 7X	36509.29985653	12590.54511781	87.07010448	8.41	0.0057
Class 23	0.00015991	0.00007396	48.41207200	4.68	0.0358
Class 24	-0.00026957	0.00006008	208.44119329	20.13	0.0001
Class 26	-0.00358695	0.00112198	105.83606408	10.22	0.0025
Class 28	-0.00283612	0.00111604	66.87184537	6.46	0.0145
Class 46	0.00046769	0.00008720	297.84756600	28.76	0.0001
Class 67	0.00330359	0.00103843	104.80099900	10.12	0.0026
Class 78	0.00259813	0.00104627	63.85371330	6.17	0.0167
CX 14	-1059.84148658	223.60580915	232.63057328	22.47	0.0001
CX 15	725.30753535	255.18398856	83.65437529	8.08	0.0067
CX 25	946.78449617	308.82220356	97.32767842	9.40	0.0036
CX 26	8652.78675411	3670.97970394	57.53063381	5.56	0.0227
CX 28	8129.91312437	3066.76603428	72.77155317	7.03	0.0110
CX 67	-7457.58584258	3369.18842337	50.73375959	4.90	0.0319
CX 68	-842.09011674	234.54969709	133.47456420	12.89	0.0008
CX 78	-7563.32863610	2820.20631761	74.47582187	7.19	0.0101

All variables in the model are significant at the 0.1000 level.

Backward Elimination Procedure for Dependent Variable Type 3 (Pre-1933 Navajo Sites)

$R^2 = 0.680 \quad C = 16.764$

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	24	262.22613382	10.92608891	3.99	0.0001
Error	45	123.28331782	2.73962928		
Total	69	385.50945164			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	490.59181897				
Class 2	0.26938840	0.07659272	33.89023308	12.37	0.0010
Class 7	-0.26916528	0.07631317	34.08245859	12.44	0.0010
Class 1X	-757.34710611	148.50983356	71.24777687	26.01	0.0001
Class 5X	-1007.49200460	396.29798133	17.70644180	6.46	0.0145
Class 23	-0.00012116	0.00003696	29.43035443	10.74	0.0020
Class 24	0.00030354	0.00010586	22.52379310	8.22	0.0063
Class 25	0.00043093	0.00013408	28.29714484	10.33	0.0024
Class 26	-0.00116766	0.00023351	68.50174038	25.00	0.0001
Class 28	-0.00008264	0.00002361	33.55347639	12.25	0.0011
Class 35	-0.00050303	0.00014599	32.52528200	11.87	0.0012
Class 36	0.00075304	0.00021435	33.81225296	12.34	0.0010
Class 46	-0.00016274	0.00007416	13.19436239	4.82	0.0334
Class 47	0.00008481	0.00004719	8.84916865	3.23	0.0790
Class 48	-0.00014679	0.00003115	60.83130359	22.20	0.0001
Class 58	0.00012420	0.00005617	13.39365591	4.89	0.0322
Class 67	0.00051095	0.00010819	61.10165617	22.30	0.0001
CX 24	-1480.57874903	402.01312943	37.15988395	13.56	0.0006
CX 25	-1529.47142314	406.24137089	38.83347327	14.17	0.0005
CX 26	3271.88569500	705.62211523	58.90384956	21.50	0.0001
CX 35	1496.01218286	425.62417427	33.84616653	12.35	0.0010
CX 36	-2693.88909907	658.78011942	45.81105110	16.72	0.0002
CX 46	669.18988983	279.98943852	15.64974418	5.71	0.0211
CX 67	-1272.35182747	438.45778628	23.07016295	8.42	0.0057
CX 68	-246.14133073	116.22046869	12.28840859	4.49	0.0397

All variables in the model are significant at the 0.1000 level.

Backward Elimination Procedure for Dependent Variable Type 4
(Post-1933 Navajo Sites)

