Exploring The Early Navajo Pastoral Landscape: An Archaeological Study of (Peri)Colonial Navajo Pastoralism from the 18th to 21st Centuries AD

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The undersigned, appointed by the

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Exploring The Early Navajo Pastoral Landscape: An Archaeological Study of (Peri)Colonial Navajo Pastoralism from the 18th to 21st Centuries AD.

presented by James Wade Hadley Campbell

candidate for the degree of Doctor of Philosophy and hereby certify that it is worthy of acceptance.

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An Archaeological Study of
(Peri)Colonial Navajo Pastoralism from the 18th to 21st Centuries AD

A dissertation presented by
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to
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Abstract:

How did Indigenous communities negotiate the introduction of new animal species and associated economic practices in colonial contexts? Attempts to answer this question in the American Southwest have focused largely on the adoption of Old World animal domesticates by subjugated Native communities during the Spanish colonial period. At the same time, however, contemporaneous pastoral traditions also developed in unconquered Indigenous communities beyond the colonial frontier, spurring their own processes of "pericolonial" social change (Acabado et al. 2017). Although the non-coercive adoption of sheep and subsequent rise of intensive pastoralism among Diné (Navajo) groups on the edge of Spanish New Mexico in the seventeenth and eighteenth centuries represents a particularly notable example of this process, previous studies have overwhelmingly focused on the dynamic nature of Navajo herding during the later reservation era (AD 1868-present).

This dissertation presents the findings of the Early Navajo Pastoral Landscape Project (ENPLP), the first sustained archaeological investigation into incipient Navajo pastoralism during the Spanish colonial period. In keeping with traditional Diné attitudes that discourage the disturbance of archaeological sites, the ENPLP avoided excavation-dependent faunal analyses in favor of a minimally invasive, multi-scalar "pastoral landscape" approach consisting of a series of analyses designed to winnow out those early Navajo sites in Dinétah unlikely to possess the potential remains of corral or pen-type enclosures. Specifically, the ENPLP findings demonstrate that a low-impact methodology melding experiential ethnoarchaeology, geospatial modeling, and an assortment of archaeological field and lab techniques (including geochemical and microremains analyses) enables the evaluation of an array of questions regarding Navajo pastoral practices and their roles in Diné society throughout history. In particular, the ethnoarchaeological findings highlight potential connections between contemporary and historic Diné herding practices, while the microremains analysis shows that fecal spherulites are present in soil samples from later Gobernador Phase (AD 1625-1750) Diné sites, strengthening the argument that a landscape-based approach offers an effective tool for studying the long-term development of pericolonial pastoral traditions in the American Southwest.

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Acknowledgements

As a Diné man, I believe that working to develop and maintain relationships or, put another way, to build and reaffirm *k'é*, is central to any successful undertaking. This is especially the case for this dissertation, which has spanned nearly eight years of study, research, and writing. Considering the nature of my project, the current state of Navajo archaeology, and my tendency to draw folks into lengthy conversations, the web of personal and institutional ties that have made my work possible is a large and complex one. What follows is my best attempt to acknowledge and express my thanks for that support; however, if you're not listed below, I apologize for the oversight and look forward to our next chat.

At its heart, this project has always been a very personal and family-oriented endeavor. I am, first and foremost, immeasurably thankful to my parents, Wanda Hadley and Jim Campbell, for their love and encouragement over the years - you have been my greatest supports throughout the numerous ups and downs of grad school. You helped cultivate my interests in those questions of Diné history and culture that lie at the heart of my work, you have also been the best archaeological field crew a son could ask for, and I am forever grateful you chose to raise me in Diné Bikeyah.

Growing up, I was able to learn firsthand what it means to be Diné thanks in no small part to the teachings and care shown to me by my aunts, Regina Lynch, Velma Spencer, and Maxine Denetdeel (and Stanley and Melvin too). This process is a constant one and indeed, I have continued to learn through the generosity and patience of my aunt, Annie Remiro. Thank you for taking me along the same paths used by previous generations of our family and letting me wrestle with what it really means to "learn from herding." Ahéhee' shimáyázhí.

To my sister Andrea Waseta, thank you for helping ground me when it felt like things were flying out of control. I look forward to seeing more of you, Dwayne, and the kids now that the dissertation is complete. To my other siblings, cousins, nieces, and nephews, thank you for all the support, especially Sharon Singer, Alton Henderson, and Duane Denetdeel for sharing with me about those past summers they spent in Kits'iilí with our grandparents, Linda and Wade Hadley. Their legacies loom large over this project, and I hope that they would have been proud of this work.

I owe a similar debt to my relatives on my father's side of the family. I highly doubt I would have weathered a decade-plus on the east coast as well as I have without the support of my aunts, uncles, and cousins while in New Haven, D.C., and Cambridge.

Although Harvard is likely not the first place that comes to mind when one thinks of Navajo studies, I found a welcoming home in the Department of Anthropology. In particular, I have benefited greatly from the mentorship, advice, and trust shown to me by my advisor, Matthew Liebmann. His work with and for Jemez Pueblo has been a huge inspiration to me since Day 1 and I hope to continue down the path towards doing something similar for the Navajo Nation. Classes and discussions with other members of the Harvard faculty also helped to shape the trajectory of my dissertation research, including Rowan Flad, Christian Tryon, Diana Loren, Trish Capone, Carl Lamberg-Karlovsky, Bill Fash, and David Carrasco. Notably, conversations with my other committee members, Jason Ur and Richard Meadow, encouraged me to think more critically about pastoralism as a whole and turn fully towards the realm of pastoral landscape studies (which was a good move because I'm a mediocre zooarchaeologist).

My initial interests in the relationship between landscapes, pastoralism, and early Navajo archaeology began during my undergraduate years at Yale. I continually fall back on the foundation laid by Rod McIntosh, Bill Honeychurch, and Richard Burger. Their encouragement to experience the discipline in Peru, South Africa, and Mali cultivated a love for archaeology that hasn't diminished since and I count myself lucky to have met along the way folks like Doug Park, Pete Coutros, Carlos Chiriboga, Will Gardner, Jargalan Burentogtokh, Jason Nesbitt, Kristina Douglass, Annie and Xander Antonites, Evin Grody, Kirsty Escalante, and Kirsten Forsberg.

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- Ahéhee' -

This dissertation is dedicated to the memories of my grandparents,

Linda & Wade Hadley

and

Ruth & James Campbell,

as well as the memory of shicheii

Sampson Martinez

a hataałii and lawyer whose own educational journey
made his advice and prayers all the more impactful.
I miss talking with you.

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Chapter 1: Navajo Herding and Archaeology in the American Southwest

INTRODUCTION

How did indigenous communities negotiate the introduction of new animal species and associated economic practices in colonial contexts? Attempts to answer this question in the American Southwest have focused largely on the adoption of Old World animal domesticates by subjugated Native communities during the Spanish colonial period. At the same time, however, contemporaneous pastoral traditions also emerged among unconquered indigenous groups beyond the colonial frontier, spurring their own processes of "pericolonial" societal change (Acabado et al. 2017). The non-coerced adoption of sheep and subsequent pastoral trajectory of early Navajo groups on the edge of Spanish New Mexico contrasts sharply with the missionized origins of Pueblo herding traditions in the seventeenth and eighteenth centuries; however, previous pastoral studies have overwhelmingly focused on the dynamic nature of Navajo herding during the later reservation era (AD 1868-present) (e.g., Bailey 1980; Boyer 1983; Downs 1964; Weisiger 2009). This dissertation seeks to address this gap by investigating the impacts of incipient pastoralism on the community structure of pericolonial Navajo communities in the Dinétah region during the pre-reservation period.

THE EARLY NAVAJO PASTORAL LANDSCAPE PROJECT: PROJECT OVERVIEW & RESEARCH QUESTIONS

Navajo groups in the Dinétah region of northwest New Mexico (Figure 1) experienced a number of social and cultural shifts following the Spanish colonization of the Rio Grande Valley

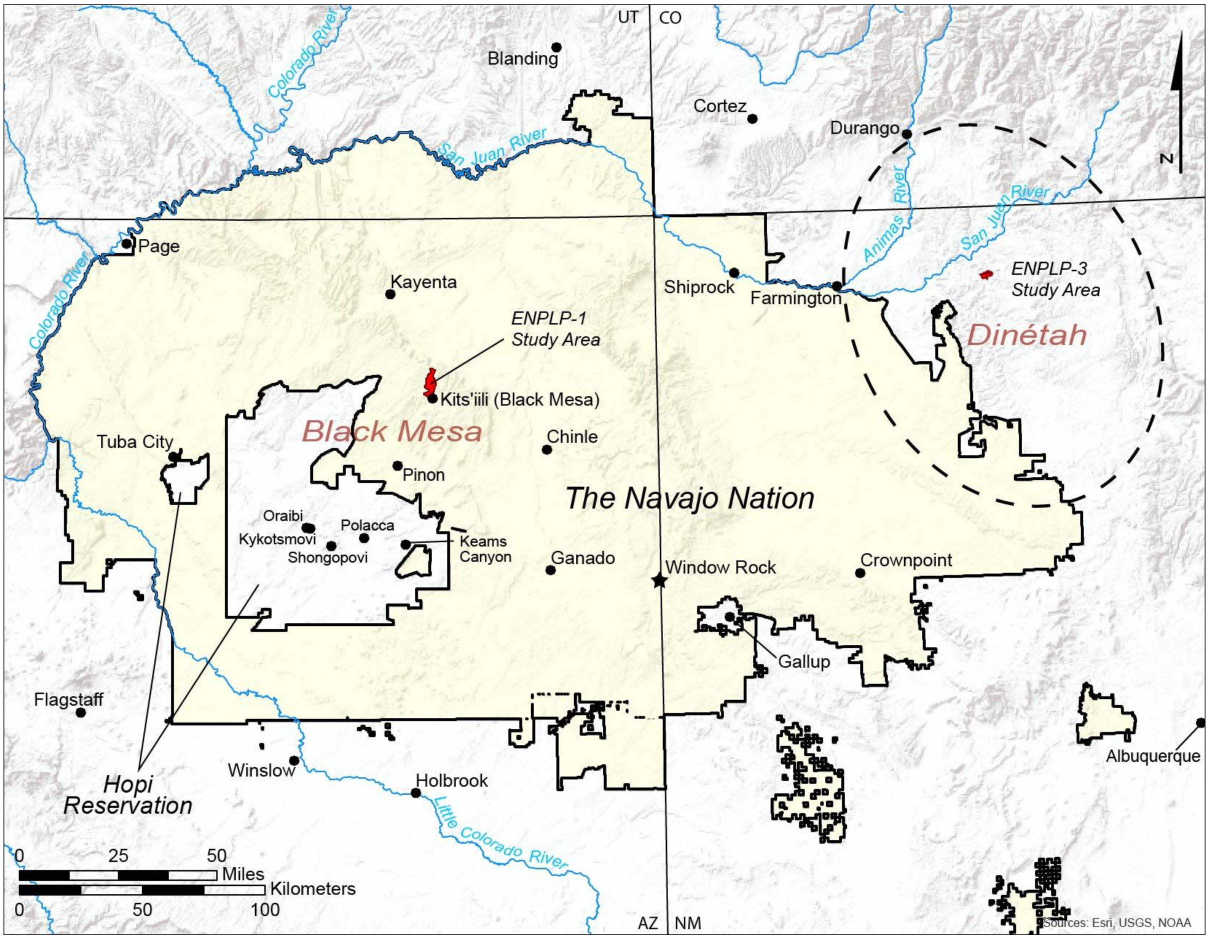

Figure 1 - Overview of the Four Corners region showing the boundaries of the Navajo Nation, Dinétah, and key project areas.

in 1598, including increased population, greater technological diversity, the construction of more than 150 masonry fortresses (*pueblitos*), and the extensive settlement of regions outside Dinétah. Intriguingly, some have suggested these Gobernador Phase (c. AD 1626-1750) shifts might reflect a form of early Navajo community development whose organizational structure mirrors the four-tiered social and settlement system of household, residence group, outfit, and local community documented among Navajo pastoralists during the late nineteenth and twentieth century reservation period.

Despite the social, economic, and historical importance of sheepherding to Diné society, the advent of the Diné pastoral tradition during the Spanish colonial period and the nature of early herding practices have rarely been explored by Southwestern archaeologists. Specifically, zooarchaeological efforts to connect the scanty domesticate faunal remains found at early Navajo sites to these societal shifts have been stymied by difficulties related to the shifting research foci of previous projects and quirks in the preservation of the archaeological record itself. Although Spanish accounts indicate that Navajo people began herding sheep prior to AD 1700, the question of when the pastoral shift occurred, the tempo of this shift, and how it relates to later developments in Navajo society visible in the Gobernador Phase archaeological record remains poorly understood.

At least one example of early Navajo corral/pen infrastructure exists in the Frances Mesa/Gobernador Canyon region of Dinétah (Hovezak 2004), while a small sample of sites possessing potential pastoral site status indicators (i.e., small domestic faunal assemblages or possible corral/pen features) are located nearby (Dykeman 2003a; Wilshusen et al. 2000). With these factors in mind, I developed a minimally invasive, multi-phase project designed to identify low-visibility corral features at Gobernador Phase Navajo sites in Dinétah. Grounded in an interpretive framework developed through the participant-observation of modern Diné sheepherding practices and their archaeological manifestations, this "pastoral landscape" approach sought to determine the spatial and material indices of early Navajo pastoral sites in the Frances Mesa/Gobernador Canyon region at multiple analytical scales. More specifically, this dissertation asks whether a novel methodological approach combining a sequence of ethnoarchaeological fieldwork, GIS-based geospatial analyses, and a focused archaeological fieldwork campaign consisting of four main activities – systematic site survey, soil sampling, soil phosphorus analysis, and dung spherulite analysis – are capable of identifying the remains of corral/pen-type pastoral infrastructure at early Navajo sites.

If the approach was successful, I wanted to use the spatial and material correlates of any potential pastoral sites to assess the following two socioeconomic factors. First, if the distribution of pastoral sites could be determined at a regional scale, what might be the extent, intensity, and type of herding strategies employed by early Navajo groups in Dinétah? Second, if the distribution of pastoral sites could be determined at a local inter-site scale, what evidence is there for social differentiation in Gobernador Phase Navajo society based on preferential access to livestock and other types of material culture? Finally, given the importance of livestock in contemporary Diné society, are there any readily apparent associations between potential pastoral practices in the Gobernador Phase and today? Answers to these and other questions will help to shed light on the mechanisms through which early Navajo groups successfully negotiated the entry of Old World domesticates and their attendant social and landscape impacts while remaining free from Spanish hegemony, lessons that hold relevance for studies of pastoralism and (peri)colonial interactions beyond the early Navajo case.

WHY ARCHAEOLOGY MATTERS: THE CONSTRUCTION OF "MAINSTREAM" EARLY NAVAJO HISTORY & CULTURE IN THE SOUTHWEST

> *"In sum, [when thinking of the Navajo] we must think of a comparatively simple culture being enriched during the prehistoric period by contact with other tribes, especially the Pueblo Indians. Furthermore, there must have been a whole series of gradual adaptations and adjustments to the physical environment of those portions of what is now New Mexico (and perhaps Arizona) to which the intruders came from the country further north."*
>
> (Kluckhohn and Leighton 1962 [1946]:35)

The beginnings of Navajo archaeology date to the first decades of the twentieth century when pioneering Southwestern archaeologists like Alfred Kidder and Earl Morris examined the remains of "pueblito" fortress sites found throughout the Dinétah region of northwestern New Mexico (Carlson 1965; Kidder 1913). Following an Ánaasází[1] or Pueblo-based classificatory scheme of Southwestern culture history, Kidder (1920a) interpreted these sites not as Navajo creations but as the work of Pueblo rebels fleeing the Spanish "reconquest" of the Rio Grande Valley in 1696, a view commonly known as the "Refugee Hypothesis." Subsequent generations of archaeologists built on Kidder's work and expanded the influence of his hypothesis by combining the underlying acculturative assumptions with the results of early archeo-linguistic models that suggested speakers of Southern Athapaskan languages (i.e., Navajos and Apaches) arrived in the late sixteenth or seventeenth centuries (e.g., Keur 1944; Hester 1962; Wilcox 1981; cf. Seymour 2012; Lekson 2018). As the above quote demonstrates, the stage was set for a general attitude in Southwestern studies that viewed Navajos as relative newcomers to the Pueblo Southwest and any major historical developments in Navajo society as the result of unidirectional transferals from outside cultural influences (e.g., from Pueblos, Spaniards, Mexicans, or Americans), rather than from processes within the Navajo community itself (Faris 2006; Thompson and Towner 2017).

Navajo archaeological research continued to grow throughout the post-World War II period and programs like the Navajo Reservoir Project and the Navajo Land Claim surveys began generating the first sets of Navajo archaeological typologies and data-driven chronologies (Dittert et al. 1961; Eddy 1966). These projects laid the foundations for a number of large

[1] This work follows the Navajo Nation Heritage and Historic Preservation Department's guidelines in using the term "Ánaasází" when referring to the ancestral populations of the Four Corners region. For in-depth statements concerning the term and its connections with Navajo people, see Walters and Rogers 2001; Warburton and Begay 2005, and Thompson and Towner 2017.

contract archaeology projects in Dinétah during the 1990s whose findings empowered a series of theoretical and methodological challenges that upended the spatiotemporal bases of the earlier acculturative framework (e.g., Brugge 2012; Dykeman and Roebuck 2012; Towner 1996; 2003); however, the old narrative and its underlying attitudes proved hard to shift. As Towner and Dean (1996:7) note, this can be linked to a number of factors including Southwestern archaeology's overwhelming focus on Ánaasází/Pueblo topics, the sporadic nature of Navajo archaeological research outside the Dinétah region, and the influence of legal and contract concerns that limit certain lines of research and the dissemination of grey literature data.

These combined factors have meant that many of the Navajo history texts from the last half-century have inevitably (and through no real fault of their own) continued discussions that rely on outmoded archaeological data that does not fully engage with the complex reality of early Navajo life before the advent of the reservation system in AD 1868 (although see Iverson 2002 and Kelley and Francis 2019 for examples of more recent works that have successfully confronted this challenge to large degree). One of the challenges for contemporary Navajo archaeological research then is to confront and overcome this interpretive time-lag because, as countless discussions have highlighted, the field plays an integral role in affirming links between modern tribal nations and their ancestral communities in a manner that has implications across a wide range of sectors from language and culture preservation to legal wranglings within the modern Western political system (e.g., Atalay 2006:301; Hays-Gilpin 2021; Liebmann 2017; 2018). Indeed, archaeological research programs (or their lack) that attempt to occlude improved understandings of the complexity of past indigenous societies serve to deny the historicity of tribal nations today and perpetuate a colonial legacy that is best left behind (Campbell et al. 2021:254).

THE PRACTICE OF INDIGENOUS ARCHAEOLOGY AND ENVISIONING A DINÉ ARCHAEOLOGY FOR THE 21ST CENTURY

> *"We have become good informants for reconstructing the language, spirituality, and cultural practices* [sic]*, but our views are not treated as equal to those of archaeologists when it comes to reconstructing our history. The information given by current Maya sources is selected and appropriated to fit the image and interpretation that archaeologists want to create, rather than considering Maya interpretation of past history as truthful and a suitable basis for further study."*
> (Cojti Ren 2006:13)

The relationship between archaeologists and indigenous peoples across the globe has long been haunted by the discipline's colonial origins and the unequal wielding of power in the pursuit of particular categories of historical and cultural knowledge held by or relating to indigenous communities. Over the past three decades, indigenous peoples have increasingly pushed back against this history by embarking on mission to "decolonize" archaeology by making it a practice done "with, for, and by" Indigenous people (Atalay 2006; Colwell-Chanthaphonh et al. 2010; Colwell 2016; Nicholas 2008). Although there remains a valid sense of uncertainty as to just how "decolonizing" an archaeological project conducted along these lines can truly be if the greater epistemological frameworks that govern Western society remain in place (Schneider and Hayes 2020), numerous researchers have worked to center Indigenous participation and viewpoints in all stages of the research process from initial planning and fieldwork to the final interpretation and dissemination of results.

A review of recent Indigenous archaeology projects in North America highlights several key trends in this movement including, first and foremost, an increase in collaborative archaeological research programs directed by Indigenous individuals and non-Indigenous allies alike that center Indigenous bodies of knowledge as a principal interpretive lens (e.g., Aguilar

2019; Gonzalez 2016; Kretzler 2019; Laluk 2015; R. Lee 2014; Liebmann 2012a; Montgomery 2015; Thompson 2009). Indeed, as Welch (2020:31) notes, the ongoing generational (and ethical) shift within the field has led to a blurring of the lines between Indigenous and non-Indigenous archaeologies such that true collaboration and partnership between researchers and diverse owner/descendant/ stakeholder communities, Indigenous or otherwise, are arguably becoming the norm. Perhaps most fascinating, this process has begun to lead to situations where researchers have chosen to give up some degree of control in accordance with the specific traditional policies of different Indigenous communities, eschewing access to certain sites and minimizing or even forgoing entirely the use of destructive or invasive research methods like excavation (Liebmann 2018; Gonzalez 2016; Nicholas 2008:1666–1668). The result in most cases? Projects have innovated, pushing both the technological and theoretical boundaries of the field forward and gathering diverse sets of data that can be applied to a variety of questions old and new.

Within the context of Navajo-focused archaeological research, a greater appreciation of Diné oral histories and the increased activity of tribal archaeologists have increasingly enabled researchers to break from Navajo archaeology's old acculturative foundations and engage with the diachronic complexity of Diné society and culture in multiple new ways. One diverse avenue of research focuses on critical discussions of Navajo ethnogenesis (Begay 2004; Dykeman and Roebuck 2012a; Preucel 2011; Warburton and Begay 2005; Wilshusen 2010), including a novel alternative hypothesis for Navajo origins that suggests Diné culture is an autochthonous Southwestern cultural development comprising elements of early Archaic-type Southwestern hunter-gatherer populations in addition to Southwestern villager and Athapaskan-speaking migrant populations (Brugge 2012; Campbell et al. 2021:256–257; Thompson and Towner 2017).

Another avenue of research considers the "historical archaeology" of the reservation period in greater detail, asking what a blend of archaeological, historical, and ethnographic research methods can say about U.S. colonialism's ongoing impacts on Diné society and links between contemporary and historic moments on the Navajo Nation (Campbell 2021; Kelley and Francis 2019a; R. Lee 2021; Two Bears 2021; Wero and Martin 2021). Elsewhere in the Four Corners, projects continue to explore the nature of seventeenth and eighteenth regional dynamics between the Spanish, Pueblos, Utes, and the early Navajo communities of Dinétah (Becenti 2019; Sinkey 2004; Towner 2016a; Wilcox 2019), although there remains much to examine, including Spanish missionization attempts in the Mt. Taylor region, shifts in Diné foodways, and the history of Navajo settlement beyond Dinétah.

Perhaps most importantly, over the past decade Diné and Anglo scholars alike have begun to reference fundamental Diné ontological and epistemological concepts when interpreting certain aspects of the Diné archaeological record. Specifically, these studies reference the ways in which the structures of *k'é* and *dóone'é* organize the Diné kinship system and how the overarching moral teachings inherent in the Blessing Way ceremonial system manifest in certain expressions of Navajo material culture, including architecture (Brugge 2012; Dykeman and Roebuck 2012; Thompson 2009); these concepts are discussed further in Chapter 3. In the Navajo case, this type of thinking is tied in part to a decades-old history of using traditional Diné concepts to structure educational practices on the Navajo Nation (e.g., Nez 2018; Singer 2020) and is part of a growing movement in Indigenous archaeology that centers culturally specific

Indigenous ways of knowing[2] as rigorous and valid tools for a range of theoretical and analytical endeavors.

On the Navajo Nation today, even though archaeology has enabled the development of infrastructure and economic opportunities across the reservation and assisted the Navajo Nation's sovereign legal claims, many groups view the practice of archaeology with distrust (Begay 1997; Thompson 2011; Thompson and Marek-Martinez 2021; Two Bears 2006). For the better part of a century, Southwestern archaeologists engaged in the same sort of history-making process Cojti Ren (2006) describes in the Maya world, treating Diné individuals as less than full partners in the interpretation and recreation of a Navajo past that did not fully engage with the more than five centuries of Diné presence in the American Southwest. The continued development of a uniquely Diné form of Indigenous archaeology that centers the interests, thoughts, and actions of the Navajo community will increasingly contribute a unique long-term viewpoint on issues of society and culture that will help to ensure the continuation of Diné society and culture in the twenty-first century (Atalay 2006:301; Campbell et al. 2021).

DISSERTATION OUTLINE

The following dissertation consists of six chapters beyond this initial Introduction to the Early Navajo Pastoral Landscape Project's main goals and the shifting ethical and theoretical environments that make up Diné archaeology in the American Southwest. Chapter 2 explores the archaeological study of colonialism with the goal of illustrating how the concept of pericolonialism is particularly well-suited to analyzing the mechanisms that permitted certain Indigenous groups to interact with colonizer populations on relatively equal footing. This is

[2] Examples of different concepts harnessed by archaeologists worldwide include: the concepts of place, *gózhó*, and avoidance in Western Apache culture (Laluk 2017; 2021); Place-Thought or *manitou* in the Great Lakes region (Howey and Brouwer Burg 2021); and Maori *whakapapa* in New Zealand (Marshall 2021).

supplemented by a breakdown of how pastoral practices could have helped more mobile Indigenous communities to maintain this balance and the ways in which an archaeological landscape approach is particularly well-suited to studies of mobile lifeways like pastoralism.

Chapter 3 presents an up-to-date summary of key aspects of Navajo history and culture intended to better contextualize the data and arguments relating to the three ENPLP project phases. The historical overview combines ethnographic, archaeological, and textual sources and covers a span of more than six centuries from the hazy origins of the Diné in the Southwest through to the twenty-first century Navajo Nation. The second half of the chapter examines how the Diné moral and philosophical concept of *Sa'ah Naagháí Bik'eh Hózhóón* connects to traditional Diné understandings of kinship (*k'é* and *dóone'é*) and how those sets of relationships in turn structure the traditional four-tiered system of Navajo social organization and land tenure seen throughout the reservation period and before.

Chapters 4 and 5 introduce the ENPLP's first and second phases of research, which revolved around of six months of sheepherding in Black Mesa Chapter, Navajo Nation. Drawing on the ethnographic observations initially made while herding and then updated through a small-scale archaeological survey of the reservation-era herding sites in the Phase 1 study area, I created a GIS-based predictive model for Navajo pastoral land use that was generalized and applied to the Frances Mesa/Gobernador Canyon region of Dinétah in order to generate the study parameters for Phase 3.

The third phase of the ENPLP is detailed in Chapter 6 of the dissertation. An overview of previous zooarchaeological and landscape-based evidence for colonial-era Navajo pastoralism in Dinétah is presented first. Next, the methodological details of the multi-step fieldwork campaign are presented along with an overview of the Phase 3 study area. Finally, the findings from surveys and soil phosphorus analyses are summarized and linked to the fecal spherulite analysis, which provides evidence for probable pastoral activities at three Gobernador Phase (c. AD 1626-1750) Navajo pastoral sites in the ENPLP Phase 3 study sample.

Chapter 7 draws upon the data presented in the two preceding chapters to discuss a series of archaeological, historical, and other thematic trends relating to Navajo pastoralism during the reservation period (ENPLP Phase 1) and the Gobernador Phase (ENPLP Phase 3). The Phase 1 discussion explores various aspects of nineteenth and twentieth century Navajo life on Black Mesa, including the 1918 influenza pandemic, the painful history of Diné-Hopi interactions, and the shifting pastoral land use strategies employed in response to more than a century of political and economic trends on the Navajo Reservation. The Phase 3 section evaluates the effectiveness of the project's "pastoral landscape" methodology, the first application of this type of approach in the Southwest, and discusses how the small sample of likely Gobernador Phase pastoral sites identified through the pastoral landscape approach allows for the start of a series of fascinating discussions about potential early Navajo economic and social considerations circa AD 1750.

Chapter 8 concludes by offering a pair of reflections. The first evaluates the effectiveness of the "pastoral landscape" approach and identifies those areas that seem to have worked well alongside a discussion of ways in which the methodology could be improved. The second reflection considers the continued prominence of sheepherding in contemporary Diné culture even as historical events have lessened its economic impact.

Chapter 2: Theorizing an Archaeology of Early Navajo Pastoralism in the (Peri)Colonial Southwest

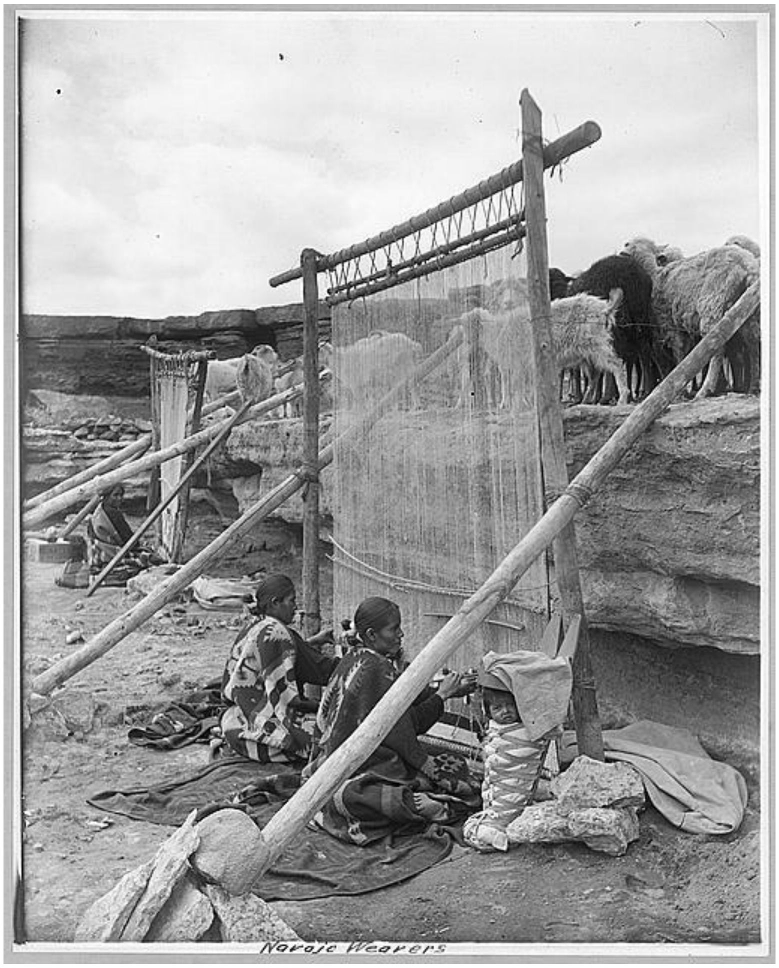

Figure 2 - Navajo Weavers (Pennington and Rowland 1914)

INTRODUCTION: THINKING ABOUT SHEEP IN NAVAJO COUNTRY

Working in the Southwest, one is eventually bound to come across classic photographic depictions of Navajos working with sheep, whether it be on postcards, book covers, or online. In one image recently immortalized on the cover of Marsha Weisiger's 2009 book *Dreaming of Sheep in Navajo Country,* a Navajo woman wrapped in a blanket watches over a mixed herd of churro sheep and goats grazing across a juniper-dotted plain. In another (Figure 2), a group of Navajo weavers pull wool through a pair of looms, rugs taking shape as a small flock of recently shorn churros look on. Despite being taken a little over a century ago, the sepia tints of these images lend a timeless quality to these scenes and the practices they depict.

History and nature, however, present a check to the Navajo pastoral tradition's seeming antiquity. Although popular conceptions of "traditional" Native American culture in North America revolve around images of Navajo herders weaving chief's blankets or mounted Lakota warriors sweeping across the prairie, the animals present in these scenes were originally domesticated millennia ago across Asia, Africa, and Europe. And while the movement of these "Old World" animals to the Americas can be clearly traced back to the European colonial projects of the fifteenth through twentieth centuries, understanding how livestock animals subsequently became key components of many indigenous cultures across the Western Hemisphere is a more complicated endeavor. When did communities gain access to sheep, goats, horses, and cattle in the first place and why? How did Native groups confront the challenges associated with developing (and transmitting) the new animal husbandry knowledge needed to maintain alien livestock? And once established, how intensive were these practices and what impacts did they have on existing social and natural environments?

In the American Southwest, the varied and complicated answers associated with these questions highlight both the danger of sweeping statements and the potential value of focused archaeohistorical investigation. The founding of *Nuevo México* by Juan de Oñate in 1598 introduced the first permanent population of Old World domesticates into the region. Within the colony, livestock were cared for by the Spanish colonists as well as by subjugated Pueblo Indians incorporated into the semi-feudal structure of the Catholic mission system. In the absence of alternative sources of wealth, pastoralism grew to become the traditional heart of the New Mexican economy from the seventeenth through to the twentieth century (Barrett 2012; Trigg

2005), weathering a variety of social and natural challenges along the way, including the Pueblo Revolt of 1680 and the Drought of 1748 (Liebmann 2012a; Towner 2008).

The success of the New Mexican colonial project allowed a European settler colonial presence to take root in the Southwest. Spanish goods and know-how did not stay locked within the confines of the missions and haciendas for long, however, as trading and raiding with Native peoples meant that the destabilizing influence of these new technologies soon spread far beyond the Rio Grande valley. In the most well-known example of this process, the arrival of horses to the Great Plains radically restructured previously hunting and farming-focused communities and spurred the development of new equestrian societies (Bethke 2016; 2017; Blackhawk 2007; Hämäläinen 2008). As detailed in Chapter 6, a relatively scant collection of archaeological and historical evidence indicate that by AD 1700, a similarly non-coerced form of sheep-based pastoralism had taken root among Navajo families in the rugged uplands of the San Juan River drainage, beyond the edge of New Mexico's poorly defined northwestern frontier. Navajo people as a whole avoided the imposition of Euro-American colonial controls until the nineteenth century, a freedom that can be tied to internal sociopolitical developments linked with the increasing importance of a pastoral lifeway. When compared to the missionized beginnings of Pueblo Indian herding practices or the inherited knowledge of Hispano settlers, the history, impacts, and legacy of early Navajo herding practices stand out as a unique form of indigenous Diné innovation in the Southwest.

Translating this realization to a course of anthropological archaeological research, however, demands interpretive frameworks capable of considering incipient Navajo pastoralism as more than simply a collection of isolated archaeohistorical moments. The following chapter describes the main theoretical influences guiding the methodological approach adopted by the

Early Navajo Pastoral Landscape Project and sets the stage for an analysis of the relative importance of sheepherding and its potential impacts to existing social and economic relationships within early Navajo communities circa AD 1700-1750.

HIGHLIGHTING INDIGENOUS RESISTANCE & INNOVATION BEYOND COLONIALISM

Colonialism

The spread of European influence and global power that began in the late fifteenth century AD represents the start of a key period in world history whose legacy is closely felt some five centuries later. The sustained contact between continents restructured the centuries-old Eurasian political order and spurred the rise of new Western European imperial states whose standing and sway depended heavily upon resources and labor extracted through networks of far-flung colonies in foreign lands. Over a comparatively short period, these colonial projects drew the Indigenous peoples of Africa, Asia, Oceania, and the Americas into newly developing systems of social, political, and economic exchange that were defined by resilient traditions as much as new introductions and radical change (Stein 2005a; Silliman 2005a). Although the complex history and broad scope of colonialism make it a challenging topic to define overall, generations of archaeologists have sought to couple the field's uniquely material-driven approach to the past with a wide array of theoretical approaches in an attempt to better understand how the structures and practices of colonialism affected communities worldwide (Gosden 2004; Lightfoot 1995). And even as the focal point of archaeology's engagement with colonialism has swung from the colonizer to the colonized to somewhere in between, one common consideration of these studies stands out as key, namely, the role and exercise of power in colonial contexts.

In particular, archaeologists have grappled with the connection between colonialism and power in two general ways, both of which take the looming figure of historic/modern Western European colonialism as their principal point of reference. The first of these is a comparative approach that specifically attempts to distance itself from the European colonial project, arguing that the legacy of domineering practices like transcontinental chattel slavery, Indigenous land dispossession, and the development of racialized social hierarchies present unique “intellectual baggage” that blinds researchers to other forms of “colonial” power relations that may have existed in the past (Gosden 2004:24-40; Stein 2005:24-27). Instead, these comparative studies of colonialism focus on evaluating different examples of “interregional encounters” between groups in a variety of past contexts from the pre-Hispanic Americas to the ancient Near East in order to understand the contextually specific social and cultural processes that structured the subsequent interactions (Given 2004; Stein 2005b). In many earlier cases, groups expanded out from their homelands into new areas for a variety of reasons in order to win and exercise forms of power associated with particular objects, ideas, or needs, although due to general regional similarities between cultures prior to globalization, interactions rarely reached the extreme scale of inequality and exploitation seen in more modern examples (Gosden 2004:41-81).

Following the work of Michael Dietler (2005:54), colonialism as a broader comparative concept can be constructively understood as “the projects and practices of control marshalled in interactions between societies linked in asymmetrical relations of power, and the processes of social and cultural transformation resulting from those practices.” This framing acknowledges that archetypal events like armed conquest and colonization (i.e., the act of establishing settlements in foreign territories) are not the sole means of generating power and control in colonial contexts. These more direct actions exist alongside a variety of shorter term or physically constrained practices (e.g., trading, raiding, missionization, education, etc.) whose influence can be just as significant (Dietler 2005: 52-55). The multifaceted nature of power in this framework also helps draw attention to the fact that although there is a degree of inequality inherent in colonial settings, the colonizing population is not intrinsically superior to other groups. Rather, each community within the colonial milieu is drawn into mutually constitutive relationships that are guided by older traditions and viewpoints as well as new ideas and material circumstances. This leads to the development of new forms of identity and societal expression as different parties attempt to successfully negotiate colonialism's shifting sociopolitical frameworks (Stein 2005a:16–17; Silliman 2005b:65–68).

The second archaeological approach towards the topic of colonialism and power is one that directly acknowledges Western Europe's colonization of the globe between circa AD 1500 and 1960 and views the pervasive legacy of this widespread historical phenomenon as a "total social fact" in need of critical analysis (Gosden 2004:24). The field has arrived at this point following a long and complicated history that in many cases saw archaeological research in Asia, Africa, Oceania, and the Americas serve as a reinforcing tool for the greater Western colonial project (Trigger 2003:74–86). Indeed, only in recent decades has it become common for researchers to conduct studies (including the comparative anthropological approaches described above) that break with this tradition and seek to understand how diverse communities, both Indigenous and otherwise, managed their involvement with aspects of the greater European colonial project in different regions and at different times (Gosden 2004:7–23; Liebmann 2008b; Lydon and Rizvi 2010).

A closer look at the history of archaeology's engagement with European colonialism in

North America can help to highlight key trends that remain relevant in the field today. The archaeology of colonization was closely tied to the development of historical archaeology and studies of colonialism's broader impacts in the modern period continue to guide the sub-discipline today (Deetz 1996; Orser 2010). Notably, the artifacts and architectural remains found at early European missions, trading outposts, and settlements throughout the first half of the twentieth century provided early North American archaeologists with readily grasped "historical" touchstones upon which to base their analyses and interpretations of those sites (e.g., Cotter and Jelks 1957; Montgomery et al. 1949). Such work (and its relevance to a particular Eurocentric understanding of history) stood apart from those archaeological investigations that dealt with "prehistoric" Native American material culture (Cotter 1993; Hume 1964).

If Native American archaeological sites *did* attest to colonial period connections with Europeans, such evidence tended to be interpreted based on the concepts of "culture contact" and "acculturation." Reflecting perhaps the exploratory connotations of early sixteenth century European colonization and "first contact," the use of contact language to refer to colonial period encounters is problematic. As Silliman (2005b) notes, "culture contact" casts Euro-indigenous interactions as being of short duration and somehow separate from longer-term "colonial" processes where coercive power and restrictive governmental frameworks structured inter-group relationships, rather than being the beginning or a distillation of these actions. Further, the uncritical use of contact language also suggests that the factors influencing the distinction between "culture contact" and "colonialism" can be broken down and understood in a manner akin to the archaeological models of acculturation developed and deployed during mid-1900s.

The model put forward by Quimby and Spoehr (1951) is perhaps the best illustration of this acculturative approach. Their model used changes in the frequency of different categories of

Western material culture at Native sites as a relative measure for the degree of European cultural replacement in Indigenous communities. Such models granted little agency to the Indigenous communities caught up in these relationships and uncritically equated changes in material culture usage with changes to social identity or societal interaction (Cheek 1974; Quimby 1966; cf. Cusick 1998:135–136). In hindsight, these early acculturation studies were particularly pernicious, as the one-way nature of the analysis left little room for non-dichotomous conceptualizations of Indigeneity. This legacy can arguably be felt in contemporary discussions that engage with the effects of earlier historical designations on determinations of indigenous identity (e.g., the legal processes related to tribal recognition in the eastern United States [Bloch 2020; Sebastian Dring et al. 2019]), or tensions between traditionalism and modernity in contemporary Indigenous economic activities (e.g., Cipolla 2013).

The movement away from "assumptions about the assimilation and extinction of native cultures, and about the relations of power and dominance these imply in colonial contexts" began to take place in the 1970s (Rubertone 2000:429). The development and popularization of Immanuel Wallerstein's (1974) world-systems framework spurred academics of all stripes – including archaeologists – to grapple with the explicitly capitalistic nature of modern European colonialism and the roles and relationships within (and between) the extractive colonial core and the colonized periphery (Champion 1995). As Lightfoot (2015:9218) notes, although the approach's emphasis on labor-based hierarchies often reinforced existing knowledge about the structures and organizations that exercised European colonial power (e.g., religious missions, trading outposts, or settler colonies), the movement away from essentialized notions of cultural superiority towards more wonky analyses of political and economic concerns also served to highlight those instances where European dominance was incomplete and resistance, mixture, and negotiation held sway.

This shift in the perception of Indigenous peoples in the Americas and elsewhere "active agents" in their own right rather than simply being Western Europe's "passive periphery" (Stein 2002) picked up steam throughout the 1980s. Conversations and archaeological research surrounding the Columbian Quincentennial in 1992 marked a particularly significant moment in this process (Thomas 1992). The influence of postcolonial thought led to increasing awareness and more thoughtful considerations of issues that had previously been obscured by the "colonizer-colonized" dichotomy (Jordan 2009). Greater critical attention began to be paid not only to Indigenous experiences, but also to the diverse interactions between colonial-period communities more broadly, including the painful history of African slavery throughout the Americas (e.g., Orser and Funari 2001; Singleton 1985; 1990; 1995) and the internal dynamics within "European" populations themselves (e.g., Lightfoot 2005; Loren 2000; Montón-Subías et al. 2016; Orser 2019; Voss 2008).

This awareness of broader and more profound forms of interconnection continues to define the archaeological study of colonialism today. Although research at early European colonial settlements, industrial centers, and religious outposts remains robust, the Eurocentric narratives of conquest and progress that traditionally framed this work have been replaced by theoretical frameworks that emphasize an array of social, economic, and political questions. Charting the general developmental trend within the realm of religious and mission-focused archaeology offers one example this process. While early scholars predominantly focused on relocating, recording, and restoring a handful of Spanish Catholic missions in the southwestern United States (Ivey and Thomas 2005), new mindsets and technologies have enabled researchers to engage with sites and materials across the globe whose findings complicate the hierarchical structures traditionally associated with mission systems. Notably, researchers have highlighted the complex demographics and labor relations of missionized indigenous communities (Silliman 2001; Panich et al. 2014), the persistence of pre-European social and political ties in both the southeastern and southwestern United States (Blair and Thomas 2014; Boyer III 2014; Stack 2017), as well as the adoption and innovation of new technologies by indigenous craftspeople within mission systems (e.g., metallurgy (Thomas 2018; Vaughan 2017)). The widened scope of work has also encouraged more in-depth analyses of other types of colonial-period religious institutions more broadly. Examples include the slave-operated plantations and workshops run by Catholic religious orders across Latin America (Lenik 2011; Weaver 2021) and the various Protestant mission projects operated by different denominations across Africa (Ashley 2018; King 2018; Klatzow 2018; Swanepoel 2018), Oceania (Flexner 2014; Lydon and Ash 2010; Middleton 2008), and the Americas (Lenik and Heindl 2014).

Expanded studies of "classic" colonial settings like those described above have helped draw archaeologists' attention towards the greater recognition of (and subsequent engagement with) the fact that any given colonial "encounter" was a long term process that saw the intricate exchanges of persons, objects, and ideas result in new societal and cultural outcomes (Jordan 2009; Lightfoot 1995; Silliman 2005). In particular, studies have shown that beyond simply engaging in armed resistance to colonizing entities, local groups responded in a variety of ways that emphasized the agentive power of both individual persons and larger communities. Example responses include the adoption of introduced technologies and cultural practices, attempts to return to or maintain older precolonial social frameworks, or the melding of both these types of influences into innovative new creations (e.g., Liebmann 2008a; Norman 2019).

This final topic, cultural mixture, lies at the heart of studies that analyze different forms of "composite" material culture in an attempt to think through the nature of colonial-era social relationships (e.g., studies in Card 2013; and van Pelt 2013). In addition to the acculturation approach described earlier, a diverse array of theoretical frameworks including creolization, syncretism, bricolage, hybridity, and entanglement have been harnessed in the service of this goal over the years. Of these studies, hybridity and hybridization have been particularly attractive to researchers working in colonial contexts due in part to the concept's ability to highlight the wider cultural and power dialectics bound up in the creation of composite cultural phenomena (Liebmann 2015). Although the applicability and interpretive effectiveness of all these approaches have been roundly critiqued (e.g., Liebmann 2013; Silliman 2015; VanValkenburgh 2013), at their core, these concepts all engage with the fact that "mixed" forms of material culture represent unique expressions of social identity and individual choice in colonial contexts and that their analysis can shed light on finer-grained negotiations of power within these settings. In this regard, flexible approaches like hybridity arguably remain useful heuristics for studying European colonialism and highlighting areas where finer-grained analyses can tease out the processes through which power was exercised within these settings (e.g., Masson et al. 2021; VanValkenburgh et al. 2017; Cain 2020).

Archaeologists have also begun to shift their attention away from early colonial period topics towards more critical examinations of Western colonialism's more recent history. Although most European colonial holdings achieved political independence during the mid to late twentieth century, several Western countries still maintain "external" territorial holdings, including the United Kingdom, France, and the United States. In communities on both sides of the colonial "divide," colonialism and its effects, both positive and negative, are relatively recent. As a result, the resulting discussions remain deeply felt in ways that extend beyond simple reflections on the historical legacy of older colonial actions (e.g., Gomes Coelho 2019). Archaeologists concerned with more recent colonial phenomena frequently engage with collaborators whose personal experiences and cultural knowledge offer profound insights on the relationships between colonial practices, their impacts, and the material record.

In this work, the role of power in recent political relationships emerges as a key concern, especially in contexts where "settler colonial" policies of territorial dispossession, resource extraction, and demographic replacement serve to erase Indigenous communities (Veracini 2010; Wolfe 2006). Perhaps most notably, the recognition of settler colonialism has expanded the scope of the traditional Eurocentric model to include modern polities like Australia, Canada, China, Israel, and the United States where the exercise of power with regard to indigenous populations has long followed a "colonial" mode. Archaeological studies of settler colonial contexts have brought to light information about individual experiences within colonial institutions like governmental agencies, residential schools, and Christian religious missions (e.g., Montgomery and Colwell 2019; Two Bears 2021), shifting indigenous economic strategies in response to capitalist investment and resource extraction (e.g., Johnson 2021), and more nuanced views of the motivations underpinning sustained colonial "encounters" between various Indigenous and non-Indigenous groups (e.g., Lightfoot and Gonzalez 2018; Morrison et al. 2019).

It is evident that the broader scope of modern colonialism studies in archaeology has increasingly highlighted the fascinating interplay between applications of colonial power and novel forms of Indigenous response. One of the most interesting developments has been the greater recognition that not all colonial impacts need to be tied to direct or sustained involvement in colonial systems. Specifically, researchers have increasingly noted a number of post-AD 1500 contexts where Indigenous groups remained free from the coercive power that frames our "standard" understandings of Western colonialism, but still experienced a variety of social and cultural changes related to colonial actions. These "atypical" scenarios appear to sit outside the common understandings of colonialism as summarized above and form the subject of the next section.

Thinking Beyond Colonial Frontiers – The Middle Ground & Pericolonialism

Writing with the benefit of more than five centuries of hindsight, it is undeniable that the scale and scope of the European colonial project that began in the early 16th century was something unique, a break with the past that upset the global order. Harnessing a fortuitous wave of technological innovation and political happenstance, European explorers brought formerly separate worlds into contact, linking people into new networks of ideas, objects, and practices that reshaped communities. Historians traditionally emphasized a relatively benign reading of this process, with ideas like the "Columbian Exchange" highlighting how Native American peoples' knowledge of crops like potatoes and maize improved the diet of European peasantry in return for benefits like domestic animals, technological wonders, and incorporation into a new global order. In this old-fashioned narrative, the European colonization process was a seamless acquisition of near-virgin territory, with any resistance met by an inexorable and inevitable wave of "guns, germs, and steel" (Diamond 2017)

This story is a fiction, however, and an incomplete one at that. We know from colonial accounts that even as explorers and conquistadors established footholds on the shores of Africa, Australasia, and the Americas, they were soon met with resistance by local peoples. The imposition of colonial control became a generational undertaking whose precarity colonial authorities sought to hide through political negotiation and the threat of violence. Aided by colonial records, researchers have explored the material signatures of revolts and uprisings, highlighting internal ruptures in colonial engagements and the ways creative cultural products emerged from moments of local resistance. Although this type of work forms a productive avenue for critical studies of colonialism, its inward-facing nature means that many analyses do not fully engage with the same sorts of questions in the context of that other key colonial trait, expansion. The slow, stuttering, and inevitably fragmentary nature of colonialism's spread across the globe, however, means that numerous communities were able to avoid being subsumed by colonial powers while still retaining the ability to negotiate colonial relationships on their own terms, resulting in unique forms of cultural expression. Seen in such a light, the experiences of uncolonized groups in contact with the colonial world offers a unique opportunity to conduct research that considers colonialism and colonial interactions from distinctly local or even specifically Indigenous points of view.

Since the 1990s, archaeological studies of these types of liminal (non)colonial cultural contexts have been guided by two broad theoretical frameworks. The first of these is generally referred to as *middle ground colonialism* (Gosden 2004:30-32, 82-113), which builds upon the work of historian Richard White (2011), who examined the relationships underlying the Algonkian-French fur trade in the Great Lakes "pays en haut" region during the seventeenth through nineteenth centuries. Following White's analysis, a middle ground approach is one that engages with those colonial period contexts where neither Indigenous nor colonizer populations possessed the upper hand, necessitating a series of cross-cultural mediations – i.e., the exchange or sharing of objects, rituals, practices, persons, et cetera – in an attempt to arrive at mutually beneficial (or at least, acceptable) relationships (Gosden 2004:31). What emerged from these "process[es] of mutual and creative misunderstanding" beyond colonial borders was twofold: the active development of new yet comprehensible cultural wholes that incorporated influences from all parties, as well as distinct spatial zones where these new practices could be embodied, enacted, and perpetuated outside colonial systems of control (White 2011:xi-xiii).

In the decades since the development and popularization of the middle ground framework, archaeologists and other material culture specialists have harnessed the approach in order to evaluate and consider the broader impacts of "colonialism beyond frontiers" in greater detail. While a number of these studies delve in to the "contact period" relationships between Indigenous communities and European newcomers in areas like Hawaii (Bayman 2009; 2010), the Great Lakes region (i.e., White's original study area; Allard and Cipolla 2021; Nassaney 2008; Schwartz and Green 2013), and the Great Plains (Rogers 1993; Trabert 2017; Vehick et al. 2010), the middle ground approach has arguably gained more traction in comparative studies of earlier forms of non-"European" colonialism. Notably, researchers have used it to interrogate the nature of Greek expansion and colonization throughout the western Mediterranean during the first millennium BC (e.g., Antonaccio 2013; van Dommelen 2012), as well as the nomadic northern frontier of imperial China (Miller 2015).

Despite its utility, however, many have pointed out that the middle ground is a highly situational framework that should not be blindly assumed to apply to all "extra-colonial" historical settings (e.g., Deloria 2006; Hämäläinen 2014). White himself has stressed that while all colonial period relations between colonizers and Indigenous peoples invariably involved some degree of creative (mis)understanding, material exchange, and shared experience, not every historical engagement was governed by the same rough balance of power or developed the types of supporting cultural infrastructure (e.g., trading posts, frontier forts, etc.) that distinguished the

Great Lakes middle ground space (White 2006; 2011:xi–xxiv). With this in mind, it is perhaps noteworthy that the most successful applications of the middle ground framework in archaeology have arguably occurred in the Great Lakes and western Mediterranean regions, settings with a wealth of additional (ethno)historic information capable of both identifying those moments of mediation and dialogue that are central to the approach and interpreting them within the attested historical sphere of sociocultural interactions. What should an archaeologist do if one's area of interest is text poor (a common occurrence on colonial frontiers, let alone beyond them), or if the existing record speaks to direct and indirect resistance rather than negotiation and politicking?

In recent years, researchers working in areas where the archaeohistorical record raises these sorts of questions have embraced *pericolonialism* as an alternative theoretical framework in an effort to better understand how past Indigenous peoples navigated the unique pressures of living in a (non)colonial world. Popularized in anthropology by the Filipino researchers Oona Paredes (2013; 2017) and Stephen Acabado (2017), a pericolonial approach takes as its main focus Indigenous groups that generally remained unconquered politically, but exhibit forms of social and cultural patterning that point to the pervasive influences of colonialism more broadly (Acabado 2017:2-3). Specifically, pericolonial archaeological studies examine the diverse experiences of "groups who were not directly colonized by a foreign force, but [still] shows parallel culture change with groups who were directly colonized. Changes such as economic intensification, political centralization or development of complexity, shifts in denser settlement patterns, and increasing inequality characterized conquered groups. …the impact of colonialism precipitated similar processes in pericolonial areas to counter the threat of conquest" (Acabado 2017:3). In this manner, this framework helps to focus analytical attention on the widespread effects of European influences beyond colonial borders while simultaneously highlighting the various ways that resources, knowledge, and practices with external origins might become integral to the character of local communities even as they maintain distinct identities as "unconquered" peoples.

Pericolonialism can trace its intellectual foundations back in part to developments in Native American literary studies beginning with the work of the Anishinaabe writer and academic Gerald Vizenor.[3] In his 1994 book *Manifest Manners*, Vizenor coined a new term, "paracolonialism," whose prefix he felt more adequately captured the all-encompassing nature of European settler colonialism in the United States, especially when compared to the more mundane connotations of colonization and colonialism that had previously prevailed. Riffing off of Vizenor's work, the Native American studies scholar Jace Weaver subsequently proposed another new term, "pericolonialism," whose prefix he argued works to acknowledge "…the thorough, pervading nature of settler colonialism and marks it as something that, for indigenes, must be gotten around, under, or through" (Weaver 2006:39). In perhaps the most useful move for anthropologists interested in spatial relationships, Weaver's discussion of this new term explicitly highlights the power of the "peri-" prefix to literally move new analyses of colonialism "beyond" older frameworks and settings in much the same way that "postcolonial" studies challenged the bounds of colonial studies.[4]

[3] Vizenor's writings are an important source of inspiration for scholars working with Native American communities (and Indigenous groups more broadly), including archaeologists. Several terms and phrases, most notably *survivance* (i.e., survival+resistance), have become invaluable analytical tools for studies of Indigenous settings and Indigenous communities (e.g., Handsman 2018; Kretzler 2019; Silliman 2014; Two Bears 2021), leading to Vizenor being described as a "serial producer of timely neologisms" (Whitehouse 2016:58).

[4] It is worth noting that although Paredes discusses the same general type of indirect Spanish colonial influences on Filipino culture explored by Acabado, both her earlier (2013) and more recent (2017) usage of "pericolonialism" appears to represent a case of intellectual "convergent evolution." Specifically, while Acabado explicitly references the Indigenous connection in his presentation of the term (2017:3), Paredes' use of the "pericolony" and "pericolonial" is never fully defined (e.g, 2013: 23, 37, 169-170, etc.; or 2017:232, etc.). Further investigation reveals that Paredes' 2013 book grew out of her 2008 dissertation, where she originally deployed an undefined hyphenated version of the term that appears to be a Vizenorian portmanteau of "peripheral colonialism" (e.g., pp. 33). While the Greek etymology of the peri- prefix leads in the end to the same general understanding of

In the short time since Acabado popularized the term in 2017, the concept of pericolonialism has seen a relatively high degree of "researcher buy-in" among archaeologists that appears to go beyond simple theoretical trendiness. Notably, the looser, less text-dependent nature of the pericolonial framework spurred a number of investigations that examine local and often explicitly Indigenous responses to European colonial ventures around the globe. Acabado's research program in the Philippines has explored the indirect impacts of eighteenth century Spanish colonization on the Ifugao region of northern Luzon through landscape and settlement pattern studies (Acabado 2017; Acabado and Barretto-Tesoro 2020), as well as zooarchaeological analyses of communal feasting activities (Lapeña and Acabado 2017). Recent archaeological investigations in northern Taiwan have harnessed the framework to explore the contrasting impacts of seventeenth century European and nineteenth century Han Chinese colonization on Indigenous Taiwanese villagers (Wang and Marwick 2020a; 2020b; 2021). In North America, Sarah Trabert has employed a succession of conceptual frameworks, including the middle ground (2017) and pericolonialism (2018), in order to better understand the poorly understood colonial period history of Great Plains Indigenous communities and their connections to both Spanish New Mexico and the French trading system (2019). Additionally, many earlier studies of the relationships between colonizers and unconquered local peoples in diverse places like California (Schneider and Panich 2014; Schneider 2015); Chile (Dillehay 2014), Guatemala (Palka 2005), and West Africa (Ogundiran 2001a; 2001b; 2002; Stahl 1999; 2001) can also be characterized as investigations of pericolonial contexts.

The concept of pericolonialism presents archaeologists with a decolonizing theoretical framework that diversifies studies of colonialism in several important ways. Pericolonialism's

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pericolonialism as proposed by Weaver and employed by Acabado, the explicit engagement with a greater Native/Indigenous theoretical framework is not present in Paredes' original writings.

focus on the colonial period experiences of "unconquered" peoples moves the focus of colonial studies into a third space that sits outside the traditional dichotomy of colonizer and colonized. The less formal framing of the system encourages archaeologists to consider any number of potential variables that might speak to cultural changes "analogous to what ensued among those [communities] that were under direct colonial control" (Acabado 2017:6) and opens the door to more nuanced cross-cultural discussions of Indigenous resistance to European colonization. This aspect is particularly important, as traditional understandings of colonialism created Eurocentric cultural spaces and historical narratives that celebrated and reified settler power while simultaneously obscuring less palatable aspects of colonial-era relationships that frequently persist to this day (Acabado 2017:22–23; Acabado and Martin 2020; Liebmann 2012b). Indeed, for many Indigenous communities the so-called "historical" legacy of colonial events and practices is only one or two generations removed from the cultural, political, and economic realities of the twenty-first century. By drawing attention to new trading relationships, alternative forms of social organization, or the development of new economies, pericolonial archaeological projects highlight the richness and complexity of Indigenous responses to European colonialism and offer another way to decolonize the field *and* our own understandings of past peoples and cultures.

PASTORALISM AND THE PASTORAL LANDSCAPE APPROACH

When archaeologists talk about pastoralism they typically refer to a concept that covers a wide range of human-animal relationships whose activities have been tailored to meet the unique demands of specific social and natural environments. A young West African villager's daily foray out with the family goat flock, the sweeping seasonal migrations of 19^{th} and early 20^{th}

century cattle drivers, and the high altitude grazing rounds of Andean llama herders can all be categorized as "pastoral" in nature. Although radically different in their scope and intensity, what defines these and other forms of pastoralism is their shared dependence upon domestic herd animals (held as property) that demands variable degrees of mobility within a community to ensure the success of the relationship (Chang and Koster 1986:99).

In general, archaeological studies of pastoralism have tended to concentrate in one of two areas: identifying initial domestication events across the globe or exploring the role and impacts of animal domesticates on the cultural developments of various regions, most notably in the Near East. By far the oldest and most common approach is the morphometric analysis of faunal remains recovered from archaeological contexts, although a number of new techniques are increasingly being brought to bear on these questions, including stable isotope (Mathwich et al. 2019; Weber 2019), biomolecular (Culley et al. 2021; Taylor et al. 2018; 2020), and ancient DNA analyses (Brunson et al. 2020; Hermes et al. 2020). The reliance on zooarchaeological approaches towards these questions, however, has arguably led to a methodological imbalance that hampers contemporary attempts to explore the wider range of pastoral adaptations developed by past peoples around the globe (Chang and Koster 1986; Honeychurch and Makarewicz 2016:349–350). Because faunal remains are typically recovered from accumulative, end-of-use contexts (e.g., middens), the ensuing archaeological analyses and discussions often engage with certain aspects of pastoral practices (e.g., age-profiles and herd composition, or butchery practices and cuisine) that overlook or are incapable of engaging with the fact that the successful management of herd animals over their lifetime depends on number of factors that extend far beyond the bounds of any one site (although see Wilkinson et al. 2014 for a regional counterexample). These factors include the animals' need for forage, water, shelter, and exercise as well as human cultural considerations like property, territory, natural resource management, and herd-related economic activities.

Working to better understand the complex interplay between specific cultural practices and the environmental settings in which they occur lies at the heart of the approach commonly referred to as landscape archaeology (David and Thomas 2008; Knapp and Ashmore 1999; Wilkinson 2003). A landscape archaeology framework is well-suited for pastoralist studies, as the inherently multi-scalar nature of the approach offers a way to consider and analyze varying degrees of mobility, a key aspect of pastoral practice that is notoriously hard to identify in the archaeological record (Honeychurch and Makarewicz 2016:347–348). Specifically, because herding practices are typified by repeated moments of rest and site-specific activity as much as they are by the movement of animals, potential relationships between otherwise disparate (and distanced) archaeological phenomena linked to these activities can be evaluated as part of a more comprehensible whole. Delving into the nature of these "*pastoral landscapes*" at the macro, meso, and micro-scales can thus call our attention to differences in material relationships that speak to the dynamic nature of past pastoral practices and their role in society (Chang 1992; Frachetti 2008; Hammer 2014; Honeychurch and Amartuvshin 2007; Ur and Hammer 2009; Wright 2016).

Within the pastoral landscape framework, "sites" as they are commonly understood by archaeologists represent single nodes within larger systems of pastoralist land use. Micro-scale studies of the intra-site patterning of pastoral features and practices can be used to contextualize and evaluate the day-to-day movements of family or extended family-based herding groups, the primary economic units within pastoral communities, at local or regional scales (Cribb 1991; Kuznar 1995; cf. Binford 1983). Within any given system, pastoral communities may employ a number of different herding strategies at varying scales and intensities in order to negotiate the constantly shifting demands of both the natural and cultural environment. Mobility is the common factor in potential pastoral management strategies, although the degree of mobility that is practiced in any given community falls along a spectrum. Common strategies include (but are not limited to): village-centered pastoralism (low mobility), seasonal or "transhumant" pastoralism (moderate mobility), and (semi-)nomadic pastoralism (high mobility) (Abdi 2003; Cribb 1991). The process of switching between different pastoral strategies (including the initial transition to or incorporation of a pastoral lifeway) can lead to diagnostic structural changes in the settlement patterns, social roles, and economy of a community as members respond to domestic animals' innate needs for pasture and protection (Russell and Lander 2015).

Defining Archaeological Landscape Markers of Pastoral Activities

Distinguishing between different potential modes and moments of pastoral land use at larger scales depends on the ability to first identify those individual archaeological sites and features potentially associated with herding and animal husbandry activities. However, this need raises the question: what makes an archaeological site "pastoral"? In this regard, the faunal remains of domesticated animals remain an important indicator of pastoral activities, as they provide direct evidence for the consumption of animals in addition to (presumably) a range of other preceding economic activities and secondary products uses. There are also a wide range of other physical features, cultural spaces, and environmental locales that are commonly associated with pastoral activities. Of this second group, the most archaeologically distinctive pastoral indicators are those particular points where repeated visitation and interaction results in their becoming lasting "*landscape anchors*" (Hammer 2014) that structure the herding and settlement patterns of communities over long periods of time because they are economically important or because they possess a particular cultural resonance for a community (Basso 1996; Wright 2016:138–140).

Although the exact nature of herders' relationships with specific types of features can vary over time and between groups and regions, identifying archaeological features associated with the basic needs of animal domesticates (and their human companions) represents the most promising lines of pastoral-focused research at larger analytical scales (Honeychurch and Makarewicz 2016:347). Drawing upon a range of ethnographic, historic, and archaeological data, Chang and Koster (1986:111-115) present seven types of common pastoral activities and their associated material signatures. The most common human-focused markers consist of herders' *habitations* and *culturally important areas* (e.g., cemeteries, shrines, rock art panels, "storied" ritual/sacred spaces), although other types of gathering spaces associated with repeated pastoral events exist like regional trade fairs (González-Ruibal and de Torres 2018) and historic-period shearing/dipping stations (Hangan and Jaquay 2020). Animal-focused pastoral markers consist of a variety of infrastructural elements associated with herding or husbandry activities. These include: *grazing*-related features (e.g., walls or cairns that delineate pastures or lookout areas); natural and constructed *watering*-related features (e.g., springs, streams, ponds, etc., and wells, cisterns, reservoirs, etc. [Hammer 2014]); *movement*-related features (e.g., trails or driveways (Gulliford 2018)); *storage*-related structures and features (e.g., barns, haylofts, troughs); and a variety of structures and features associated with the *sheltering and confinement of animals.*

This last set of indicators – which include a variety of enclosing structures like corrals, pens, and stables – arguably represents the most relevant category for archaeologists seeking to identify pastoral sites on the landscape. First, animal enclosures (like faunal remains) offer direct biological evidence for animal husbandry through the deposition and accumulation of animal dung and urine. Second, some form of enclosure is a ubiquitous component of most pastoralist settlements. Even if practicing a highly mobile form of pastoralism where animals are frequently bedded in the open, all herders will periodically gather and confine their animals for a variety of management purposes (Chang and Koster 1986:115). These can include social gatherings and environmental concerns as well as an array of economic and animal husbandry-related tasks like lambing/calving, branding/marking, shearing, milking, et cetera (Murray and Chang 1981). In many cases, these types of activities are highly seasonal, and the associated form, materials, and spatial distribution of different enclosures can reflect both the nature and timing of their use (Kelley 1982a; Russell and Dean 1985). Taken together, these various factors indicate that animal enclosures represent an important locus of economic *and* social activity for pastoralist communities whose integral nature makes them an ideal focus for archaeological studies of pastoral land use practices (Badenhorst 2009; Chang and Tourtellotte 1993; Huffman 2001; Walton 1958).

Distinguishing Corrals & Other Animal Enclosure Areas in the Archaeological Record

Corral-type enclosures can be constructed out of many different materials and take a number of different forms based on both cultural and environmental factors. Archaeological discussions of corralling have traditionally focused on the remains of "high archaeological visibility" enclosures with substantial wood or stone superstructures at the expense of "low visibility" phenomena. Examples of enclosures types or confinement practices that can be classified as "low visibility corralling" include the creation of structures from cut and stacked brush elements (e.g., *bomas* and *kraals* in eastern and southern Africa), the reuse or adaptation of other types of structures (particularly ruined or dismantled ones), rope- or wire-bounded areas, and ad hoc overnight bedding areas without additional modifications.

Researchers have increasingly attempted to rectify this bias, however, by applying a variety of archaeological science techniques to identify pastoral sites and corral-type phenomena through geochemical changes associated with dung concentrations (Chang and Koster 1986:115–119; Boles and Lane 2016; Lancelotti and Madella 2012; Shahack-Gross 2011; Shahack-Gross et al. 2003; Shahack-Gross et al. 2008; Rosen et al. 2005). Dung studies have also provided information on herding strategies at sites with poor faunal preservation, including the types of animals present (Linseele et al. 2013) and different foddering and land use practices (Valamoti and Charles 2005). The versatility of dung-focused studies and the central role corral areas play in pastoral systems make them both logical focal points for the archaeological study of pastoral landscapes.

Chapter 3: An Overview of Navajo History and Key Structural Concepts in Navajo Society

INTRODUCTION

In our own language, the Navajo are the *Nihooka Diné'e Bilai Ashdla'i* – the "Five-fingered Earth People," or simply *Diné* – "the People" for short. For centuries, the Navajo have been recognized as a distinct Indigenous ethnic group within the rich mosaic of languages, peoples, and cultures that make up the modern-day American Southwest. Over the last 150 years, Western scholars of all stripes have endeavored to pinpoint the place of the Navajo within the *longue durée* of Southwestern history by examining numerous aspects of Diné society. Indeed, the amount of research into Diné material culture, oral traditions, linguistics, religion, philosophy, social structure, et cetera reached such a point that during the twentieth century, a typical Navajo family was jokingly said to be comprised of "…a father, mother, children, and an anthropologist" (Witherspoon 1975:ix). By the 1980s, a prevailing historical narrative had emerged which viewed Navajos as "Athapaskan newcomers" to the Southwest who rapidly acculturated through contact with the local Pueblo communities (Thompson and Towner 2017).

In recent decades, however, new archeological, historical, and ethnographic research has come to light that upends many of the old models about Navajo presence in the Southwest. Importantly, this work has increasingly involved in the participation and direction of Diné people themselves. The result has been an array of new ideas, new discoveries, and new approaches towards the synthesis of these data that challenge certain old models while building and strengthening others. This chapter presents a modernized Navajo historical review-cum-historiography alongside an overview of Navajo social organization that is rooted in traditional Diné intellectual concepts. Together these two discussions situate the research framework of the

ENPLP and its broader interpretive goals within a Southwestern context that offers connections to similar scenarios further afield.

A HISTORICAL OVERVIEW OF THE DINÉ IN THE AMERICAN SOUTHWEST

Diné Origins (pre-AD 1540)

Ałkidą́ą́,[5] a long time ago, the immortal beings, the *Diyin Dine'é*, journeyed up through a series of lower worlds into this final world. Upon their Emergence at the site of Hajíínáí, the deities delineated a homeland – *Dinétah* – centered on two mountains, Dził Na'oodiłii and Ch'ool'į́'į́, and bounded by a set of sacred peaks in each of the cardinal directions, Sisnaajini to the east, Tsoodził to the south, Dook'o'osłiid to the west, and Dibé Ntsaa to the north. The Warrior Twins, Changing Woman's sons, were charged with ridding the land of monsters and once cleared, the Diyin Dine'é brought into being the distinctive elements of Navajo culture. These included the first traditional "hogan" dwelling, the divisions between night, day, and the seasons, the songs and prayers that form the core of traditional Diné ceremonialism, the first woman's puberty rite, and more before creating the first *Nihooka Diné'e Bilai Ashdla'i*, mortal man.

These Diné travel throughout Dinétah, meeting and joining with other groups of people throughout the modern Southwest, each of whom develops a distinct clan identity that references

[5] What is presented here is a generalized summary of the traditional Diné view of their origins as synthesized from previously published sources and additional information shared with me. Prior to the late nineteenth century, these accounts existed in a purely oral form that even today remains "…a kind of boundless, sprawling narrative… fixed in its actual limits only by what might be recited during a particular performance" (Zolbrod 1984:19). As a result, the various written accounts generated by Anglo-American researchers in the nineteenth and twentieth centuries (e.g., Matthews 1994 [1897]; Klah 1942; Fishler 1953; Zolbrod 1984) exhibit numerous variances that reflect differences in informants, audiences, and settings *as well as* the recorder's own opinions (e.g.,. Zolbrod's [1984:10-12] assessment of Matthews' Victorian sensibilities influencing his recording process). More recently, Diné and non-Diné educators alike have developed curriculum designed to introduce Navajo children to these fundamental narratives as part of a push to develop more nuanced histories and preserve traditional Navajo language and culture (Hadley 1986; Lynch 1987; Iverson 2002:7–34).

the initial circumstances of their union with the larger Diné community. Eventually these groups settle at the Confluence of Waters in Dinétah. After some time, this first group of Diné is joined by a *second* large group of Diné peoples created from the divine body of Changing Woman at her home on the Western Water. These four clans were sent east in search of their kin and over the course of their journey, they too encounter and incorporate various peoples before reaching their kin in Dinétah. The success of this Diné coalition continues to attract outsiders wishing to join, giving rise to new clans as they are incorporated into Diné society and spread throughout *Diné Bikéyah* – the land beneath the People's feet.

Like the traditional Dine oral accounts, the dominant view of Navajo origins today also takes the Navajo language as its basis, although this Western intellectual approach could hardly be any more different. Since the early 1850s, scholars have approached the question of Navajo origins guided by the realization that the Apachean languages (i.e., Navajo and the six Apache languages[6]) are the southernmost expressions of the greater Athapaskan language family, which is spoken by peoples throughout the northwestern Pacific Coast and Subarctic regions of North America (Hoijer 1938; Sapir 1936; Turner 1852). The presence of multiple Athapaskan-speaking ethnic groups throughout the greater American Southwest, hundreds and thousands of miles from the next nearest existing Athapaskan language communities, has traditionally been explained as the result of large-scale migration from the north.

The impetus, timing, and path(s) of this southward spread of Athapaskan-speaking peoples, however, remains poorly understood. Extensive ashfalls linked to large eruptions of the Mt. Churchill stratovolcano in southeastern Alaska circa AD 300 and 800 have been suggested as one set of possible "push" factors (Matson and Magne 2007; Magne and Matson 2010; Magne

[6] These are the Western Apache, Mescalero Apache, Chiricahua Apache, Jicarilla Apache, Lipan Apache, and Kiowa Apache (Hoijer 1938).

2012). Scholars have hypothesized and debated a number of scenarios describing the migration of Athapaskan peoples to the Southwest, the majority of which fall into two general groups. The first group draws in part on Spanish colonial-era accounts to argue for a "post-AD 1500 late entry" into the region via the High Plains. The second "early entry" group holds Athapaskan migrants took an intermontane route through the Rockies pre-AD 1500 and gradually adapted to life in the Southwest (Dykeman and Roebuck 2012a:277–278; Thompson and Towner 2017:483–485). In both cases, the eventual blending of northern language with certain key pan-Southwestern traits (e.g., the practice of maize agriculture and the development of painted pottery) that distinguishes Navajo culture from other Apache groups was commonly interpreted as the result of acquisitive or "adaptive," one-way acculturative processes that flowed from Pueblo communities to these migrant groups (Dittert et al. 1961; Kidder 1920; Keur 1941; Hester 1962).

Over the past two decades, however, an alternative model of Navajo ethnogenesis has slowly emerged that simultaneously attempts to complicate and improve our understanding of Diné origins in the Southwest. Echoing similar analyses of Indigenous migration and ethnogenesis ongoing elsewhere in the Southwest,[7] this framework rejects the large-scale Athapaskan migration and acculturation narrative in favor of a hypothesis that draws upon Diné oral traditions, archaeological data, and broader anthropological frameworks in equal measure. The central thesis of this argument is that some Diné clans, those fundamental units of traditional Diné kinship and social order, have their origins deep in the Southwestern past (Brugge 2006;

[7] Examples of this recent wave of well-regarded studies include Wesley Bernadini's work with the Hopi (Bernardini 2005; Bernardini et al. 2021); Scott Ortman's study of Tewa migration to northern New Mexico (Ortman 2012); and the work of Severin Fowles and B. Sunday Eiselt with the Jicarailla Apache and northern Tiwa pueblos (Bernardini and Fowles 2011; Eiselt 2012; Fowles and Eiselt 2019). In these accounts, semi-frequent long-distance movements by multiple groups of different peoples result in new multiethnic (or, in many cases, "multi-clan") fusions that "come to be" in specific culturally-informed places.

Kelley and Francis 2019a:84–114; Warburton and Begay 2005). Indeed, these clans – those first Diné who wandered through Dinétah as described above – likely represent elements of non- or semi-sedentary Southwestern forager-farmer populations (i.e., groups practicing a Southwestern "Archaic"-style lifeway) that avoided or departed from Pueblo II-III village life during the ninth through fourteenth centuries AD (Brugge 2012:140). Hypothetical reasons for this separation include potential sociopolitical turmoil, ecological deterioration, or other factors in these communities, particularly at Chaco Canyon (cf. the despotism described in the Gambler narrative [Begay 2004; Weiner 2015; 2018]). The overall lack of Pueblo II and Pueblo III period archaeological sites in the upper San Juan River region – a rugged canyon and mesa system on the periphery of the Chacoan world – is noteworthy in this regard (Brown 2014a), suggesting a landscape ideal for small groups of forager-farmers wishing to interact with other more sedentary communities on their own terms. The slow incorporation of small groups of Athapaskan-speaking hunter-gatherers[8] into these existing Southwestern populations accompanied by the adoption of Diné bizaad as a lingua franca[9] thus sets the stage for the growth of a robust and recognizably Diné community in the Southwest.

The Pericolonial Navajo World (c. AD 1500-1750)

Looking past questions of origins, Diné tradition identifies that part of northwestern New Mexico and southwestern Colorado located along the upper San Juan River drainage as *the* Dinétah of generations past, the place where Navajo people came to be. Similarly, the current

[8] Recent isotopic studies of Subarctic-style moccasins from Promontory Cave, Utah present evidence for long distance travel between northern Utah and the Four Corners region or the Great Plains, as well as buffalo hunting by possible Athapaskan-speaking peoples during the thirteenth century AD (Metcalfe et al. 2021).

[9] The intentional choice of Diné bizaad as an inter-clan lingua franca is described an oral account of the Navajo origin story that was recorded during the late nineteenth century [Matthews 1994 (1897):135-159]. Spanish historical accounts record the use of the Navajo language as a regional lingua franca by Hopi and New Mexican genízaros during the colonial period (c. AD 1776) [Escalante 1995:130–131]).

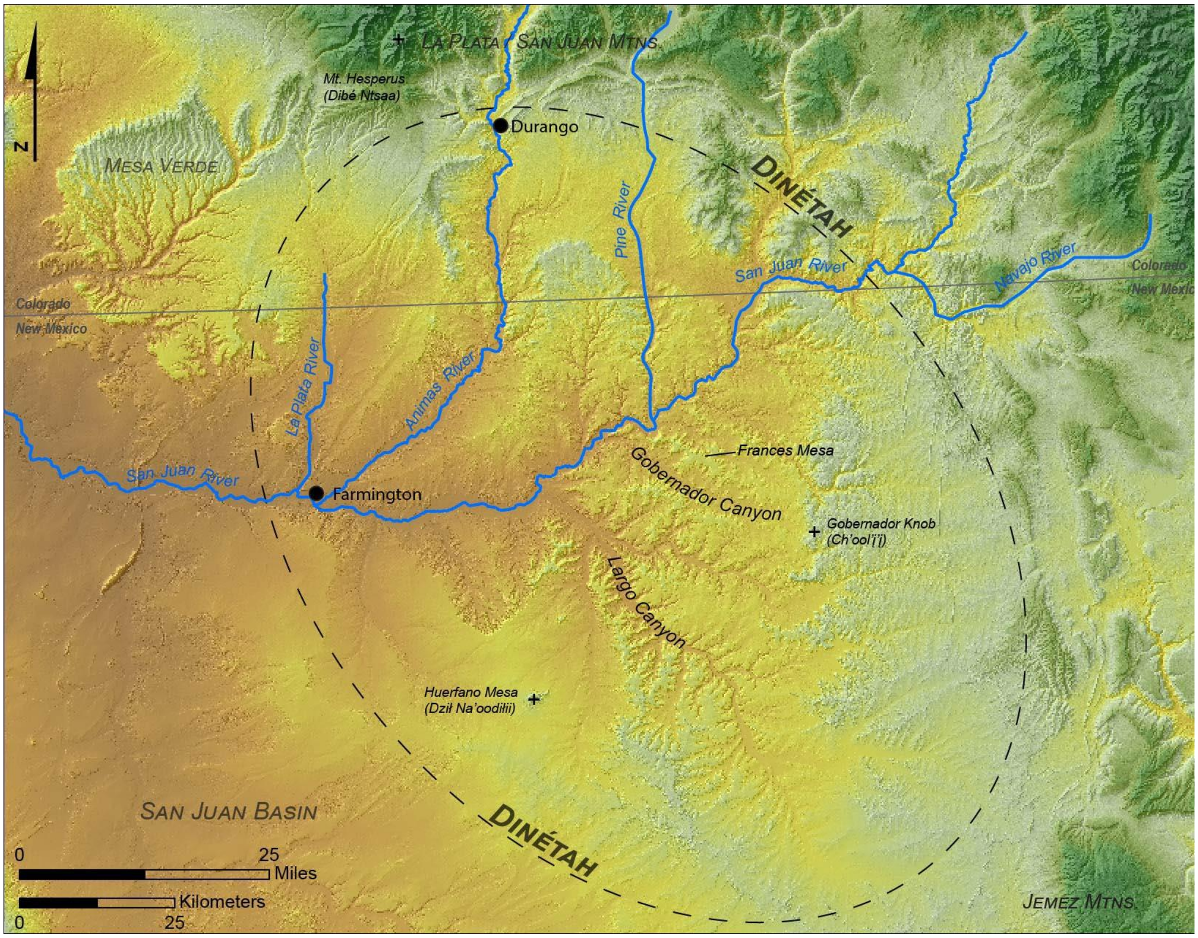

Figure 3 - Map of the Upper San Juan drainage and key regions within the early Navajo landscape of Dinétah.

archaeological record indicates that a recognizable and ethnically distinct Navajo presence was firmly established in the greater Upper San Juan region by the early 1500s (Figure 3).[10] The river and its main tributaries (the Pine, Navajo, Largo, and Gobernador drainages) form the central loci of Navajo settlement during the sixteenth and seventeenth centuries (Dykeman and Roebuck

[10] LA 55979, a multi-component settlement overlooking the San Juan River/Navajo Lake, is the oldest securely dated Navajo site in Dinétah. Tree-ring and thermoluminescence dates indicate the site was occupied from at least AD 1541 until circa 1580 (Dykeman and Roebuck 2012b:276–277). During the late 1980s and early 1990s, a number of early Navajo sites from the nearby La Plata and Animas river drainages were radiocarbon-dated. Although these sites lack archaeological materials associated with later 17th and 18th century Navajo sites, there remains hesitancy about the utility of these results, which span the 14th through 20th centuries and lack good correspondence with dates determined via dendrochronological or thermoluminescence methods (Brown 1998; Brown and Hancock 1992; Hancock 1992). It is worth noting though that many of these dates were obtained by traditional (non-AMS) radiocarbon assays over thirty years ago and a synthetic reexamination and reconsideration of these data is overdue.

2012b; Wilshusen et al. 2000), although early Navajo sites are also present in the nearby La Plata and Animas drainages to the west (Brown and Hancock 1992; Honeycutt and Fetterman 1994; Reed and Horn 1990) and have been attested to on Forest Service and Ute tribal lands in southern Colorado (D. Loebig 2019, personal communication; W. Tsosie 2017, personal communication).

Early Navajo sites are distinguished by suites of potential archaeological markers that indicate a shared Diné ethnic identity, with particular combinations of traits traditionally separating with two distinct chronological periods. The first period – the Dinétah Phase – is commonly associated with a fundamental set of diagnostic elements include east-facing forked-stick earthen lodge structures termed "hogans" (from the Navajo *hooghan* or "home place"), smaller sweatlodge structures (*tacheeh*), a lithic microblade toolkit, a mixed subsistence practice incorporating both maize-centered farming and foraging, as well as a distinctive thin-walled, pointed-bottom plainware style known as Dinétah Grey. The second period – the Gobernador Phase – comprises all the components of the Dinétah Phase with the addition of key differentiating elements like high-fired Gobernador Polychrome pottery, masonry defensive structures known as "pueblitos," and the presence of Eurasian floral and faunal remains (Dykeman and Roebuck 2012a).

When this subtractive two-part chronology was first proposed in the early 1960s (Dittert et al. 1961; Hester 1962), these distinctive Gobernador Phase traits were held to represent the cultural influence of pan-Southwestern (i.e., "Puebloan") communities on recently arrived Athapaskan groups, while the absence of these traits (that is, the Dinétah Phase) hypothetically reflected the "original" culture of the hunter-gatherer migrants. Building on the earlier work of Kidder (1920), Keur (1944), and others, the advent of the Gobernador Phase was specifically thought to represent an acculturative episode following the Pueblo Revolt of 1680 whereby an influx of Pueblo refugees fleeing the Spanish Reconquest of New Mexico introduced a defining set of "Puebloan" traits into early Navajo society. In the decades since, however, contract and academic work throughout the greater Dinétah region has turned this framework on its head. Not only do the most visible markers of the Gobernador Phase (i.e., Gobernador Polychrome ceramics and pueblito fortresses) respectively pre- and post-date the Pueblo Revolt period by several decades (Reed and Reed 1996; Towner 2003), but absolute dating techniques have firmly demonstrated that "Dinétah Phase"-type sites occur throughout the seventeenth and eighteenth centuries as well (Wilshusen et al. 2000:179–180). While the specific time periods and requisite criteria associated with the phases remain fluid, the Gobernador Phase as used here is held to represent a period circa AD 1625-1750, while the Dinétah Phase covers the poorly understood period leading up to AD 1625 (Dykeman 2003b:36–43).

Despite these temporal and definitional shifts, the Dinétah/Gobernador chronology remains a useful heuristic for examining the Navajo role in the dramatic restructuring of the Southwestern world following the arrival of Spanish settlers circa AD 1600. Colonial-era documents offer precious little information about the internal structure or motivations of Diné society, even as Diné communities seemingly beyond the reach of Spanish colonial authority experienced various events and influences whose origins lay in the colonial-era Rio Grande Valley core. Archaeological data like Gobernador Phase traits offer a way to document and evaluate Diné pericolonial responses to direct and indirect Spanish colonial pressures. Seen in such a light, the advent of Gobernador Polychrome pottery in the 1620s echoes contemporaneous developments in both the Eastern and Western Pueblos, possibly as a material and iconographic manifestation of anti-Spanish sentiment (Reed and Reed 1996; Reed 1999; Timothy Wilcox

2021, personal communication). The proliferation of over two hundred pueblito fortresses between circa AD 1700 and 1760, first in Dinétah (Towner 2003) and eventually in the Mt. Taylor/Rio Puerco region to the east (Carroll et al. 1979; Keur 1941; Towner 2016a), Chacra Mesa and Mesa de los Lobos to the South (Brugge 1972; Vivian 1960), and beyond the Chuska Mountains to the west (Gilpin 1996), speaks to the increasing intensity of internecine conflict between Navajos, Utes, Spaniards, Pueblos, and others during the mid-eighteenth century, as well as an expansion of Navajo settlement beyond the San Juan Basin (Madrid et al. 1996; Towner 2008).[11] Even as Navajos rejected Spanish attempts at settle them at mission sites in Mt. Taylor region during the 1740s (Brugge 2010; Kumli 2009), Diné families increasingly incorporated other colonial technologies into their daily lives, including a growing focus on mobile, sheep/goat-based agro-pastoralism (Weisiger 2004).

Diné Florescence & Colonization (c. AD 1750-1868)

Increasing Diné presence throughout the greater Four Corners region during the so-called "Navajo Wars" period of the late eighteenth and early nineteenth centuries saw the historical hey-day of the pericolonial Navajo world and its eventual end at the hands of the United States government in the 1860s. During the latter half of the eighteenth century, the center of historical Navajo settlement gradually shifted away from Dinétah across the San Juan Basin towards the Chuska Mountains and Chinle Wash drainage in the west (Bailey 1980; Towner 2008). From these new centers, decentralized Navajo bands alternated between periods of raiding, livestock rustling, and treaty-protected trading with Spanish and Pueblo villages along the Rio Grande, as

[11] Early Navajo archaeology in general and focused dendroarchaeological work in particular have been relatively limited outside Dinétah. Questions about the veracity, antiquity, and intensity of Navajo presence in other portions of the greater Four Corners region remain a topic of great debate (e.g., Colwell and Ferguson 2017) and focused research remains sorely needed, particularly on the Navajo Nation itself.

well as continued conflicts with the Utes (Reeve 1960). Fraying Navajo-Spanish relations circa 1800, however, led to renewed warfare that threatened both the New Mexican economy and colonial efforts at westward expansion in the Mt. Taylor region, prompting authorities in Santa Fe[12] to approve official punitive missions as well as informal slaving campaigns deep into Navajo territory (Brugge 1964; Marino 1954; McNitt 1990; Reeve 1971). Despite these attempts at deterrence, by the mid-1830s Navajo herds had grown such that Diné society had become increasingly organized around an intensive agro-pastoral lifeway in which large herd size functioned as a key marker of social status separating Navajo leaders ("headmen" or "*ricos*") from the rest of the population ("*pobres*") (Guiterman et al. 2019; Kelley 1980).

The draining nature of this endemic conflict on the New Mexican economy during the first decades of the nineteenth century led to Navajos being regarded as marauding thieves and a regional menace, a reputation which set the tone for the United States' own attitudes and policies towards the Navajo following the U.S. takeover of New Mexico in 1846. Over the next twenty years, the U.S. continued to follow the earlier Hispanic approach, alternating military expeditions with seven different attempts at treaty-making. The acephalous nature of Navajo society and the reluctance of Congress to ratify most of the agreed-upon treaties, however, meant that conflicts between the Navajo, New Mexicans, and U.S. continued throughout this period. In an effort to resolve "the Navajo problem," U.S. planners in the 1850s began preparations to remove the Navajo population to a reservation beyond the bounds of Diné Bikeyah (Iverson 2002:35–51).

This plan was put into action during the autumn of 1863 when a U.S.-New Mexican territorial militia led by the former "mountain man" and U.S. Indian agent Colonel Christopher

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[12] Governmental control of New Mexico transitioned from the Spanish Empire to the Republic of Mexico following Mexican independence in 1821. Mexican policies towards the *indios barbaros* of the northern frontier (i.e., Navajos, Apaches, and Comanches) in the two decades prior to the Mexican-American War and the 1848 Treaty of Guadalupe Hidalgo, however, did not differ in any substantial manner from those of the previous administration. See D. Tyler (1980), A. Reséndez (1999), and D. Weber (1982) for more information.

"Kit" Carson embarked on the first in a series of new expeditions against the Navajo. Unlike the Euro-American forays of years past, these campaigns held as their goal neither simple retaliation nor the capture of slaves and goods, but rather total war at a scale not previously seen in the Southwest. Sweeping through the eastern half of Navajoland, the U.S. troops burned homes and fields, destroyed wells and orchards, and killed or drove both livestock and Diné families into temporary confinement at forts along the U.S.-Navajo frontier (Kelly 1970). Coupled with the harsh winter of 1863/64, Carson's scorched earth policy forced many families to subsequently turn themselves in to the military even as others resisted by fleeing to remote or rugged areas of the Four Corners, including along the Grand Canyon, around Navajo Mountain, atop Black Mesa, in the Bears Ears, and among the uplands of Dinétah (Ackerly 1998; Roessel and Johnson 1973). Those individuals that were captured, however, were consolidated and marched east to the new reservation that had been established for them at Fort Sumner, a military post at Bosque Redondo in eastern New Mexico (Iverson 2002:48-57).