$R^2 = 0.460$ $C = 5.829$

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	15	511.35759881	34.09050659	3.07	0.0013
Error	54	599.51721043	11.10217056		
Total	69	1110.87480924			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	218.37928617				
Class 2	0.23287805	0.10442038	55.21975505	4.97	0.0299
Class 7	-0.20957276	0.09404834	55.12838440	4.97	0.0300
Class 1X	-304.30179556	109.41411976	85.87567891	7.74	0.0074
Class 2X	-542.95960415	238.75118517	57.41850254	5.17	0.0270
Class 25	0.00028564	0.00011359	70.19924540	6.32	0.0149
Class 26	-0.00006041	0.00002274	78.33785315	7.06	0.0104
Class 28	-0.00031134	0.00010852	91.37769114	8.23	0.0059
Class 35	-0.00011742	0.00004238	85.21633900	7.68	0.0077
Class 46	0.00007839	0.00003798	47.29409224	4.26	0.0438
Class 47	-0.00012046	0.00004909	66.84432163	6.02	0.0174
Class 78	0.00026606	0.00009950	79.38207528	7.15	0.0099
CX 14	-186.31759084	97.34518669	40.67116853	3.66	0.0609
CX 24	374.81564686	181.73584050	47.22393280	4.25	0.0440
CX 25	-787.64957338	335.70077051	61.11802380	5.51	0.0227
CX 46	-271.30933249	145.10040421	38.81504700	3.50	0.0669

All variables in the model are significant at the 0.1000 level.

Backward Elimination Procedure for Dependent Variable Type 5
(Anglo/Spanish Sites)

$R^2 = 0.516 \quad C = 12.913$

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	21	15.63121209	0.74434343	2.44	0.0054
Error	48	14.65133776	0.30523620		
Total	69	30.28254985			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	-173.60677645				
Class 3	0.11974297	0.02760477	5.74338262	18.82	0.0001
Class 7	-0.12455661	0.02945666	5.45761234	17.88	0.0001
Class 5X	422.13592142	113.59596837	4.21516740	13.81	0.0005
Class 7X	791.32833888	283.91334459	2.37125287	7.77	0.0076
Class 23	-0.00005782	0.00001976	2.61214636	8.56	0.0052
Class 24	0.00007483	0.00003207	1.66206508	5.45	0.0239
Class 25	0.00002174	0.00001085	1.22433812	4.01	0.0509
Class 35	-0.00002292	0.00001251	1.02443595	3.36	0.0732
Class 36	0.00007175	0.00002840	1.94793685	6.38	0.0149
Class 46	-0.00009560	0.00004150	1.62003328	5.31	0.0256
Class 48	0.00003014	0.00001000	2.77128227	9.08	0.0041
Class 58	-0.00004257	0.00001320	3.17484387	10.40	0.0023
Class 78	0.00002093	0.00000872	1.75910637	5.76	0.0203
CX 18	123.69468730	33.97285922	4.04644776	13.26	0.0007
CX 24	-311.30167383	125.04180940	1.89185765	6.20	0.0163
CX 28	291.77076750	80.69887545	3.99010784	13.07	0.0007
CX 36	-370.98392558	106.58230576	3.69807747	12.12	0.0011
CX 46	436.12788995	155.97698997	2.38639699	7.82	0.0074
CX 67	285.84264514	85.81054094	3.38695017	11.10	0.0017
CX 68	-101.46033685	37.30817522	2.25746293	7.40	0.0091
CX 78	-190.88070723	78.05218451	1.82553426	5.98	0.0182

All variables in the model are significant at the 0.1000 level.

Backward Elimination Procedure for Dependent Variable Type 6 (Unknown Historic Sites)

$R^2 = 0.530 \quad C = 10.888$

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	20	49.00318502	2.45015925	2.77	0.0019
Error	49	43.37685750	0.88524199		
Total	69	92.38004252			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	-555.65739111				
Class 2	0.11864025	0.04219906	6.99713988	7.90	0.0071
Class 3	0.25728528	0.05592283	18.73758490	21.17	0.0001
Class 7	-0.37250819	0.08821857	15.78387305	17.83	0.0001
Class 1X	617.96195020	155.07598694	14.05712052	15.88	0.0002
Class 5X	1647.30528741	356.46949673	18.90451085	21.36	0.0001
Class 7X	2573.22072050	546.75325406	19.60800155	22.15	0.0001
Class 23	-0.00007476	0.00002121	11.00291583	12.43	0.0009
Class 25	0.00016071	0.00004512	11.23223224	12.69	0.0008
Class 35	-0.00012960	0.00003035	16.14489127	18.24	0.0001
Class 46	-0.00016658	0.00004313	13.20736158	14.92	0.0003
Class 48	0.00009072	0.00001773	23.17816100	26.18	0.0001
Class 67	0.00011675	0.00002523	18.95940938	21.42	0.0001
CX 14	-162.42161208	44.43816640	11.82598646	13.36	0.0006
CX 15	-233.98532143	112.41070926	3.83551652	4.33	0.0426
CX 18	196.88393183	54.73439717	11.45412385	12.94	0.0007
CX 25	-726.22146324	159.40700795	18.37322298	20.76	0.0001
CX 28	281.09430036	103.94276738	6.47407214	7.31	0.0094
CX 36	-216.69441381	57.86490046	12.41443664	14.02	0.0005
CX 46	785.81907967	207.15071118	12.73896918	14.39	0.0004
CX 78	-253.81250158	118.83160337	4.03853742	4.56	0.0377

All variables in the model are significant at the 0.1000 level.