Between 1863 and 1866, some 8,300 Diné made the 375-plus mile "Long Walk" from Navajoland to Fort Sumner. More than 53 different Long Walk episodes have been documented during this period, ranging in size from 23 to 2,400 persons and encompassing five general routes (Ackerly 1998). Once there, Navajos found themselves in a situation where alkaline water and locusts stymied attempts to farm the over-foraged Pecos River valley and overcrowding, resource scarcity, disease, Comanche raids, and death ran rampant, leading them to name the fort *Hwééldi*, or "the place of suffering." The common goal of surviving these shared tribulations proved a key motivating factor behind the political unification of the previously independent regional and extended family Diné "bands." When the U.S. government renewed treaty negotiations with the capture Navajos in 1868, a representative group of ten headmen led by

Hastiin Dághá (Barboncito) successfully lobbied against removal to Indian Territory,[13] securing instead the promise of a reservation within the traditional boundaries of the four sacred mountains. On June 1, 1868, the two parties signed *Naaltsoos Sání*, the Treaty of Bosque Redondo, enabling the return later that month of the more than seven thousand Diné captives to Diné Bikeyah (Iverson 2002:57–65; Tohe 2007).

Early Reservation Life (AD 1868-1950)

Today, Diné life is distinguished by the fact that the modern Navajo Nation is the largest tribal nation in the United States, both in terms of population (nearly 400,000 tribal members as of May 2021 [Romero 2021]) and land base (approximately 27,413 square miles across Arizona, New Mexico, and Utah). Within the contemporary Navajo community, there is considerable pride in both this status and in the continued survival of Diné culture, language, and people into the twenty-first century. Such pride is tempered, however, by the knowledge that despite surviving *Hwééldi* and achieving a relative measure of socioeconomic and political success, numerous aspects of Navajo life have been irrevocably caught and altered by the United States' greater colonial project. Over the past 150 years, a handful of key events stand out as particularly illustrative examples of this dichotomy, beginning with the creation and growth of the reservation itself.[14]

The Treaty of 1868 initially established a narrow, 5,100 square mile reservation along the northern Arizona-New Mexico border; however, this area did not include many of the pre-Long Walk population centers. Many Navajo families simply ignored the intangible lines of the treaty

[13] The modern state of Oklahoma.
[14] For an in-depth discussion of the history of Navajo governance, the impact and organization of federal Indian policies, and current political structure of the Navajo Nation, see David E. Wilkins (2013), *The Navajo Political Experience.*

and returned to previous homes which lay outside these boundaries, while those groups who had avoided going on the Long Walk generally remained outside the 1868 reservation as well. As a result, between 1878 and 1933, a series of sixteen different executive orders, legislative actions, and land swaps expanded the Navajo reservation to an area approximating its modern extent (Figure 1). Accompanying this formal expansion of Navajo territory came an increase in U.S. Bureau of Indian Affairs (BIA) oversight and the imposition of various federal Indian policies, as well as increasingly complex interactions with Euro-American bureaucrats, entrepreneurs, prospectors, and railroads, missionaries, anthropologists, and more (Iverson 2002:66-81).

Navajo life in the decades soon after internment followed along the same general lines as before, although the role and influence of raiding was replaced by incorporation into the Western capitalist economy. This included off-reservation wage work on the railroad, in mines, or lumber camps as well as the establishment of the reservation trading post system (Kelley and Francis 2019a:133–246). In these small stores, a predominantly Anglo-American cast of traders freighted materials from off-reservation railroad towns into remote corners of the reservation, offering ready access to hard goods and simple foodstuffs in exchange for highly prized Navajo textiles, jewelry, raw wool, livestock, pinyon nuts, and other goods. At the peak of the trading post era in the 1930s, there were more than 150 trading posts in operation that served as social and economic hubs on the reservation (Iverson 2002:76–81; Kelley 1985; Kelley and Francis 2018).

As Navajo families worked throughout the late nineteenth and early twentieth centuries to rebuild the large livestock holdings they had maintained prior to internment (aided in part by the distribution of 15,000 sheep and goats as per Article 12 of the 1868 treaty), the trading post economy further spurred this process, encouraging the astronomical growth of Navajo herds in order to meet subsistence and market demands. By the time the BIA began conducting detailed livestock censuses in the 1930s, Navajo sheep herds had grown to some 1.3 million head, severely taxing the natural carrying capacity of the drought-afflicted region. Faced with a denuded landscape, increased erosion throughout the reservation, and intense opposition to the expansion of reservation lands from Arizonan and New Mexican ranchers, in 1933 the BIA and the U.S. Soil Conservation Service instituted a livestock reduction program on the Navajo reservation to curtail overgrazing and allow range regeneration (Iverson 2002; Weisiger 2009).

Although well-intentioned, the New Deal era program was poorly conceived and implemented, with percentage-based cuts and the imposition of fixed herd caps based on "sheep units"[15] that took little note of the broader social role pastoralism played in Navajo society. Not only are herd animals gifts from the *Diyin Dine'é*, but traditional beliefs about individual autonomy and ownership mean that Diné women can own livestock (especially sheep and goats) without male support, providing them a level of economic power that echoes their social importance in Navajo matrilineal society. Initial efforts to voluntarily purchase and process sheep and goats for meat were stymied by the scope of the effort, leading federal officials to begin conducting involuntary and uncompensated mass culls of Navajo herds across the reservation. By 1945, the sheep/goat population numbered approximately 477,200 animals, along with an equivalent number of horses and cattle. Coupled with the creation of formal grazing districts in 1936, the livestock reduction programs effectively broke the two-centuries-old, highly mobile, agro-pastoral economy while also undercutting a fundamental aspect of traditional Diné gender relations, marking a period of intergenerational trauma whose effects are still felt today (Bailey 1980; Iverson 2002; Roessel and Johnson 1974; Weisiger 2007; Weisiger 2009).

The trials of the reduction era helped to solidify the growing sense of Navajo tribal unity

[15] A "sheep unit" was a metric developed by federal grazing officials that corresponded to the "amount of forage needed to support one sheep," with other animals counting as an equivalent number of sheep units (goats 1:1; cattle 1:4; horses 1:5) (25 CFR 167 - Navajo Grazing Regulations [2018])

that began in the wake of the Hwééldi experience. Between 1868 and 1921, local political power continued to be exercised by regional headmen who engaged with U.S. officials individually or in council. Local interests often clashed with those of the larger tribal community, however, and in 1922, the federal government chose twelve headmen from across the reservation to form the first Navajo Tribal Council under the leadership of Chee Dodge. Despite being formed in part to approve extractive oil, gas, and mining activities on reservation lands, over the next two decades the council expanded to become a voice for the greater Navajo tribal community (including against livestock reduction) while the development of a regional "chapter" system served to organize local community governance (Iverson 2002:133-136; 166-168).

Reservation to Nation (AD 1950-2021)

The onset of the Second World War marked a sea change in Navajo political attitudes and activities. Between 1941 and 1945, more than 3,600 Navajos joined the armed forces while another 12,000 men and women worked in off-reservation wartime industries. Many of these individuals had also been educated in federal boarding schools and upon their returns were acutely aware of the social, political, and economic inequities that plagued the reservation. From the late 1940s through the 1960s, many Navajo veterans and others entered the wage economy, working to build roads, water and power infrastructure, schools, and hospitals across the reservation, while Navajo children were increasingly encouraged to attend boarding schools (on and off the reservation) and develop professional skills. Likewise, Navajo politicians negotiated with the federal government for funding to support the infrastructure and economic development projects underway, including the embrace of natural resource extraction (e.g., oil, gas, uranium, timber, and coal). They also worked to secure civil rights, develop tribal social services (e.g., a police force and judiciary), and assert the tribe's right to self-governance. Reflecting these efforts, in 1968 – a century after the Treaty of Bosque Redondo – the tribal council declared that the tribe would be hence known as the "Navajo Nation" in recognition of the Diné community's inherent sovereignty, past, present, and future. (Iverson 2002:182-214, 244-245).

Even as the modern Navajo Nation was coming into being, a unique challenge arose in the 1950s whose incredible divisiveness and slow resolution left impacts still felt in the twenty-first century. Amid the flurry of late nineteenth century executive orders expanding the Navajo reservation, the U.S. also issued a separate executive order in 1882 that established a roughly 2.5-million-acre reservation for the Hopi people "and other Indians." Soon surrounded by the expansion of Navajo territory, the arbitrary rectangular boundary of the 1882 reservation centered on the twelve principal Hopi villages along the southern edge of Black Mesa, but also included several thousand dispersed Navajo families who had lived, farmed, and herded the wider country beyond the villages for generations. In 1951, a "progressive" pro-U.S. faction within the Hopi community reformed the disbanded 1930s-era tribal council in order to negotiate natural resource leases and claim compensation for lands allegedly lost to the Navajos. In 1956, the Hopi tribal council laid exclusive claim to all mineral and water rights within the entire 1882 area in an attempt to control the extensive Black Mesa coal bed; the Navajo tribe protested and in 1958, both tribes entered into a lawsuit to resolve what has become known as the Navajo-Hopi land dispute (Brugge 1999:24–92; Iverson 2002:73, 214–216; LaCerenza 1988).

The initial lawsuit was resolved by a federal district court panel in 1962, which declared that the greater portion of the 1882 area that lay outside the main Hopi villages' exclusive use area (referred to as "District 6") would be a "Joint Use Area" (JUA) for both tribes. Over the next four years, the Department of the Interior negotiated mining leases in the JUA between the

Hopi, Navajo, Western Energy Supply & Transmission, and Peabody Coal;[16] the main lease was approved in 1966 and the Peabody opened the Black Mesa and Kayenta strip mines in 1970 and 1973, respectively. Disagreements about the rights to surface usage and settlement in the JUA continued throughout this period, however, leading to two momentous federal decisions with catastrophic consequences. In an attempt to force negotiations in 1966, the BIA commissioner, Robert Bennett, declared a total halt on development across 1.5-million-acres of Navajo reservation land to the west of the 1882 Hopi reservation; the Bennett Freeze restrictions were ineffective but remained in place until 2009, resulting in 40 years of miserable conditions for tens of thousands of Navajo residents *outside* the contested area.[17]

Later, Congress passed the Navajo-Hopi Land Settlement Act of 1974, dividing the JUA into the Navajo and Hopi Partitioned Lands (NPL; HPL). The 100 Hopi and over 10,000 Navajos living in the opposite areas were compensated and relocated to other parts of their respective reservations, although legal challenges and widespread Navajo reluctance to abandon their homes meant that the relocation process unfolded slowly from the 1970s through the 2010s, with a small number of Navajo resisters remained in the HPL. The struggle has only lessened in recent years as the two mines on Black Mesa closed in the face of economic and environmental concerns (first in 2005 and later in 2019), removing the money from the equation that pit two tribes against each other (Brugge 1999:93–258; Iverson 2002:242–244, 265–267; LaCerenza 1988; Schwarz 1997).

[16] Unbeknownst to either the Hopi or Navajo tribes at the time, the Hopi Tribe's attorney, John Boyden, was operating under a severe conflict of interests. Boyden's firm also counted Peabody Coal and Western Energy Supply & Transmission as clients during the 1960s and is suspected of having helped arrange Black Mesa mine lease terms that favored Peabody Coal (e.g., the use of 4,600 acre-feet per year of pumped groundwater to feed a 273 mile coal slurry pipeline) (LaCerenza 1988; Wilkinson 1999:298–304).

[17] The terms of the Bennett Freeze prohibited both the development of new buildings, power lines, water lines, roads, and commercial operations *and* the repair of existing features. As of November 2020, ~24% of the homes in the area are habitable, ~60% do not have electricity, and the majority lack access to potable running water. In the decade since the end of the Freeze, the Nation Nation government has developed a $4 billion economic development plan to address impacts of both the Freeze and the Navajo Relocation (Navajo Thaw Recovery Plan 2020:31).

The historical legacy of this six-decades-long struggle presents a framework for engaging with developments elsewhere on the Navajo Nation during this same period. In particular, one of the key tensions seen in the Black Mesa case – the push for equitable development and improved quality of living butting up against the desire to maintain Diné culture, language, and political sovereignty – has emerged as one of the defining features of Diné society in the late twentieth and early twenty-first century. Since the 1990s, the collapse of older extractive industries on the reservation has seen the Navajo Nation to enter into the oil and gas business, open casinos, and explore the potential of renewable energy alternatives in a bid to build a more independent and sustainable economy (Curley 2018; 2019; 2021; Pasqualetti et al. 2016; Yazzie 2018). Both underemployment and the promotion of educational pursuits within the Navajo community have sped the growth of a large urban-area Navajo population; however, in some cases this separation has led to decreased language and cultural fluency that creates challenges when these individuals return to the reservation (Lee 2009; Pepion 2021).[18] Fuller incorporation into the Western world has led to lifestyle and dietary shifts that have increased the prevalence of medical issues like diabetes, prompting discussions of Diné food sovereignty and the reclamation of traditional agro-pastoral foodways (Diné Policy Institute 2014; Lombard et al. 2014; Ornelas et al. 2018). As the Navajo response to the dangers posed by recent 2020-2021 coronavirus pandemic has shown (Emerson and Montoya 2021), however, an overall sense of shared responsibility and solidarity continues to motivate the contemporary Diné community as it continues to navigate its way through these types of challenges into the future.

[18] The controversy surrounding the 2014 Navajo presidential election is one example of this issue. One of the frontrunners, Chris Deschene, an attorney with a background as a U.S. Marine officer and engineer, exemplified the pro-education, pro-service path encouraged by the Diné community. Deschene was disqualified, however, after he failed to demonstrate "fluency" in Diné bizaad (a requirement of the position per Navajo law), a decision which has led to several analyses and discussions within the greater Navajo community (e.g. Jacobsen and Thompson 2020).

DINÉ CULTURAL INSTITUTIONS & TRADITIONAL NAVAJO SOCIAL ORGANIZATION

Sa'ah Naagháí Bik'eh Hózhóón: A Practical Metaphor for Diné Life and Identity

The Diné bizaad phrase *Sa'ah Naagháí Bik'eh Hózhóón* (SNBH) is deceptive in its shortness. Often translated as "long life and happiness," the phrase is the introduction to a profound, multifaceted concept that lies at the core of Diné life and thought. Over the years, Western scholars of all stripes – anthropologists, philosophers, psychologists, and others – have broken down, analyzed, and described the concept in ways ranging from a religious mantra, a kind of abstracted indigenous-Platonic form, or just a simple rule for right living (Farella 1984:153–154; Witherspoon 1977:17–46). All of these approaches wrestle with the fact that SNBH is the principal metaphysical metaphor that structures (unconsciously as much as consciously) the traditional Navajo world. Although an exact definition is impossible, Diné people – scholarly and avocational thinkers alike – tend to agree on the following two points: SNBH serves as a reminder that existence is rooted in an all-encompassing state of *hózhó* – Beauty/ Good/Harmony/Balance, *and* a process template for the goal of achieving (and maintaining) this state of being during one's life (e.g., chapters in L. Lee 2014; Nez 2018). Diné culture possesses several key traditional epistemological "institutions" (Laluk and Burnette 2021) that exist to facilitate (and if necessary, reorient or restart) the SNBH process, including the vastly complex world of traditional *Hózhóójí* (Blessing Way) ceremonialism and the clan system.

The lifelong embodied nature of the SNBH process means that the search for hózhó ideally informs all aspects of Diné life and interactions, be they ceremonial, social, or cultural, in thought and speech as well as deed, and with the natural world as much as with other people. The resulting emphasis on multiple forms of relationality inherent in SNBH is fundamental to a Navajo individual's conception of what it means to be Diné (L. Lee 2021). This sense of interconnectedness and indeed, interdependence, is referred to as *k'é*, a multi-faceted term that signifies " 'compassion,' 'cooperation,' 'friendliness,' 'unselfishness,' 'peacefulness,' and all those positive virtues which constitute intense, diffuse, and enduring solidarity" between Navajo individuals (Austin 2009; Witherspoon 1975:37). A closely related concept – *k'éi* – can be understood as the application of the tenets of *k'é* to the relationships one has with his or her kin at *all* levels – i.e., close blood relatives, more distant clan relations, and unrelated yet still ethnically Navajo acquaintances – and the promotion of a positive Diné self-identity that is affirmed by the greater Navajo community (Lynch 1987:v). These traditional Diné teachings serve to underline the centrality of family-focused kin relationships in Navajo thought and action.

Within Navajo society, one's own identity as a Diné individual is defined and expressed as a fourfold set of descent-based clan relationships, or *dóone'é*.[19] More than sixty different clans are recognized today, although the number of clans that existed in the past is unknown as oral traditions identify some clans as having been absorbed into other clans or become extinct. In practice, Navajo clans function as social units based on consanguineal or adoptive kinship that is charted through matrilineal descent in reference to a common matriarch. The individual clans are further organized into nine groups of non-descent-related clans; clan group size is unequally

[19] One's own clan *is* Clan A (i.e., his or her mother's clan), one is *born for* Clan B (i.e., his or her father's clan), and one is kin to the clans of both one's *cheii,* or maternal grandfather (Clan C), and *nali*, or paternal grandfather (Clan D). Introductions between Navajo individuals begin with declarations of one's fourfold clan identity with the goal of ascertaining the type and degree of relationship that exists between the parties. For example, if Person 1 is a member of Clan X, and Person 2's paternal grandfather's clan is Clan X, 1 and 2 share a grandchild-grandparent relationship in which 1 is the elder to 2. In the case that a direct clan link cannot be made, the same process is carried out only with reference to the larger clan groups. Thus, if Person 1 was Clan X and Person 2's nali clan is Clan Z, but Clans W, X, Y, and Z are all members of Clan Group 7, then the grandchild-grandparent relationship would remain. In the same vein, if different components of individuals' fourfold clan identities pair up, a parent-child, sibling, grandchild-grandparent (maternal) or in-law-type relationship can be established instead (Witherspoon 1975:35-48)

distributed and each clan group is technically regarded as exogamous (Brugge 2005; Witherspoon 1975:35–48).

Although the clan system plays a central role in establishing relationships between Diné individuals, clan identity in and of itself does *not* directly influence the structure of Navajo socioeconomic organization. None of the clans or clan groupings "…is utilized in the formation of a social group which meets together, takes collective action, or holds property" (Witherspoon 1975:48). Instead, the clan system forms the framework for both Diné culture's exogamic kinship structure (i.e., intra-clan sexual relations are held to be incestuous) *and* the general *k'é*-based rules of Diné hospitality and ceremonial cooperation. Thus, two otherwise unrelated *Kinyaa'áanii* (Towering House) clan members from different corners of Navajoland can reference their shared clan tie to begin developing a personal relationship; however, any resulting social or economic development is not done or interpreted as an inherently *Kinyaa'áanii* "corporate action." It is instead the extended family unit – a collection of first and second-order kin sharing a common matriarch – that manages the socioeconomic arena, and although a family unit will be dominated by one principal clan due to the processes of matrilineal descent, it is not the clan identity that is seen as the organizing element (Witherspoon 1970; 1975).

SHIK'ÉI DÓÓ SHIDINE'É: TRADITIONAL NAVAJO SOCIAL STRUCTURE

The Household

As described above, traditional Diné teachings underline the centrality of family-focused kin relationships in organizing Navajo relationships and activities. Anthropological definitions similarly highlight the family-based household's position as the basic economic and social unit in historic and modern Navajo society. Households typically consist of a nuclear family sharing a single dwelling structure (although additional members might be present [e.g., grandparents]) who engage in close daily interaction, and are economically interdependent (Kelley 1986:2; Rocek 1995:43, 67–68). Physically, households are typically organized as a homesite that incorporates a dwelling structure (traditionally a type of hogan) and any number of related special use areas and structures (e.g., shadehouses, activity and storage areas, corrals, agricultural fields, etc.). According to Kelley, an average household occupies 1.2 to 1.3 dwellings and consists of approximately six individuals. Importantly, the size of individual dwellings can vary according to the type and intensity of activities being carried out in them, a phenomenon that suggests floor area is not a good indicator of the number of occupants at a particular site (Kelley 1982:51–55). Ethnographic information indicates that the use life of a traditional hogan averages approximately ten years (Kelley 1986:38, 188). When situated on the landscape, individual homesites tend to display a preference for sheltered locations with a southern or eastern aspect near to sources of water and fuel wood (Jett 1980:113). When coupled with the low visibility nature of a hogan's traditional building materials, these preferences would have also served to provide a level of security to the household (Jacobsen et al. 1992; Jett 1980:n. 31).

The Residence Group

Residence groups or "camps" form the second organizational tier of Navajo society and represent a simple scalar expansion of the household homesite interaction model. While a single isolated family household would technically represent its own camp, residence groups are most commonly defined as a group of multiple households that "...are closely related, live close together, and cooperate in a variety of basic economic activities on a daily basis" (Rocek 1995:44). As Kluckhohn and Leighton (Kluckhohn and Leighton 1962:102) describe:

"Commonly this "extended family" consists of an older woman with her husband and unmarried children, together with her married daughters and their husbands and unmarried children." The loosely clustered, matrifocal settlement pattern that results reflects both the traditional *k'é*-based teachings of familial interdependence as well as distinctive social practices like matrilocality and (formerly) polygamy (Aberle 1981; Hamamsy 1957; Kluckhohn and Leighton 1962:100–105; Witherspoon 1975).

Residence groups are regarded as the primary land-using unit in traditional Navajo society (Kelley 1986:2). This designation reflects their status as a collection of one or more economic units engaged in "…daily cooperation in basic subsistence activities" (Rocek 1995:44). In the nineteenth and twentieth century, residence groups became increasingly organized "…around a [communal] sheep herd, a customary land use area, a head mother [matriarch], and sometimes agricultural fields" (Witherspoon 1975:72). In particular, communal sheep herds functioned as an important symbol of and mechanism for social integration within the residence group. A household's membership in a particular residence group could be ascertained based on their sheep's presence or absence in a particular herd, and the movements of communal herds delimited the de facto territory associated with a particular residence group (Witherspoon 1973:1443; 1975).

Spatially, Navajo residence groups are typically defined as a clustered aggregate of dwellings located within "shouting distance" of each other (Rocek 1995:44, Table 3.1). The general composition of a residence group "camp" thus represents a scaled-up version of the individual household homesite as described above, complete with special use features. Reflecting the increased scale of residence group activities, however, the size and/or number of certain special use areas like corrals, shadehouses, and fields are frequently greater than those at individual household homesites (Russell and Dean 1985).

The "Middle-level Social Unit," aka the "Outfit"

The concept of a middle-level social unit that transcends residence groups yet exists below the level of a community has been one of the most intensively investigated topics in Navajo anthropology. As Rocek notes, however, it has also been one of the most contentious, with "Basic questions includ[ing] the existence or nonexistence of middle-level units, their composition, size, function, and spatial characteristics" all being subject to debate (Rocek 1995:68). Initial attempts to identify this type of social unit date to the 1940s when Kimball and Provinse (1942) and Kluckhohn and Leighton (1962 [1946]:109-111) each described a similar form of socioeconomic unit comprised of two or more residence groups within a particular region that occasionally join together in order to carry out certain communal tasks. Subsequent investigations into these groups or "outfits" have sought to determine the degree to which kinship relations between residence groups further influence these geographic and functional supraresidence groups (Aberle 1981; Adams 1983; Lamphere 1977; Kelley 1982b; 1986; Witherspoon 1975).[20]

Rocek's synthetic investigation of multi-household social units suggests that this is indeed the case, identifying four basic characteristics common to most of the discussions about Navajo middle-level social units. First, while traditional matrilateral relations descending from a common matriarch form an important core demographic in many Diné groups, the larger network of *k'é*-based relationships can all serve to bring additional members into a middle-level

[20] When one considers that these studies were carried out over a sixty-year-long period that saw substantial outside pressures weigh on Navajo society, as well as the sheer size of the historic/modern Navajo community in both spatial and demographic terms, it seems likely that these numerous attempted definitions of the elusive Navajo middle-level social unit actually reflect different forms of seasonal, regional, or historical difference at this particular level of Diné society, rather than a universal cultural trait (Rocek 1995:69, 78).

outfit. These ties can potentially include patrilateral, affinal, and non-kinship relationships (e.g., friendship), as well as clan-based connections (Rocek 1995:149; Aberle 1981). Second, the different residence groups involved must come from the same community; however, they do not need to be contiguous groups, nor do individual members need be present in the area at all times (Rocek 1995:149). Third, although middle-level groups lack social agency themselves and are thus hard to identify (Lamphere 1970; 1977), said groups form "webs of cooperation" that provide the labor force and social connections necessary to form "action groups."
These ad hoc groups become analytically visible when they carry out "behaviors" that go beyond the expected capacity of individual households or residence groups (Rocek 1995:150-151). Examples of these sorts of larger communal undertakings might include the formation of war parties (Kemrer and Graybill 1970), communal hunting missions (Copeland 2017), or the hosting of expensive large multi-day ceremonies like the Enemy Way, Night Way, or Mountaintop Way (Haile 1938; Faris 1990; Wyman 1975). Fourth, middle-level groups exist along a spectrum that sees both diffuse and intensive degrees of integration between the component residence groups (Rocek 1995:66, 150, 152-153). Taken together, middle-level units provide a flexible form of social organization that allows individuals and relationships to act in a flexible manner as needed without collapsing the greater societal whole (Rocek 1995:163).

Interestingly, it is difficult to ascertain specific spatial or demographic patterns associated with the size and extent of middle-level social units in the Navajo ethnohistoric data. Middle-level group population estimates provided in the literature range from 19 in one case to between 50 and 200 in another, with averages between 40 and 70 individuals (Rocek 1995:162). Data sampling issues hamper the statistical evaluations of middle-level clusters on Black Mesa; however, ethnographic data notes cooperating group territories of "perhaps three to six miles average diameter" (Rocek 1995:163). It is possible though that this varying information reflects in part the historic conditions under which it was collected, as none of the ethnographies predate the United States government's Livestock Reduction Program in the 1930s (Weisiger 2009). As described by Kelley (1986:11), the widespread slaughter of hundreds of thousands of livestock crippled the old agro-pastoralist system and ushered in capitalist markets and wage work. The "traditional systems" of land use and land tenure recorded by early anthropologists would have thus been adversely affected by these events. Prior to this period, however, it is likely that the relationships between different Diné residence groups would have resembled the larger self-sufficient "natural communities" as discussed by early twentieth century ethnographers (Hill 1940a).

The Community

Navajo communities are high-level social units that comprise numerous individual households, residence groups, and middle-level groups. Early anthropologists identified these "natural communities" or regional "bands" as geographically defined, self-sufficient economic entities loosely organized under the nominal leadership of one or more local *naat'áanii*, or "headmen" (Hill 1940).[21] It is thought that the unifying structure of these otherwise dispersed communities would have been shaped by repeated marriages among localized lineages, with "…affinal ties among lineages [possibly resulting] in a community with a land base adequate for both farming and herding that might have remained stable for generations" (Kelley 1980:311).

[21] *Naat'áanii* historically came into leadership roles by exemplifying the tenets of SNBH through their character, speaking skills, practical wisdom, and ceremonial knowledge. Drawing on these skills and knowledge, they would be called upon to resolve disputes and provide community guidance at key moments (Denetdale 2006; Hill 1940a; Van Valkenburgh 1948). Spanish accounts referencing various named and unnamed Navajo "captains" indicate that the naat'áaníí-led band organization was in place during the nineteenth and eighteenth centuries, and likely earlier as well (McNitt 1990; Reeve 1960). Although the majority of historically documented leaders were male, the Diné historian Jennifer Denetdale (2006) has pointed out that Diné oral traditions reference female leaders as well.

With the U.S.-Navajo Treaty of 1868 and the creation of the Navajo reservation, the installation and popularization of American-style economic and political institutions led to the steady replacement of the older Diné band system. Following the initial creation of the Navajo tribal government structure in the 1920s, the smallest administrative unit, the chapter, became the de facto unit of regional community organization in contemporary Diné society (Wilkins 2013). Currently, each of the Navajo Nation's 110 chapters is represented in the tribal council by an elected delegate who works closely with a separate board of elected chapter officials led by a chapter president.[22] Each community has a central chapter house where a variety of local activities are conducted, including both monthly tribal political meetings and special events like fun runs, holiday celebrations, and family gatherings. Chapter houses serve as the central point for various economic and logistical activities in their communities, including the periodic disbursement of financial and material aid (e.g., summer youth jobs, student scholarships, federal commodities, or community hay purchases), the storage and use of heavy equipment (e.g., road graders, bulldozers, tractors, etc.), and reliable access to water, electricity, and phone/internet service.

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[22] Although the contemporary chapter organization is part of a much more formalized type of political system, the fact that these administrative units are inherently connected to local Diné communities – and the *k'é* relations that underlie them – means that certain aspects of the previous headman-focused band system can still be seen in the present day. Indeed, when the first iteration of the modern Navajo governmental system was established in the 1920s, the earliest Navajo council delegates and chapter presidents were essentially local headmen. In the twenty-first century, the ability to demonstrate one's ability to access and embody traditional Diné teachings on harmonious governance via a command of the Navajo language and traditional culture remains an important (if increasingly contentious) prerequisite for holding political office in Navajoland (Jacobsen and Thompson 2020). Today, many council delegates and chapter officials maintain a degree of social prominence and respect in their respective chapter communities that echoes that of earlier headmen.

Chapter 4: The Early Navajo Pastoral Landscape Project Phase 1 – Learning from Herding on Black Mesa

INTRODUCTION

Over the past century, many academic studies have engaged with the topic of Navajo pastoralism to some degree. Closer inspection reveals, however, that the bulk of these historical and ethnographic texts are overwhelmingly focused on the post-Long Walk reservation period and boom-bust nature of Navajo herding in the early twentieth century (e.g., Bailey 1980; Downs 1964; Weisiger 2009). The portions of these and other texts that discuss the role of classic Diné sheep and goat herding in Navajo society during the preceding 250 year period, however, are much more spotty due in part to the incomplete nature of Spanish language records from colonial New Mexico and the lack of definitive archaeological evidence (Weisiger 2004:254; Dykeman 2003c:430–431). More specifically, although there is clear evidence for the presence and maintenance of sheep and other animal domesticates at early Navajo sites throughout the Dinétah region, the paucity and fragmentary nature of this data makes it difficult to generate a synthetic assessment of the intensity, scale, and importance of pastoralism to seventeenth and eighteenth century Navajo groups.

Confronted with this challenge, I resolved to take a different tack, one that reflected upon the tangible demands of working with a herd of sheep out on the land and used those real-world lessons to help interpret the early Navajo archaeological record. Pastoral-focused research across the globe has shown that archaeological studies of pastoralism benefit greatly from the application of ethnographic or experiential knowledge (e.g., Chang 1992; Chang and Tourtellotte 1993; Égüez and Makarewicz 2018; Kuznar 1995; Murray and Chang 1981; Webley 1986;

2007). Despite growing up on the Navajo Nation, however, I did not have any personal knowledge of sheepherding! As such, I sought to apprentice with a knowledgeable Diné herder and gain firsthand appreciation for the daily demands of a lifeway that had supported Diné families for centuries.

The realization that sheep and goat herding had formed the main livelihood for earlier generations of my own family provided the catalyst for the ENPLP's first phase. Conversations with my family revealed that one of my relatives, Annie Remiro, continued to maintain a herd of over a hundred sheep and goats in our extended family's traditional grazing area on Black Mesa near the community of Kits'iilí, Arizona. Not only was the herd managed in the traditional way, free-range and on foot or horseback, but the hilly wooded drainages of northeastern Black Mesa possessed a number of topographic and environmental similarities to the Spanish colonial-era Navajo heartland in Dinétah. With my family's blessing I moved to Kits'iilí at the start of 2018 and began a six-month period of "experimental ethnoarchaeology" with the goal of answering three questions. First, what factors influence the choices one makes while managing a herd of animals? Second, how do different types of pastoral activities express themselves on the landscape and in the archaeological record? Third, what answers to these two previous questions might prove useful to the goal of better understanding earlier Navajo herding practices?

This chapter details the results of my work to address these questions, in terms of the initial data gathering on Black Mesa. The subsequent GIS-based geospatial analysis of the ethnoarchaeological data is detailed in Chapter 5. This process revealed numerous lessons about the more recent history of the nineteenth and twentieth century Navajo community, as well as the continued importance of traditional agro-pastoralism in Diné culture. These observations are analyzed and discussed in greater detail in Chapter 7.

SITUATING THE ENPLP PHASE 1 WORK: KITS'IILÍ AND NORTHEASTERN BLACK MESA IN SPACE AND TIME

Figure 4 – View from hill overlooking the Upper Oraibi drainage.

The Political and Physical Environment of Kits'iilí

The community of Kits'iilí is located in the central portion of the Navajo Nation atop *Dziłíjiin*, or Black Mesa, a large formation covering more than 5,400 square miles (13,985 km^2) (see Figure 1) in northeastern Arizona. Kits'iilí is the seat of Kits'iilli/Black Mesa Chapter, one of the Navajo Nation's 110 local governmental units, and is located within BIA Grazing District 4. The area is regarded as very remote and rural, with ranching forming the traditional economic activity for most of the chapter's 200 residents (Yurth 2012). Black Mesa Chapter occupies the northeastern corner of Black Mesa and is characterized by rugged topography flanking the upper reaches of the Oraibi Wash drainage system (Figure 4). The elevation varies from approximately 2315 m (7600 ft) along the northeastern mesa rim to 1920 m (6300 ft) in the Oraibi Wash floodplain to the southwest. The main wash and its tributaries are heavily incised and commonly reach between 9-15 meters deep; erosional sinkhole networks are present along some drainages. Vegetation in the floodplains is dominated by forage plants including greasewood (*díwózhiishzhiin*), sagebrush (*ts'ah*), and four-winged saltbrush (*díwózhiiłbáií*), while the hills are covered by dense piñon-juniper woodland (*chá'oł*; *gad*) interspersed with stands of Gamble oak (*chéch'il*), cliffrose (*awééts'áál*), and mountain mahogany (*tsé'ésdaazii*). Small groves of aspens (*t'iisbáí*) are found near springs close to the mesa rim, which overlooks the greater Laguña Creek-Chinle Valley lowlands to the north and east.

The History of Northeastern Black Mesa

Ánaasází - The Early Inhabitants (pre- c. AD 1300)

The northeastern portion of Black Mesa has seen relatively little archaeological research compared to the former coal mine lease areas to the west or the Hopi mesas to the south. Yet as the chapter's Navajo name (*Kits'iilí*; "shattered stone house") indicates, there is widespread evidence of the Ánaasází occupation throughout the area. Although limited in scope, cultural resource management projects have identified numerous Basketmaker and Kayenta Ánaasází (c. AD 550-1300) sites along the upper Oraibi Wash drainage ranging from simple artifact scatters to small multi-room pueblos (Kakos 1993). Kits'iilí Ruin (AZ-D-12-1) is the principal site in the area and consists of an 800 m^2, J-shaped masonry pueblo occupying a hilltop at the junction of the Main and West forks of Oraibi Wash. The site's architecture and ceramic assemblage indicate a late Pueblo III period occupation between at least AD 1265 and 1285 (Gilpin 1990). Northern Black Mesa and the adjacent Tsegi region were depopulated between AD 1150 and

1300 due in part to environmental shifts in the region and it is likely that the upper Oraibi Ánaasází community was caught up in these population movements (Powell 2002; Dean 2002).

Pre-Long Walk Diné History of Northeastern Black Mesa (c. AD 1300-1868)

The transitional period between the heyday of Ánaasází settlement and large-scale Navajo presence on Black Mesa is poorly understood. Colwell and Ferguson (2017) have argued that Navajo settlement west of Chinle Wash was negligible before AD 1840. Early Navajo-focused archaeological research across the Navajo Nation remains extremely limited, however, and substantial work is needed to verify these claims. Thirty-seven Navajo archaeological sites were identified along upper Oraibi Wash and adjacent drainages as part of the wide-ranging Navajo Land Claims (NLC) research during the 1940s and 1950s (Navajo Tribe 1960). Using the NLC data, Kemrer (1974) determined that Navajo settlement on Black Mesa dated to at least AD 1703 and likely earlier. In the upper Oraibi Wash valley, evidence for Navajo settlement becomes clearer during the first half of the 19th century, with 17 sites tree-ring dating to the AD 1830s onwards (Navajo Tribe 1960:Exhibit 520W).

Although Spanish interactions with the Hopi on the southern edge of Black Mesa are well documented, the early history of Euro-American activity to the north is unclear. The first recorded activities date to the first half of the nineteenth century when Vizcarra's 1823 punitive mission against western Navajos ventured north and west of Hopi (Brugge 1964). Notably, the upper Oraibi Wash drainage formed a key natural travel corridor across the mesa that linked the Hopi mesas with the northern Chinle Wash drainage. In 1859, a U.S. Army expedition from Fort Defiance to Navajo Mountain crossed the northern edge of Black Mesa, likely passing Kits'iilí Ruin (Walker and Shepherd 1964:79–90). Increased U.S. military pressure throughout the 1850s culminated in Kit Carson's scorched earth campaign of 1863 and a series of forced relocations to

Fort Sumner, New Mexico between 1863 and 1868. Oral histories recorded during the 1950s and 1960s indicate that while some Navajo families along Oraibi Wash were forced into captivity, many others resisted by fleeing to more defensible parts of Navajo territory, including the rugged uplands of northern Black Mesa (Ackerly 1998; Roessel and Johnson 1973)

Post-Long Walk Diné History of Northeastern Black Mesa (AD 1868-Present)

Following the Navajo Treaty of 1868 and the end of hostilities with the United States, Navajo families returned to the Four Corners region. Following the founding of the Navajo reservation in 1868, many families (re)settled beyond its boundaries, including on Black Mesa (Russell 1983). Navajo families rebuilt their herds through government livestock distributions or by recovering animals from non-interned relatives and continued to engage in the same suite of economic activities as earlier in the century (albeit without the threat [or practice] of raiding). This included seasonal trading with the Hopis and other Navajos as well as the resumption and intensification of a sheep and goat-focused form of mobile agropastoralism (Iverson 2002:66-71). Beginning in the 1870s and becoming more common after 1910, however, trading posts established on the reservation provided a ready source of Euro-American goods and a market for Navajo wool, livestock, and crafts sales (Kelley and Francis 2019). The nearest trading posts to Kits'iilí were those at Rough Rock (~15 miles northeast, established 1897), Chilchinbito (~14 miles north; established circa 1910), and Pinon (~25 miles south; established 1916) (Kelley and Francis 2018:99–101, 301–304, 329–332). Kits'iilí was incorporated into the growing reservation following the presidential order of 1884 and recognized as a chapter unit in 1922 (Eck 1982).

Despite its remoteness, the Kits'iilí area has been affected by several major events in twentieth century Navajo history. The 1918-1920 influenza epidemic saw a 12 percent mortality rate in Navajo communities across the reservation, including isolated camps on Black Mesa (Brady and Bahr 2014; Gillmor and Wetherill 1934:228; Reagan 1919; Russell 1985). The imposition of the Livestock Reduction Programs of 1933-1936 and the creation of permitted grazing districts in 1936 by the Bureau of Indian Affairs constrained traditional herding practices in the region (Henderson 1989), although it remained the key economic activity in Kits'iilí.

The U.S. push to extract coal from northern Black Mesa and the ensuing Navajo-Hopi Land Dispute has affected the region since the 1950s. The western half of Black Mesa Chapter (including the Phase 1 study area) fell within the disputed territory designated in 1962 as the Joint Use Area (JUA) and subsequently as part of the Navajo Partitioned Lands (NPL) in 1974. Following preparations during the 1960s, Peabody Coal opened two large surface mines in 1970 and 1973 on a 64,000 acre (25,900 ha) lease in the JUA twenty kilometers west of Kits'iilí. Although operations ceased in 2019, the mines have left the Black Mesa N-aquifer severely depleted and the land only partially reclaimed (Iverson 2002:242–244; Kelley and Francis 2019a:258–262).

THE ENPLP PHASE 1 WORK: OVERVIEW OF STUDY ACTIVITIES

The ENPLP's first fieldwork phase (*ENPLP Phase 1* or *ENPLP-1*) consisted of six months of participant observation and archaeological reconnaissance at the Remiro, Todacheene, and Hadley (R/T/H) extended family "sheep camp" in the Navajo community of Kits'iilí, Arizona. I moved to Kits'iilí on January 28, 2018 in order to familiarize myself with the various demands and expectations associated with contemporary Navajo sheepherding. I commenced formal ethnoarchaeological recording on March 20, 2018 following approval of the project by the Navajo Nation Human Research Review Board. The Phase 1 fieldwork was completed on

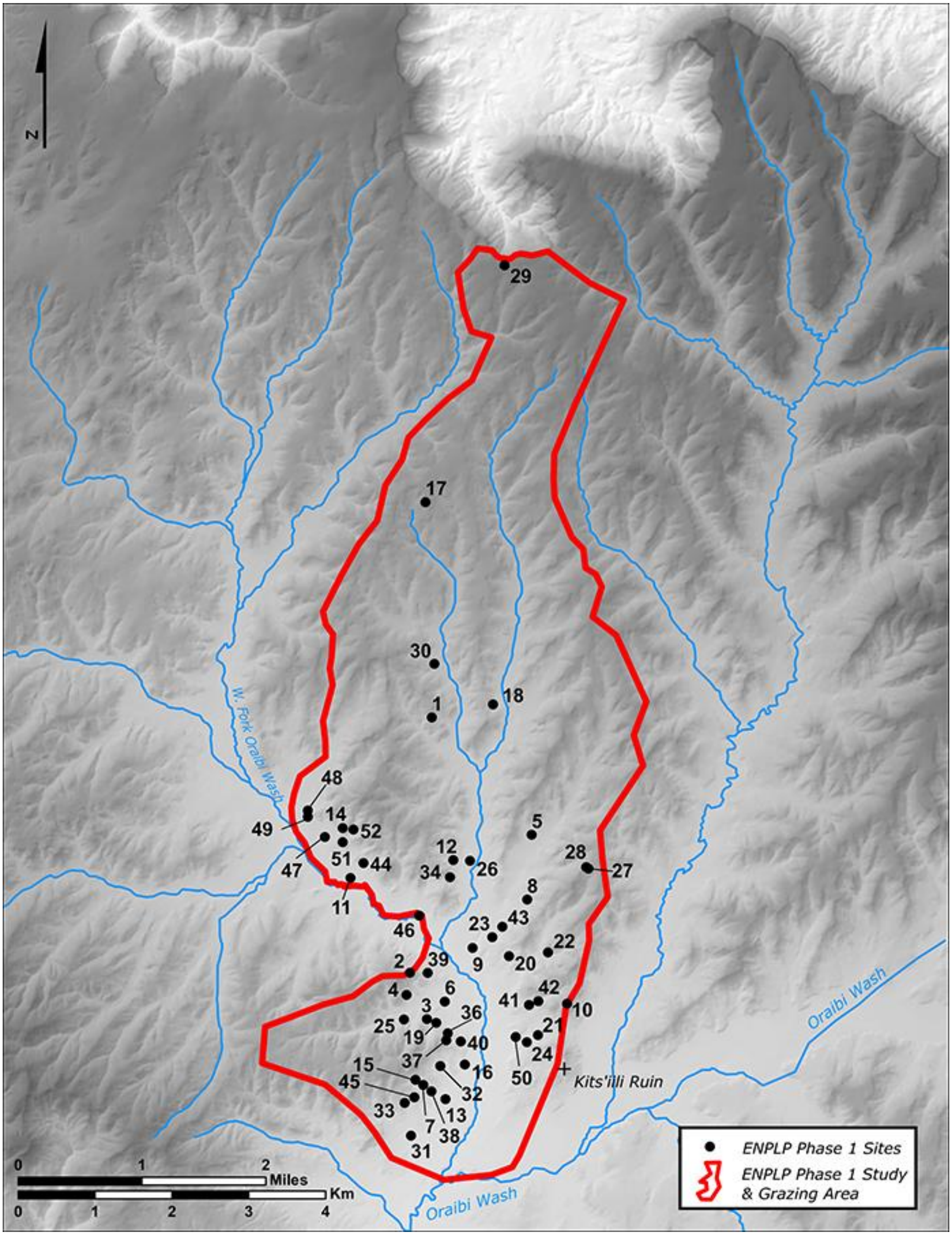

Figure 5 - ENPLP Phase 1 Study Area boundaries and distribution of identified sites.

August 9, 2018. The Phase 1 study area corresponds to the traditional boundaries of the R/T/H family's grazing area atop Black Mesa, an approximately 13 square mile (34 km^2) area encompassing the lower portions of the West Fork of Oraibi Wash and the entirety of Red Point Wash (Figure 5).

The principal Phase 1 activity consisted of active participation in the daily activities of the R/T/H sheep camp. Under the direction of Annie Remiro (A.R.), I focused on helping manage the daily grazing of approximately 200 sheep and goats, as well as engaging in other ranch activities. These included the less intensive management of several dozen cattle and a number of seasonal ranching chores, including shearing and summer sales. Note that due to the severe drought conditions that characterized the Four Corners region during the winter of 2017 and most of 2018, A.R. intentionally chose to prevent the herd's mating and lambing activities to avoid straining the already limited resources of the grazing area. Throughout the course of the 2018 activities (and continuing through the 2019/2020 research phases), I engaged in numerous informal conversations with A.R. and other R/T/H family members regarding the nature of past and present Navajo herding, the history of the greater Kits'iilí area, and the R/T/H family's role in said events. This ethnographic information was collected and examined through a combination of daily journaling, mapping, and sketching activities.

Phase 1's archaeological component comprised three distinct sets of fieldwork activities. First, while carrying out the daily herding round or participating in other ranch activities, I also conducted an opportunistic reconnaissance survey that focused on identifying archaeological sites within the study area, especially those displaying herding-related infrastructure (e.g., corrals) or other features of interest. The sites identified during the reconnaissance sites were all revisited during the second set of activities, an intensive site recording campaign conducted from

July 31 to August 9, 2018. Activities during this 10-day period consisted of formal site documentation, drone photography, GPS mapping, and dendroarchaeological sampling. Finally, a set of GPS collars ("sheePS units") were placed on two sheep beginning in March 2018 to more accurately record where and how the herd moved about the landscape.

THE ENPLP PHASE 1 WORK: ANALYSES & RESULTS

The Phase 1 reconnaissance survey resulted in the identification of a total of 51 historic Navajo sites within the study area (Figure 5). Results from the dendrochronology analysis indicates that the recorded occupation of these sites spans a minimum 135 year period from AD 1884 to the present day, although it is likely that several sites predate the 1880s. The sites comprise three general categories (habitations sites, specialized activity sites, and ceremonial sites) that are further sub-divided into a number of specific site types (Table 1). A description of the different site types and the key traits associated with each site type are provided below.

Ethnoarchaeological Survey Results

Habitation Sites

Traditional Navajo habitation sites consist of a discrete yet spatially dispersed collection of one or more dwelling structures occupied by a single family group. In many instances, single-family habitations form parts of a larger site complex that consists of a number of loosely clustered habitations united by shared membership in an extended family residence group. Both single-family and multi-family homesites are commonly referred to in Diné culture as "camps." Camps were historically situated on the landscape with the goal of optimizing access to a variety of natural resources in the area (e.g., water, pasture, fuelwood, and arable land) while also

Table 1 - Sites Identified during the ENPLP Phase 1 Survey

ENPLP Site No.	Site Name	Site Types
Habitation Sites		
ENPLP1-1	Ben Da'alchihi Winter Camp	Sheep Camp
ENPLP1-3	Broken Reservoir Camp	Sheep Camp
ENPLP1-8	Celebration Grave Hogan Cluster	Sheep Camp
ENPLP1-12	F.H. Red Point Wash Camp	Sheep Camp
ENPLP1-17	Hut House Winter Camp	Sheep Camp
ENPLP1-18	Junction Camp; Beegaashii Jolgali	Sheep Camp
ENPLP1-20	K.Y. Camp	Sheep Camp
ENPLP1-29	Rim Camp	Sheep Camp
ENPLP1-32	South Grave Hogan Camp	Sheep Camp
ENPLP1-39	Ts'ah Desk'idi Camp	Sheep Camp
ENPLP1-40	Tse Dez Aha Summer Camp	Sheep Camp
ENPLP1-41	Tseazoli Camp	Sheep Camp
ENPLP1-45	Wedge Camp	Sheep Camp
ENPLP1-48	West Fork Grave Camp	Sheep Camp
ENPLP1-51	West Fork Summer Camp	Sheep Camp
ENPLP1-5	C.G. Celebration Camp	Single Habitation Camp
ENPLP1-13	F.H. Stone House Site	Single Habitation Camp
ENPLP1-24	Northeast Kits'iilí Hogan	Single Habitation Camp
ENPLP1-28	Ridgetop Tree Hogan	Single Habitation Camp
ENPLP1-4	Broken Reservoir Tree Hogan	Single Habitation Camp
ENPLP1-15	Hidden Hogan Camp	Single Habitation Camp
ENPLP1-21	Kits'iilí Gap Grave Hogan	Single Habitation Camp
ENPLP1-30	Sliding House	Multiple Habitation Camp
ENPLP1-19	K.R. Brush Shelter	Temporary Campsite
ENPLP1-22	Long Valley Shelter	Temporary Campsite
ENPLP1-27	Ridgetop Shelter	Temporary Campsite
ENPLP1-43	VA Hill Tent Camp	Temporary Campsite
Specialized Activity Sites		
ENPLP1-14	F.H. West Fork Old Camp	Isolated Herding Feature
ENPLP1-25	Ram Corral	Isolated Herding Feature
ENPLP1-33	Southwest Corral	Isolated Herding Feature
ENPLP1-34	Strawberry Hill Corral	Isolated Herding Feature
ENPLP1-49	West Fork Lamb Pen	Isolated Herding Feature
ENPLP1-38	Tinaja Tank	Isolated Herding Feature
ENPLP1-26	Red Point Wash Main Camp Tacheeh	Sweatlodge Site
ENPLP1-36	Tacheeh Cluster Site	Sweatlodge Site

Table 1 (Continued) – Sites Identified during the ENPLP Phase 1 Survey

ENPLP1-37	Tacheeh West of Tse Dez Aha	Sweatlodge Site
ENPLP1-42	Tseazoli Tacheeh	Sweatlodge Site
ENPLP1-52	West Fork Summer Camp Tacheeh	Sweatlodge Site
ENPLP1-16	Hopi Rock Art Site	Rock Art
ENPLP1-50	West Fork Oraibi Wash East Bank Rock Art	Rock Art
ENPLP1-2	Broken Reservoir Cairn	Cairn
ENPLP1-10	Chiih Hill Cairn	Cairn
ENPLP1-46	West Fork Cairn	Cairn
ENPLP1-9	Celebration Wash Bridge	Bridge
ENPLP1-7	Cairn Grave	Grave Site
Ceremonial Sites		
ENPLP1-6	C.G. Ceremony Site	Ceremonial Site
ENPLP1-11	E.T. Fire Dance Site	Ceremonial Site
ENPLP1-23	M.T. Fire Dance Site	Ceremonial Site
ENPLP1-31	South Enemyway Site	Ceremonial Site
ENPLP1-44	W.H. Fire Dance Site	Ceremonial Site
ENPLP1-47	West Fork Enemyway Site	Ceremonial Site

providing residents with a degree of shelter and privacy. Families frequently maintained and traveled between a series of camp locations that were used at different times of the year for a variety of seasonal tasks (e.g., “summer camps,” “winter camps,” “pinyon picking camps,” etc.).

A total of 27 historic Navajo habitation sites were identified in the ENPLP Phase 1 study area, as well as the main camp of the R/T/H extended family. They comprise four general types of sites: single habitation and multiple habitation camps, sheep camps, and temporary campsites.As defined here, all *single* and *multiple habitation camps* follow the general base model described below. *Sheep camps* are distinguished from general habitation camps by the positive identification of one or more corrals at the site, while *temporary campsites* are defined by the presence of unaccompanied ad hoc or short-term habitation structures.

Single & Multiple Habitation Camps – Eight habitation sites identified during the ENPLP Phase 1 work were classified as general “camps” (seven “single habitation camps” and one “multiple habitation camp"). Navajo camps display a great deal of diversity in their internal composition, although all homesites include at least one or more dwelling structures. Habitation types include "permanent" structures like Diné vernacular *hogans*[23] and Western-style masonry or framed lumber buildings to more "temporary" or "seasonal" constructions described in greater detail below. Hogans are built in one of two general types following a culturally proscribed process that utilizes a variety of locally available resources ranging from timbers, stone, and earth to more modern materials. The first type is the "male" conical, earth-covered forked-stick hogan, while the second type is the round "female" hogan, which can be built in several different ways (Figure 6). As a cultural rule, the entryways of Navajo homes, regardless of traditional or Western origins, are predominantly oriented toward the east to greet the rising sun.

Navajo camps also contain a number of non-habitation elements associated with a wide range of on-site activities (Figure 7). These include those associated with various domestic tasks like shadehouses, outdoor cooking areas, ovens, storage platforms, butchering racks, and middens, as well as areas for specialized economic pursuits like weaving or metalworking. Homesites with frequent or long-term occupations often have one or more sweatlodge areas nearby for hygienic purposes. Perhaps the most notable non-habitation component of many historic period Navajo camps, however, is the presence of one or more corrals used to manage herds of sheep, goats, horses, and cattle.

[23] As described by Campbell and colleagues (2021:257): "…Navajo archaeology depends upon the identification of hogan structures as its key ethnic marker and unit of analysis. However, the English word "hogan" is derived from the Navajo term *hooghan*, which is less a defined building and more like a category. Put simply, in Diné bizaad, *hooghan* is a "home place" and can equally refer to a specific geographical space, campsite [i.e., a homesite "camp" like those defined here for the ENPLP Phase 1 work], forked-stick structure, circular structure, masonry structure, log cabin, or three-story mansion. Explanations of Navajo culture and history that uncritically rely on hogans as the primary markers of Navajo identity treat Navajos as a monolithic population building hogans and adopting a pastoral lifestyle all at the same time. It is more appropriate to think of a hogan as representative of only one type of Diné structure and activity in the past."

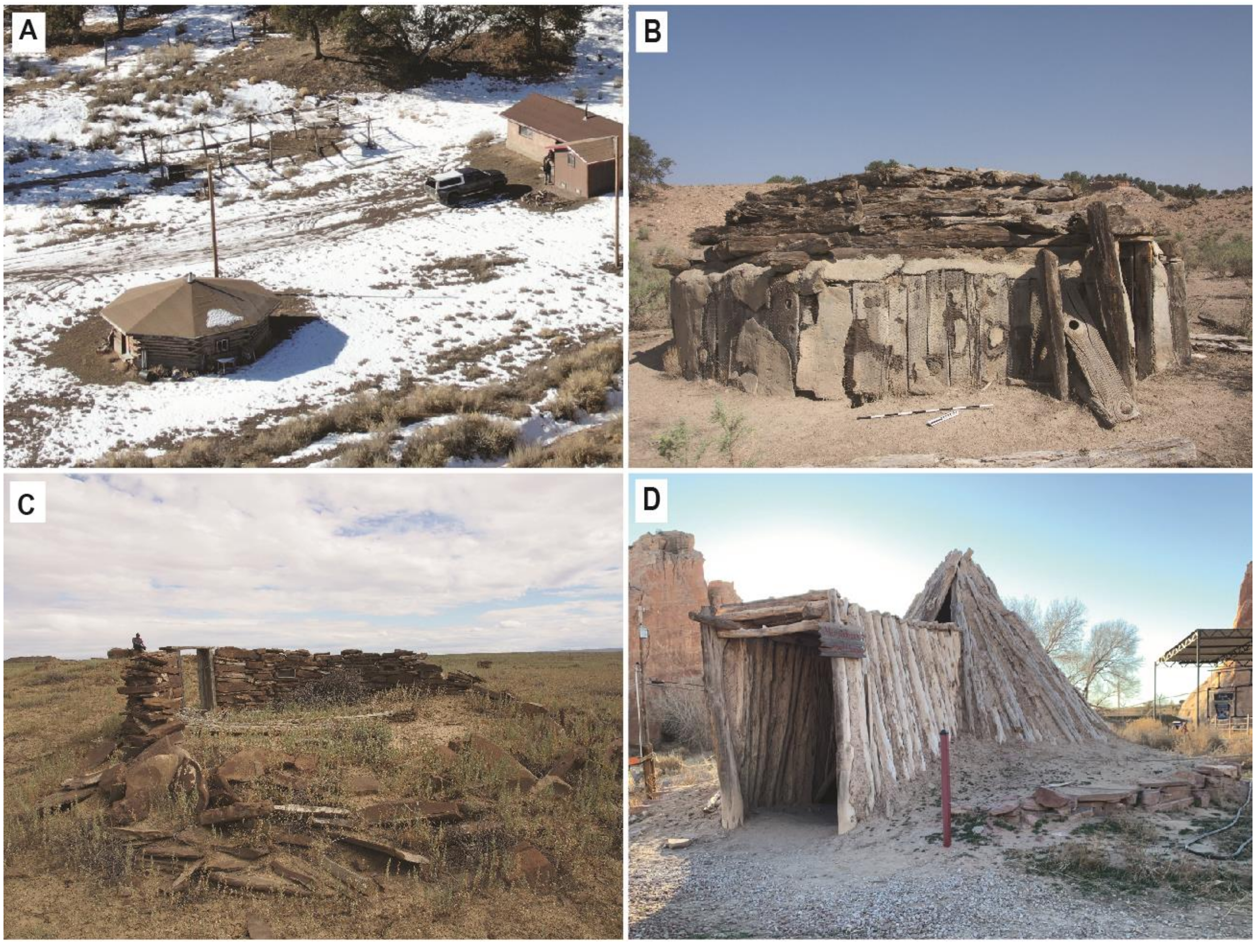

Figure 6 – Examples of different types of Diné hogans, including: A) a modern cribbed-log version with a framed roof; B) a palisaded board hogan with stuccoed walls and corbelled roof, C) a stone hogan from the San Juan Basin, and D) a forked stick hogan (note the "melted" layer of earth that previously covered the structure) [Images C & D courtesy of Zackery Sam].

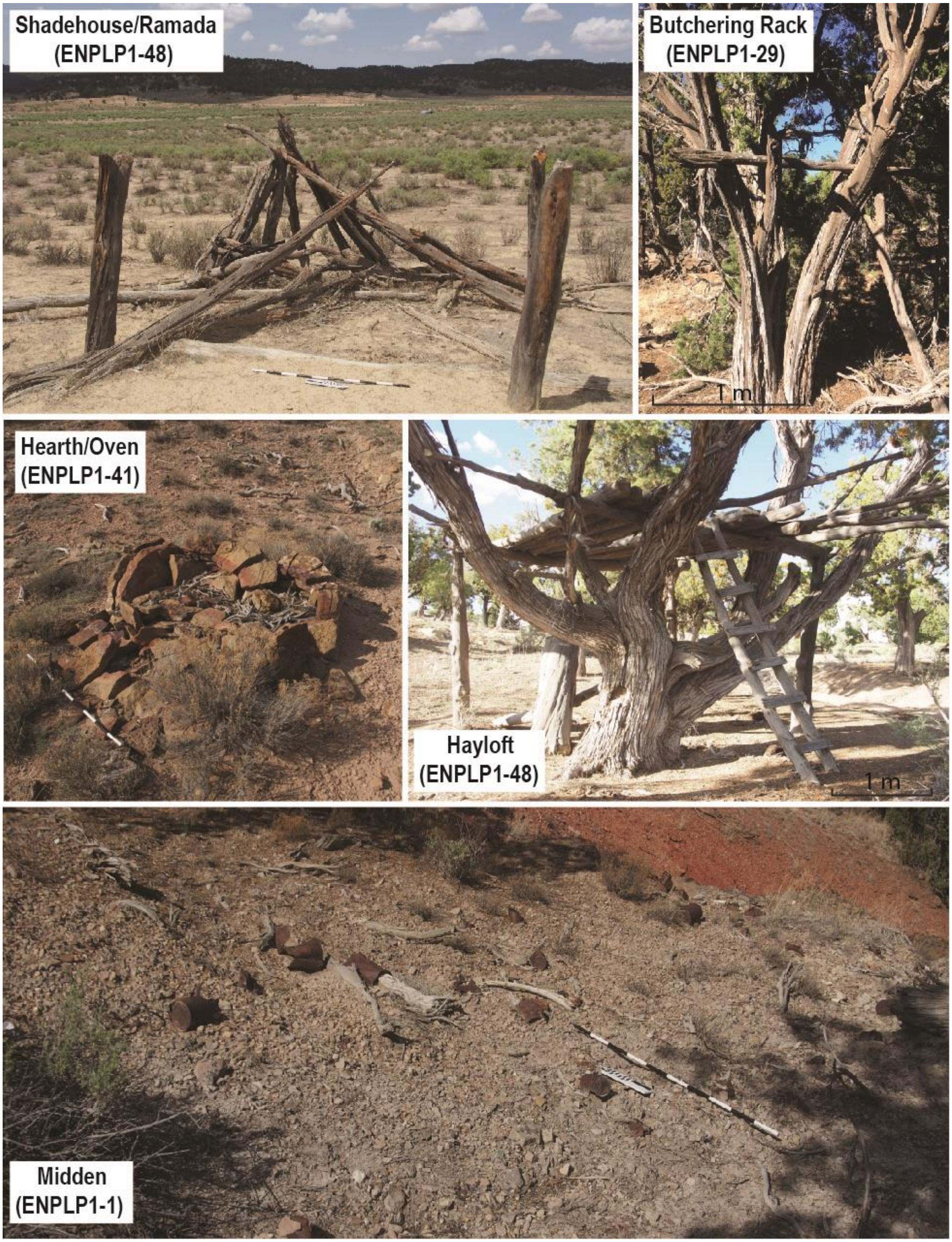

Figure 7 – Examples of common types of non-habitation elements encountered at historic Navajo camps.

Sheep Camps – A minimum of 15 historic sheep camps are dispersed throughout the ENPLP Phase 1 study area. In many instances, the sheep camp category can be further divided into two seasonal sub-categories – "summer camps" and "winter camps" – based on a combination of ethnographic information and archaeological site characteristics. Specifically, in the ENPLP-1 study area, *summer* sheep camps tend to be located along the lowland valley margins, while the two sites explicitly identified as *winter* camps (ENPLP1-1 and 17) are located away from the valleys in atop heavily wooded hilltop locations that provide natural windbreaks and fuelwood for cold-weather usage. This seasonal pattern follows that identified by earlier studies in other parts of Black Mesa (Russell and Dean 1985:10–13).

The identified sheep camp sites range in size from ENPLP1-29, a 625 square meter single-dwelling camp with one associated corral, to ENPLP1-32, a 7.5 hectare camp complex with four hogans, two large corral areas, and a series of additional structures. The intra-site relationships between corrals and habitations at the ENPLP1 sheep camps appear to be quite variable, with combined in-field and GIS-based measurements indicating that corrals are located between nine and 100 meters from the nearest identified habitation (median distance = 38 meters; Table 2)

.

Table 2 – Distance Between Corral Edge & Nearest Securely Identified Habitation

ENPLP Phase 1 Site No.	Site Name	Site Type	Corral-Habitation Distance (m)
ENPLP1-12	F.H. Red Point Wash Camp – North Corral	Sheep Camp	9
ENPLP1-41	Tseazoli Camp	Sheep Camp	9
ENPLP1-1	Ben Da'alchihi Winter Camp	Sheep Camp	10
ENPLP1-12	F.H. Red Point Wash Camp – South Corral	Sheep Camp	10
ENPLP1-18	Junction Camp; Beegaashii Jolgali	Sheep Camp	12
ENPLP1-17	Hut House Winter Camp	Sheep Camp	15
ENPLP1-3	Broken Reservoir Camp	Sheep Camp	16
ENPLP1-29	Rim Camp	Sheep Camp	19
ENPLP1-51	West Fork Summer Camp	Sheep Camp	26
ENPLP1-48	West Fork Grave Camp	Sheep Camp	28
ENPLP1-40	Tse Dez Aha Summer Camp	Sheep Camp	40
ENPLP1-8	Celebration Grave Hogan Cluster – NE Corral	Sheep Camp	42
ENPLP1-32	South Grave Hogan Camp – North Corral	Sheep Camp	43
ENPLP1-45	Wedge Camp	Sheep Camp	45
ENPLP1-20	K.Y. Camp – East Corral (identified via archaeological survey)	Sheep Camp	48
ENPLP1-39	Ts'ah Desk'idi Camp	Sheep Camp	60
ENPLP1-20	K.Y. Camp - North Corral (only visible in historic aerial imagery)	Sheep Camp	70
ENPLP1-8	Celebration Grave Hogan Cluster – SE Corral	Sheep Camp	80
ENPLP1-32	South Grave Hogan Camp - West Corral	Sheep Camp	80
ENPLP1-5	C.G. Celebration Camp	Single Habitation Camp	100


Figure 8 - The ENPLP1-51 summer camp site. Note the hogan, shade/storage structure, and the corral area up against the base of the rocky ridge.

The most common form of sheep camp in the project area consists of a single habitation structure with one corral (as well as other associated structures and features), typified here by ENPLP1-51. This site is located in a small valley on the north side of the West Fork of Oraibi Wash near its junction with Yellow Jacket Wash and was used as a summer camp by the R/T/H family during the 1950s and 1960s (Figure 8). The camp consists of one palisaded hogan, a metal-clad shadehouse, and a 25 by 51.5 meter corral built up against a rocky ridge. The site is closely associated with ENPLP1-52, a dedicated sweatlodge site located 225 meters to the north along the upper reaches of the same minor drainage.

In addition to the 15 historic sheep camps in the study area, the R/T/H extended family's main camp remains an active sheep camp and was the nexus for all pastoral activities conducted

Figure 9 - The main camp area of the R/H/T extended family, Kits’iilí. The area in view spans a half-kilometer from left to right and includes three main habitation clusters (six homes total), plus two corrals (sheep [central] and horse/cattle [left]), numerous storage and activity areas, a 100-meter-square field, and a reservoir.

during the 2018 fieldwork period (Figure 9). Although the main camp was excluded from the formal archaeological site recording and tree-ring sampling campaigns due to its occupied status, a series of observations were made in the course of daily life in and around the camp. Notably, conversations with relatives and aerial photograph analyses indicate that the earliest portion of the camp dates to at least the early 1950s. The initial hogan and corral were eventually incorporated into the modern camp's main corral, however, which currently covers 6,900 square meters and contains nine distinct subsections that include areas for lambing and shearing tasks. Two additional corrals, eight habitation structures (four hogans and four Western-style houses), and a number of associated structures and features (e.g., shadehouses, outhouses, barns, cargo/shipping containers, two reservoirs, a field, a 950-meter-long airstrip, etc.) make up the remainder of the main camp. Excluding the airstrip, the in-use R/T/H camp area spans approximately 500 meters north-south and 600 meters east-west, or ~30 hectares.

<u>Temporary Campsites</u> – Four of the ENPLP Phase 1 sites appear to be short-term or ad hoc campsites based on the remains of impermanent structures and features and the absence of other identifiable features. These elements include: a still-standing conical summer brush shelter (ENPLP1-19); two lean-tos or windbreaks consisting of branches piled against live trees (ENPLP1-22 and 27); and a set of twinned poles (ENPLP1-43). Conversations with AR and the results of the tree-ring dating helped to further contextualize the histories for three of the temporary campsites: ENPLP1-22 appears to have been an emergency shelter built in inclement weather by AR's mother, MT, while the poles at ENPLP1-43 formed part of a canvas tent frame used as part of a short-lived summer camp. ENPLP1-19 dates to 1967 and represents a temporary campsite built for summer or fall activities (possibly a pinyon picking camp [Russell and Dean

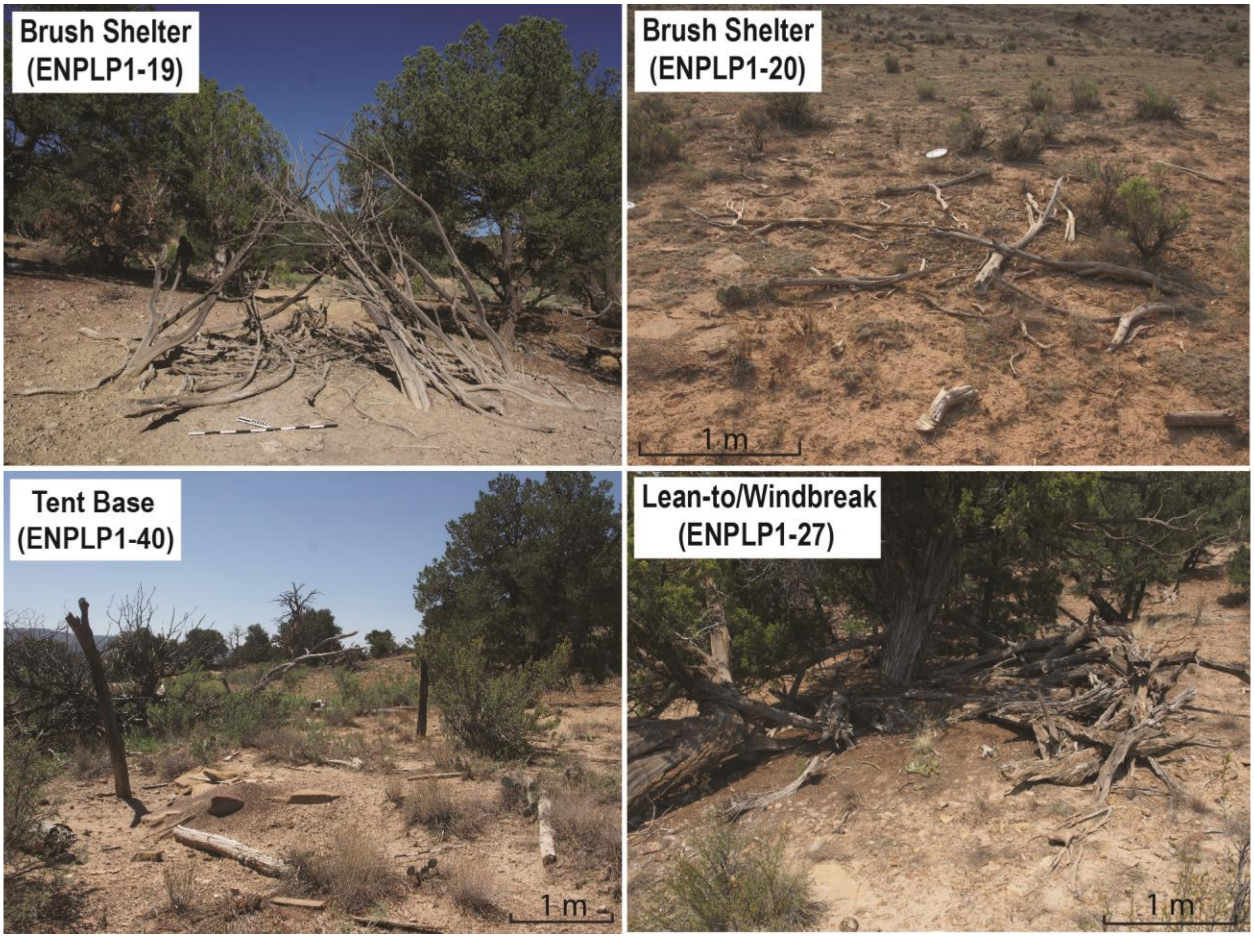

Figure 10 - Examples of "temporary" campsite structures noted at Phase 1 sites.

n.d.]).

Notably, these temporary campsites differ in intent and usage from those more substantial camps that count at least one impermanent structure as part of their overall site structure. For example, the multiple habitation sheep camp ENPLP1-20 includes the collapsed remains of a conical summer brush shelter. At the ENPLP1-40 summer camp, a canvas tent area formalized by a drystone wall and a half-dozen cut posts formed the sheep camp's principal habitation from the 1950s through the late 1960s (Figure 10). In these instances, seemingly "temporary" structures formed parts of larger sites and indeed, the primary component of one. Regardless, the presence of several different types of impermanent (and often quite fragile) structures as both primary and secondary components of habitation sites reminds us that this aspect of traditional Navajo land use practices need to be considered more carefully by archaeologists.

Specialized Activity Sites

The ethnoarchaeological fieldwork resulted in the identification of 18 different non-habitation sites associated with a variety of "specialized activities" throughout the greater ENPLP Phase 1 study area. These sites are further divided into six general types of sites: *isolated pastoral infrastructure*, *sweatlodge sites*, *rock art sites*, *cairns*, *transportation infrastructure*, and *grave sites*. Descriptions of these site types and their distinguishing activities are provided below.

<u>Isolated Pastoral Infrastructure Sites</u> – The term *pastoral infrastructure* is used here to broadly refer to the wide variety of archaeological structures and features associated with different types of animal husbandry activities traditionally performed by Navajo herders. These range from elements associated with daily herding practices like trails, dedicated pasturages, watering areas, et cetera to those elements linked to more specialized economic and maintenance tasks like corralling or penning, shearing, medicating, butchering, and birthing. Along with a variety of culturally specific considerations, these real-world animal husbandry concerns can influence the creation of pastoral infrastructure in a variety of ways. In some instances, certain types of pastoral infrastructure can persist or be maintained for long periods of time while others are only truly formed through sustained human-animal interactions. On the other hand, other types of pastoral infrastructure are distinguished by their short-term, seasonal, or ad hoc nature, with subsequent taphonomic and diagenetic concerns further affecting how these sites are perceived archaeologically.

When combined with ethnographically derived understandings of different forms of pastoral site use, the layout, construction, and landscape characteristics of archaeological corral sites present a wealth of potential information about the nature of past pastoral practices. Individually, pastoral infrastructure elements commonly form parts of larger archaeological complexes like the "sheep camp" habitation sites described above, although they can also occur as isolated archaeological phenomena. Regardless, the types of pastoral structures and features common to a particular region or culture tend to be constructed following a similar architectural vernacular.

As such, the following section discusses key formal and functional trends associated with the three main types of historic Navajo pastoral infrastructure identified in the Phase 1 study area – *corrals*, *lamb pens*, and *watering areas* – as whole groups. The potential "isolate" or "constituent" site status of certain pastoral infrastructural elements will be discussed within each subsection to the extent that such information informs the interpretation and discussion of the greater historic Navajo pastoral landscape of northeastern Black Mesa.

Corrals – A total of twenty-one archaeological elements in the study area were identified as the remnants of large animal enclosures, referred to here as "corrals." Sixteen corrals form parts of larger sheep camp complexes while four appear to represent isolated corrals that are not associated with any other archaeologically visible structures. The enclosed areas range from approximately 400 to 1890 square meters in size and are located from 10 to over 100 meters away from the nearest habitation structures.

Navajo corrals were historically built using an array of commonly available local materials and frequently take advantage of suitable landforms like rocky bluffs or natural draws to help reduce the amount of material and effort needed to constrain the animals (Figure 11). The

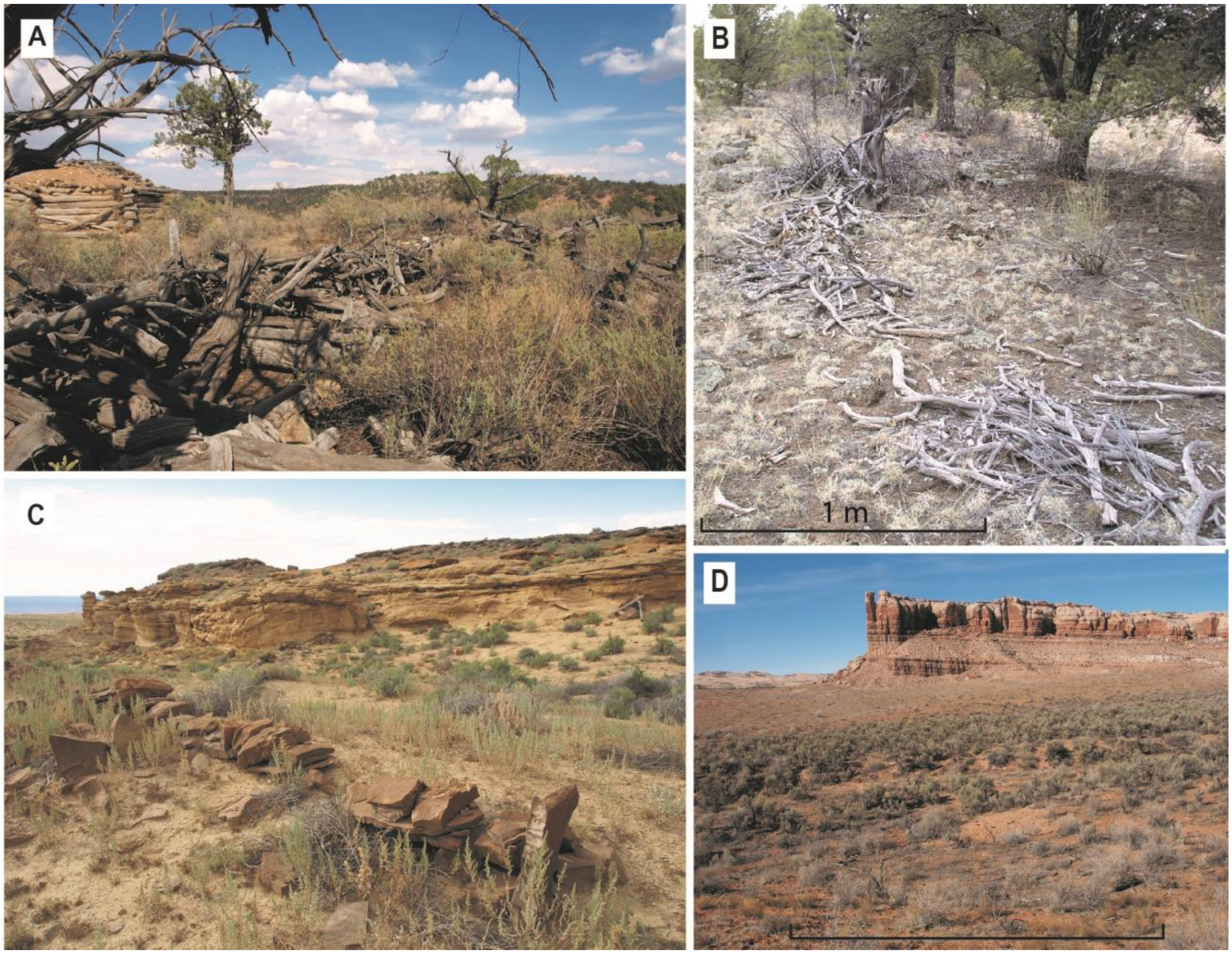

Figure 11 - Examples of different regional Navajo corral types: A) stacked log corral, Black Mesa, AZ; B) remains of brush corral in pinyon/juniper/ponderosa woodlands, Ramah, NM; C) stone corral incorporating rocky ridge, San Juan Basin, NM; sagebrush corral (circular area above bracket), Butler Wash, UT. Note the visible vegetation differences in A, C, and D. [Image B courtesy of Harding Polk and Tom McKenna].

archaeological preservation of corrals in the study area varies substantially; however, the remains of five partially intact corral structures display the same complex wooden interlocked-log and post-and-stacked log superstructures that have been identified at both archaeological and in-use sheep camps elsewhere on Black Mesa (Figure 11-A; Russell & Dean 1985). The remaining corrals in the study area, however, are “lower visibility” archaeological phenomena that lack readily identifiable architectural elements. These features are instead distinguished by partially buried log and stone alignments and/or distinctive soil and vegetation differences relative to the surrounding environment.

Key potential markers of low visibility corral features include: areas of discolored or compositionally distinct soils caused by the build-up and decay of animal dung; the concentrated presence of common forage plants away from their typical habitats; or the presence colonizing plants (e.g., wolfberry, tumbleweed, etc.) or human mutuals (e.g., tobacco, cheno-ams, beeweed, etc.) that favor nutrient-rich disturbed soils near habitations (Kuznar 2001). The presence of lower visibility corral features can generally be interpreted as the result of one of two types of general processes – the application of less intensive herd management techniques and the use of low durability materials (e.g., wire fencing, brush walls, or successive periods of opportunistic animal bedding), or the later modification (e.g., deterioration, dismantling, destruction, etc.) of a more substantial original structure.

As evidenced by the history of the ENPLP1-41 sheep camp, a corral's transformation from high-visibility structure to low-visibility feature can occur in a relatively short period of time. Aerial imagery clearly shows the site in use in October 1952 and inactive or abandoned in October 1967; oral histories describe non-local individuals harvesting the corral timbers and surrounding trees for firewood during the 1970s and 1980s, effectively destroying the site while leaving behind archaeological evidence of its presence (Figure 12).

In a similar vein, ethnoarchaeological landscape-based approaches also allow researchers to harness discussions of past pastoral practices derived from evaluations of well-preserved sites in order to interpret the potential uses of other more marginal sites. For example, corrals associated with historic Navajo summer camps and winter camps on Black Mesa exhibit different traits that help to differentiate the two types of sites (Russell and Dean 1985:10-13). In addition to the characteristic topographic settings described earlier (i.e., "highland" winter camps

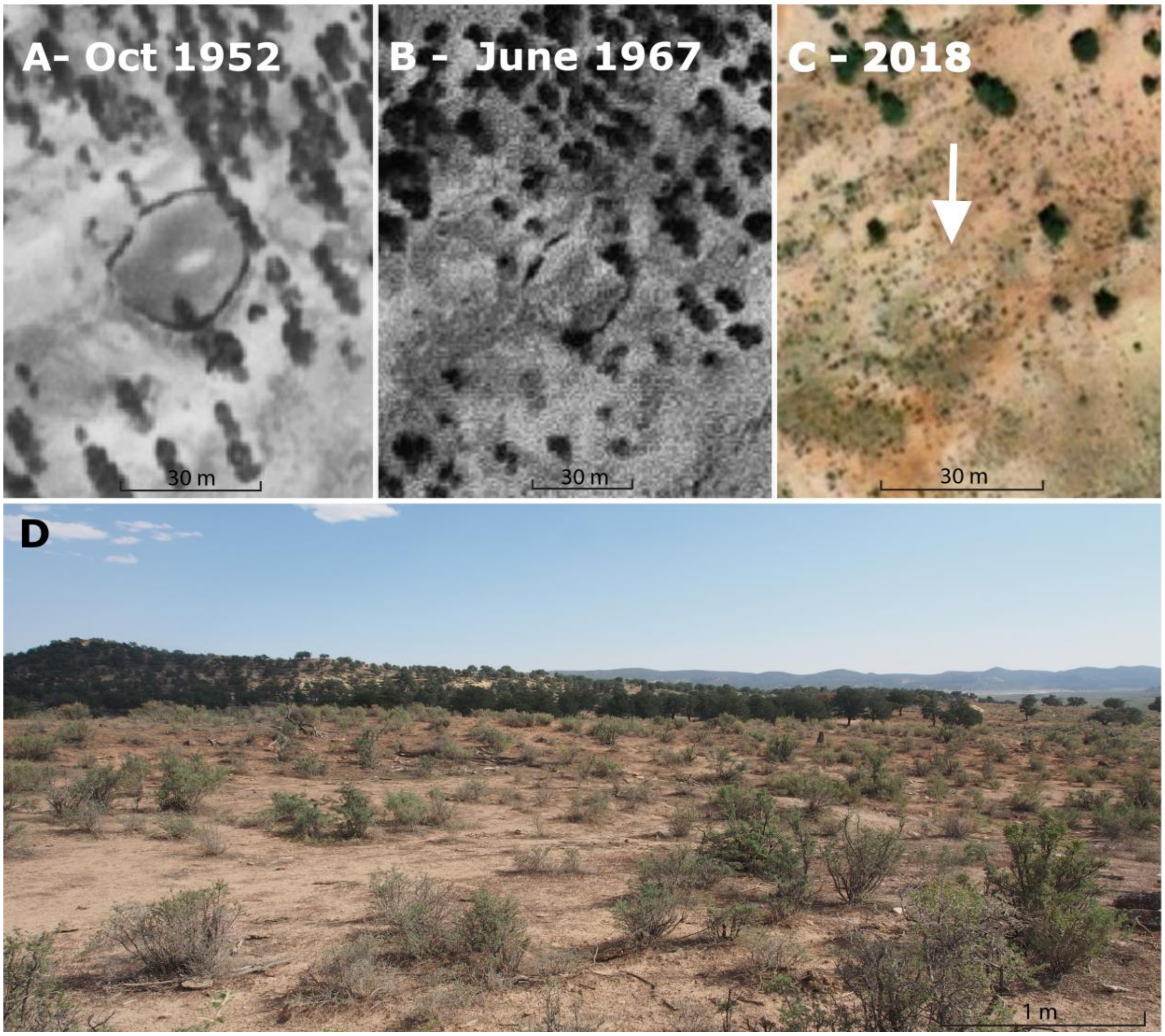

Figure 12 – Remotely sensed imagery series documenting the transformation of the ENPLP1-41 corral into the low-visibility feature seen today in Image D (Image C arrow notes the view direction in D).

versus “valley margin” lowland camps), winter camp corrals tend to be more distinguished by more substantial and sturdily built construction to protect from inclement weather. Additionally, as seen at ENPLP1-1 and 17, winter camps frequently contain numerous small pen structures built along the corral walls to facilitate lambing, a traditionally late winter/early spring activity. In comparison, the summer camp corrals are less built-up, lack the dedicated lamb pens, and are associated with a greater range of non-hogan habitation structures like tents or ramada “shadehouses.”

The case of the four isolated corrals in the Phase 1 study area (ENPLP1-14, 25, 33, and 34) offer another example of the ethnoarchaeological approach's value. Sites 14, 33, and 34 are low visibility corral features at the margins of the main drainage valleys distinguished by vegetation differences, fragmentary corral wall timber remnants, and relatively large size (~1100, 1050, and 500 square meters, respectively). In contrast, the ENPLP1-25 feature is distinguished by a 9 meter diameter circular arrangement of heavily fragmented timbers positioned up a minor side drainage. The characteristics of the first three isolated enclosure areas compare well with those associated with corrals at sheep camps (especially summer camps), an identification borne out by discussions with AR and other RTH family members; however, the fourth isolated feature does not fit the either the typical summer or winter camp patterns. Conversations with AR instead revealed that ENPLP1-25 was the remains of a "ram corral," a dedicated structure linked to the twentieth century practice of keeping bachelor herds of rams and billy goats separate from the rest of herd outside of the breeding season due to the difficulty in handling them and a desire to control the lambing process.

Lamb Pens – The small one- to two-meter-wide enclosures commonly referred to as "lamb pens" are built for the purposes of confining and sheltering newborn lambs and kids until they are strong enough to join the herd. During the twentieth century, Navajo herd management practices meant that lambing generally occurred during the later winter and early spring. As a result, lamb pens are typically found built into corrals used during this period and are often of two types: smaller pens intended for newborns and larger enclosure areas used to occasionally separate lambs from the larger herd (Jett and Spencer 1981:163–165). The corrals at the ENPLP1-1 and 17 winter camps and the modern year-round R/T/H camp incorporate a number of pens and sub-enclosures used during the lambing season.

Because pregnant sheep and goats will often give birth while grazing away from corrals, herders will construct ad hoc pens to protect newborns and their mothers until they can be taken back to the main camp area. These small, isolated pen features are built out of locally available materials and often take advantage of suitable landscape features to enclose and protect the animals from the elements and predators. The ENPLP1-49 lamb pen site consists of a natural cleft in a rocky bedrock outcrop that has been blocked off and covered by tree branches, while the multi-component site ENPLP1-6 includes a single small drystone pen in addition to its other non-associated features.

Watering Areas – Water availability and reliable access to and between water resources form key concerns for pastoralists. Six engineered water control features are located throughout the Phase 1 study area and are designed to complement the area's natural water sources, which include natural seeps in the beds of the Oraibi Wash drainage as well as small upland springs. One water control feature, ENPLP1-38, is built around a small shallow bedrock depression of the type commonly referred to in the greater Southwest as a *tinaja*. The natural depression has been expanded into five by seven meter wide pool through the creation of a tree trunk-and-earth berm of unknown age.

The remaining five water control features are large earthen dams and stock tanks built with heavy machinery during the twentieth century. Oral histories and aerial imagery analyses indicate that these were built with government assistance in the decades after 1955 and with the exception of one early dam which failed between 1955 and 1967, all remain in active use. A long low earthen berm dam located roughly 500 meters west of the ENPLP Phase 1 study area boundary also remains in use. Aerial photographs indicate that this dam was already in use in 1951 and oral histories describe its creation in the early twentieth century by F.H., the former head of the R/T/H family, whose efforts earned him the name *Hastiin Be'ak'id*, "Reservoir Man."

Sweatlodge Sites – Sweatlodges or *táchééh* are traditional Navajo sudatory structures used for both hygienic and ceremonial cleansing purposes (Franciscan Fathers 1910:340–345; Jett and Spencer 1981:193–197). The archaeological remains of 13 sweatlodge areas were identified during the Phase 1 fieldwork. Although the majority of the identified areas form part of larger homesite camp complexes, three sites not closely associated with any camp contain multiple sweatlodge features in close proximity and appear to represent sites of long-term or specialized usage.

Figure 13 - The standing remains of a sweatlodge structure showing nearby piles of heating rock.

The most common form of sweatlodge is that of a miniature forked-pole hogan approximately 2 meters in diameter and 1 meter high (Figure 13). The conical timber frame is covered with layers of juniper bark and earth and is heated by a small collection of hot rocks placed inside the structure to the right of the entrance. Archaeologically, a sweatlodge area can be identified by the remains of the wooden superstructure and associated rock piles linked to the heating process. A single sweatlodge will typically have two accompanying piles: an initial stockpile of unaltered local rock and a discard pile of thermally-altered rock. In many instances, however, no wooden elements remain and paired rock piles provide the only evidence for the use of an area as a sweatlodge site.

Rock Art Sites – A trio of rock art panels were identified in the southern half of the Phase 1 study area. Two of the panels – ENPLP1-16 and 50 – each form distinct reservation-era sites on the edge of the West Fork valley distinguished respectively by scratched/incised Navajo and Hopi names and figurative designs. Both sites are associated with activities by members of the R/T/H family during the twentieth century, although two inscriptions at ENPLP1-16 – the names "Herbert Yestewa" and "Fred Lomayesva" – attest to an occasional Hopi presence in the Upper Oraibi region as well. The third rock art panel is located on a boulder that forms part of the large ENPLP1-32 sheep camp site's southern corral and clearly displays the deeply incised inscription "1841."

Cairns – Three cairns (ENPLP1-2, 10, and 46) are dispersed throughout the southern half of the ENPLP Phase 1 study area. These cairns are constructed of stacked flat tabular sandstone and measure between 30 and 50 centimeters on side and one-half to one meter tall. Their tall stacked-rock form differs from other types of traditional Navajo piled rock constructions like graves (Jett and Spencer 1981:205; Ward 1978) or the large travel shrines known as *tsé ninájihí* (Jett 1994; Kelley and Francis 2005; Van Valkenburgh 1940). As Jett (1994:132) describes, Diné sheepherders have been know to build cairns for a variety of reasons, including as boundary markers and to simply pass time. Although AR described these cairns as being erected by her mother and brother in years past to pass time while herding, it is worth noting that the three cairns locations (two atop ridgelines and one at a narrow stretch of the West Fork valley) *do* also roughly correspond with key transition areas between the current R/T/H grazing area boundary and those of the families to the west and east.