Backward Elimination Procedure for Dependent Variable Type 7
(Total Navajo Sites)

$R^2 = 0.574$ $C = 8.605$

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	18	971.47681912	53.97093440	3.81	0.0001
Error	51	721.66033308	14.15020261		
Total	69	1693.13715220			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	461.76461029				
Class 2	1.05928467	0.28896255	190.15375389	13.44	0.0006
Class 7	-1.01985574	0.27223597	198.58622903	14.03	0.0005
Class 1X	-893.13002432	195.87305798	294.19997377	20.79	0.0001
Class 23	-0.00008774	0.00002865	132.71529838	9.38	0.0035
Class 24	0.00025365	0.00008864	115.87375895	8.19	0.0061
Class 25	0.00080632	0.00027960	117.68349503	8.32	0.0057
Class 26	-0.00130869	0.00042823	132.15370416	9.34	0.0036
Class 28	-0.00087389	0.00022151	220.22509705	15.56	0.0002
Class 35	-0.00072859	0.00028982	89.42684688	6.32	0.0151
Class 36	0.00095407	0.00037371	92.22518235	6.52	0.0137
Class 48	-0.00010573	0.00002987	177.29262628	12.53	0.0009
Class 67	0.00033587	0.00015979	62.51895510	4.42	0.0405
Class 78	0.00077894	0.00020069	213.16474786	15.06	0.0003
CX 24	-1089.72854539	338.90942286	146.29585630	10.34	0.0023
CX 25	-2695.83694231	818.25132828	153.59478173	10.85	0.0018
CX 26	2678.27113923	1099.71833621	83.92837384	5.93	0.0184
CX 35	1861.38337715	806.57315004	75.36102544	5.33	0.0251
CX 36	-3203.27320652	1130.17682665	113.67313149	8.03	0.0066

All variables in the model are significant at the 0.1000 level.

Backward Elimination Procedure for Dependent Variable Type 8 (Total Sites)

$R^2 = 0.599$ C = 12.504

	DF	Sum of Squares	Mean Square	F	Prob >F
Regression	21	3476.67579847	165.55599040	3.41	0.0002
Error	48	2329.94804438	48.54058426		
Total	69	5806.62384285			

	B Value	Std Error	Type II SS	F	Prob >F
Intercept	995.28317029				
Class 2	1.53593917	0.65390988	267.80410386	5.52	0.0230
Class 3	-0.47146510	0.13207128	618.56782024	12.74	0.0008
Class 7	-0.98995395	0.57840201	142.19207622	2.93	0.0934
Class 1X	-1626.90489778	411.01836708	760.51340520	15.67	0.0002
Class 25	0.00236046	0.00061967	704.33639182	14.51	0.0004
Class 26	-0.00361926	0.00083175	919.09647104	18.93	0.0001
Class 28	-0.00185436	0.00041235	981.65481133	20.22	0.0001
Class 35	-0.00221899	0.00057869	713.70801544	14.70	0.0004
Class 36	-0.00270388	0.00077957	583.93671432	12.03	0.0011
Class 46	0.00026465	0.00013737	180.17577718	3.71	0.0600
Class 67	0.00080975	0.00039663	202.31780534	4.17	0.0467
Class 78	0.00157499	0.00036662	895.84998142	18.46	0.0001
CX 14	-1643.72329771	398.27300107	826.80041853	17.03	0.0001
CX 18	937.57892392	223.84208444	851.60301242	17.54	0.0001
CX 25	-8571.88367354	1877.92554555	1011.34841327	20.84	0.0001
CX 26	6392.91689561	2123.83145636	439.80789321	9.06	0.0042
CX 28	3031.58606544	1195.32828947	312.22696527	6.43	0.0145
CX 35	6799.82212067	1490.41856469	1010.37734631	20.82	0.0001
CX 36	-7581.37387359	2358.67465160	501.49285346	10.33	0.0023
CX 46	-683.99518052	352.50293951	182.76187162	3.77	0.0582
CS 78	-4147.71078223	1169.48236596	610.56875387	12.58	0.0009

All variables in the model are significant at the 0.1000 level.

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