<u>Transportation Infrastructure</u> – Trails, roads, and their attendant structures and features represent a valuable if often ephemeral avenue for archaeological research. When analyzed, these elements have with the potential to generate data relevant to studies of mobility and human-landscape interaction, as well as the connections within social and economic networks. As automobiles slowly became more common throughout northeastern Black Mesa during the 1950s and 1960s (Russell 1983), older horse and wagon trails in the greater Oraibi Wash drainage were formalized into wider dirt roads that remain in use today. In some cases, older paths were rerouted, like the road west from Kits'iilí which bisects the study area and links the area to the Peabody coal mines. During the early 1960s, the road was moved from the western side of the West Fork drainage to the east bank and a bridge was constructed by WTH and others where the new road crossed Celebration Wash; the remains of this bridge were recorded as ENPLP1-9. Although the span is gone, the two foundations remain in varying degrees of preservation, with the western footings indicating that the bridge was originally 3 meters wide and consisted of

railroad ties sitting upon a base of large flat sandstone blocks. The bridge remains are visible from the modern road crossing over Celebration Wash, a formalized steel culvert-and-gravel feature 15 meters downstream.

Grave Sites – Traditional Diné culture has a complex relationship with death. The traditional SNBH system promotes the practice of a harmonious, balanced lifestyle with the goal of achieving the state of old age. In this view, although death should be avoided as long as possible, when natural aged death is inevitable it should be accepted (Brugge 1978:310–311). Deaths that occur outside the natural SNBH trajectory due to causes partially ascribed to the influence of disharmonious thoughts, words, or deeds, however, are treated with a great deal more caution due to the potential malign influence of an individual's spirit, or *ch'į́įdii*. Mortuary practices traditionally emphasized the quick preparation and burial of the body in a nondescript and even secret location, and the ritual abandonment of goods associated with the individual and the burial process (Brugge 1978; Ward 1978).

Traditional graves (*jishcháá*) can take a variety of different forms, including Christian-style burial plots, simple pits, rock crevices, cairns, and tree burials (Jett and Spencer 1981:205-207). Should an individual come to pass unexpectedly while in a habitation, the body would be either be removed and buried elsewhere before the structure was made unusable (e.g., burned, roof pulled down, etc.), or the structure itself would be used as the grave (Jett and Spencer 1981:28). These "grave hogans" are frequently referred to as "chindi hogans" in earlier Navajo archaeological literature, an English corruption of the common Navajo name for the structures, although they are more formally referred to in Diné bizaad as *hook'eeghan* or "hearthless homes." All types of resting places (including Ánaasází sites) are traditionally avoided out of respect for the deceased individual(s) present at the site.

A total of five grave areas were identified in the study area, although many more undoubtedly exist on the landscape. One area (ENPLP1-7) consists of a single low piled-rock cairn-covered burial constructed within the remains of a structure – either a hogan or a temporary shelter – occupied by the deceased. The remaining five areas (ENPLP1-8, 32, 48, and 21) are camps that contain one or more grave hogans at the site. Because grave areas are traditionally avoided by Diné during everyday activities, Phase 1 work at the sites was limited to simple recording and any dendroarchaeological sampling was limited to non-habitation features like shadehouses, corrals, and culturally modified trees.

Ceremonial Sites

The traditional Diné ceremonial system comprises a vast array of highly organized chant and prayer sets – broadly referred to here as "ceremonies" – that are designed to address specific physical and mental conditions individuals experience with the goal of returning these "patients" to a state of *hozho*. The core of this system is the *Hózhóójí* or "Blessing Way," although historically dozens of other ceremonies like the Night Way, Enemy Way, Flint Way, Water Way, or Wind Way branch off in a manner some have likened to the leaves of a corn plant (Farella 1984). Patients are guided through the specifics of a ceremony by *hataałii* ("chanters" or "singers"), knowledgeable individuals who have mastered the various song sets and material requirements associated with a particular ceremony. Navajo ceremonies can take between two to nine nights to complete and draw upon the resources of a patient's greater *k'é* network to properly host, as ceremonies are inherently communal affairs. Attendance can range from immediate family for small personal prayers held in a family home to hundreds of people for the larger multi-day ceremonies like the Night Way or Enemy Way. Areas associated with any part of the traditional Diné ceremonial process – for example, where raw materials are initially collected, the location where a ceremony is held, the places where materials are laid to rest or offerings are made, et cetera – are all held to be *hodiyin*, or holy places.[24]

Several such places are located throughout the ENPLP Phase 1 study area. The majority represent resource areas or activity loci that remain in use by local community (e.g., a pair of *chiih* [red ochre] mines) and as such are not reported here. The study area does, however, contain the remains of six separate "*ceremonial ground*" areas that were used to hold large multi-day ceremonies at various points during the mid-to-late twentieth century. As Brugge and Gilpin (2008) describe, a combination of ethnographic information and archaeological site characteristics associated with the practices of certain key ceremonies allow for the identification of those specific events held at the six ceremonial grounds in the study area. Because these ceremonies were bespoke, unrepeated events whose locations were intended to be closed naturally and without outside interference, the basic descriptive and locational information associated with these sites was recorded in order to help preserve and avoid the remains.

Three of the areas (ENPLP1-11, 23, and 44) were the sites of large winter ceremonies held for patients during the 1970s and 1980s that incorporated the *Iłnáshjinjí hatáál* or the "Dark Circle of Branches" performance. Generally referred to in English as the Fire Dance or Corral Dance, this event most commonly occurs on the final night of the nine-night winter Mountaintop Way ceremony. For this event, a large *iłnáshjin* – a circular enclosure formed by cut conifer boughs – is built in front of the ceremonial hogan and forms the venue for the ceremony's final acts around a massive communal bonfire (Haile 1946; Matthews 1887; Wyman 1975). When the ceremony is finished, the brush enclosure is either left in place or disassembled and piled to the

[24] In the language of modern cultural resource management, these types of areas form part of the larger collection of sites and places referred to as "traditional cultural properties" (TCPs).

north of the ceremonial hogan. At all three of the areas identified as Fire Dance locations, the remnants of large, 20-25 meter diameter circular brush alignments are clearly visible and sit in flat open areas suitable for hosting the large numbers of attendees typical at winter ceremonies.

Two sites, ENPLP1-31 and 47, represent areas that were previously used to host parts of the large, multi-day summer ceremony known as the *Anaa'jí* or Enemy Way. This ceremony extends over a roughly week-long period during which a stick representing an enemy trophy is prepared and taken away from the patient's base camp to the camp of a supporting individual (the stick taker), who then returns the trophy to the base camp in order that the patient may be cleansed. The demands of this process result in a distinctive collection of structures at the base camp, including a large shadehouse kitchen area used to feed all the attendees, a ceremonial hogan and nearby shade structure for the patient, and a separate set of slightly removed brush shelters used by the stick taker and his party (Brugge and Gilpin 2008:366-369). Once complete, brush cover elements are ritually disposed of while the shelters used for the stick party are often left standing; it is not uncommon for an Enemy Way site to be reused multiple times by a local community. ENPLP1-47 consists of the remains of a ceremonial frame hogan, a disassembled bough covering discard area to the east of the hogan, and two brush shelters all associated with an Enemy Way held the 1980s by the H family. ENPLP1-31 consists of a debris scatter in the valley plain west of the Oraibi Wash junction that likely represents the kitchen area associated with an Enemy Way held in the area during 1960s or 70s for JW.

The final ceremonial ground site – ENPLP1-6 – is located in the greasewood-covered floodplain at the mouth of Broken Reservoir Valley and consists of the remnants of a frame hogan with a piled brush discard area to the north. Discussions with AR indicate the area is associated with either a Fire Dance or Enemy Way ceremony held for C.G. in the 1980s. When compared to the archaeological signatures of both these types of ceremonies held in study area, however, the fragmentary nature of the ENPLP1-6 remains prevent a clear identification of the type of gathering held at the site.

Dendroarchaeological Sampling Results

A total of 100 dendroarchaeological samples were collected from 21 Navajo sites within the ENPLP Phase 1 study area under the guidance of Dr. Ronald H. Towner (University of Arizona). Following Towner's (2016b) discussion of traditional Navajo wood use practices, a concentrated effort was made to identify and sample "CMT" features (culturally modified trees; e.g., ax-cut limbs or stumps) closely associated with nearby site components in addition to architectural wood. The samples included both drilled cores and sawn cross-sections, all of which were submitted to the University of Arizona's Laboratory of Tree-Ring Research (LTRR) for analysis and dating.

Thanks to the more than two decades of archaeological work at the nearby Peabody Black Mesa mine lease areas, the regional tree-ring chronology for northern Black Mesa is well-developed and well-studied in comparison to other parts of the Southwest (Smiley and Ahlstrom 1998). Despite this, only a total of 23 samples from fifteen Phase 1 sites yielded dates (Table 3); however, half of these samples came from CMTs at sites that otherwise contained no other datable material or had architectural samples that did not date.

Table 3 - All Dated Tree-Ring Samples Collected from ENPLP Phase 1 Sites

Field ID	LTRR No.	Wood Type	Site No.	Site Name	Structure/ Feature	Function/ Type	Inner Date	Outer Date	Attributes	Tool Marks	Notes
4	PBM-8086	PNN	ENPLP 1-40	Tse dez Aha Summer Camp	Tent Platform	Fork; Loose Log	1815	1949vv	True Outside; Weathered	Metal ax cut	
7	PBM-8089	PNN	ENPLP 1-40		Corral	Upright Post	1837+	1969vv	True Outside; Weathered	Metal ax cut	West gate post
9	PBM-8091	JUN	ENPLP 1-32	South Grave Hogan Camp	Ramada	Upright Post	1816+	1910+vv	True Outside; Weathered	Metal ax cut	North pair of posts; abundant sapwood; cutting
12	PBM-8094	JUN	ENPLP 1-32		Ramada	Upright Post	1838	1912vv	True Outside; Weathered	Metal ax cut	South pair of posts; abundant sapwood; cutting
22	PBM-8104	PNN	ENPLP 1-15	Hidden Hogan Camp	CMT (near hogan)	Ax-cut Limb	1871	1920B inc	Bark; L-Condition	Metal ax cut	Growth season
24	PBM-8105	PNN	ENPLP 1-15		CMT (near sweat)	Ax-cut Limb	1578	1731++v v	Weathered	Metal ax cut	
31	PBM-8112	PNN	ENPLP 1-45	Wedge Camp	CMT (near hogan)	Ax-cut Limb	1578	1920++v v	Bark; L-Condition; Weathered	Metal ax cut	
36	PBM-8117	PNN	ENPLP 1-33	Southwest Corral	CMT (near corral)	Ax-cut Limb	1746+-p	1925+B comp	Bark; L-Condition; Weathered	Metal ax cut	Post-growth season
40	PBM-8121	JUN	ENPLP 1-42	Tseazoli Tacheeh	Sweatlodge	Door Jamb Fork	1841	1916+B inc	Bark	Metal ax cut	Growth season
43	PBM-8124	PNN	ENPLP 1-41	Tseazoli Camp	CMT (near corral)	Ax-cut Limb	1763	1918vv	Bark	Metal ax cut	
46	PBM-8127	PNN	ENPLP 1-20	K.Y. Camp	Sweatlodge	Ax-cut Limb	1835+-	1970+vv	Beetle Galleries; Weathered	Metal ax cut	Sapwood present; near-cutting (?)
53	PBM-8134	JUN	ENPLP 1-20		Brush Shelter	Upright Post; Loose Limb	1896	1956+vv	Beetle Galleries; Weathered	Metal ax cut	Sapwood present; near-cutting (?)
66	PBM-8147	PNN	ENPLP 1-29	Rim Camp	Forked Stick Hogan	Leaner	1805+-	1928+vv	Beetle Galleries; Weathered	Metal ax cut	
68	PBM-8149	PNN	ENPLP 1-29		Corral	Loose Log	1604p	1822++v v	Beetle Galleries	Metal ax cut	Gate element

Table 3 (Continued) – All Dated Tree-Ring Samples Collected from ENPLP Phase 1 Sites

Field ID	LTRR No.	Wood Type	Site No.	Site Name	Structure/ Feature	Function/ Type	Inner Date	Outer Date	Attributes	Tool Marks	Notes
70	PBM-8151	JUN	ENPLP 1-30	Sliding House Camp	CMT (near hogan)	Ax-cut Limb	1750+-p	1884+B inc	Bark; Beetle Galleries; L-Condition; Weathered	Metal ax cut	Growth season
71	PBM-8152	PNN	ENPLP 1-30		CMT (near hogan)	Ax-cut Limb	1701+-p	1884+B inc	Bark; Beetle Galleries; L-Condition; Weathered	Metal ax cut	Growth season
72a	PBM-8153	PNN	ENPLP 1-30		CMT (near hogan)	Ax-cut Limb	1639+-p	1885++B inc	Bark; Beetle Galleries; L-Condition; Weathered	Metal ax cut	Growth season
72b	PBM-8153	PNN	ENPLP 1-30		CMT (near hogan)	Ax-cut Limb	1639+-p	1885++B inc	Bark; Beetle Galleries; L-Condition; Weathered	Metal ax cut	Growth season
75	PBM-8156	JUN	ENPLP 1-30		CMT (near hogan)	Ax-cut Limb	1738+-p	1883+LB inc	Bark; Beetle Galleries; Weathered	Metal ax cut	Growth season
80	PBM-8161	JUN	ENPLP 1-18	Beegaashii Jolgali Camp	CMT (near corral)	Ax-cut Stump	1649+-p	1871+vv	Weathered	Metal ax cut	Sapwood present; near-cutting (?)
83	PBM-8165	PNN	ENPLP 1-39	Tsah Deskidi Camp	Sweatlodge	Fork (West)	1809+-	1945vv	Bark; Beetle Galleries; L-Condition; Weathered	Metal ax cut	
88	PBM-8169	PNN	ENPLP 1-3	Broken Reservoir Camp	CMT (near corral)	Ax-cut Limb	1830+-p	1900+vv	Bark; Beetle Galleries; L-Condition; Weathered	Metal ax cut	
94	PBM-8175	PNN	ENPLP 1-19	K.R. Brush Shelter	CMT (near shelter)	Ax-cut Limb	1857+-p	1967B inc	Bark; L-Condition; Weathered	Metal ax cut	Growth season; cutting
97	PBM-8178	JUN	ENPLP 1-36	Tacheeh Cluster	Sweatlodge	Leaner	1864+-	1944r inc	Bark; L-Condition; Weathered	Metal ax cut	Growth season; cutting

Comparative Dung & Soil Sample Collection

Three soil and dung samples were collected from the ENPLP Phase 1 study area in October 2020 in order to provide Dr. Chad Yost (Indiana State University) with comparative material prior to the start of the ENPLP Phase 3 microremains analyses. The full results of these soil analyses are presented in Chapter 6; however, the specific comparative samples consisted of: one modern sheep dung sample obtained from the in-use corral at the main R/T/H camp; one soil sample from the southern section of the in-use corral (rarely used since 1990); and one soil sample from the corral feature at the ENPLP1-12 sheep camp site (last used during the 1960s).

RESERVATION-ERA NAVAJO PASTORAL ARCHAEOLOGY SIGNATURES

Over the past four centuries, the intensity and practice of Navajo herding throughout the greater Four Corners region has varied substantially across time and space. Indeed, the size of sheep herds on Black Mesa and elsewhere across the Navajo Nation today are considerably smaller than what was once common only a few decades ago, let alone at the turn of the twentieth century. As is discussed further in Chapter 7, charting the archaeological correlates of this diachronic process offers a unique material understanding of how Diné herders managed their flocks at different moments in time and how the choices of Navajo pastoralists were linked to larger social and economic developments in the Southwest and beyond. More directly, though, the identification of both intrasite/feature-level and landscape-level archaeological patterns associated with the locations and physical remains of contemporary/historic Navajo pastoral sites can help generate interpretive criteria for identifying and evaluating similar areas at older Navajo sites potentially associated with pastoral activities.

The *sheep camp corral* arguably represents the type of herding infrastructure most suited for this analysis because the repeated use of an area for animal containment increases its archaeological visibility through a series of cultural and natural transformations discernable at the site level. These include the construction of penning structures or features (e.g., walls, fences, etc.), dung deposition, the chemical alteration of soils, and the introduction of nonlocal plant species (Chang & Koster 1986:115-119). Additionally, because corrals are the locus for a variety of sustained, high-intensity human-animal interactions, the locations of Navajo sheep camp sites and their corrals typically reflect a series of landscape-level decisions made with both human and animal considerations in mind.

In the ENPLP Phase 1 study area, a landscape analysis revealed that most sheep camp sites were commonly located in the following four environmental settings.

1. Along moderate (0-13º) slopes along treelines overlooking valleys. In addition to providing ready access to fuelwood, these areas might have been specifically chosen for their natural drainage capabilities, which would have helped to remove animal feces and extend the use life of a structure (as well as offering a way to mitigate the smell of manure);
2. Against the base of steep ridges, rocky outcrops, or natural alcoves/overhangs. These natural features form partial enclosure walls that can be expanded with if necessary, and would have represented a cheaper alternative to a standalone enclosure;
3. At the heads of narrow draws with openings blocked off; and
4. On heavily wooded hilltops. At reservation-era Navajo sites on Black Mesa, this setting is commonly associated with winter usage due to the natural windbreaks and fuelwood provided by the tree cover (Russell & Dean 1985:10-13).

The condition of the identified corral areas ranged from nearly intact structures to deteriorated, near-invisible archaeological features. The latter class of corral remains were the most common in the study area and their successful in-field identification necessitated the recognition of spatially discrete vegetation differences (e.g., dense stands of forage plants like saltbrush or colonizing plants like wolfberry) that were frequently associated with collapsed and scattered structural remains (e.g., semi-buried timber or rock alignments). The details of the preservation processes at these corral features is unclear; the typical style of corral on Black Mesa during the mid to late twentieth century employed hundreds of individual timbers. The disappearance of corral superstructures at sites that often retain hogan remains can be clearly associated with timber reuse and firewood gathering, although it is possible that brush corral or no corral strategies were more frequently employed in the past.

The spatial characteristics of the twenty-one historic corrals associated with the ENPLP-1 sheep camp sites were variable and potentially reflect a range of concerns including herd size, security, seasonality, environmental constraints, et cetera. The enclosed areas range from approximately 400 to 1890 square meters in size, with twelve corrals being less than 1000 square meters. The identified corrals are located between 10 to 100+ meters from the nearest associated habitation, with half being within 30 meters. The ethnoarchaeological data indicate that all of the corrals identified during the Phase 1 fieldwork were less than ~110 years old, suggesting that additional methods (e.g., geochemical or micromorphological analyses [Shahack-Gross 2011]) are needed to more confidently identify similar features at older Navajo sites.

Chapter 5: The Early Navajo Pastoral Landscape Project Phase 2 – Geospatial Analyses of Navajo Pastoral Landscapes, New and Old

INTRODUCTION

Phase 2 of the ENPLP work focused on conducting a geographic information system-based (GIS) locational analysis to help guide investigations of early Navajo pastoral site location and land use in the Dinétah region of northwest New Mexico circa AD 1700. Previous studies of early Navajo lifeways were stymied by a relative lack of traditional zooarchaeological evidence for pastoralism at early Navajo sites that made it near impossible to discuss pastoral systems or their impacts on Diné society in any great detail. Instead, because the upper Oraibi Wash region on Black Mesa was judged to possess a broad similarity to Phase 3's Frances Mesa/Gobernador Canyon study area in terms of topography and vegetation, this challenge was approached in a "backwards" manner, drawing on observations made about historic/modern Diné pastoral land use and habitation on Black Mesa to create a weighted locational model for Navajo pastoralist settlement. Next, the underlying model parameters were combined with data detailing seventeenth and eighteenth century Navajo settlement site locations in Dinétah to generate two models for early Navajo pastoralist settlement in the Frances Mesa/Gobernador Canyon study area. The mesatop and valley models were subsequently used to help choose six of the sites examined during the ENPLP Phase 3 fieldwork.

LOCATIONAL/GEOSPATIAL ANALYSES: THEORY & APPROACHES

Geospatial analyses have long played a fundamental role in archaeological research and a variety of methodological approaches exist. These run the gamut from survey archaeologists who draw on decades of field experience to identify springs, defensible promontories, or other "high potential" areas to the examination of aerial or satellite images to the creation of bespoke models that seek "…to predict, at a minimum, the location of archaeological sites or materials in a region, based either on a sample of that region or on fundamental notions concerning human behavior" (Kohler and Parker 1986:400). The basic premise of archaeological geospatial analysis holds that an array of underlying environmental and cultural considerations that inform human activities in a particular region (e.g., settlement, farming, mining, etc.) can be broken down, examined through distinct analytical frameworks, and the resulting observations on past relationships used to guide studies that seek to better to understand how analogous actions might have occurred in other similar areas (Judge and Sebastian 1988; Kohler and Parker 1986; Verhagen and Whitley 2012).

At their simplest, formal archaeological locational models can be generally characterized as being either *inductive* or *deductive* processes. Inductive models (also referred to as empirical or correlative models) focus utilizing a known population of sample sites to statistically delineate a suite of related environmental features that can be used to forecast where similar intersections of features forecast or predict the presence of a site. On the other hand, deductive models (also referred to as "explanatory" or "intuitive" models) focus on first generating a suite of theories and assumptions about past behavioral practices that are then tested against archaeological data to determine their effectiveness (Kohler and Parker 1986:402-403, 432-438; Verhagen and Whitley 2012:51-55). Frequently, developers of locational models incorporate elements of both approaches as they attempt to tailor the method to the questions at hand.

The development of computerized geographic information systems during the 1980s and 1990s revolutionized geospatial analyses with the ability to collate and visualize vast amounts of geospatial data derived from disparate sources as well as applying increasingly sophisticated statistical operations to examine potential connections. In the decades since, geospatial models and questions have continued to expand, with increased computing power, new remote sensing technologies, and innovative analytical programs driving the development of ever new approaches (e.g., machine learning). Along the way, however, the use of GIS-based frameworks has been strongly critiqued due to a number of theoretical and methodological concerns. For example, GIS-based models have been cited for a perceived lack of theoretical rigor, as well as a certain fuzziness regarding the anthropological explanatory power of "predictive" models (i.e., the "black box" critique).[25] This family of geospatial analyses has also been critiqued for a general dependance on natural science datasets potentially creating a type of "environmental determinism," where quantifiable natural factors (e.g., elevation, distance to water, slope, soil types, etc.) are given more weight and consideration than qualitative data linked social or cultural factors that might have equally guide past settlement or land use practices (Verhagen and Whitley 2012:55-72).

While the indiscriminate application of GIS methods is a valid concern for geospatial analyses overall, worries about an overemphasis on environmental factors are arguably less of an issue in the case of pastoral archaeology, particular when an ethnoarchaeological pastoral landscape approach is employed. The logic of pastoral landscape analysis holds that because pastoral activities are conditioned by the basic subsistence needs of livestock as much as they are by the "rational" actions of herders themselves, interactions between herders, animals, and their

[25] Verhagen and Whitley (2012:52-53) argue that despite the popularity of "predictive modeling" in archaeology, it frequently seems to be used as a catch-all term for a range of geospatial analytical models. Importantly, not all these models truly work to *predict* archaeological phenomena by providing "…a quantitative estimate of the probability of encountering archaeological remains outside the zones where they have already been discovered in the past." They note that "…"models" without predictions are better categorized under the header of site location analysis." Although the ENPLP Phase 2 work followed the general process associated with GIS-based predictive models, the lack of a final statistical statement moves it into the realm of more "intuitive" forms of location modeling sometimes referred to as "suitability," "likelihood," or "sensitivity" models.

surroundings result in suites of cultural and environmental factors influencing the placement of pastoralist settlements and herding infrastructure (Frachetti 2006; 2008:22-24; Hammer 2014; Wright 2016b). Ethnoarchaeological observations derived from more recent pastoral practices in the same or similar areas as archaeological sites allow for the development of interpretive analogs that enable discussions of spatial models to extend past simple presence/absence statements (Carrer 2013; Chang 1992; Chang and Tourtellotte 1993).

GIS-BASED MODELING IN SOUTHWESTERN ARCHAEOLOGY (WITH A SPECIFIC NAVAJO FOCUS)

In the American Southwest, the application of formal GIS-based locational modeling exercises date to the late 1970s and grew out of earlier settlement pattern studies in the region that sought to identify Ánaasází archaeological sites and their relationship to surrounding settlements and natural features (e.g., Plog and Hill 1971). Many of the GIS models were developed to help guide CRM projects on vast tracks of public land in and around the San Juan Basin that inevitably engaged with historic Navajo archaeological sites to some degree (e.g., Kemrer 1982). Few projects specifically focused on questions related to earlier Navajo site locations or land use practices, however, and only as natural gas development in the greater San Juan Basin/Dinétah region picked up in the late 1980s and 1990s did the explicit application of GIS models to Navajo issues take place.

Specifically, between 1989 and 1996, the Fruitland Coal Gas Data Recovery Project saw multiple contractors conduct survey and excavation activities across an approximately 3,500 square kilometer area. As part of this work, five large block survey projects were carried out, one of which - the Morris Site 1 Early Navajo Land Use Study (MENLUS) – developed a GIS-based settlement and land use analysis for the early Navajo occupation of a portion of Gobernador Canyon (Dykeman 2003d:391–426). The main Fruitland Project work was followed by the creation of a final GIS "cultural landscape model" developed the University of New Mexico's Office of Contract Archaeology to provide the BLM planners with probabilistic estimates for projecting site types (e.g., Archaic, Pueblo, early Navajo, etc.) across the project region's various environmental zones (Hogan et al. 2004). It is unknown whether GIS-based geospatial models that engage with Navajo archaeology to various degrees have been developed as part of CRM projects in other parts of the traditional Diné territory, including on the Navajo Nation.

THE ENPLP PHASE 2 WORK: GEOSPATIAL MODELING METHODOLOGY & ANALYSIS OVERVIEW

Work on Phase 2 occurred between May and October of 2019 and followed conventional methodologies for creating GIS-based models of archaeological site location (Kvamme 1988; 1989; 1990; Tripcevich 2015). The majority of the geospatial analyses described in this section were carried out using ESRI's ArcGIS 10.6 software and utilized the standard suite of geoprocessing tools included in the program as well as tools included in the ArcGIS Spatial Analyst and Geostatistical Analyst extensions. The use of two non-ESRI products – the open-source GIS program SAGA-GIS and the "Grid and Raster Editor for ArcMap" tool produced by Aris – are noted in the relevant submodel sections below. The locational modeling process was conducted using the ArcGIS Predictive Analysis Tools (Version 1.3.1). The historic Black Mesa Navajo archaeological site data used as the training data for the submodel identification process was collected during ENPLP Phase 1, while early Navajo archaeological site data for the Dinétah region was obtained through a request to the New Mexico Archaeological Records Management Section (ARMS).

The general analytical sequence consisted of identifying cultural and environmental factors associated with Navajo pastoral site locations appropriate for geospatial modeling and transforming them into site suitability rasters. These rasters, referred to here as *submodels*, were then incorporated into a manually adjusted weighted overlay framework that generated a final synthesized, pastoral site locational suitability raster that ranked individual 30 by 30 meter pixel areas as possessing “Low,” “Moderate,” or “High” pastoral site suitability. Notably, the Phase 2 work combined inductive and deductive approaches to produce the locational analysis discussed here, with the Phase 1 survey data being used to identify and produce generalized submodels that were then applied to the theoretical pastoral landscape of Dinétah circa AD 1700.

THE ENPLP PHASE 2 BLACK MESA MODEL: HISTORIC NAVAJO HERDING & SUBMODEL IDENTIFICATION

Study Area

The study area established for the Black Mesa locational model consists of a rectangular region measuring 16.8 north-south by 13.1 kilometers east-west. This area encompasses the main catchment of the West Fork of Oraibi Wash drainage and goes well beyond the boundaries of the ENPLP Phase 1 study area, which correspond to the R/T/H family’s traditional grazing/use area in the Red Point Wash system. The expanded model study area allowed for the full analysis of the local hydrological network and provided additional spectral datapoints for the land classification.

Base Datasets

Archaeological Site Data

A total of twenty surveyed corral locations derived from the results of the ENPLP Phase 1 fieldwork were used as the training dataset for the Black Mesa model (see Table 4 in the "Submodels" section below). This dataset included corrals at sheep camp sites as well as isolated corral features.

Elevation Data and Hydrological Network Data

The Black Mesa model used the highest resolution digital elevation dataset freely available for the Kits'iilí region, a 1/3 arc second (9.33 meter) resolution product from the National Elevation Dataset. This digital elevation model (DEM) formed the basis for all elevation-derived products generated in the Black Mesa study area, including a hydrological stream network.

Land Classification Data

A series of supervised land classifications were conducted in order to obtain general data about the natural landcover on Black Mesa. The classifications were carried out using the Image Classification tools included with the ArcGIS Spatial Analyst extension. The analyzed image was a 30-meter resolution Landsat 8 satellite scene (ID: LC08_L1TP_036035_20180508) originally captured on May 8, 2018 downloaded from the USGS EarthExplorer website. The multi-band image stack used in the classification process consisted of the first seven Landsat 8 spectral bands (encompassing the visual, near-infrared (NIR), and shortwave infrared (SWIR)

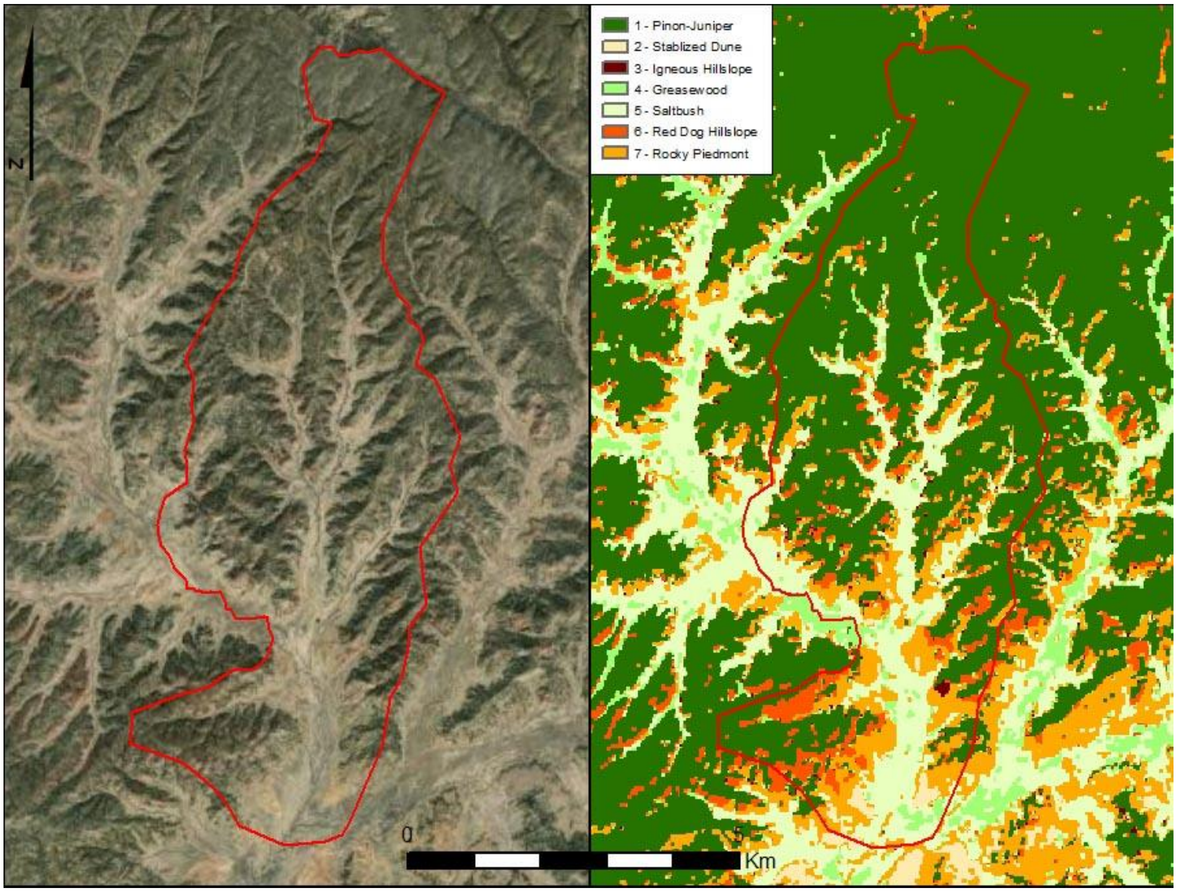

Figure 14 – Comparison of Landsat scene & final supervised classification for the ENPLP Phase 1 study area (outlined in red).

wavelengths),[26] as well as a normalized difference vegetation index (NDVI) band and three separate SWIR ratio bands.[27]

This 11 band composite image (Figure 14) formed the basis for all subsequent "maximum likelihood" supervised classifications, which drew upon seven different land class

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[26] The Landsat 8 bands and wavelengths referenced here are: Band 1 - Coastal aerosol (0.43-0.45 µm), Band 2 – Blue (0.45-0.51 µm), Band 3 – Green (0.53-0.59 µm), Band 4 – Red (0.64-0.67 µm), Band 5 - Near Infrared (NIR) (0.85-0.88 µm), Band 6 - SWIR 1 (1.57-1.65 µm), and Band 7 - SWIR 2 (2.11-2.29 µm). The Landsat 8 sensor includes a 15m panchromatic band, a 30m cirrus band, and two 100m thermal infrared bands, none of which were used in the study.

[27] Although the inclusion of a NDVI band is fairly common practice in remote sensing studies, SWIR band ratios are arguably less common outside the field of geology. The following three ratios – Band 4/Band 3, Band 6/Band 3, and Band 7/Band 5 – were included because the SWIR wavelengths have been shown to be particularly sensitive to soil moisture and mineral/rock composition (Thi et al. 2019; Zeinelabdein and El Nadi 2014). Ratios that incorporate at least one of the SWIR bands can help to enhance these differences, potentially even highlighting areas associated with the types of low-visibility corral features observed during the Phase 1 fieldwork.

training sets delineated based on environmental observations made during the six month sheepherding period. The seven final land classes were: Pinon-Juniper Woodlands, Stabilized Dunes, Igneous Hillslopes, Valley 1 (areas dominated by greasewood), Valley 2 (areas dominated by saltbush), Red Dog Shale Hillslope, and Rocky Piedmont.

Submodels

Topographic Position Index (TPI)

Topographic Position Indices have been used in archaeological analyses to help highlight particular archaeological site types frequently associated with topographically distinct areas on the landscape, for example ridgetop defensive sites, valley bottoms field systems, or river bench settlements (Argyriou et al. 2017; De Reu et al. 2011; 2013; Patterson 2008). A TPI compares the elevations and slopes of individual cells in a DEM to the means of specified neighborhoods around those cells, with positive TPI values representing relatively higher locations and negative TPI values reflecting locations lower than their surroundings. Because the different neighborhood thresholds can be modified, TPIs at two separate scales (one smaller, one larger) can be standardized and the overlapping classifications analyzed to further separate out topographically distinct areas (Weiss 2001).

The Black Mesa TPI submodel was created using the SAGA-GIS program's "TPI Based Landform Classification" tool because older TPI toolkits developed for use in ArcGIS were no longer compatible with the current version of the program. The paired small-scale and large-scale TPIs were generated at 50 and 500 meters respectively, distances that seemed appropriate for the DEM resolution as well as the scale of local environmental features and human activities. The ten classes output by SAGA-GIS follow the parameters of the ten-class system originally defined by Weiss (2001) and consist of: High Ridges, Midslope Ridges, Local Ridges, Upper

Table 4 - Black Mesa Corrals Training Set and Submodel Results

Site No.	Site Name	Site Type	TPI (class)	Slope (degree)	Aspect (degree)	Stream Distance (m)	Treeline Distance (m)
ENPLP1-1	Ben Da'alchihi Winter Camp	Sheep Camp	4	148.66	2.05	157	10.00
ENPLP1-3	Broken Reservoir Camp	Sheep Camp	5	165.53	10.93	38	20.00
ENPLP1-8	Celebration Grave Hogan Cluster	Sheep Camp	1	274.59	7.85	243	10.00
ENPLP1-12	F.H. Red Point Wash Camp	Sheep Camp	5	273.13	7.08	77	20.00
ENPLP1-14	F.H. West Fork Old Camp	Isolated Corral	5	94.34	12.87	246	92.20
ENPLP1-17	Hut House Winter Camp	Sheep Camp	5	302.32	7.02	158	0.00
ENPLP1-18	Junction Camp (Beegaashii Jolgali)	Sheep Camp	5	158.11	12.75	95	20.00
ENPLP1-19	K.R. Brush Shelter	Temporary Camp	5	272.03	10.62	15	10.00
ENPLP1-20	K.Y. Camp	Sheep Camp	4	108.17	3.01	321	120.42
ENPLP1-25	Ram Corral	Isolated Corral	5	70.71	9.27	321	31.62
ENPLP1-29	Rim Camp	Sheep Camp	6	543.32	3.77	157	130.00
ENPLP1-32	South Grave Hogan Camp	Sheep Camp	1	342.05	5.89	197	60.00
ENPLP1-32	South Grave Hogan Camp	Sheep Camp	5	388.33	12.83	140	20.00
ENPLP1-33	Southwest Corral	Isolated Corral	1	282.84	7.52	85	36.06
ENPLP1-34	Strawberry Hill Corral	Isolated Corral	5	230.00	11.60	178	41.23
ENPLP1-39	Ts’ah Desk’idi Camp	Sheep Camp	5	313.85	9.94	93	58.31
ENPLP1-40	Tse Dez Aha Summer Camp	Sheep Camp	5	180.28	4.60	109	28.28
ENPLP1-41	Tseazoli Camp	Sheep Camp	5	260.77	7.20	233	72.11
ENPLP1-45	Wedge Camp	Sheep Camp	5	152.64	6.08	167	20.00
ENPLP1-48	West Fork Grave Camp	Sheep Camp	4	20.00	1.78	292	31.62
ENPLP1-51	West Fork Summer Camp	Sheep Camp	5	20.00	22.70	255	0.00

Slopes, Open Slopes, Plains, Valleys, Upland Drainages, Midslope Drainages, and Streams. A frequency analysis of the Phase 1 corral sites revealed that 14 of the 21 corrals (67%) are associated with "Class 5 - Open Slopes," while 3 corrals (14%) were each associated with "Class 1 – Midslope Drainages" and "Class 4 – Plains" (Table 4). The sites in "midslope drainages" appear to reflect the practices of corral placement in natural "coves" along long ridgelines or formed by blocking off narrow draws. Similarly, the "plains" sites correspond to a different types of flat open areas, including the edges of the main wash valleys and atop hills.

Slope

A slope submodel was created using the ArcGIS Slope tool to account for the observation that many of the historic Navajo sheep camp sites in the ENPLP Phase 1 study area appeared to be positioned on along gentle slopes. Potential explanations for this placement include pragmatic concerns regarding flooding, but it can also be interpreted as a form of passive corral cleaning whereby waste could be naturally carried downslope via wind and water. Analysis of the slope data (Table 4) revealed that 20 of the 21 corral areas (95%) are located in areas with a slope angle between 1 and 13 degrees, with six corrals (29%) specifically occupying slopes between 6 and 8 degrees.

Interestingly, one corral located in an area of 22 degree slope appeared to be an outlier; however, closer examination of the archaeological data indicated that this value reflected the fact that the corral at the ENPLP1-51 sheep camp had been built up against a short rocky cliff face and utilized this natural feature as one "wall" of the corral. Because this was the only corral of this type originally observed during the Phase 1 fieldwork, this association was not transformed into a submodel for the Black Mesa-area work. As work on the Dinétah region began and the unknown pastoral character of the area became apparent, however, this observation was eventually developed into a submodel for that analysis. The details of this "*Toe of Slope*" submodel are described in the Dinétah model section below.

Aspect

A slope direction or aspect submodel was created to account for the observed tendency of historic Navajo sheep camp sites to be positioned on south and southeast facing slopes. This placement has been linked to strategies associated with maximizing solar gain at winter and all-season sheep camps (Russell and Dean 1985:11) and might also reflect traditional site location preferences associated with the Navajo tradition of east-facing habitations (Jett and Spencer 1981:17-18). The majority of the sheep camp sites in the ENPLP Phase 1 study area are situated along south or east facing slopes. A frequency analysis reveals that 10 of the 21 corrals (48%) are located on slopes that face generally south (between 135 and 225 degrees from north), while five other corrals (24%) face generally east (between 45 and 135 degrees from north) (Table 4).

Distance to Water

Ready access to reliable water sources is an important consideration for both human settlement and economic activities like herding. Although perennial surface water is currently rare due in part to lower water tables associated with anthropogenic arroyo cutting around the turn of the twentieth century and generally arid climatic conditions throughout the Southwest, evidence for alternating wetter periods in the climatic record indicate that this was not always the case (Aby 2017; Sheppard et al. 2002).

The potential for earlier surface water availability in the Upper Oraibi drainage coupled with the observed presence of natural seeps along the beds of the modern wash systems led to the creation of two submodels based on the Euclidean distance between a site and the larger branches of the West Fork of Oraibi Wash drainage. The first submodel was based on the observation that 17 of the 21 surveyed Phase 1 corrals (81%) are located with 300 meters of larger stream branches (i.e., stream network values of 3-7) (Table 4). The second submodel was a negative parameter that accounted for the fact that habitation sites and activity areas are not located in the immediate boundaries of watercourse.

Distance to Treeline

Over the course of the Phase 1 fieldwork, it was noted that many of the historic sheep camp sites were located along the woodland/grassland ecotone. In addition to providing camp residents with convenient construction materials and fuelwood, Russell and Dean (1985:11) note that both summer and winter corrals were frequently situated in or around wooded areas for reasons of shade and windbreaks.

The Black Mesa forest ecotone submodel was generated using data from the Landsat 8 supervised landscape classification activity. The edges of "Pinon-Juniper Woodland" class polygons were cleaned using the Aris "Grid and Raster Editor for ArcMap" tool before being converted into polyline features and the Euclidean distance measured between the treelines and the Phase 1 corral sites. Examination of the respective distances to treelines revealed that 15 of the 21 corral features (71%) lie within 40 meters of a treeline (Table 4). This includes both sites that are set back into wooded areas as well as sites out in the open near the treeline.

Final Black Mesa "Pastoral Site" Submodel Parameters

The Black Mesa work identified a series of geospatial relationships between historic Navajo herding sites and the surrounding natural landscape that were held to be strong potential indicators of archaeological corral locations. These relationships were translated into submodels for use in a GIS-based locational model. The specific submodels descriptions are summarized in Table 5 below along with the levels of importance associated with each expressed as weighted adjustments to the model.

Table 5 - Summary of Base Submodels Identified in the Black Mesa Analysis

Submodel	**Description**	**Weight**
Topographic Position Index (TPI)	TPI Zone 5 (Open Slopes)	2
	TPI Zones 1 (Midslope Drainages) and 4 (Plains)	1
Slope	Areas with slopes less than 13 degrees	3
Aspect	East & South Facing	2
	North & West Facing	1
Distance to Water	Within 300 meters of stream network	2
	In a stream channel	-3
Distance to Treeline	Within 40 meters of treeline	2.5

THE ENPLP PHASE 2 DINÉTAH STUDY: EARLY NAVAJO PASTORAL SITE LOCATION MODELS

Study Area

The Phase 2 study area established for the Dinétah locational model consists of a rectangular region measuring 12.7 kilometers north-south by 7.8 kilometers east-west. This area encompasses the main catchment of the West Fork of Oraibi Wash drainage and goes well beyond the boundaries of the ENPLP Phase 1 study area, which correspond to the R/T/H family's traditional grazing/use area in the Red Point Wash system. The expanded model study area allowed for the full analysis of the local hydrological network and provided additional spectral datapoints for the land classification.

Base Datasets

Archaeological Site Data

The early Navajo site location data for the Dinétah region was obtained through a request to the New Mexico State Historic Preservation Office's ARMS department. Although these geospatial data were not used to create a training dataset, they were used to evaluate the Dinétah models and guide in-field activities during the ENPLP Phase 3 period.

Elevation Data and Hydrological Data

The Dinétah models used the highest resolution digital elevation dataset freely available for the Frances Mesa/Gobernador Canyon region, a 1/3 arc second (9.47 meter) resolution product from the National Elevation Dataset. This DEM formed the basis for all elevation-derived products generated for the Dinétah area model, including a hydrological stream network.

Land Classification

A supervised land classification was carried out with the goal of rapidly characterizing the general natural landcover along Gobernador Canyon and the adjacent mesas. The work was completed in ArcGIS using the Spatial Analyst extension's Image Classification tools. The analyzed image was a ten band Sentinel-2A satellite scene (ID: L1C_T13SBA_A021874_ 20190830T175704) originally captured on August 30, 2019 and downloaded from the USGS EarthExplorer website. The Sentinel-2A data was preferred over Landsat 8 imagery due to its finer resolution (10 meter visual bands and 20 meter NIR and SWIR bands).[28] Like the Black Mesa classification, a composite multi-band image was created that included the Sentinel-2A spectral bands 2-8, 11, and 12 (visual, NIR, and SWIR wavelengths), as well as three SWIR band ratios.[29]

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[28] Note: Database searches did not identify suitable Sentinel-2A scenes for the Black Mesa area.
[29] The Sentinel-2A bands and their central wavelengths are: Band 2 – Blue (0.492 μm), Band 3 – Green (0.559 μm), Band 4 – Red (0.664 μm), Band 5 – Vegetation red edge (0.704 μm), Band 6 – Vegetation red edge (0.740 μm), Band 7 – Vegetation red edge (0.782 μm), Band 8 - Near Infrared (NIR) (0.832 μm), Band 8A – Narrow NIR (0.864

The 13 band composite image was used to generate a series of “maximum likelihood” supervised classifications for the Dinétah study area. Land class training sets were created based on preliminary environmental observations made during a series of short field reconnaissance trips to the greater Dinétah region between 2015 and 2019. Ten separate classes were created for the Dinétah analysis: Mesatop Pinon-Juniper Woodland, Mesatop Plain, Valley Plain – Low Vegetation, Valley Plain – Dense Vegetation, Well-watered Herbaceous Vegetation/Deciduous Trees, Sunny Wooded Talus Slope, Shaded Wooded Talus Slope, Natural Gas Well Pads; Highway; and Wooded Mesa Bench.

While working through the supervised classification process, however, the geological homogeneity of the region coupled with intense shadowing created by the vertical relief of the Dinétah mesa systems made it difficult to confidently assign some areas specific land classes. Upon assessment, the amount of effort needed to improve the automated classification’s final product (which would only be used to delineate woodland areas) was deemed unfeasible and an alternative approach taken towards making the Dinétah treeline submodels.

Submodels

Topographic Position Index (TPI)

The Dinétah TPI submodel was created using the “TPI Based Landform Classification” tool provided in SAGA-GIS. The small-scale and large-scale TPIs needed for the landform classification were generated at 50 and 500 meters respectively. Like the Black Mesa TPI, the ten output are structured along the parameters of the ten-class system originally defined by Weiss (2001). They are: High Ridges, Midslope Ridges, Local Ridges, Upper Slopes, Open Slopes,

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μm), Band 11 - SWIR 1 (1.613 μm), and Band 12 - SWIR 2 (2.202 μm). Because of the difference in band order, the SWIR band ratios were: Band 4/Band 3, Band 11/Band 3, and Band 12/Band 8.

Plains, Valleys, Upland Drainages, Midslope Drainages, and Streams.

Slope

A standard slope submodel was created from the Dinétah area DEM using the ArcGIS Slope tool.

Toe of Slope

Analyses of the Phase 1 data and conversations with Navajo herders drew attention to the occasional use of natural landforms to construct corral enclosures in a more secure and efficient manner. Specifically, natural "walls" formed by rocky ridgelines or bedrock outcrops were highlighted as the most common types of features, although elements like cliff/canyon edges, box canyons, and amphitheaters were also discussed.

Calculating the "toe of slope" – an engineering term used to refer to the topographic breakpoint where the lower limit of a hillslope meets the horizontal plane – emerged as the most effective way to develop a submodel that highlighted potential "corral against natural rock wall" areas. This was achieved by following an ArcGIS workflow proposed by Huber (2003) that compares the mean elevations of "flat slope" and "steep slope" areas in a DEM (as separated by a predetermined slope breakpoint) and highlights areas where local steepness exceeds flatness. Three separate submodels were created at different slope breakpoints: 13, 10, and 7 degrees. Although the 13 degree submodel reflected the upper limit of corral slope placement in the Black Mesa area, the decision was made to use the more moderate submodels for the two Dinétah models (7 degrees for the Mesatop model and 10 degrees for the Valley model).[30]

[30] In hindsight, the decision to use lower slope breakpoints was a mistake. In keeping with the "natural enclosure" practice described above, the slope breakpoints should have been set *higher* to better capture areas of steep topography that reflect the "harder for sheep/goats to escape" logic that is partially behind this practice. Because

Aspect

A standard aspect submodel was created from the Dinétah area DEM using the ArcGIS Aspect tool.

Distance to Water

A single submodel was created detailing Euclidean distances away from the larger branches of the greater Gobernador Wash drainage. During the creation of the hydrology stream order, the flow accumulation threshold was set at 1500 pixels, resulting in the detection of substantially fewer minor (ephemeral) drainages.

Distance to Treeline

In contrast to the Black Mesa treeline submodel, the Dinétah study area's forest ecotone submodel was not generated via the supervised classification of satellite imagery. Instead, the borders of the pinon-juniper woodlands on Frances Mesa and the adjacent portion of Gobernador Canyon were manually digitized in ArcGIS using two aerial photographs: a 1 meter resolution National Agriculture Imagery Program (NAIP) image with visual and NIR bands obtained via ArcGIS Online and a historic 1935 Soil Conservation Service (SCS) image obtained from the University of New Mexico's Earth Data Analysis Center. The NAIP image was used as the main source for the digitization process, with the SCS image used to correct for areas where natural gas development had modified the woodlands. The treeline polyline features were then used as the target of a Euclidean distance measurement and the resulting raster used as the submodel.

DEMs effectively average slope values within the area of pixel resolution (in this case ~10m), a slope value of 20° or 25° would have more accurately reflected what was observed at the one example of this corral type documented during the Phase 1 fieldwork, the corral area at ENPLP1-51 (slope ~22°).

FINAL DINÉTAH MODELS: MESATOP & VALLEY EDGE

One of the critiques levied against locational models is that they can easily be leveraged to force answers to questions they might not be suited to ask. That is, a locational model whose underlying criteria were developed through an examination of settlement sites is likely not the best tool to study ceremonial sites or quarry area or field systems, for example. Similarly, a model developed for use in a flat grassland region will reflect different environmental and cultural considerations than models developed for more rugged or densely vegetated regions. While developing the framework for the ENPLP Phase 2 geospatial analyses, the upper Oraibi Wash drainage on Black Mesa was judged to be a region within the Navajo Nation whose broad topographical and vegetative similarities to the Dinétah region – and the continued practice of Diné sheepherding – made it suitable candidate for developing pastoral site submodels that could later be applied in Dinétah.[31]

At the same time, however, it was recognized that the Black Mesa submodels (which were developed from sheep camp site locations predominantly situated along the margins of the West Fork of Oraibi Wash) could not be directly applied to the entirety of the Dinétah model area. Because the ENPLP Phase 3 study area includes portions on top of Frances Mesa, a generally flat and wooded area, as well as a series of rocky mesa benches leading down to the Gobernador Wash valley, the Black Mesa data was instead used as the starting point for two separate models tailored to the distinct mesatop and valley edge sections. The new models – which were distinguished by different groups of submodels and different submodel weights – were created using the ArcGIS Predictive Analysis Tools' "Query Generator." This manually adjusted iterative weighted sums analysis tool output a 30 meter resolution site suitability raster

[31] Although many Diné families across the Navajo Nation continue to herd sheep and goats in the traditional manner, regions like Monument Valley, the San Juan Basin, or the Chuska Mountains are not good environmental analogs for the canyon and mesa landscape of Dinétah.

that was manually thresholded into areas of “Low,” “Moderate,” or “High” pastoral site suitability. The final models were loaded onto GPS units to help guide in-field site survey and selection activities during the Phase 3 work.

Mesatop Model Results

Frances Mesa is one of the main geological formations in the greater Dinétah region and a center of Navajo settlement during the early 1700s (Wilshusen et al. 2000). Bracketed by the San Juan River and Smith Canyon to the north and Gobernador Canyon to the south, the mesa rises to an elevation of 2120 meters, approximately 200 meters above the valley floor. The top of the mesa is characterized by a series of gently rolling hills covered with extensive pinon-juniper woodlands and open areas dominated by sagebrush. Given the relatively gentle topography and low hydrological variability of the mesatop, the original Black Mesa submodel parameters formed the basis of the model with some minor additions and adjustments as detailed in Table 6.

Table 6 - Dinétah Mesatop Analysis – Submodels & Weights

Submodel	Description	Weight
Topographic Position Index	Zones 5 (Open Slopes) and 4 (Plains)	1
Slope	Slopes less than 13 degrees, but not 6-8 degrees	1
	Slopes between 6-8 degrees	2
Aspect	East & South Facing	2
	North & West Facing	1
Toe of Slope	Toe of slope (7 degree breakpoint)	1
Distance to Water	Within 300 meters of stream network	1
Distance to Treeline	Within 40 meters of treeline	1.5

These parameters resulted in a mesatop site location model with suitability scores ranging from zero to 9.5. Pixels with scores between 0 and 3 were designated “Poor,” pixels between 3 and 7.25 were designated “Moderate,” and pixels with values above 7.25 were designated as “High” (Table 7). In total, 13.1% of the ENPLP Phase 2 Frances Mesa study area were designated as

"High" suitability areas where early Navajo pastoral sites might be found (Figure 15).

Table 7 - Dinétah Mesatop Model Suitability Score Breakdown

Low (0-3)	Moderate (3.01-7.25)	High (7.25+)	Total (0-9.5)
2,194 px [11.8%]	13,948 px [75.1%]	2,435 px [13.1%]	18,577 px [100%]

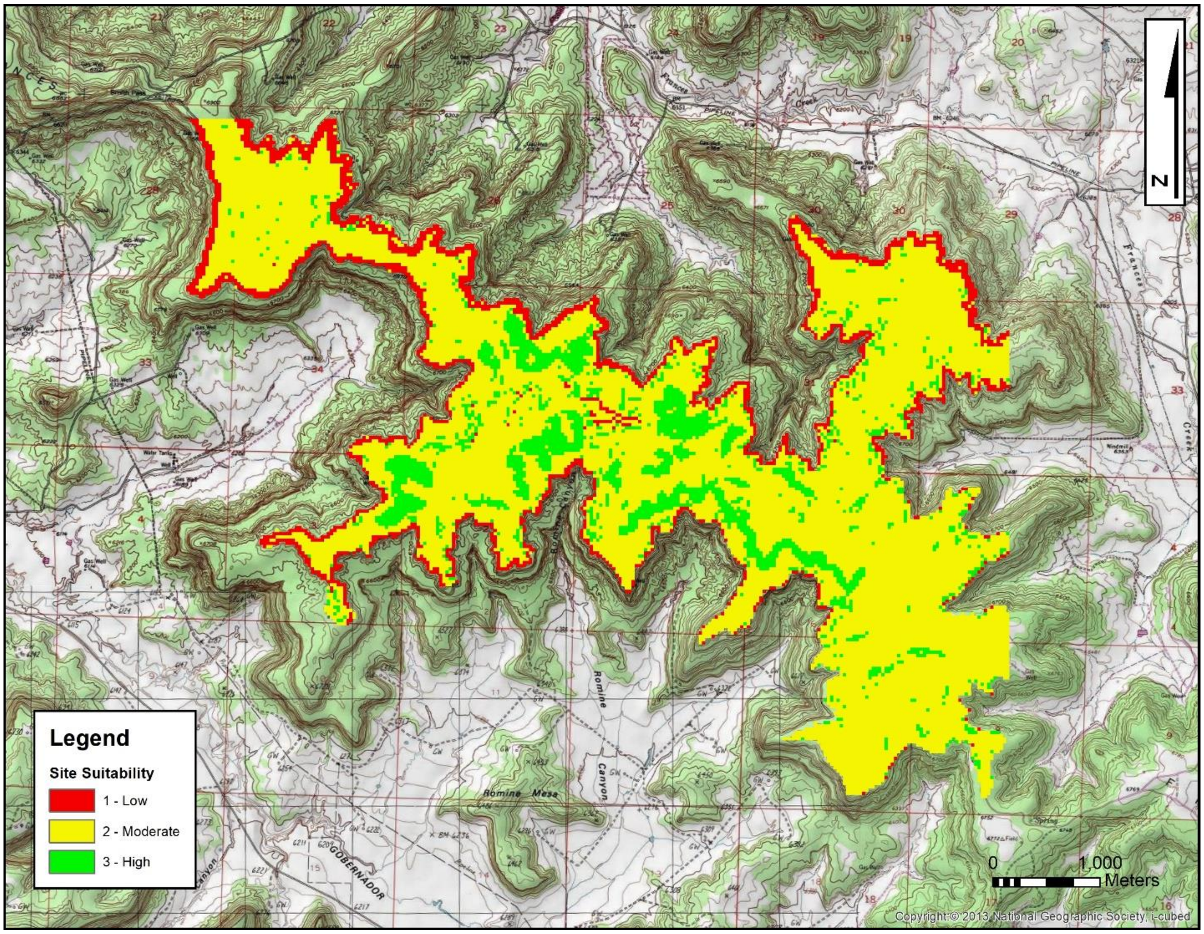

Figure 15- The ENPLP-2 Dinétah Mesatop Model

Valley Edge Model Results

The canyon or valley formed by Gobernador Wash is one of the Dinétah region's defining landforms. Extending some 25 miles from its source under the foot of Gobernador Knob, the home of the Navajo deity Changing Woman, to its confluence with the San Juan River, the drainage has been described by some Navajos as a sacred cornstalk (Cleveland et al. 1999). The numerous side canyons and tributaries that form the plant's leaves and ears are fittingly home to numerous early Navajo archaeological sites, including the former MENLUS project area on the south side of Frances Mesa (Dykeman 2003a).

The ENPLP Phase 2 valley model specifically focused on the intermediate area between the top of Frances Mesa and the main Gobernador Valley plain. Here a sequence of wide wooded mesa benches descended down to the margins of the valley, forming a landscape full of small clearings, short draws, and drainage heads separated by steep talus slopes and sandstone bluffs. The original set of Black Mesa-derived parameters was accordingly adjusted to reflect this more rugged environment, resulting in the suite of submodels shown in Table 8.

Table 8 - Dinétah Valley Edge Analysis – Submodels & Weights

Submodel	**Description**	**Weight**
Topographic Position Index	Zone 4 (Plains)	0.5
	Zone 5 (Open Slopes) and 6 (Upper Slopes/Mesas)	1.25
Slope	Slopes less than 13 degrees, but not 6-8 degrees	1
	Slopes between 6-8 degrees	1.5
	Slopes greater than 13 degrees	-2
Aspect	East & South Facing	1.5
	North & West Facing	1
Toe of Slope	Toe of slope (10 degree breakpoint)	2
Distance to Water	Between 125-250 meters from stream network	1
Distance to Treeline	Within 40 meters of treeline	1

These parameters resulted in a valley edge/mesa bench site location model with suitability scores ranging from 0.5 to 9.25. Pixels with scores between 0.5 and 2 were designated “Poor,” pixels between 2 and 6 were designated “Moderate,” and pixels with values above 6 were designated as “High” (Table 9). In total, 13.1% of the ENPLP Phase 2 Frances Mesa study area were designated as “High” suitability areas where early Navajo pastoral sites might be found (Figure 16).

Table 9 - Dinétah Valley Edge Model Suitablility Score Breakdown

Low (0.5-2)	Moderate (2.01-6)	High (6+)	Total (0.5-9.25)
3.827 px [16.4%]	17,465 px [74.7%]	2,089 px [8.9%]	23,381 px [100%]

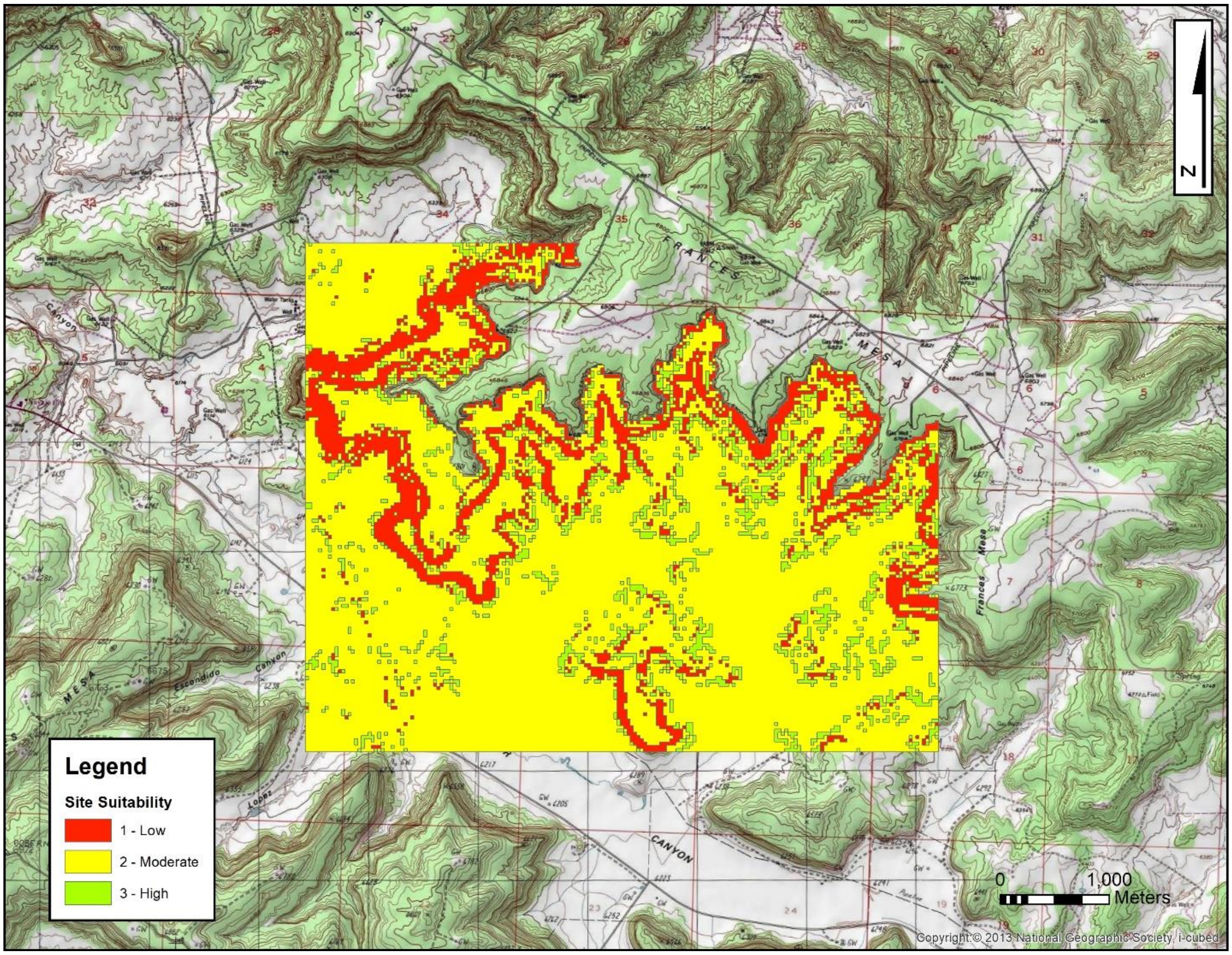

Figure 16 - The ENPLP-2 Dinétah Valley Edge Model

DISCUSSION

The lack of clear archaeological data detailing incipient Navajo pastoralism in the Gobenador and Largo drainages presents an opportunity to apply a variety of geospatial analytical techniques to the question. The lack of suitable Dinétah-area site data needed to create an inductive model training dataset, however, led the ENPLP to take a two-part approach that combined a series of methods to model the locations of early Navajo pastoral sites. The first part of the ENPLP Phase 2 work drew upon ethnoarchaeological observations of late nineteenth and twentieth century Diné herding sites to generate a hypothetical set of geospatial assumptions about earlier Navajo pastoral settlement. This set of ethnographic analogs formed the framework for the second part of the Phase 2 analysis, an inherently more experimental and intuitive process that resulted in a pair of geospatial models indicating areas of high potential site suitability. This work represents the next step in developing tailor-made GIS-based locational models that seek to address specific questions regarding early Navajo settlement and land use practices in Dinétah. Importantly, lessons learned through geospatial studies in the early Navajo heartland can potentially be used in the future as the basis for similar analyses across the greater Four Corners region that seek to better understand other episodes in Navajo history across both time and space.

Chapter 6: The Early Navajo Pastoral Landscape Project Phase 3 – Pastoral Landscape Survey & Sampling Work in Dinétah

INTRODUCTION

For decades, students of Navajo history and culture have wrestled with the question of when and how Diné communities began the iconic sheepherding practice that continues to this day. Because the surviving corpus of seventeenth century texts from Spanish colonial New Mexico lack substantive discussions about Navajo society and life during this early period, researchers have turned to the archaeological record in an attempt to clarify matters (e.g., Weisiger 2004). When combined with the vagaries of the archaeological record itself, however, the developmental history of Navajo archaeology up to this point has made it difficult to come to any clear understanding of the Navajo pastoral tradition's early days. Indeed, when one looks at the major works of Navajo archaeology over the past thirty years, a common theme emerges – although sheep and goat faunal remains are present at seventeenth and eighteenth century Navajo sites throughout Dinétah, small sample sizes have stymied zooarchaeological attempts to investigate the role of animal husbandry and incipient pastoralism in early Navajo life.

The ENPLP was designed to redress this issue by moving the analysis away from faunal remains towards key pieces of pastoral infrastructure whose archaeological traces might still be identifiable on the landscape. Specifically, the Phase 3 work sought to test the applicability of a multi-method approach designed to identify the archaeological remains of corral-type enclosures at a sample of 11 previously identified Gobernador Phase (AD 1625-1750) Navajo sites along the margins of Gobernador Canyon, one of the primary tributaries of the San Juan River in Dinétah. The initial fieldwork was carried out between October 2019 and January 2020 and focused on testing for subsurface dung concentrations through a combination of intensive survey and systematic soil phosphorus sampling at each site. High phosphorus concentration samples associated with features of archaeological interest were then subjected to a microremains analysis to determine whether the soils contained concentrations of preserved fecal spherulites, evidence that could be used to confirm whether a feature might represent an early Navajo sheep corral.

This chapter presents the results of these Phase 3 activities alongside a summary of previous archaeological and historical evidence for pastoral interactions in the Dinétah region. Together these data form the basis for an analysis of potential early Navajo herding strategies beyond the edge of the Spanish colonial world and a methodological discussion about expanding this work further (see Chapter 7).

PRIOR EVIDENCE FOR EARLY NAVAJO PASTORALISM

Pastoral Archaeology in the Greater Southwest

Studies of pastoralism in the American Southwest are relatively rare considering the amount of archaeological work that has been conducted in the region over the past century. Most research into the subject has consisted of zooarchaeological analyses of faunal assemblages from Spanish colonial era sites, especially missionized Pueblo and O'odham villages in New Mexico and the Pimeria Alta (southern Arizona). While these studies largely focus on issues related to European influence on Indigenous subsistence practices and food culture, they also highlight issues that are inherently tied to broader pastoralist concerns like animal husbandry, suitable infrastructure, and land-use practices. Examples include the persistence of Indigenous foodways versus restricted access to European domesticates (Chapin-Pyritz 2000 [Awatovi]), questions about Indigenous involvement in the colonial pastoral economy (Tarcan 2005; Tarcan and Driver 2010 [Zuni]), and animal domesticate preferences (e.g., sheep/goat or cattle) at different colonial sites (Pavao-Zuckerman 2017; Pavao-Zuckerman and LaMotta 2007 [Pimeria Alta]).

A handful of studies have recently begun to approach these types of questions through a broader pastoral landscape lens while experimenting with an array of different methodological approaches. Notably, Mathwich (2018; 2021; Mathwich et al. 2019) has used isotopic studies to identify shifting pastoral land use practices in the Pimeria Alta that reflect differences between associated domesticated animals, water infrastructure, *and* Spanish colonial sites. Along the Middle Rio Grande terrace in New Mexico, a CRM project on Kirtland Air Force Base sought to evaluate the extent of Southern Tiwa herding practices during the mid-seventeenth century by examining a potential pastoral site near Tijeras Arroyo (Church et al. 2012). A single random soil sample was sent off for fecal spherulite analysis; although the results were negative, the resulting discussion highlighted several factors for researchers interested in pastoral archaeology, including paying close attention to artifact scatters and other ephemeral features, emphasizing sample collection at potential corral areas, and the need to sample multiple sites in a particular region (Church et al. 2012:130-132). Elsewhere, a study of Laguna Pueblo sheepherding practices throughout the greater Mt. Taylor region of west-central New Mexico between 1862 and 1940 offers another example of the power of an ethnoarchaeological approach for studying pastoralism (Hopkins et al. 2016). As in the case of the ENPLP Phase 1 work (Chapter 4; Campbell 2021), the ability to augment archaeological interpretations with oral and textual histories allows one to create refined models for past pastoral practices and improve one's ability to identify potential pastoral features when in the field.

Perhaps most intriguingly, Conrad (2021) has argued that the centuries-old tradition of Pueblo/Ánaasází intensive turkey husbandry throughout the greater Four Corners region can be productively understood as a form of small-scale pastoralism. Not only did the birds provide feathers, an important secondary product valued by Pueblo people, but their successful care was secured through a series of dedicated management practices including village-based herding and penning. These same turkey management practices may have helped pave the way for the Pueblos' incorporation of European animal domesticates during the Spanish colonial period (Conrad 2021:7-9), a connection first noted by Cushing when he recalled Zuni sheepherders circa 1880 employing bone spatulas to "pluck" the "down" off of their sheep – that is, the same tools and terminology as used for turkeys (Cushing 1979:182–183)! In the case of the ENPLP, the turkey pastoralism argument is particularly useful as it emphasizes the value and applicability of broader analytical frameworks to questions of Southwestern pastoralism. On one hand, it allows one group of researchers to begin to more critically evaluate the resiliency of Indigenous cultural traditions and technologies across the pre-/post- colonial period divide. On the other hand, it also serves to emphasize the unique nature of pericolonial pastoral developments like those seen on the Great Plains or in Dinétah during the seventeenth and eighteenth centuries.

Historical Evidence for Early Navajo Herding in Dinétah

The first recorded entry of sheep and other Old World animal domesticates into the American Southwest occurred with Don Francisco Vázquez de Coronado's AD 1539-1542 entrada in search of the cities of Cibola. The two thousand-strong expedition was initially supplied with 5,000 head of livestock (Flint 2003:50). Following Coronado's return to New Spain, a small flock of sheep remained among the Pueblos along with a few Franciscan missionaries, but the ultimate fate of those sheep is unknown (Bolton 1949:338). Historians surmise that the expedition's livestock served as provisions and were consumed as such (Flint and Flint 2012:533).

The creation of a true pastoral industry in the region dates instead to the founding of the New Mexico colony by Don Juan de Onate in 1598. Records indicate that 7,000 livestock, including more than 3,600 sheep and goats, accompanied this expedition (Bailey 1980:49; Barrett 2012:5). With the exception of the capital, Santa Fe, Spanish colonial settlement in seventeenth century New Mexico was highly dispersed and focused largely on animal husbandry and subsistence farming (Trigg 2005). By the 1630s, sheep and cattle byproducts produced at secular estancias and at Franciscan missions had become one of the colony's key economic exports, and both groups of colonists relied heavily on the labor of missionized Pueblo peoples to care for these animals (Scholes 1935; Trigg 2005).

Intensified Spanish pastoral practices during the seventeenth century demanded additional environmental resources and necessitated transhumant herding strategies that likely placed Pueblo caretakers into contact with Navajo groups (MacCameron 1994; Bailey 1980:53–55). Navajo and Apache bands began an alternating strategy of raiding and trading with colonial settlements for livestock and other goods during the 1600s, resulting in periodic Spanish military reprisals and slave-taking missions (Brooks 2002:80–116; Brugge 2010; McNitt 1990:10–25). Indigenous discontent with the colonial regime reached a peak in 1680 when the Pueblos united with Navajo and Apache allies to drive the Spanish out of New Mexico for twelve years (Liebmann 2012a). Decades of diverse contacts between seventeenth century Southwestern communities suggest that initial Navajo herding experiments may have begun prior to the 1680

Revolt and became increasingly widespread in post-Revolt decades (Bailey 1980:67; Bailey and Bailey 1986:14-17; Weisiger 2004).

Two Spanish documents from the first half of the eighteenth century provide the earliest surviving historical accounts of Navajo herding activities. The first text is the campaign journal from a 1706 punitive mission into Dinétah led by the New Mexico colony's *maestre de campo*, Roque Madrid. The journal notes that soldiers captured two very small herds of sheep that were abandoned by Navajo groups fleeing to mesa-top strongholds [proto-pueblitos?] (Madrid et al. 1996:27, 31). The number of animals seized – two and thirty, respectively – have led some to question the economic importance of herding at this time (Madrid et al. 1996:93). Given the size and slow speed of the punitive expedition, however, it is likely that a valuable and highly mobile resource like livestock would simply have been shepherded to safety, and the thirty-two animals noted in historical documents represent unfortunate stragglers (Weisiger 2004:259-260).

The second text, known as the Rabal Document, comprises a series of twelve legal depositions made in 1745 by members of the colonial militia to Joaquín Codallos y Rabal, then governor of New Mexico (Hill 1940b). The testimonies recount a number of Spanish forays into the Dinétah region between 1712 and 1717, as well as a later entrada in 1743. While these accounts likely represent the condensed memories of three decades of raiding and trading with colonial-era Navajo groups beyond the New Mexican frontier, they all describe Dinétah-area Navajos managing small sheep herds of varying size (between 50 and 200 head). Furthermore, all twelve interviewees highlight the production of woolen textiles as a known Navajo economic activity.

By 1795, Navajo pastoralism had grown to such an extent that the Spanish governor Fernando de Chacón commented that Navajos "do not want for sheep, for those that they possess are innumerable" (Weisiger 2004:266). The mid- through late-eighteenth century increase in Navajo pastoral intensity was accompanied by an increasingly "sheep-minded" form of social organization in which an extended family residence group looked after a common herd (Bailey 1980:123; cf. Witherspoon 1973), as well as increasing migration to areas south and west of Dinétah beginning circa 1750 (Brugge 1972; Towner 2008). United States military encroachment during the mid-1800s and the eventual imposition of the reservation system following the US-Navajo Treaty of 1868 signaled a decrease in widespread Diné land-use in Dinétah.

Although a small number of Navajo families continued to live along the southern and western margins of Dinétah following the Ft. Sumner internment, regional demographics in the Largo/Gobernador area flipped during the late 1800s and early 1900s as Anglo and Hispanic homesteaders arrived and founded small village settlements. These families predominantly engaged in cattle ranching supplemented by subsistence agriculture, while other parts of Dinétah became winter grazing range for Hispanic New Mexican herders from the Rio Arriba region to the east (Leckman et al. 2013; Wooderson 1998). Today, scattered cattle ranches operate on private and public lands in the region, while a Colorado sheep ranching outfit continues to drive its animals to the western edge of Dinétah for the winter (Erik Simpson, personal communication 2020).

Archaeological Evidence for Early Navajo Herding in Dinétah

For over a century, archaeologists have worked to better understand the workings of early Navajo society. Occasional excavations, particularly at the pueblito fortresses for which Dinétah is famed, coupled with extensive CRM-driven survey work throughout the region have identified both the remains of Western domesticate fauna and different types of pastoral infrastructure at early Navajo sites. Many researchers (e.g., Brown 2014b:210; Hester 1962:25; Powers and Johnson 1987:137; Towner and Johnson 1998:146–147; Wilshusen et al. 2000:212) have noted, however, that while these data attest to some degree of animal husbandry by early Navajo groups, the small sample sizes and limited scope of many projects have limited attempts to discuss the timing or intensity of early Navajo herding in greater detail.

A survey of references to Western domesticate faunal remains and potential pastoral infrastructure in the Navajo archaeology literature, which mainly consists of CRM reports associated with the greater Fruitland Project work in the 1990s, is summarized below.

Faunal Evidence

The osteological remains of Old World animal domesticates have been identified at a minimum of 31 early Navajo sites in Dinétah (Table 10), although surveys have noted faunal remains at numerous other sites that remain as yet unsampled. Ten of these sites are pueblito complexes, while the remaining 21 are single household and multiple household sites. Ovicaprids – that is, sheep or goats – form the largest single group of identifiable domesticate remains, while equids (horse, donkey, or mule) form the second most identified group. Although one of the Rabal Document testimonies describes seeing cattle tracks in Dinétah (Hill 1940:405), cattle remains were not identified during the Fruitland work.[32] Pigs have not been identified at any early Navajo site to date nor are they referenced in colonial period historical accounts.

[32] In light of the lack of cattle remains at early Navajo sites, the historical reference to cattle tracks in the Rabal Document is commonly held to reflect a misinterpretation of elk tracks (Dykeman 2003c:430; Marshall 1991:249). In a similar vein, the unidentified and often very fragmented remains of large artiodactyl fauna from early Navajo sites are generally assumed to be elk (or the intrusive remains of later historic period cattle).

Table 10 - Counts (NISP) of confirmed Western domesticate remains at early Navajo sites in Dinétah

	LA No.[1]	*Ovis/Capra* Sheep/Goat	*Ovis* sp. Sheep	Small Artiodactyl Sheep/Goat	Sm./med. Artiodactyl Sheep/Deer/ Pronghorn	*Equus* sp. Horse, donkey, mule	Source
1	46147	-	-	-	22	-	Fruitland Synthesis 2014 Data Table
2	71781	10	1	-	-	-	Fruitland Synthesis 2014 Data Table
3	71835	-	-	-	1	-	Fruitland Synthesis 2014 Data Table
4	72362	1	-	-	-	-	Fruitland Synthesis 2014 Data Table
5	72779	-	-	2	-	-	Fruitland Synthesis 2014 Data Table
6	72787	5	-	-	-	-	Fruitland Synthesis 2014 Data Table; (Hovezak and Schneibs 2002)
7	78825*	-	-	1	-	-	Schneibs 2000 (FMATP)
8	79462	-	-	-	-	1	Fruitland Synthesis 2014 Data Table; (Hovezak and Schneibs 2002)
9	80318	-	-	-	6	-	Fruitland Synthesis 2014 Data Table
10	80319	-	-	-	1	-	Fruitland Synthesis 2014 Data Table
11	80321	-	-	-	2	-	Fruitland Synthesis 2014 Data Table
12	80910	-	-	-	5	-	Fruitland Synthesis 2014 Data Table
13	80911	-	-	-	1	-	Fruitland Synthesis 2014 Data Table
14	83529* (Morris 1 Pueblito)	-	7	-	-	-	Fruitland Synthesis 2014 Data Table; Goodman 2003
15	89898	28	-	-	-	-	Fruitland Synthesis 2014 Data Table
16	104202	5	-	-	-	-	Fruitland Synthesis 2014 Data Table
17	105530*	-	7	-	-	-	Fruitland Synthesis 2014 Data Table; Goodman 2003
18	106203*	-	5	-	-	1	Fruitland Synthesis 2014 Data Table; Goodman 2003
19	113103*	19	-	-	-	-	Fruitland Synthesis 2014 Data Table; (Hovezak 2004)
20	113256	-	-	11	-	1	(Wilshusen et al. 2000)
21	121967	-	-	-	6	-	Fruitland Synthesis 2014 Data Table
22	122574	-	-	-	8	-	Fruitland Synthesis 2014 Data Table
23	1869 (Old Fort Pueblito)	3	-	-	-	11	(Carlson 1965:11)
24	1871 (Three Corn Pueblito)	8	-	-	-	7	(Carlson 1965:21(
25	2298 (Tapacito Pueblito)	3	-	-	-	-	Brown & Brown 1995 in Marshall 1995: 145-199
26	2135 (Frances Canyon Pueblito)	6	3	-	-	2	Brown & Brown 1995 in Marshall 1995: 145-200
27	5660 (Shaft House Pueblito)	3	-	-	-	-	Brown & Brown 1995 in Marshall 1995: 145-201
28	5662 (Hooded Fireplace Pueblito)	11	4	-	-	4	Brown & Brown 1995 in Marshall 1995: 145-204
29	5664 (Split Rock Pueblito)	21	11	-	-	2	Brown & Brown 1995 in Marshall 1995: 145-205
30	5657 (Largo School Pueblito)	4	-	-	-	-	Brown & Brown 1995 in Marshall 1995: 145-206
31	5665 (Adolfo Canyon Pueblito)	Present (# unspec.)	-	-	-	Present (# unspec.)	(Haskell 1975:134–135 [no detail])
	TOTAL	127	38	14	52	29	

[1] – Asterisk indicates site chosen for the ENPLP Phase 3 work.

Although the osteological evidence is scanty, Goodman (2003) has argued that the small size and “gracile nature” (Dykeman 2003c:430) of the sheep remains recovered from two early eighteenth century sites in the MENLUS project area (LA 83529 and LA 106203) indicate the presence of Churro breed sheep. The Churro or “Navajo-Churro” sheep is a heritage breed that traces its lineage to the earliest days of Spanish New Mexico and is closely associated with contemporary Diné and Hispanic communities in the Southwest. Distinguished in part by their small stature and multi-horned rams, Churro sheep are held to be well adapted to the high desert environment of the greater Four Corners region, while their long wool is particularly valued in the traditional Navajo weaving community (Strawn and Littrell 2007).

Pastoral Infrastructure

Over the decades, researchers have noted nearly two dozen different structures and features at seventeenth and eighteenth century archaeological sites throughout the Dinétah region that can potentially be classified examples of early Navajo pastoral infrastructure (Table 11). These include clearly identifiable, high visibility wood corral enclosures and dung-filled rock shelters as well as more subtle features like stone alignments and potential stock trails. In some cases, the presence of dung deposits, diagnostic artifacts, and datable materials attest to the nature and timing of a feature’s use, although in the majority of other cases potential pastoral relationships and cultural associations are inferred and have yet to be confirmed by direct testing. As Marshall (1991:120, 249) notes, many early Navajo corrals have likely gone unnoticed due to their informal nature. Developing ways to more securely identify and confirm the existence of

Table 11 - Possible pastoral infrastructure elements at early Navajo sites in Dinétah

	LA Number	Site Name	Est. Site Date Range (AD)	Possible Pastoral Infrastructure Type	Description of Pastoral Infrastructure	Source
1	5664	Split Rock Pueblito	post 1727	Alcove/Shelter	"A small [rock] shelter under the south and southeast section of Split Rock Pueblito has a remnant formation of sheep dung. The area was apparently used to shelter sheep and may have been closed with a deadwood corral. A dung sample and single iron pellet was removed from this area. An attempt was made to reconstitute the dung sample in order to examine its morphology, but this was unsuccessful."	Marshall 1995:57
2	5658	Compressor Station Pueblito	post 1727/28	Alcove/Shelter	"Cursory examination of the surrounding area... indicates that features associated with the pueblito include... an alcove overhang that contains approximately 25 centimeters of sheep dung and is the best preserved sheep corral associated with any of the pueblito sites. An alignment of small boulders along the front of the overhang demarcates the extent of the corral, but it contained no wooden elements useful for dating."	Towner 1997:164
3	5665 (?)	Adolfo Canyon pueblito complex - Hogan 7 area	n/a	Corral (Wood)	"…2 hogans are associated with the architectural features located on the erosional bench 300 yd to the southwest [of the pueblito]. This cluster also includes 2 ramadas and a corral. The ramada and attendant corral associated with Hogan 7 came to within several yards of it (Fig. 15). These structures... are in direct alignment with each other and are separated from one another by no more than a few feet. The corral is essentially elliptical in shape and is reasonably well defined despite the fact that a small arroyo has eroded nearby surficial deposits. This structure undoubtedly was utilized to corral livestock and in particular sheep." [nb. No tree-ring samples collected]	Haskell 1975: 80-85
4	10733	Pointed Butte Ruin	1710s-1750	Corral (Wood)	"Pointed Butte Ruin consists of four masonry rooms around and on top of boulders, six associated forked-stick hogans, and a corral on the bench below the pueblito. ...*[nb. The pueblito post-dates 1713, while nearby a nearby hogan post-dates 1720]* It is interesting, however, that the corral associated with the site dates to the Hispanic occupation of the area in the 1880s [1881+G; 1877+vv; 1888+G], long after the Navajo abandoned the Dinétah."	Towner 1997:246-249
5	99809	Buffalo Mask Site	1680	Corral (Wood)	"The Buffalo Mask site is a small two- or three-room structure located in an alcove high above a tributary of Delgadito Canyon... No hogans are associated with the site, but a portion of a corral fence is located on one of the benches below the site. ...The dates from the corral [1915G; 1918G] clearly indicate an early twentieth century use of the area, probably by Hispanic sheep herders and are consistent with dates from all other sampled corrals associated with pueblitos."	Towner 1997:144-147
6	55841	Unreachable Rockshelter Hogans	mid 1600s to mid 1700s	Corral (Wood)	"Twenty-one tree-ring samples from nine different forked-stick hogans, an ax-cut stump, and a possible corral were collected (Table 27). Unfortunately, these samples produced only 10 dates, and only six of those are applicable to the Navajo occupation. The ax-cut stump and dead trees though to be part of a corral all indicate twentieth century activity in the area [1947+G; 1917++GB; 1961LGB]."	Towner 1997:178-180
7	2136	Dos Cerritos Pueblito	1730s	Corral (Wood)	"One sample was collected from a dead tree approximately 200 m east of the pueblito that may have been part of a possible corral." [The sample did not date].	Towner 1997:187-190
8	101393	Dooyiit'íìní Pueblito	1710s-1720s	Corral (Wood)	"Dooyiit'íìní Pueblito is a collapsed three room masonry structure on top of a sandstone boulder, an associated room or rooms below the boulder, a brush structure or corral *[Towner 1997:Figure 74 shows the "possible corral area" amid a collection ~3 m wide boulders some 15 m south of the pueblito. Nb. Towner did not collect the samples from this site]*... The two samples directly associated with the pueblito suggest it was occupied in the 1710s or early 1720s. The 1719 cutting date probably dates the occupation, although not necessarily the construction events. The 1712 noncutting date from the brush structure [or corral] suggests that structure is contemporaneous with the pueblito."	Towner 1997:273-274

Table 11 (Continued) - Possible pastoral infrastructure elements at early Navajo sites in Dinétah

9	5661	Pork Chop Pass Pueblito	late 1730s to 1740s	Corral (Wood)	"The Pork Chop Pass site consists of a three- or four-room masonry structure, three associated middens, and a deteriorated wooden corral approximately 50 m east of the pueblito. *[nb. The two samples from the corral resulted in a pair of non-cutting dates that likely reflect usage in the 1910s or 1920s (1914+vv; 1847++vv)]*."	Towner 1997:249-252
10	2135	Frances Canyon pueblito complex	1710-1745+	Pen/Corral (Stone)	"…An enclosure 6 x 4 m in size and formed by an alignment of sandstone blocks (20 x 600 cm in size) is built up against a low slickrock exposure south of Midden 3 [nb. ~20 m E of the main pueblito complex]. There is little rubble here and the walls probably did not exceed 50 cm in height. The function of this enclosure is undetermined, although it might be an animal pen or small corral."	Marshall 1991:147
11	55830	Hadlock's Crow Canyon pueblito complex	poss. late 1600s, early 1700s	Pen/Corral (Stone)	"A small corral is present on a cliff top ledge about 70 m northwest of the pueblito. An area of the ledge, 10 x 16 m in size, is closed off by a low stacked rock wall. The cliff edge and upper ledge form much of the enclosure. This type of cliff edge corral has been found elsewhere in the Dinétah District and similar corrals are known near Shaft House at LA 71576 and on a cliff ledge below Star Rock Pueblito."	Marshall 1991:214
12	5657/6351	Largo School pueblito complex - Area B, Features 3 & 5	late 1730s to 1740s	Pen/Corral (Stone)	Feature B-3: "An alignment of sandstone blocks (Feature B-3) located 12 m south of the hogan ring [nb. ~20 m N of the Area B boulder-top pueblito] forms an enclosure 8 x 4 m in size. Sandstone blocks 20 cm to 75 cm in size, are placed among a group of boulders and form a kind of terraced enclosure. Masonry rubble adjacent to the north wall suggests that the original wall elevation was about 50-75 cm. This unroofed enclosures was perhaps a corral. Estimated depth of fill in the enclosure is 50 cm." Feature B-5: "Directly southeast and below the boulder top unit is another masonry enclosure (Feature B-5) measuring 5 x 6 m. The enclosure is an alignment of stacked rock elements (20-70 cm in maximum dimension) that incorporates a group of large boulders. Little rubble is present and it is estimated that the original wall elevation was 50 cm. The structure was apparently unroofed and may have been a masonry-based ramada or a corral pen enclosure. The structure retains soils to an estimated depth of 50 cm to 1 m."	Marshall 1991:15-16
13	5662	Hooded Fireplace pueblito complex - Feature 5	early 1720s	Pen/Corral (Stone)	"Located on the bench flat directly below the Feature 4 room, is Feature 5, an alignment of large blocks, which is a probable corral. Large stones 30-60 cm in size form a semicircular alignment in a 10 m long arc. These stones are the probable base of a brush corral enclosure, formed by large boulders on the talus base, the stone alignment, and a probable deadwood fence."	Marshall 1991:39-40
14	71576	Part of larger Shaft House pueblito complex (LA 5660)	post 1712	Pen/Corral (Stone)	"This site is located on a high cliff ledge on the north side of Cuervo Canyon approximately 150m NE of Shaft House. The ledge is 10m below the mesa top canyon rim in a situation very similar to that of Shaft House. Access to the ledge is from the mesa top via a single cleft in the upper cliff and cannot be gained directly from Shaft House. The ledge is 12m wide with a high cliff below. This site includes a corral enclosure and a shelter located on a high cliff ledge in an area 20m east-west by 12m north-south. The enclosure is defined by a semicircular alignment of large sandstone blocks (30-70cm in size) placed against the cliff; it is 8x5m in size and is partially under a narrow overhang. The location is well sheltered. The stones that form the enclosure are burned, probably due to a conflagration of the brush or deadwood fence originally placed on the rock alignment. A shelter defined by an alignment of stones in a group of boulders is located on the cliff edge 8m south of the corral. The boulders and the stacked-rock wall enclose a 3x2m area. No artifacts were found.	Marshall 1991:120 & 122 (map)

Table 11 (Continued) - Possible pastoral infrastructure elements at early Navajo sites in Dinétah

15	11096	Northeast Burial Knoll - Three Corn pueblito complex	1717-1737	Pen/Corral (Stone)	"Feature 9 is located in the sage flat northeast of Three Corn Ruin. It is approximately 20 m beyond the base of the talus slope. The feature consists of at least ten sandstone blocks arranged in a row 4 m long and aligned to 16 degrees east of north. Sediment has accumulated on the upslope (west) side of the alignment. Several cobble-sized pieces of oxidized sandstone are located about 1 m south of the alignment and others are located 6 m to the east. The rock alignment may represent a wall segment and could be associated with the walls in Feature 10. Feature 10 is located approximately nine meters southeast of Feature 9 and consists of a single course of large (50 to 70 cm) sandstone boulders forming a rectangular foundation. There may have been two or three courses of smaller (20 to 30 cm) sandstone blocks and slabs above the foundation as evidenced by debris along the walls. The feature is 7 m north to south and 6.5 m east to west; there is a one meter gap in the east wall. The feature was previously recorded as a possible jacal structure with a sandstone foundation. This seems unlikely due to the low clay content of the soil near the foundation and an absence of any burned jacal. Although there are Dinétah Gray sherds scattered around the feature, trowel tests failed to reveal any subsurface deposits. The feature may represent an unfinished structure or some sort of pen or shelter for animals. Its cultural affiliation is probably Navajo."	Towner & Johnson 1998:124
16	105422	n/a	mid 1600s to mid 1700s	Pen/Corral (Stone)	"LA 105422 is a hogan with a masonry entryway and possibly a second hogan indicated by a stone circle... The site is on a bench below Old Fort Ruin (LA 1869) which is visible on the skyline approximately 900 m to the west-southwest. ...Feature 2 is a partial circle of stones (sandstone) approximately 5.5 m in diameter slightly southeast of the hogan. This may represent another hogan or some other type of structure or feature, such as a lambing pen. There is no evidence of internal features, but the ground is covered with a heavy layer of duff that inhibits surface visibility."	Towner & Johnson 1998:104-107
17	11092	Kin Tsézéí Pueblito	late 1600s to mid 1700s	Pen/Corral (Stone)	"Kin Tsézéí is a Navajo site consisting of a pueblito, a hogan, two possible hogans, and a ceramic and lithic scatter… near the bottom of San Rafael Canyon… Feature 2 is a roughly circular arrangement of sandstone rocks that may be the remains of a hogan or other structure. A trowel test failed to reveal evidence of cultural deposits."	Towner & Johnson 1998:111
18	109396	n/a (ENPLP3 Site)	mid 1600s to mid 1700s	Pen/Corral (Stone)	"[A single unit habitation site that contains]… both structural remains and hearth/oven features [and] also contain rock alignments that may indicate corrals. The [site is] situated at the base of talus slopes and the rock alignments extend between talus boulders to close off small areas. The alignments are located in loose sediments and may have served as the base of a brush corral. The foundation stones may have been used to anchor the brush superstructure, or may have discouraged animals from digging out of the corral. These sites may have functioned as sheep camps, seasonally or periodically." Feature 1 is a possible masonry structure which consists of an L-shape lineation of dry laid, unshaped sandstone blocks and small boulders. The front wall of this possible structure is a single course of large boulders, approximately 0.5 by 0.5 m; these are laid upon a very large sandstone boulder which acts as a foundation. The south end of this front wall abuts one of three other very large boulders which circle around the back of the room and comprise the south and western perimeter of the inferred structure. Feature 2 is similar to Feature 1 and lies just 15 m due south of Feature 1. It consists of a 5-m-long arc-shaped wall lineation which abuts a medium-sized sandstone boulder. Although the wall is mostly collapsed and eroded, it appears to still have two courses of masonry relatively intact. A large sandstone boulder with a vertical eastern face which opposes the wall is likely to represent the back wall of the structure. The building stones consist of unshaped sandstone blocks and boulders, and there is no sign of remaining adobe or mortar. This feature is located at the base of the colluvial talus slope. The possible structure is considered a single room which had been situated amongst two to three medium-sized sandstone boulders"	Dykeman 2003:75; NM ARMS Site Form

Table 11 (Continued) - Possible pastoral infrastructure elements at early Navajo sites in Dinétah

19	110272	n/a	unknown	Pen/Corral (Stone)	"[A single unit habitation site that contains]… both structural remains and hearth/oven features [and] also contain rock alignments that may indicate corrals. The [site is] situated at the base of talus slopes and the rock alignments extend between talus boulders to close off small areas. The alignments are located in loose sediments and may have served as the base of a brush corral. The foundation stones may have been used to anchor the brush superstructure, or may have discouraged animals from digging out of the corral. These sites may have functioned as sheep camps, seasonally or periodically. Feature 1 is manifested on the surface as a semirectangular arrangement of 22 natural sandstone cobbles ranging in size from 25 cm to 45 cm in diameter. This configuration may represent a masonry structure or single room, 3.5 m by 2 m in size. A number of artifacts appear concentrated in the vicinity of these cobbles."	Dykeman 2003:75; NM ARMS Site Form
20	104113	Morris' Earthen Dam (San Rafael Canyon)	mid 1700s	Reservoir	1. "Reservoir Dam: A dam apparently used for impounding water in a small reservoir was observed near the ruin [Three Corn]." 2. "...a large earthen dam located (Fig-4.15) on a mesa top approximately 400 m south of Three Com Ruin, near the rimrock above an arm of San Rafael Canyon. The area between the site and the mesa edge, approximately 10 m, consists of bedrock. The site area has an overstory of pinyon and juniper trees; the understory consists of sage and various grasses. ...The dam was observed but not recorded by Earl Morris during his 1915 expedition (Carlson 1965). The dam measures approximately 40 m x 6 m and has a maximum height of 1 m. The structure forms a gentle arc with the outside of the arc downslope, and conforms to the criteria established by Doolittle et al. (1993) for identifying prehistoric water control features. ...Several mature pinyon trees are growing on top of the dam and the largest was cored for an dendrochronological sample. The sample (DNT-738) from the living tree demonstrated that the tree was growing on the dam by at least A.D 1838. The core did not reach the pith of the tree and, thus, a true germination date for the tree is probably 8-10 years prior to 1838. The early 19th century date is considered too early for Euro-American homesteading of the region and the dam probably relates to the mid-18th century Navajo use of the area. ...The survey and auger testing revealed no artifacts in association with the feature. The temporal and cultural affiliation of the dam are inferred from its shape and structure (Doolittle et al. 1993) and the tree-ring date."	1. Carlson 1965:27; 2. Towner & Johnson 1998:51-53
21	104124	San Rafael Canyon Tinaja Tank Reservoir	Unknown	Reservoir	"Feature 1 is a possible earthen dam located near the mesa edge. It consists of two clumps of sandy sediments covered by grasses and prickly pear cactus. The center portion and both ends have eroded away. The complete dam would probably have measured 11.0 m long and would have created a reservoir approximately 11.0 m x 6.5 m in area and 30 cm deep. The roughly linear feature is on the north edge of the largest tinaja in the vicinity and currently increases the amount of water the tinaja will hold. …The reservoir could have held 2,000 to 3,000 gallons of water and the barrier utilized a naturally high area of the sandstone bedrock as part of its construction. … If the features at LA 104124 are indeed eighteenth century Navajo constructs, they represent activities commonly assumed to be associated with the Navajo occupation of Dinétah, but rarely documented in the archaeological record. …The earthen dam at LA 104124 is not large, but could have supplemented other sources of drinking water in the area. A similar feature has been observed near a pueblito above Jesus Canyon (Gaudy, personal communication)."	Towner & Johnson 1998:64-66

Table 11 (Continued) - Possible pastoral infrastructure elements at early Navajo sites in Dinétah

21	173061	Moss Trail	unknown	Trail	"LA 173061 (Moss Trail) is located along the rim of Encinada Mesa overlooking Largo Canyon, opposite the mouth of the large side canyon knows as the Big Rincon. Features associated with the site extend along Moss Trail from the mesa rim to the canyon floor below. ...The site consists of a prehistoric and historical-period trail presumably established during the Navajo occupation of Largo Canyon or earlier, as well as associated features, including retaining walls, a possible trail marker, a corral, a fence line, a tinaja (tank), and multiple rock-art panels. The trail extends for a considerable distance along the mesa top, descending to disappear around the modern unpaved road running along the canyon floor and then appears again for a short distance. Although the presence of extensive rock art consistent with late prehistoric to eighteenth-century Navajo rock-art styles clearly indicates the use of the trail during the late prehistoric, protohistoric, and early historical periods, other motifs are consistent with earlier Anasazi styles and may indicate an earlier use of the area (Schaafsma 1980). Similarly, the condition of the corral feature at the head of the trail and the presence of milled lumber and wire nails within this feature indicate that the trail's use extended into the later historical period. ...The location of the enclosure at the head of the trail thus indicates a possible function as a temporary holding area to organize livestock that was to ascend to or descend from the mesa top. The feature evidently dates to the later historical period, although it may have had earlier antecedents."	Leckman et al. 2013:4.123-4.141

potential low visibility pastoral infrastructure remains one of the principal challenges for any study of early Navajo herding.

Corral or pen-type structures for confining animals represent the most diverse and commonly identified type of pastoral infrastructure in Dinétah. A variety of wood, stone, and brush enclosures historically constructed by Navajo herders have been documented throughout the greater Four Corners region and the circumstances behind their creation and use reflect a variety of pragmatic and environmental factors (e.g., Kluckhohn et al. 1971:76–78; Polk II 2018; Russell and Dean 1985). Of these three corral types, those with wooden superstructures are arguably the most distinctive, as their larger size, layout, and the quantity of timber used frequently precludes their misidentification. Previous archaeological studies have identified the remains of at least seven wooden corrals loosely associated with early Navajo sites in Dinétah (Table 11); however, the four wooden corrals sampled by Towner (1997) during his regional pueblito tree-ring dating study postdate the early Navajo occupation of the region, as do those identified by the FMATP survey (Sesler et al. 2000:197–198, 212).

These wooden corral remains are most likely associated with intensive sheepherding following the Hispanic and Anglo colonization of the upper San Juan River area during the late nineteenth and twentieth centuries. The lack of correspondence between many of Dinétah's wooden corrals and postulated seventeenth or eighteenth century dates might be due to factors like wood preservation or the later destruction and reuse of corral timbers. It is also possible, however, that earlier Navajo herders simply did not engage in herding strategies that necessitated the construction of large wooden enclosures like those seen at reservation-era Navajo sites, and instead favored smaller or more ad hoc types of wooden enclosures.

Past researchers have also identified ten stone alignment features at pueblito and non-pueblito Gobernador Phase Navajo sites that might represent potential animal enclosures (Table 11). These features vary substantially in size and shape between sites, with smaller areas generally termed pens rather than corrals, and include both discrete rectilinear and circular alignments as well as collections of shorter alignments that fill gaps between natural barriers like boulders, bedrock outcrops, or steep drops. Although the rock alignments identified at Dinétah sites might reflect the buried remains of corrals that originally possessed low drystone walls like those observed at reservation-era Navajo sheep camps in the treeless San Juan Basin, Marshall (1991:249-250) has argued that the many of the rock alignments likely represent basal supports for corrals made of cut brush and deadwood.

In at least one case (Table 11, entry 14), the stone alignment itself shows evidence of burning, suggesting that the overlaying brush corral superstructure caught fire. To date, however, none of the soils within the previously documented potential stone pen/corral features have been subjected to direct geochemical testing, while the general lack of datable material raises questions about contemporaneity similar to the wooden corral case. Similarly, small rock shelter/alcove features in the immediate vicinity of the Compressor Station and Split Rock pueblito sites appear to have been used as penning locations. Unlike the open-air examples discussed above, these natural rock features are better protected from the elements and are distinguished by the presence of remnant dung; however, no direct chronological analyses have been conducted and contemporaneity is uncertain.

Two other examples of potential pastoral infrastructure categories have been recorded in Dinétah (Table 11), although the evidence for the explicit use of any specific features by early Navajo herders is circumstantial at best. The first category, watering infrastructure, is a key consideration for pastoralists, especially in a semi-arid region like the Four Corners. The clearest evidence for early Navajo water management strategies can be seen at LA 104113 and LA 104124, a pair of earthen berm reservoir sites atop Delgadita Mesa within 400 meters of Three Corn pueblito. Ovicaprid and horse remains were recovered from excavations at Three Corn (Carlson 1965:21), suggesting that these features may have been used to supplement the water needs of the pueblito complex's residents as well as their animals. The second category, movement or travel infrastructure, is best distinguished by the Moss Trail (LA 173061), a formalized path that climbs some 70 meters up the eastern side of Largo Canyon to Encinada Mesa above. Although a deadwood fence and corral at the mesatop trailhead attest to its use as a stock driveway during the early 1900s, a number of rock art panels along the trail document earlier use by Navajo and Ánaasází groups. As Leckman and colleagues (2013:4.129) intimate, Gobernador Phase Navajo herders may have similarly used the trail to move between the Largo Canyon floodplain and the woodlands and sage flats of Encinada Mesa. Similar valley-mesa trails, albeit possibly less formalized, undoubtedly exist in other parts of the rugged Upper San Juan drainage system that makes up Dinétah.

Alternative Approaches? Lessons from the LA 113103 Site

LA 113103 is a multi-habitation Gobernador Phase site that dates to the early AD 1740s and consisted of three structures and several additional features. The site is located along a narrow portion of Frances Mesa approximately 2.25 kilometers north of the main ENPLP Phase 3 study area. LA 113103 is notable for having the best evidence for a pen/corral feature at a non-pueblito-related early Navajo site in Dinétah. The complicated history of the feature's discovery and eventual identification as a form of early Navajo pastoral infrastructure are directly relevant to the goals, arguments, and methodological approach taken by the ENPLP.

La Plata Archaeological Consultants (La Plata) first identified LA 113103 in 1993 during the Frances Mesa Alternative Treatment Project. Although roughly half the site had been destroyed by earlier pipeline construction activities, the site was recorded as Gobernador Phase multiple habitation site from the 1740s consisting of the apparent remains of three collapsed forked stick hogan structures and one large scatter of juniper pole fragments (Hovezak et al. 2000:128–130). In 1998, La Plata subsequently won the contract to conduct a data recovery excavation at LA 113103 as part of mitigation activities for a new gas pipeline project on the mesatop (Hovezak 2004). These excavations were overseen by the same archaeologists who had directed the earlier survey and their familiarity with the site aided in the reinterpretation of one of the previously identified forked stick hogans – Structure 2 – as a small livestock enclosure which lacked the obvious evidence of a traditional wooden superstructure (Figure 17).

Structure 2 was reclassified based on diverse array of evidence uncovered during the data recovery work, which fully stripped and excavated a 220 square meter area. First, a total of 19 identifiable sheep-goat faunal remains (12% of the total assemblage) were recovered from across the site, including within Structure 2 itself and in the nearby hogans and middens (Hovezak 2004:156-157). More important, however, was the discovery of a 10-cm-thick stratum of mottled, organic-looking, yellow-brown soil at Structure 2 that was buried at a depth of 10 cm, as well as a low mounded soil feature of similar composition located a meter away. In Structure 2, this stratum lay atop a floor surface distinguished by a whitish "salt pan" layer (possibly a layer of urine salt deposits? [e.g., Abell et al. 2019]). Soil samples from both the mottled stratum and the floor layer were sent off for chemical analysis and returned soil phosphorus values 10 to 100 times higher than control samples taken from elsewhere on Frances Mesa (Table 12). Based on these results, Hovezak (2004:130–134) and colleagues interpreted the stratum as a layer of dung-rich soil and Structure 2 as a domestic livestock pen.

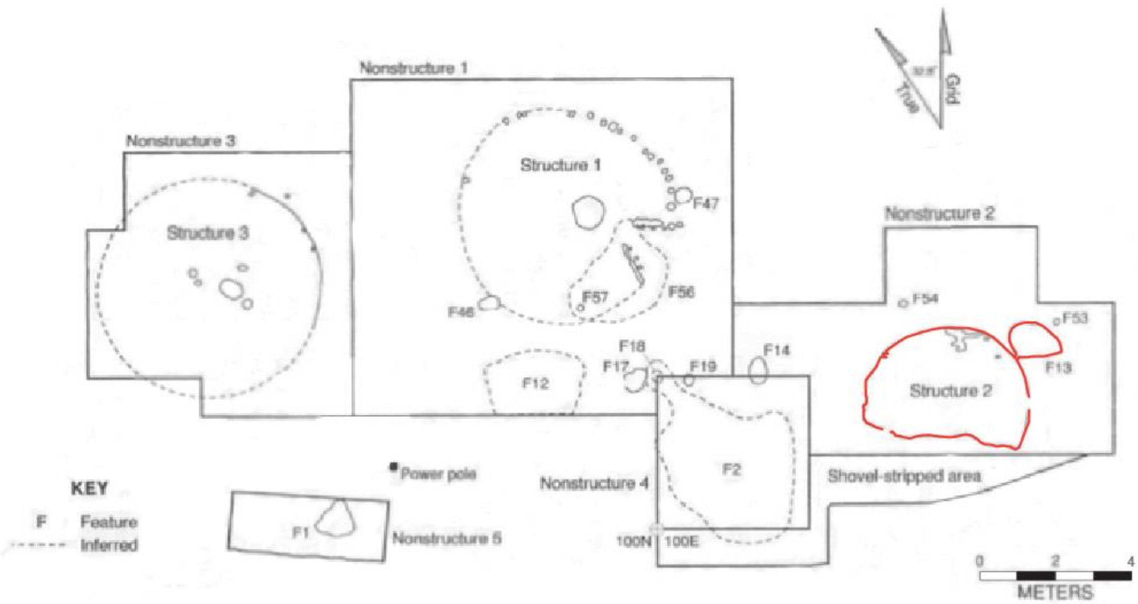

Figure 17 - LA 113103 Site Plan. Structure 2 and Feature 13 (in red) are the enclosure and related dung pile. Structures 1 and 3 are forked stick hogans (adapted from Hovezak 2004:Figure 8.19).

Table 12 – Results of Soil Chemistry Analysis, Structure 2, Site LA 113103 (adapted from Hovezak 2004:Table 8.5)

Context	**Sample no.**	**pH**	**EC**	**OM (%)**	**$N0_3$-N (ppm)**	**P (ppm)**	**K (ppm)**	**Sl (ppm)**	**Ca (ppm)**	**Zn (ppm)**	**Fe (ppm)**	**Mn (ppm)**	**Cu (ppm)**
Control	FMATP 2	7.4	0.1	1.1	3	1.7	49.5	-	-	0.3	3.9	0.9	1.4
Control	FMATP 4	7.3	0.1	1.1	2	2.2	78.7	-	-	0.3	3.6	0.5	1.2
Strat 2	8	8.2	0.4	5.4	1	281.0	374.0	52	5041	0.3	6.0	8.3	0.2
Floor	2	8.2	0.5	2.3	1	27.0	219.0	26	4837	0.7	3.0	9.3	0.3

Keppm – parts per million; pH – Negative logarithm of the hydrogen ion concentration; EC – electrical conductivity (a measure of salt concentration in mili-mhos per centimeter); OM – organic matter; P – Phosphorus; K – Potassium; Sl – Sulpher; Ca – Calcium; $N0_3$-N – Nitrates; Fe – Iron; Mn – Manganese; Cu – Copper; Zn – Zinc. Control data from Colorado State University Soil, Water, and Plant Testing Laboratory, Ft. Collins, CO (Wilshusen et al. 2000); LA 113103 data from Servi-Tech Laboratories, Dodge City, KS.

Structure 2 was located approximately 10 meters east of the principal hogan feature and was estimated to have covered an approximately 4 meter diameter circular area (Hovezak 2004:130). While some of the scattered wooden elements on the surface of Structure 2 likely derived from mechanical disturbances associated with the pipeline construction work, the majority of the timbers averaged ~1 meter long and were arranged in un-patterned semi-circle. Post holes and a cut stump along the margins of the feature indicate a perimeter enclosure, although it is unclear whether Structure 2 was a bespoke pen construction or a disused hogan that was repurposed as a pen. Importantly, the stratigraphic data strongly support the interpretation that Structure 2 is contemporaneous with Structure 1, a large 5.6 meter diameter forked-stick hogan that has been tree-ring dated to circa AD 1743 (Hovezak 2004:125-127; 130-132).

The characteristics of LA 113103 present archaeologists interested in early Navajo pastoralism with a methodological blueprint for new investigations of the topic, as well as a cautionary note regarding the veracity of structure/feature identifications derived from purely survey-based approaches. Specifically, the history of Structure 2's initial identification, investigation, and reclassification suggests that other similar corralling features have previously been identified at early Navajo sites in Dinétah, but have been recorded as different types of structures, especially "disturbed" forked stick hogans. Structure 2 presents direct evidence that a small wood or brush pen/corral feature distinguished in part by buried dung-rich soils exists at a Gobernador Phase Navajo habitation site. Notably, the presence of distinct chemical differences (particularly elevated phosphorus levels) between feature soils and off-site control soils supports the argument that a systematic multi-method and multi-scalar research program that harnesses a collection of suitable soil analysis activities like those described by Shahack-Gross (2011) would be capable of identifying other corralling features at early Navajo sites.

THE ENPLP PHASE 3 WORK: OVERVIEW & METHODOLOGY

Study Area & Permitting

The ENPLP Phase 3 fieldwork occurred between October 8, 2019 and January 14, 2020 and focused on investigating a sample of twelve previously recorded Gobernador Phase Navajo habitation sites atop Frances Mesa and the adjoining portions of Gobernador Canyon in Rio Arriba County, New Mexico (Figure 18). The study area encompassed 1,147 hectares that had previously been examined by two large CRM block surveys conducted under the auspices of the greater Fruitland coal gas development project during the 1990s (Brown 2014). The northern portion of the study area comprises 354 hectares of mesa-top land surveyed during the Frances

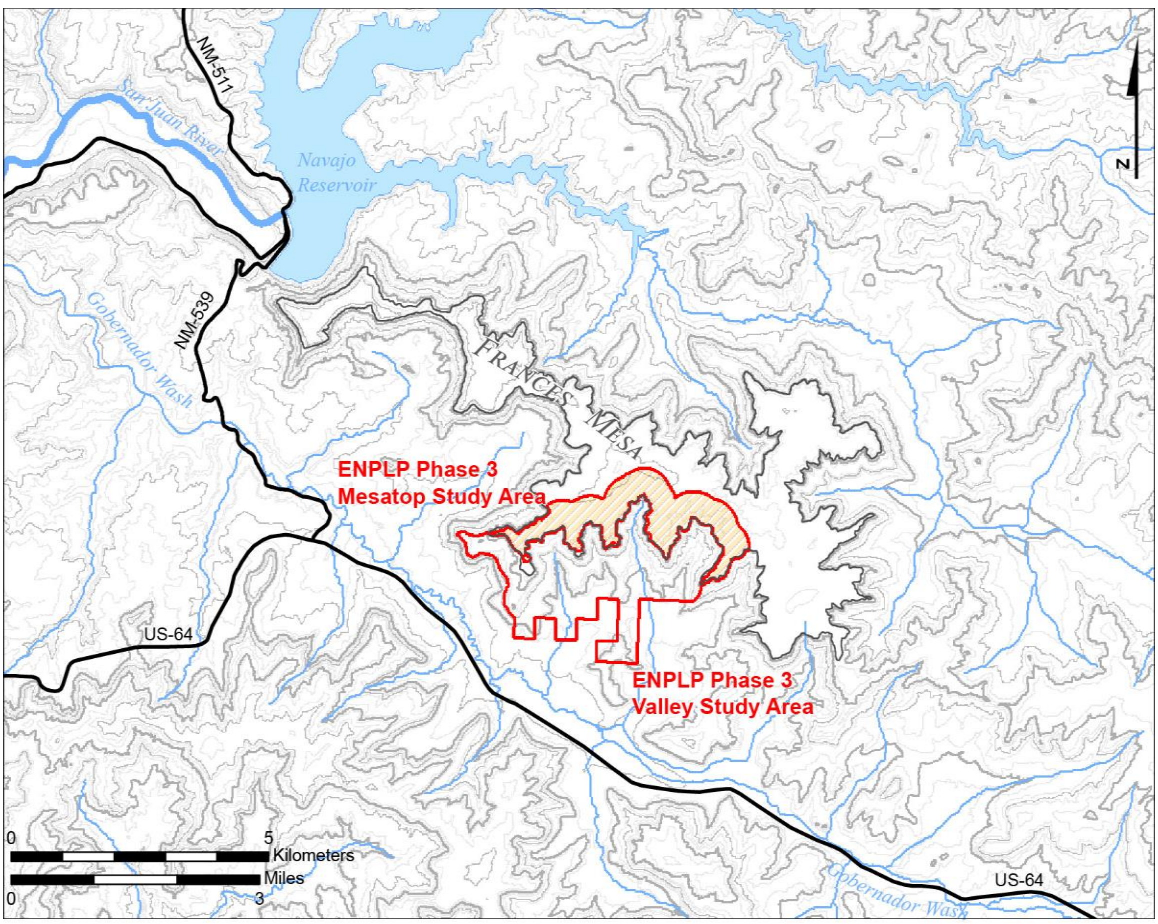

Figure 18 - Map of the ENPLP Phase 3 study area encompassing parts of Frances Mesa and Gobernador Canyon.

Mesa Alternative Treatment Project (FMATP) (Wilshusen et al. 2000), while the southern portion totals 793 hectares and corresponds to the former Morris Site 1 Early Navajo Land Use Study (MENLUS) project area (Dykeman 2003a).

All of the sites examined during the Phase 3 fieldwork were located on public lands managed by the Bureau of Land Management (BLM) or the New Mexico State Land Office (NMSLO). Research activities on BLM land parcels were conducted under the auspices of a Cultural Resource Use Permit (No. 336-8152-19-1) issued on August 14, 2019. A modification to the permit to allow for the collection of dendroarchaeological samples at study sites was approved on December 20, 2019 (CRUP No. 336-8152-19-1A). Research activities on a New Mexico State Land parcel (Sec 2 T29N R7W) located in the middle of the ENPLP-3 study area were carried out through a Project-Specific permit (No. SE-385) approved by the New Mexico State Historic Preservation Office's Cultural Properties Review Committee on September 16, 2019.

The Site Selection Process

Based on a review of the New Mexico Cultural Resource Information System, a minimum of 452 early Navajo archaeological sites are located within the boundaries of the 1,147 hectare ENPLP Phase 3 study area. 66 of these sites are habitation-type sites comprising a pair of pueblito sites and numerous single and multiple habitation sites. Previous projects in the study area had noted faunal remains or possible corral features at seven of these habitation-type sites: LA 78825, 83529, 113304, 113410, 109396, 110272, and 106203. The original plan called for these seven sites to form the initial Phase 3 site pool with an additional 18 sites to be selected from the remaining 59 habitation sites in the study area, bringing the total sample to 25 sites.

Additional sites would be chosen based on the following criteria: 1) if a site was located in or within ~30 meters of a "high potential for pastoral site location" region indicated on the ENPLP Phase 2 Mesatop or Valley Edge models; or 2) if reconnaissance work identified a site as possessing a combination of archaeological and landscape factors that might reflect potential pastoral activities (based on interpretive lessons from the Phase 1 fieldwork and the LA 113103 saga).

Following a series of reconnaissance trips in September and October 2019, however, the rugged nature of the study area became more apparent and three of the initial sites were judged to be unsuitable for the proposed analyses. The scoping work also highlighted that rather than simply looking at a random distribution of potential Gobernador Phase pastoral sites throughout the study area, the ENPLP's overarching goal of better understanding pastoralism's role in early Navajo society would benefit from a tighter analytical focus on the local intrasite relationships between the study area's two pueblito sites and any potential pastoralist activities in the surrounding habitation site "neighborhoods." Further, given the unprecedented nature of the ENPLP's proposed soil chemistry and microremains work, a handful of sites were selected to help serve as temporal and interpretive controls for the results of these analyses.

With these factors in mind, the Phase 3 site pool was lowered to a more feasible twelve sites and a series of eight new sites chosen to complete the sample. A description of the final set of twelve ENPLP Phase 3 study sites and their respective selection criteria are provided in Table 13 while their spatial distribution is show in Figure 19.

Table 13 - Final Pool of ENPLP Phase 3 Study Sites

LA No.	Site Type	Occupation Period	Selection Criteria
MESATOP SITES			
LA 113103	Multi-habitation camp	Gobernador Phase (c. AD 1741)	*Control Site* - Previous excavation recovered ovicaprid remains. - Previous survey & excavation identified a scattered timber feature later determined to a corral/pen feature.
LA 113276	Multi-component herding camp	Dinétah or Gobernador Phase & Historic Period (AD 1950s-1960s)	*Control Site* - Historic 20th century brush corral with an unassociated Dinétah/Gobernador Phase artifact scatter inside.
LA 113152	Single habitation camp	Gobernador Phase (date unknown)	- Previous survey noted unidentified bone in midden. - Previous survey noted unaligned group of timbers. - Site located along woodland/sagebrush ecotone.
LA 78825	Multi-habitation camp	Gobernador Phase (c. AD 1746)	- Largest non-pueblito habitation site on Frances Mesa (12 structures) & is situated directly above Romine Canyon. - Previous survey & limited collection noted unidentifiable (but likely ovicaprid) bone in midden. - Previous survey noted an unaligned timber scatter feature.
MORRIS SITE 1 PUEBLITO NEIGHBORHOOD			
LA 83529 (Morris Site 1)	Pueblito (boulder-top)	Gobernador Phase (post AD 1748)	- Pueblito site complex - Previous test unit recovered sheep faunal remains from midden.
LA 105530	Multi-habitation camp	Gobernador Phase (post AD 1719)	- Previous survey & limited collection recovered sheep faunal remains from midden. - Previous survey noted an unaligned timber scatter feature.
LA 110271	Multi-component habitation site	Pueblo I period & Gobernador Phase (date unknown)	- Previous survey noted unidentified bone in midden. - Previous survey noted potential stone alignments in between boulders.
LA 110285	Multi-habitation camp	Gobernador Phase (date unknown)	*Control site* - A valley-bottom Gobernador Phase multi-habitation camp at the head of a small draw ~150 m south of the Morris 1 pueblito. - No obvious potential pastoral elements but both masonry structures and hogans, as well as extensive middens.
ROMINE CANYON PUEBLITO NEIGHBORHOOD			
LA 55836* (Romine Canyon Ruin)	Pueblito (multi-room)	Gobernador Phase (c. AD 1720s)	* *Not examined as part of the ENPLP-3 work.*
LA 109396	Multi-component habitation site	Pueblo I period & Gobernador Phase (date unknown)	- Previous survey noted possible corral/pen enclosures formed by stone alignments.
LA 106201	Multi-habitation camp	Dinétah or Gobernador Phase (date unknown)	*Control site* - No obvious potential pastoral elements but the site is ~700 m north of the Romine Canyon pueblito and is a good example of an undifferentiated Dinétah/Gobernador Phase site, a common challenge in early Navajo archaeology.
LA 106199	Multi-habitation camp	Gobernador Phase (c. AD 1750)	- Previous survey noted unidentified bone in midden.
LA 106203	Single habitation camp	Gobernador Phase (date unknown)	- Previous survey & limited collection recovered sheep & equid faunal remains from midden. - Previous survey noted an uncertain stone alignment feature.

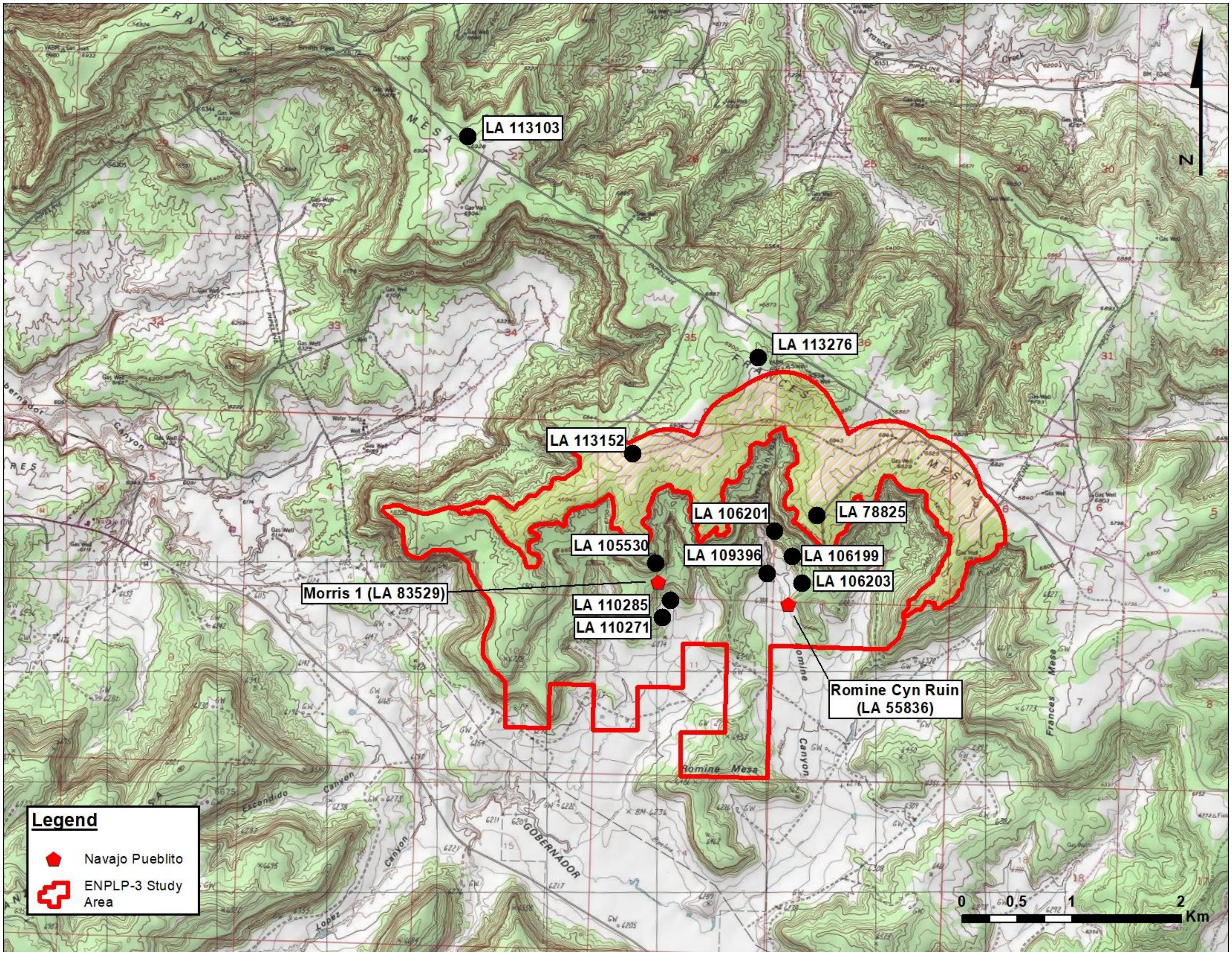

Figure 19 - Distribution of sites that comprise the ENPLP-3 study pool.

Methodology Summary

The third phase of research comprised three general sets of activities – site resurvey, soil sampling and total phosphorus analysis, and focused dung spherulite analysis, as well as a focused dendroarchaeological sampling campaign intended to improve the temporal controls for the project sites. The survey, soil phosphorus, and dendroarchaeology work is summarized here, while the dung spherulite analysis is discussed in greater detail in its own separate section.

Site Resurvey & Feature Recording

The first set of activities was an intensive survey program at each of the project sites that focused on relocating previously identified structures and features, as well as documenting any new elements in order to update the New Mexico ARMS site record. At four sites, larger faunal remains were identified on the ground surface near key features or structures. Scale drawings, notes, and photographs were collected while in the field while all physical remains were left in situ; the resulting zooarchaeological data were analyzed remotely by Dr. Sadie Weber (Harvard). A handheld Trimble GeoXT GNSS receiver was used to collect global positioning satellite (GPS) coordinates for each site and their constituent archaeological elements. A DJI Mavic 2 Pro drone was deployed to capture aerial photograph series suitable for three-dimensional photogrammetry and orthophoto creation.

Systematic Soil Sampling & Total Phosphorus Analysis

The second set of activities focused on the systematic collection and evaluation of soil samples to be used in both the total phosphorus and fecal spherulite analyses. Soil sample collection points were laid out along a 15-meter interval grid fitted to a roughly 1 hectare area centered on the primary structure of each archaeological site. Additional sample points designated as off-grid areas of interest were identified, while some sample points were skipped if the local geology or topography made those areas unsuitable and a nearby alternative could not be identified. The soil samples were collected using a pair of ½" diameter AMS footstep soil probes modified by local welders to be operated using hand-operated, 15 pound post-drivers.

A total of 516 soil samples were collected and submitted to Envirotech Analytical Laboratory in Farmington, NM for total phosphorus analysis. Envirotech employed an inductively coupled plasma – optical (or atomic) emission spectrometry (ICP-OES/AES) approach that followed methodological parameters outlined in the U.S. Environmental Protection Agency's Method 6010C. Specifically, Envirotech processed the ENPLP-3 samples in 20 sample batches, including a method blank and two laboratory control samples. For each sample, 2 grams of soil (± 0.02 g) were weighed out on a calibrated balance and 10 mL of deionized water, 7 mL of reagent grade hydrochloric acid, and 3 mL of reagent grade nitric acid added. Samples were brought to a temperature of 93° Celsius (±2° C) to begin digestion, which continued for 2 hours at the same temperature. Deionized water was added to the cooled samples to bring the total volume to 50 mL, creating a dilution factor of 25 (50 mL final, 2 g initial). The digested samples were analyzed using a Thermo Scientific iCAP 6300 Duo ICP-OES calibrated to a pair of phosphorus-sensitive wavelengths (primary: 177 nm; secondary: 213 nm). For each sample, the spectrometer averaged three iteration responses to provide a result in µg/mL that was multiplied by the dilution factor to give a final reported total phosphorus result in mg/kg, or "parts per million" (ppm).

The total phosphorus data were incorporated into a geodatabase and analyzed using ArcGIS 10.6 to identify potential conjunctions with the archaeological structure and feature data recorded for each of the twelve sampled sites. Specifically, the ArcGIS "IDW" (inverse distance weighted interpolation) tool was used to generate a total phosphorus isopleth “heat map” surface overlay that was used to determine areas where high phosphorus value soil samples were closely associated with structures or features of potential pastoral interest. As detailed in the ENPLP Phase 3 site descriptions below, these areas of interest included: features previously identified as potential corral/pen features, previously identified features that may have been misidentified à la LA 113103 Structure 2, and new features identified during the Phase 3 resurveys. A total of 82 high phosphorus value soil samples from nine of the ENPLP-3 sites were marked as suitable candidates for the final dung spherulite analysis.

Dendroarchaeological Sampling

A dendroarchaeological sampling campaign was carried out in order to collect chronological data for the ENPLP-3 sites. Any surviving architectural timbers at the project sites were evaluated for their dendrochronological suitability, however, all were heavily weathered or had been previously sampled by previous CRM projects. When this information was considered alongside discussions of traditional Navajo wood use practices in the greater Dinétah region (Towner 2016b; Towner 1998), the ENPLP-3 sampling campaign instead chose to focus on identifying and sampling “CMT” features (culturally modified trees; e.g., ax-cut limbs or stumps) closely associated with early Navajo archaeological site features. Following an extensive evaluation of potentially datable CMTs at all twelve sites, a total of 33 dendroarchaeological samples were collected from seven of the Phase 3 sites (Table 14).

The samples consisted of both drilled cores and sawn cross-sections, all of which were submitted to the University of Arizona’s Laboratory of Tree-Ring Research (LTRR) for analysis and dating. Thanks to the extensive dendroarchaeological work conducted by in the greater Dinétah area (Brown et al. 2014:121-122), the regional tree-ring chronology is relatively well-

Table 14 - All Tree-Ring Samples Collected from ENPLP Phase 3 Sites

Field ID	LTRR ID	Wood Type	Site No.	Feature	Type	Inner Ring Date (AD)	Outer Ring Date (A.D)	Wood Element Surface Attributes	Tool Marks	Beam End Modification	In-field Notes
1	DNT 1872	PNN	LA 105530	CMT 4	Loose Log	No Date	-	Weathered		Meta ax cut	Possible loose cut limb leaning against tree. Bottom appears worked (but possibly rotten)
2	DNT 1873	JUN	LA 105530	CMT 14	Ax-cut Limb	No Date	-	Weathered		Meta ax cut; Broken	
3	DNT 1874	JUN	LA 105530	CMT 18	Ax-cut Limb	No Date	-	Weathered		Meta ax cut	
4	DNT 1875	JUN	LA 110271	CMT 1-1	Ax-cut Limb (Trunk)	No Date; cross-matches with DNT 1881 (FN10) & DNT 1882 (FN11)		Bark; Weathered	Limb Trim	Meta ax cut	Multi-limbed juniper. South trunk; larger. Lichen on ax-cut end
5	DNT 1876	JUN	LA 110271	CMT 1-2	Ax-cut Limb (Trunk)	No Date	-	Bark; Weathered		Meta ax cut	Multi-limbed juniper. North trunk; smaller
6	DNT 1877	JUN	LA 110271	CMT 21	Ax-cut Limb (Trunk)	No Date	-	Bark; Weathered		Meta ax cut	Lichen on ax-cut
7	DNT 1878	JUN	LA 110271	CMT 7	Ax-cut Limb (Trunk)	No Date	-	Bark; Weathered	Limb Trim	Meta ax cut	West half of upper portion of ax-cut trunk is rotten
8	DNT 1879	JUN	LA 110271	CMT 17	Ax-cut Limb (Trunk)	No Date	-	Bark; Weathered	Limb Trim	Meta ax cut	
9	DNT 1880	JUN	LA 110271	CMT 20	Ax-cut Stump	No Date	-	Bark; Weathered		Meta ax cut	Lichen on ax-cut
10	DNT 1881	JUN	LA 110285	CMT 3	Ax-cut Limb (Trunk)	No Date; cross-matches with DNT 1875 (FN4) & DNT 1882 (FN11)		Bark	Limb Trim	Meta ax cut	Primary trunk in live juniper. ~25m S of Feature 1
11	DNT 1882	JUN	LA 110285	CMT 4	Ax-cut Limb (Trunk)	No Date; cross-matches with DNT 1875 (FN4) & DNR 1881 (FN10)		Bark		Meta ax cut	Primary trunk in live juniper. E of west midden
12	DNT 1883	JUN	LA 110285	CMT 7	Ax-cut Limb (Trunk)	No Date	-	Bark		Meta ax cut	10m W of Feature X
13	DNT 1884	JUN	LA 110285	CMT 8	Ax-cut Limb (Trunk)	No Date	-	Bark	Limb Trim	Meta ax cut	Secondary trunk in live juniper at S edge of site
14	DNT 1885	JUN	LA 110285	CMT 9	Ax-cut Limb (Trunk)	No Date	-	Bark		Meta ax cut	
15	DNT 1886	JUN	LA 109396	CMT 1	Ax-cut Limb (Trunk)	No Date	-	Bark; Weathered		Meta ax cut	North of game trail at north edge of site
16	DNT 1887	JUN	LA 109396	CMT 2	Ax-cut Limb	No Date	-	Bark; Weathered		Meta ax cut	Live juniper with 3 ax-cut limbs south of game trail
17	DNT 1888	JUN	LA 109396	CMT 5-1	Ax-cut Limb (Trunk)	No Date	-	Weathered		Meta ax cut	Core from base of same cut trunk/stump as Sample 18
18	DNT 1889	JUN	LA 109396	CMT 5-2	Ax-cut Limb (Trunk)	No Date	-	Weathered		Meta ax cut	Core from upper side of same cut trunk/stump as Sample 17
19	DNT 1890	JUN	LA 106201	CMT 2	Ax-cut Limb	No Date	-	Bark?; Weathered		Meta ax cut	Live juniper with ax-cut trunk & limb 25m from hogan. Regrowth around base of ax-cut.
20	DNT 1891	PNN	LA 106201	CMT 5	Ax-cut Limb	1616±	1746+v	Weathered		Meta ax cut	Toppled pinyon trunk 7m from hogan. Ax-cuts indicate trimmed trunk.

Table 15 (Continued) - All Tree-Ring Samples Collected from ENPLP Phase 3 Sites

21	DNT 1892	JUN	LA 106201	CMT 6	Ax-cut Limb	No Date	-	Bark?; Weathered; Charred/Blackened		Meta ax cut; Burned	Ax-cut branch with burn mark at base of toppled juniper 2m west of hogan. Regrowth around base of limb.
22	DNT 1893	JUN	LA 106201	CMT 8	Ax-cut Limb (Trunk)	No Date	-	Weathered		Meta ax cut	
23	DNT 1894	JUN	LA 106201	CMT 16	Ax-cut Limb	No Date	-	Bark?; Weathered		Meta ax cut	Regrowth around base of limb
24	DNT 1895	JUN	LA 106199	CMT 12	Ax-cut Limb	No Date	-	Galleries; Weathered		Meta ax cut	Live juniper with multiple ax-cut limbs
25	DNT 1896	JUN	LA 106199	CMT 104	Ax-cut Limb (Trunk)	No Date	-	Weathered		Meta ax cut	Live juniper 5m east of hogan. Initial core fragmented so took wedge from same area.
26	DNT 1897	PNN	LA 106199	CMT 6	Ax-cut Limb	No Date	-	Weathered		Meta ax cut	Lower limb of pinyon hit by collapsed diseased pinyon. Appears to be ax-cut and not a natural break or weathering-related.
27	DNT 1898	JUN	LA 106199	CMT 16	Ax-cut Limb	No Date	-	Bark; Weathered		Meta ax cut; Broken	Branch lobe that had been partially cut and then broken off. Break scar 40cm long on living lobe of branch. Originally "CMT 16"
28	DNT 1899	JUN	LA 106199	CMT 5	Ax-cut Limb	No Date	-	Bark?; Weathered		Meta ax cut; Broken	Partially cut and then broken branch
29	DNT 1900	JUN	LA 106203	CMT 1	Ax-cut Limb	No Date	-	Weathered		Meta ax cut	
30	DNT 1901	JUN	LA 106203	CMT 7	Ax-cut Limb (Trunk)	No Date	-	Weathered	Limb Trim	Meta ax cut	Core taken from base of 1.5m long dead trunk with multiple ax-cuts in live juniper
31	DNT 1902	JUN	LA 106203	CMT 4	Ax-cut Limb (Trunk)	No Date	-	Bark	Limb Trim	Meta ax cut	Twisted core. West face of same trunk as Sample 32
32	DNT 1903	JUN	LA 106203	CMT 4	Ax-cut Limb (Trunk)	No Date	-	Bark	Limb Trim	Meta ax cut	Better core. East face of same trunk as Sample 31
33	DNT 1904	JUN	LA 106203	CMT 4	Ax-cut Limb	No Date	-	Bark; Weathered		Meta ax cut; Broken	Branch extended out from same ax-cut trunk as Samples 31 & 32

developed and well-studied in comparison to other parts of the Southwest. Despite this fact, only four of the 33 samples successfully cross-matched. Compounding the issue, three of the samples only cross-matched with each other and not the master chronology. As a result, the Phase 3 tree-ring campaign returned a single chronological date of AD 1746+v from LA 106201.

THE ENPLP PHASE 3 WORK: SITE SURVEY & SAMPLING RESULTS

The following section presents a summary of the various study activities carried out alongside a description of key cultural features at each of the twelve Phase 3 sites. Detailed datasets describing the results of the zooarchaeological analysis and soil phosphorus analyses can be found in Appendices A and C, respectively.

Mesatop Sites

LA 113103

LA 113103 is a multi-habitation Gobernador Phase site that dates to the early AD 1740s. The site is located approximately 2.25 kilometers north of the ENPLP Phase 3 study area along the north side of the main pipeline road at a point where Frances Mesa drastically narrows into a long thin neck-like formation. Previous data recovery excavations at LA 113103 resulted in the best evidence to date for a securely identified corral feature at a non-pueblito early Navajo site in Dinétah (Hovezak 2004). Considering this history and the site's relative proximity to the project area, the site was visited several times as part of the ENPLP-3 reconnaissance work in order to better understand potential landscape criteria that might be associated with other early Navajo pastoral sites in the region.

Because the 1993 mitigation work completely removed the area around the site's core structures, ENPLP Phase 3 activities instead focused on collecting soil samples from a 105 by 60 meter (0.63 hectare) region outside the excavated area. A total of 47 samples were collected and submitted to Envirotech Analytical Laboratory for total phosphorus analysis.

LA 113276

LA 113276 is a multi-component site whose principal features are associated with a historic period sheep camp that likely dates to the AD 1950s or 1960s. The site was originally identified during the FMATP survey and is located in piñon-juniper woodland on the edge of a drainage running south from the main ridge in the center of Frances Mesa. It is distinguished by a large brush corral, a smaller structure, and a log trough feature, as well as an earlier Dinétah or Gobernador Phase artifact scatter located inside the corral (Hovezak et al. 2000:312). The brush corral is a typical example of this type of temporary herding infrastructure found throughout the greater Southwest (e.g., Polk 2018) and measures approximately 25 meters in diameter. The remnants of the brush wall range up a meter in height and incorporate live tree "anchors" into its alignment. The smaller structure is constructed from juniper poles and baling wire and likely represents a windbreak or pen used by the herders.

Due to the clear evidence for a historic period site occupation, the ENPLP-3 team did not examine the for potential dendrochronological samples, nor were soil samples collected following the 15 meter grid strategy employed at the other sites. Rather, a total of six soil samples were collected with the goal of obtaining comparative samples from a historic "known" brush corral feature in the overall project area to help interpret the data obtained from the older Navajo sites. Specifically, three samples were taken from within the corral at its center, western edge, and inside the ashy artifact scatter, while three samples were taken from outside the collapsed brush fence approximately 20 meters away from the central sample to the west, north, and east. These samples were submitted to Envirotech Analytical Laboratory for analysis alongside the samples from other ENPLP Phase 3 sites. Due to the non-systematic nature of the sampling activity, LA 113276 was not included in the later phase of GIS-based phosphorus isopleth analyses. As seen in Table 16, however, the total phosphorus content of the two main interior samples, including the most sheltered sample near the western edge of the corral (samples 2), are between ~50 to 100 ppm greater than the outside samples, suggesting that soil chemistry can distinguish between feature and non-feature areas at early Navajo sites. Two samples – samples 1.1 and 6.1 – were selected for follow-up dung spherulite testing.

Table 16 - Soil Phosphorus Analysis Results from LA 113276

Sample ID No.	**Sample Level**	**Depth (cmbd)**	**Envirotech ID No.**	**Total Phosphorus concentration (ppm)**	**Notes**
1.1	1	0-11	P910160-05	171	Inside historic corral feature
1.2	2	11-22	P910160-06	165	Inside historic corral feature
2	1	0-19	P910160-07	126	15 m SSE of Sample 1. Within prehistoric midden context with numerous pieces of thermally altered rock & ceramics within 2m.
3	1	0-14	P910160-08	172	20m SW of Sample 1. Outside brush fence. Area around shows obsidian, tin cans, & ax-cut stumps.
4	1	0-20	P910160-09	109	20m NNW of Sample 1. Outside brush fence. Axe-cut limbs nearby.
5	1	0-19	P910160-10	121	20 m NE of Sample 1. Outside brush fence.
6.1	1	0-7	P910160-11	210	50cm inside brush fence along W edge of corral
6.2	2	7-20	P910160-12	155	50cm inside brush fence along W edge of corral

LA 113152

LA 113152 is a Gobernador Phase single habitation site originally recorded in 1996 as part of the FMATP work. The site spreads across the south-facing middle slope of a gentle rise in the southwestern portion of Frances Mesa and sits at the ecotonal boundary between a large sagebrush meadow to the south and piñon-juniper woodland to the north. Four features were defined at the site and comprise a scatter of juniper timbers, a domestic midden, a dense artifact concentration, and a concentration of fire-reddened sandstone. Identified artifacts included Dinétah Grey and Gobernador Polychrome ceramic sherds, lithics of varying materials (including obsidian) in different production stages, burned and unburned bone, and one Olivella bead. One tree-ring sample was taken from an ax-cut limb and returned a near-cutting date of AD 1640v (Hovezak et al. 2000:181–182).

ENPLP Phase 3 fieldwork at LA 113152 focused on relocating site features, examining the site for additional dendroarchaeological samples, and collecting soil samples. The work at LA 113152 resulted in the identification of the same set of features as previously described. Notably, Feature 2 is a collection of five one-to-two meter-long weathered juniper poles that lack a clear structural alignment. The original recorders interpreted them as stockpiled or disassembled hogan timbers; however, it is also possible they represent the remains of another type of structure (e.g., a shadehouse, windbreak, or pen). Feature 3 is a midden seven meters to the west of Feature 2 with charcoal-flecked soil, burned sandstone fragments, and a collection of Dinétah Grey sherds and lithic flakes. Feature 4 is a large artifact concentration 15 meters south of Feature 3 identified as a possible burned hogan structure. The densest portion contains a number of medium-sized oxidized sandstone fragments, charcoal-flecked soil, charred wood fragments, and lithic flakes, as well as both Dinétah Gray and Gobernador Polychrome sherds. Although bone fragments were previously noted at Features 3 and 4, none was observed during the ENPLP-3 visits. 15 CMTs were identified at LA 113152, including a cluster of five cut stumps along the eastern edge of the site roughly 20 meters east of Feature 2. However, all CMTs were deemed to have poor dendrochronological potential due to extreme weathering and no tree-ring samples were collected.

Due to the open nature of the LA 113152 site, soils were collected from across the maximum proposed 105 by 105 meters (1.1 hectare) sample area, as well as three samples from Features 2, 3, and 4. In total, 67 samples were collected and submitted to Envirotech Analytical

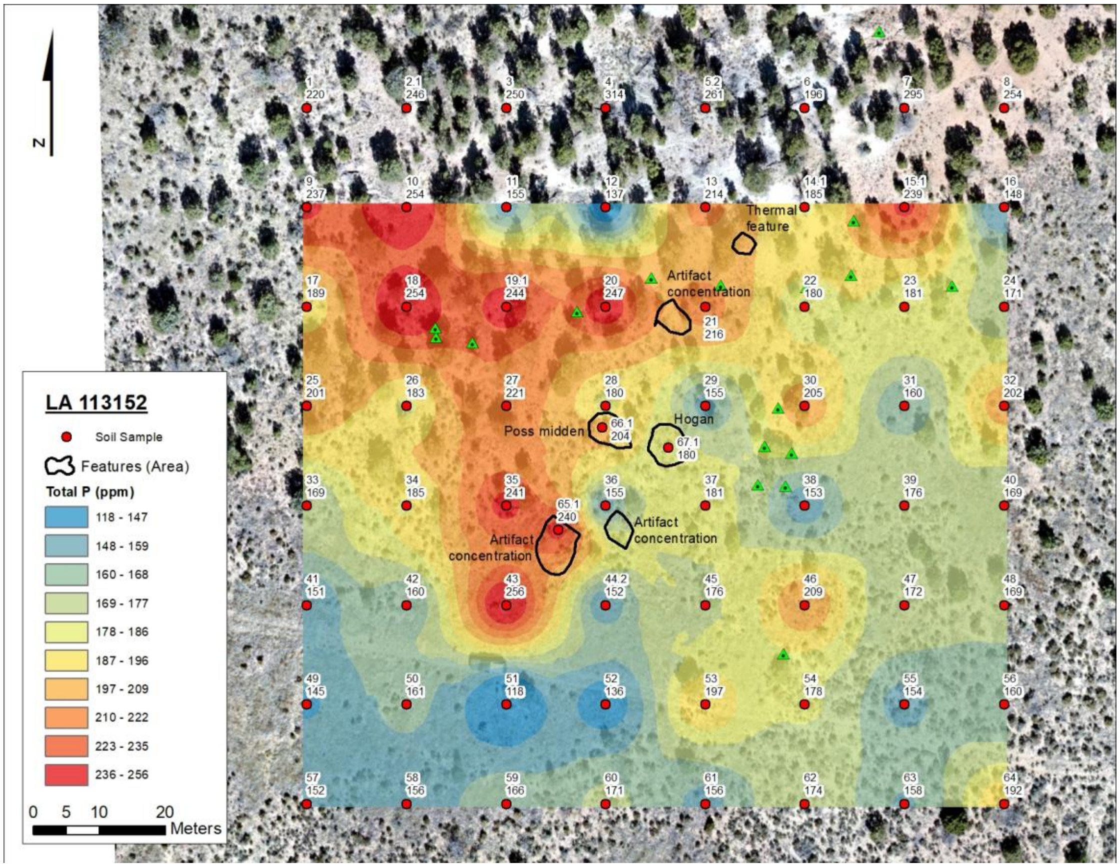

Figure 20 - LA 113152 overlay analysis results (soil sample labels note sample number [upper] and total phosphorus content [lower]).

Laboratory for total phosphorus analysis. The results of the overlay analysis (Figure 20) highlight two areas of high phosphorus concentration are present at LA 113152: samples 1-8 and samples 18-20, 27, 35, 43, 65, and 66. The first group of samples represent the northernmost row of the sampling grid and all but one sample were above 200 ppm, with Sample 5.1 returning the highest phosphorus concentration at the site, 314 ppm.[33] These samples are a minimum of 30 meters from the nearest likely early Navajo feature at the site, however, and no potential features were noted along the transect during sample collection. These high values are instead interpreted as being potentially associated with LA 113151, a burned Pueblo 1 period jacal habitation with

[33] Even the "outlying" LA 113152 Sample 6 returned a value of 196 ppm.

an extensive midden located approximately 100 meters upslope of LA 113152's central feature cluster (Hovezak et al. 2000:180-181).

In contrast, the second group of high phosphorus samples correspond to a collection of eight samples from within or near the site's central feature cluster. All of the samples returned concentrations above 200 ppm with the exception of sample 67.1 (180 ppm), which was collected from within the array of scattered timbers at Feature 2. Due to this sample's comparatively low phosphorus level as well as the clear midden association of the other two feature-related samples (samples 65.1 and 66.1), the likelihood for potential corral-type features at the site was judged to be low. None of the samples from the site were selected for additional dung spherulite testing.

LA 78825

LA 78825 is the largest non-pueblito Navajo habitation site on Frances Mesa and includes the remains of twelve collapsed or burned structures, as well as a series of associated features. The site is located amidst pinon-juniper woodland covering a low ridge on a point that extends out from the mesa's southern edge and forms the eastern side of the upper portion of Romine Canyon. The site is bisected by a dirt road leading to a natural gas well pad 175 meters to the south. Due to the concentration of both well-preserved hogan structures and less visible burned or weathered hogan features, LA 78825 is used by BLM archaeologists as "training site" for CRM companies planning to engage with early Navajo archaeology in Dinétah. Perhaps reflecting its prominence and relative ease of access, however, the site has clearly been subject to pothunting and other forms of vandalism over the years.

LA 78825 was first identified by La Plata Archaeological Consultants during natural gas-related CRM work in 1990 and subsequently revisited as part of the FMATP in 1996. This work identified a total of 19 features at the site, including six well-defined collapsed forked stick hogans, five carbonaceous artifact scatters typical of burned hogans, two large middens, and six assorted smaller features (e.g., artifact scatters, hearths). Local lithics and Dinétah Grey and Gobernador Polychrome ceramics dominated the assemblage, while non-local obsidian and single sherds of Ashiwi Polychrome and an unidentifiable Northern Rio Grande glazeware type were also recovered. Three fragments of burned bone were collected from a midden context and identified as artiodactyl remains, the smallest of which might reflect the presence of sheep/goat at the site. The tree-ring dating of both architectural timbers and CMTs across the site indicate that at least three of the five well-preserved forked stick hogans in the southern cluster were occupied contemporaneously circa AD 1746, while the burned and heavily weathered hogans likely date from separate, earlier occupations during the AD 1600s (Hovezak et al. 2000:65-73).

Due to the success of previous dendrochronological sampling at the site, ENPLP Phase 3 activities at LA 78825 were limited to relocating features and collecting soil samples in order to minimize impacts to the site. During the site recording work, elements of one of the features in the southern cluster displayed traits that suggested it might be a potentially misidentified corral or pen feature like at LA 113103. Specifically, Feature 2 is a dispersed scatter of approximately 45 cut and burned short juniper limbs covering an 8 by 10 meter area situated eight meters east of Hogan 3 and immediately north of the Feature 18 midden (Figure 21). An earlier tree-ring sample previously taken from one of the surface timbers returned a non-cutting date of AD 1713vv, suggesting it is related to the other structures in the southern half of the site . A scatter of CMT stumps and short living junipers surround the feature, including a 1.5 meter tall standing trunk with limb trim scars. Small fragments of fire-reddened rock are scattered throughout the feature while a single Dinétah Grey sherd and a 10-centimeter-long shaft straightener were also

Figure 21 - LA 78825 Feature 2 timber scatter is visible in the center of the image, while the circular arrangement of Hogan 6 is visible in the clearing to the upper left of the image.

identified. Feature 2 was originally interpreted as a collapsed forked stick hogan whose remains had been disturbed by modern vandalism (Hovezak et al. 2000:66); however, the size of the Feature 2 area, the indistinct nature of the wood scatter, the shortness of the timbers, and the lack of clear hearth or interior furniture elements (e.g., mealing bins) often seen on the surface of ephemeral hogan sites all suggest that an alternative identification – e.g., a shadehouse or a corral/pen – is possible.

Although elements of LA 78825 extend further to the north and northwest, the ENPLP-3 soil sampling focused on a roughly 120 by 75 meter (.9 hectare) area encompassing the mid-eighteenth century component in the southern half of the site. The presence of the pipeline road plus bedrock in the northeast and southwest portions of the sample area meant that only sixty-

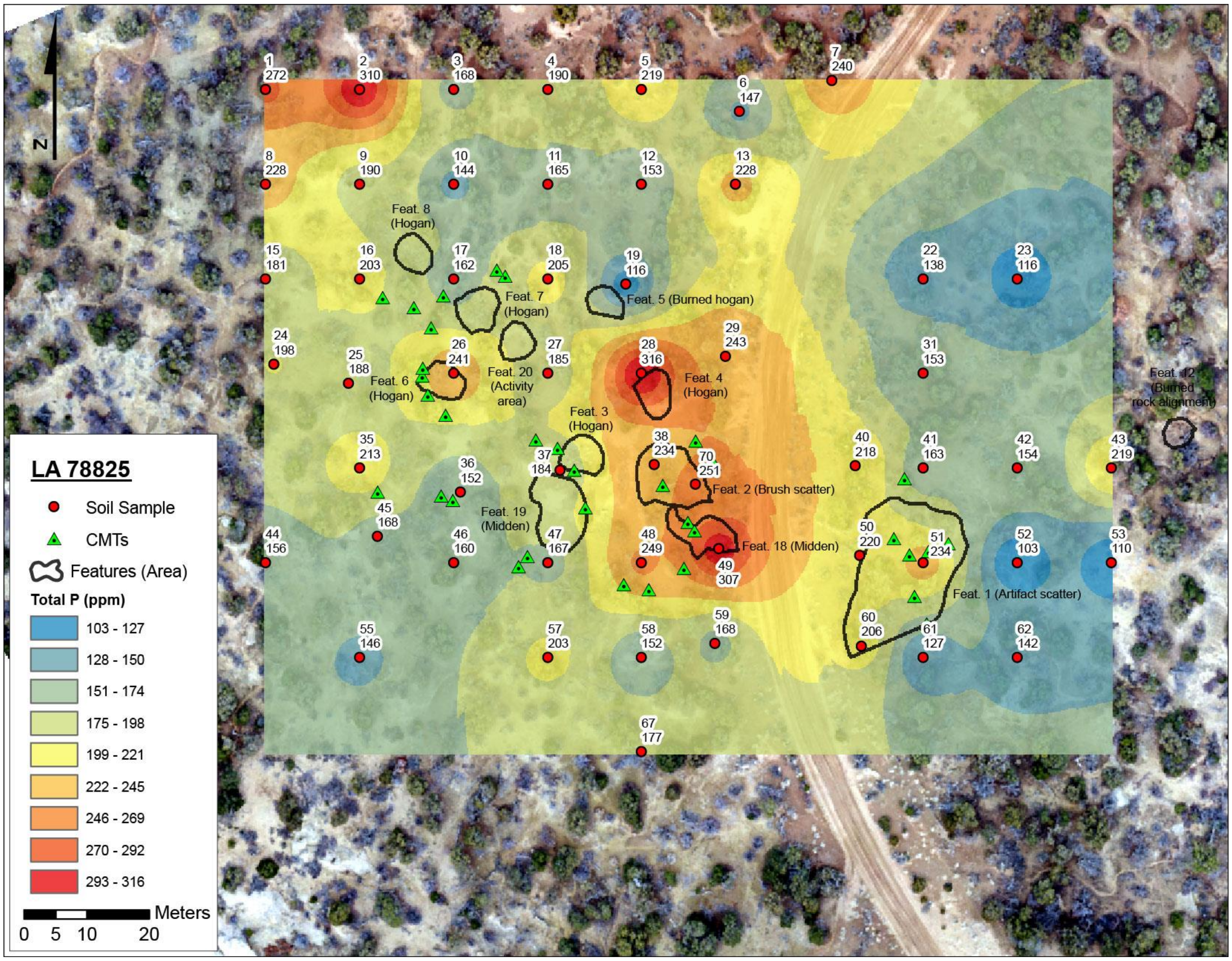

Figure 22 - LA 78825 soil phosphorus overlay analysis results (soil sample labels note sample number [upper] and total phosphorus content [lower]).

two samples were collected and submitted to Envirotech Analytical Laboratory for total phosphorus analysis. The subsequent overlay analysis (Figure 22) revealed two high phosphorus areas within the southern half of the site: samples 1, 2 and 8 and samples 28, 29, 38, 48, 49, and 70. Because the first group of samples were located in the northwestern corner of the sampling region and did not appear to relate to any early Navajo features, attention focused on the second group, which was located amid the main feature cluster and reported phosphorus concentrations between 234 and 316 ppm. Samples 38 and 70.1 came from within the Feature 2 scatter, while samples 48 and 49 came from the Feature 18 midden and sample 28 derived from the edge of

Hogan 4. Due to the clear identity of Hogan 4, only samples 38, 48, and 70.1 were selected for the subsequent dung spherulite analysis.

The Morris Site 1 Pueblito Neighborhood

LA 83529 (Morris Site 1 Pueblito)

LA 83529 is a Gobernador Phase site complex centered around a boulder-top pueblito fortification located on the lowest bench of France Mesa's south face overlooking a side drainage of Gobernador Canyon (Figure 23). First identified by Earl Morris as "Site 1" during his Dinétah-area work in 1915, the pueblito was effectively lost until a natural gas-related CRM survey encountered it in 1991 (Carlson 1965:3–5; McKean 1991). The site's "disappearance" owed to the fact that Morris's original site description incorrectly described the pueblito as being situated on the main valley floor of Gobernador Canyon. The rediscovery of the pueblito led a series of subsequent CRM projects to more thoroughly examine the site and expand its boundaries to include the numerous features that make up the rest of the larger "pueblito complex" (cf. Marshall 1991; 1995). The 1995 MENLUS work was the most recent investigation at the site to date, with limited test excavations and combined dendroarchaeological and thermoluminescence sampling[34] demonstrating that the pueblito was constructed sometime after AD 1748 and that domestic sheep were associated with this occupation (Dykeman 2003a; Dykeman et al. 2002; Goodman II 2003).

[34] LA 83529 was one of the sites chosen as a candidate for a dendrochronology-thermoluminescence dating experiment that was run during the MENLUS project (Dykeman et al. 2002). Due to the frequent lack of materials suitable for traditional dendrochronology or radiocarbon analyses at early Navajo sites, the experiment explored whether thermoluminescence dating of sherds as well as the sampling of CMT features could provide viable alternative methods for dating early Navajo sites. Although the initial results were promising, only the sampling of non-architectural timbers has since become a common alternative method (e.g., Towner 2016), perhaps due to the comparatively technical sampling protocols required for thermoluminescence dating.

Figure 23 - Drone image showing the Morris Site 1 pueblito and surrounding features, including a partially buried ground-level stone foundation (center) and midden (right edge near dead pinon).

The Morris Site 1 was selected as one of the ENPLP Phase 3 sites due its potential for helping to better understand the early Navajo pastoral landscape. Considering the comparatively large amount of previous chronological research at the site, ENPLP-3 activities only focused on soil sampling and site reinventory. The survey of LA 83529 resulted in the successful relocation of eighteen of the twenty-two previously identified features, including all those that form the principal cluster of features around Feature 1, the Morris Site 1 pueblito. The pueblito is a classic example of the “boulder-top” pueblito type (Powers and Johnson 1987:125-127; Towner 2003:61-64), a four-room masonry structure located on top of a freestanding 5 meter tall boulder at the base of the talus slope. Portions of the structure’s south, west, and north walls remain partially intact with sections of mud mortared stonework reaching up to 1.5 meters high. A large

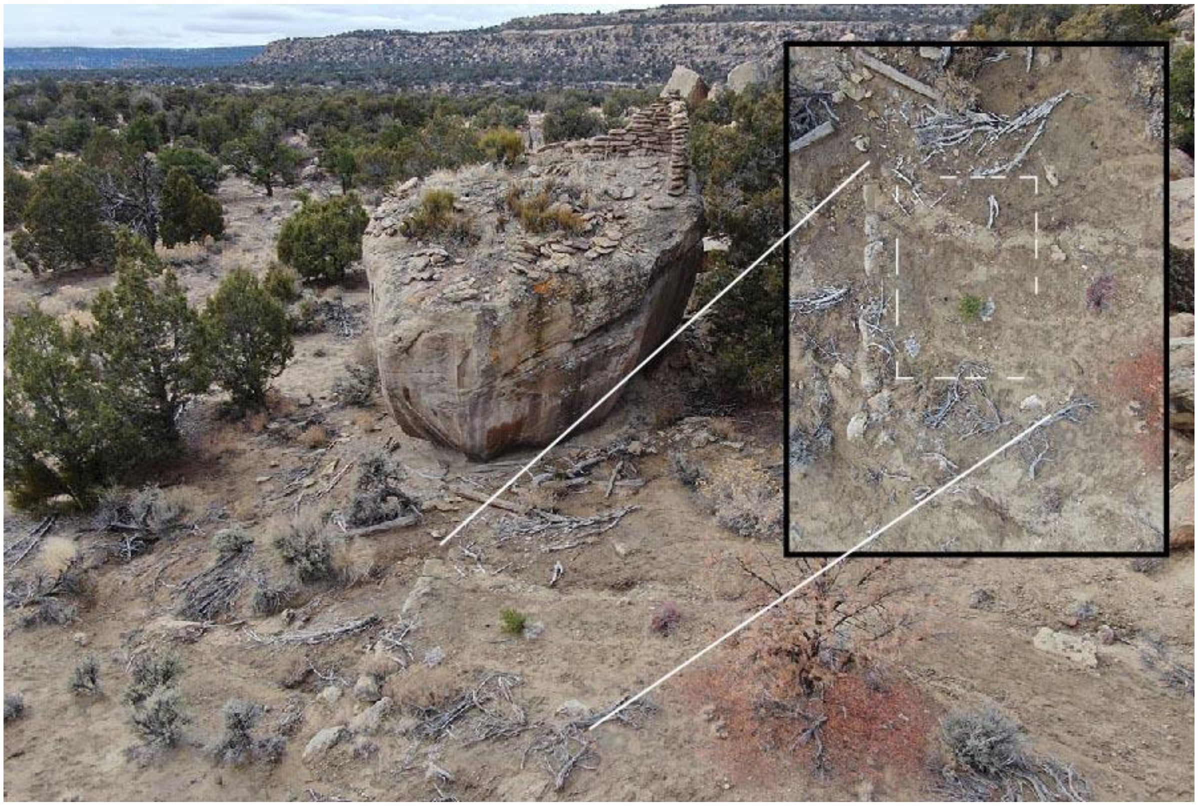

Figure 24 – The Feature 18 rock alignment at LA 83529. Inset offers top-down view of feature.

amount of tumbled architectural debris rings the boulder, including a dozen weathered wooden beams, several of which were previously sampled. A pair of ashy soil features thought to be ash dumps or hearths associated with the pueblito are located in along the base of the boulder's western face.

Located three meters to the east of the pueblito boulder, Feature 18 was previously described as a possible water-control feature consisting of a single east-west stone alignment crossing an ephemeral drainage off the talus slope. Since then, however, other stones have become exposed which indicate that the original alignment forms the southern side of a larger 3.25 by 2.5 meter rectangular alignment (Figure 24). This larger feature consists of a single course of at least 16 large rectangular sandstone blocks that appear to have been roughly shaped and arranged end to end. Although portions of the alignment are partially buried, there is no visible indication of additional stone courses, wall fall, or other architectural debris nearby, nor does it appear to connect with the pueblito boulder. Considering this information, it is possible Feature 18 represents part of an enclosure or the foundations for a perishable structure.

Feature 6 is a large 7 by 10 meter midden located 15 meters east of the pueblito. Its charcoal-rich ashy soil contains many Gobernador Polychrome and Dinétah Grey sherds, as well as flaked lithics and a large amount of burned and unburned faunal material visible on the surface. Many of the faunal elements are extremely fragmented although phalanx, rib, and teeth elements are all present. An earlier test unit in the feature recovered 23 faunal remains, seven of which were identified as the remains of Churro breed sheep (Goodman II 2003:304-305). As part of the ENPLP-3 work, a small collection of bones visible on the surface of the midden were analyzed in situ. Analysis of the scale drawings and photographs allowed for the remains to be identified as vertebral fragments from a medium-sized artiodactyl (e.g., a deer or sheep) (see Appendix A for more information).

Following the identification and delineation of features at LA 83529, a sampling grid was laid out over a 165 by 60 meter (~1 ha) area north of the natural gas access road bisecting the site. A total of 62 samples were submitted to Envirotech Analytical Laboratory for total phosphorus analysis. The GIS-based overlay analysis (Figure 25) highlighted two high phosphorus areas. The first area consists of sample 27, which returned a concentration of 779 ppm, a value that is substantially greater than the surrounding soil samples. No discernable archaeological feature is associated with the sample, although past human-animal activities (including possibly a recent visit from a deer, elk, or cow) might be the source for this result. The presence of another sample from LA 83529 with an unexpectedly *low* concentration value (sample 49, 9.8 ppm), however, suggests that a pair of data entry errors may have occurred at the laboratory.

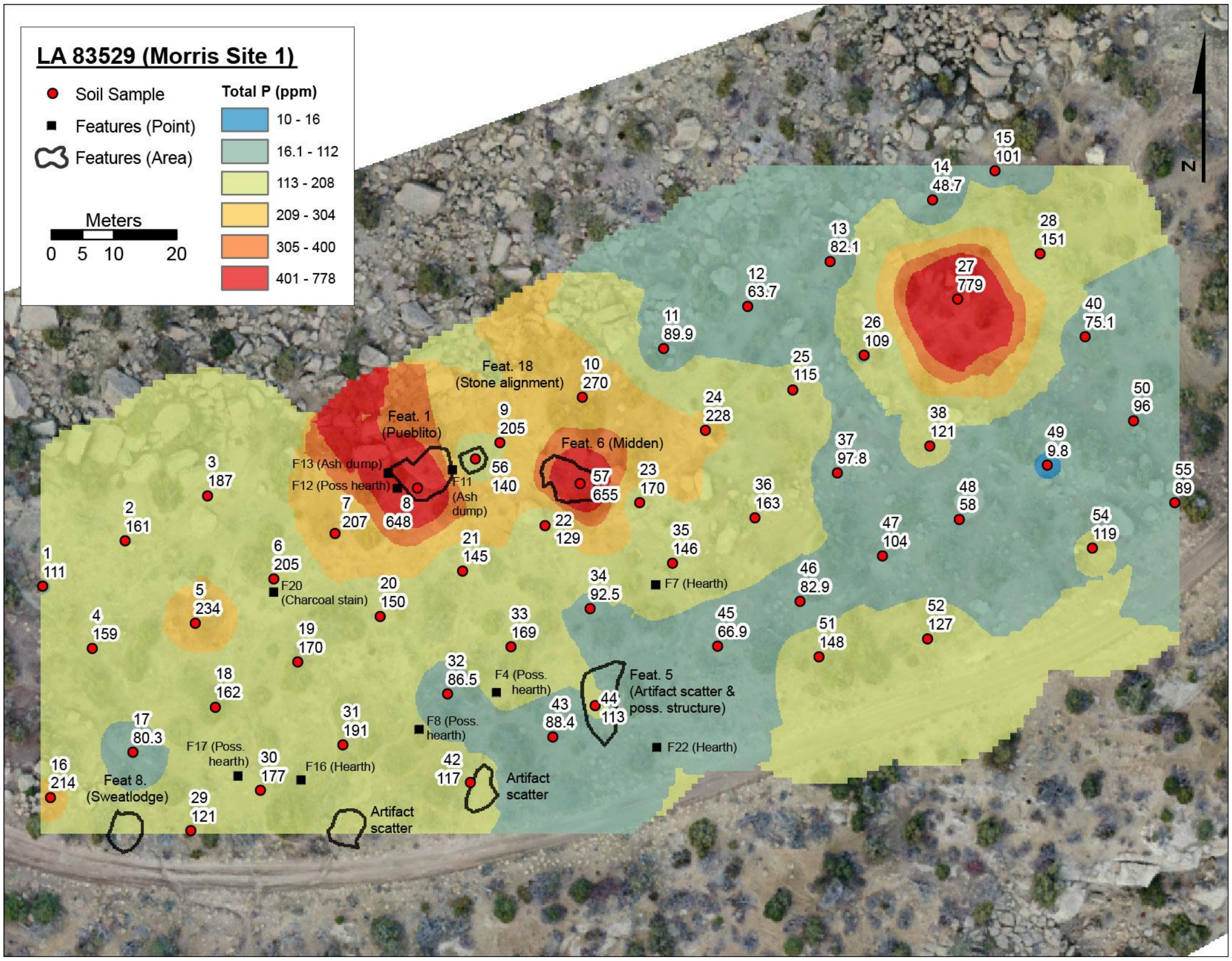

Figure 25 - LA 83529 soil phosphorus overlay analysis results (soil sample labels note sample number [upper] and total phosphorus content [lower]).

The second area of high phosphorus samples is clustered around the pueblito itself. Like sample 27, the reported concentrations from samples 8 and 57 (648 and 655 ppm, respectively) are considerably higher than those from nearby samples. Unlike sample 27 though, these two samples are directly associated with archaeological features: sample 8 was collected adjacent to Feature 12, a charcoal-flecked ash stain and associated cluster of oxidized sandstone below the gently overhanging southwest face of the pueblito boulder, while sample 57 was collected from within the limits of the Feature 6 midden. A smaller set of samples (7, 9, and 10) are higher than average and are also within what is presumed to have been the main activity area at the site.

Interestingly, sample 56.1 was collected from within the update rectangular stone feature near the pueblito that may have been a corral/pen.

Based on these associations, a subset of five samples – 7, 8.1, 9, 56.1, and 57.1 – were selected for the subsequent dung spherulite analysis.

LA 105530

LA 105530 is a multi-habitation Gobernador Phase site dating to the early/mid-1720s or later. It is located on a portion of the south-facing second bench of Frances Mesa overlooking LA 83529, the Morris Site 1 pueblito. The site was originally surveyed and subjected to limited testing in 1994 as part of the Morris 1 Early Navajo Land Use Study (Dykeman 2003a). No subsequent work was conducted at the site until it was sampled and mapped as part of the ENPLP Phase 3 activities. All eight previously identified features were relocated as well as one new feature. The site consists of two structures and seven other features, the clearest of which is Feature 1, a collapsed forked stick hogan at the southern edge of the site. An ashy charcoal-rich midden with an abundant artifact assemblage is located nearby (Feature 2) and includes more than one hundred Dinétah Grey sherds representing the remains of at least two vessels.

An earlier test unit from Feature 2 recovered a small sample of 18 burned and unburned bone fragments; however, the faunal analysis was inconclusive (Goodman II 2003). During the course of the ENPLP-3 work at the site, a pair of bone fragments suitable for analysis were identified on the surface of the midden and an in-field zooarchaeological recording session was conducted. Analysis of the material classified the bones as the humerus of a large artiodactyl unidentifiable to taxon and the distal metapodial of large bovid (i.e., *Bos* or *Bison*). Both elements possess green breaks, suggesting they were processed for marrow (Appendix A).

Figure 26 - Feature 3 at LA 105530. The highly dispersed timber scatter was originally interpreted as a collapsed hogan. North is to the upper left of the image..

Feature 3 is the second structure at the site and the most intriguing, as it consists of scatter of thirty-five fragmented juniper poles covering a circular area 14 meters in diameter. Two distinct areas within the feature are apparent, with the first a cluster of fifteen long poles between 1 to 2+ meters in length oriented towards a cluster of shaded boulders at the northern edge of the feature. The remaining pole fragments are thinly scattered across the southern portion of the feature, which appears to have a midden-like aspect complete with thermally altered rock fragments, chert, Dinétah Grey and Gobernador Polychrome sherds, as well as a small unburned bone fragment (Figure 26). A CMT stump at the southern edge of the site was previously sampled and returned a date of AD 1714vv. Due to its dispersed nature, the feature was originally interpreted as a collapsed hogan that had been modified by erosion; however, the difference between the two parts of Feature 3 suggest that the northern pole elements represent

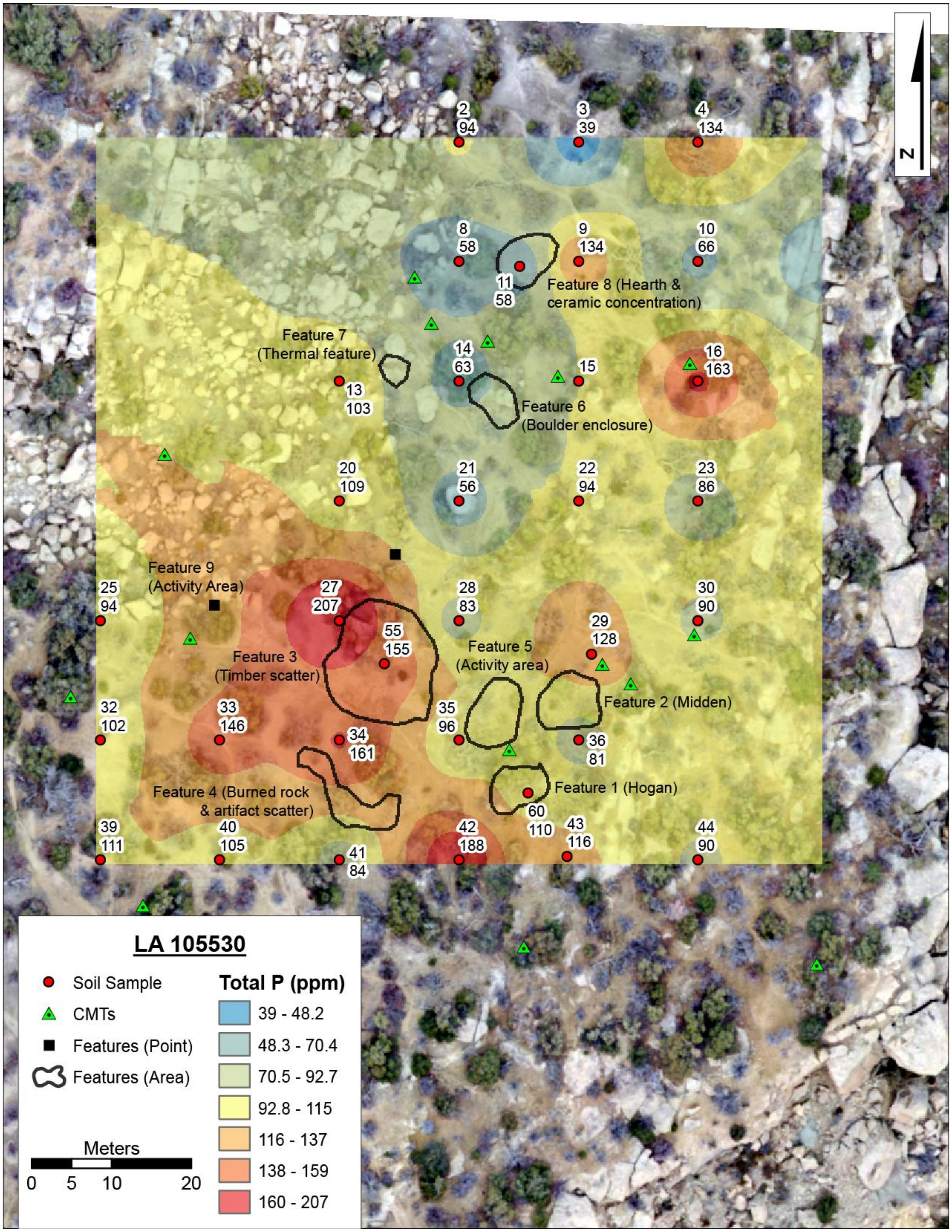

Figure 27 - LA 105530 soil phosphorus overlay analysis results. Feature 3 is associated with sample points 27 and 55 (soil sample labels note sample number [upper] and total phosphorus content [lower]).

something distinct from the southern artifact scatter. It is possible that Feature 3 represents the remains of a different type of structure like an informal lean-to, a shadehouse, or a corral/pen.

Three dendroarchaeological samples were collected from CMTs across the site and submitted to the University of Arizona Laboratory of Tree-Ring Research for analysis (Table 14). These samples were intended to supplement the work done during the MENLUS project, which returned the following non-cutting dates: AD 1689vv, AD 1714vv, and AD 1719++vv. Unfortunately, none of the ENPLP-3 tree-ring samples successfully cross-dated.

The LA 105530 sampling grid covered a roughly 60 by 90 meter (~0.5 ha) portion of the second mesa bench. Due to shallow bedrock at many of the sample locations near the rim of the bench, only 33 samples were submitted to Envirotech Analytical Laboratory for total phosphorus analysis. The GIS-based overlay analysis (Figure 27) revealed that only sample 27 possessed a phosphorus concentration higher that 200 ppm, while the samples from within Hogan 1 and Feature 3 were lower (sample 60, 110 ppm; sample 55, 155 ppm, respectively). Because a scatter of deer dung was noted less than a meter from sample 27, the sample was not chosen as part of the initial dung spherulite sub-sample, which only included samples 55 and 60 from the site.

LA 110285

LA 110285 is a multi-habitation Gobernador Phase site located 175 meters south of LA 83529, the Morris Site 1 pueblito. The site is ensconced within a wooded peninsula of land at the head of small draw on the valley floor and was first identified in 1995 as part of the Morris Site 1 Early Navajo Land Use Study. Features at the site include the remains of one masonry structure, two burned hogans, a rock art panel, a sweatlodge, and nine ancillary elements. The site was chosen as part of the ENPLP Phase 3 site pool because initial investigations did not identify any evidence for potential pastoral features, yet the site is closely associated with the Morris 1 pueblito and its position at the base of Frances Mesa's talus slopes would provide ample spots for ad hoc enclosures.

Fieldwork at LA 110285 included systematic soil sampling, feature relocation and mapping, and dendroarchaeological sampling. The site resurvey resulted in the reidentification of all but two of previously identified features at the site. A series of five dendroarchaeological samples were collected from CMTs at LA 110285 in an effort to obtain baseline chronological data, as the site was not sampled during the MENLUS project (Towner 2003b). Unfortunately, none of the samples from the site cross-dated with the master chronology (Table 14). Intriguingly, two of the samples cross-matched with the nearby LA 110271 site, a relationship that likely reflects a sensitivity to specific localized microclimate or soil moisture conditions within their shared drainage setting (Ronald Towner 2021, personal communication).

LA 110285 Feature 1 is a masonry rubble structure in the center of the site. Three sides of the structure are visible, with apparent wall fall along the southern edge. Dinétah Gray sherds lay in among the rocks while a sparse artifact scatter extends out from the structure and includes assorted sandstone blocks, a coarse-grained red mano, a white chert flake, and a small amount of Gobernador Polychrome. When viewed from the south, Feature 2 is readily visible in the background behind the masonry remains. This feature is a two-meter-tall anthropomorphic petroglyph panel pecked and incised onto the flat south face of a large talus boulder at the northern edge of the site. The petroglyph depicts a sashed and kilted Navajo yé'ii figure wielding a staff. The area around the head is discolored; photomanipulations of the figure using the DStretch program reveal that these areas are the remains of highly weathered paint (Figure 28). The association would have likely presented visitors to the site (perhaps en route to LA 83529?) with a powerful image and raises questions about LA 110285's role within the local Morris Site

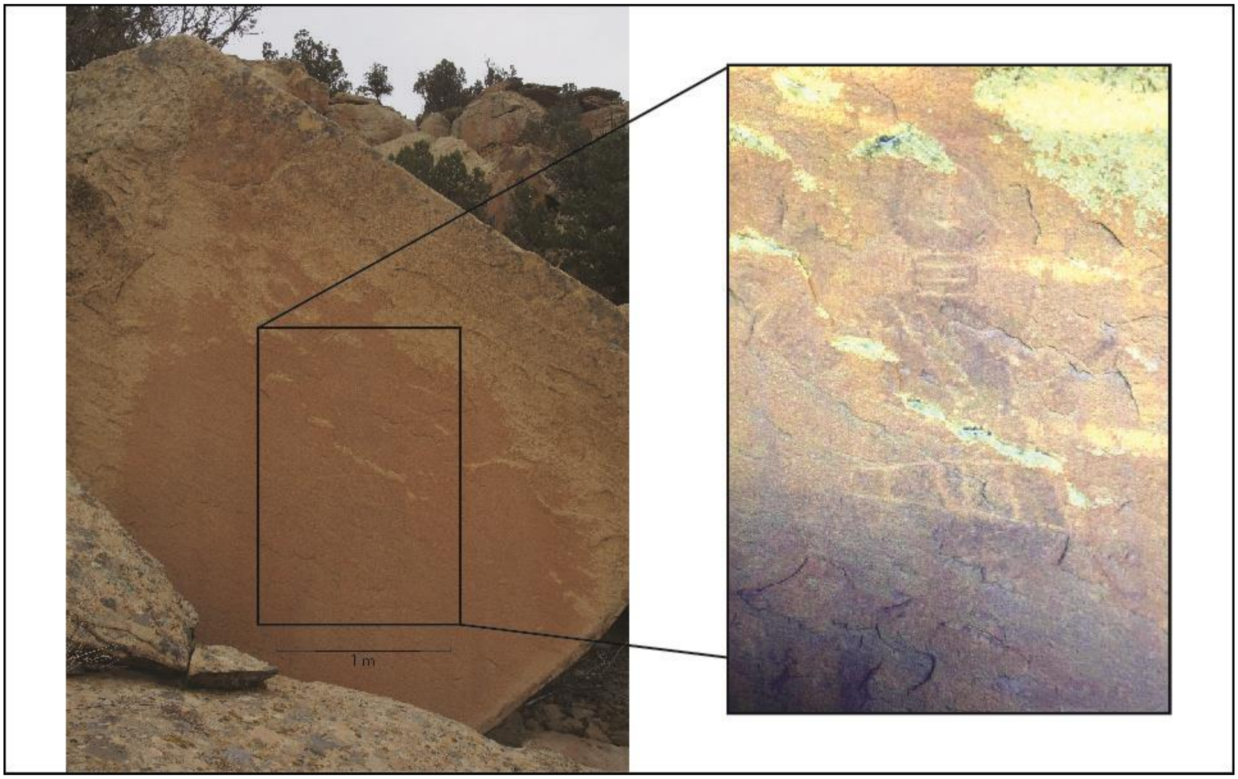

Figure 28 - Inscribed and painted yé'ii petroglyph, LA 110285 Feature 2. Right false color image derived from DStretch.

1 pueblito neighborhood.

Features 6 and 7 consist of dispersed sweatlodge rock pile adjacent to the remains of a burned hogan feature at the western edge of the site. Both features have been cut by the arroyo that bounds the site and cultural materials are eroding down into the drainage. The hogan's burned stratum is clearly visible in the cut bank 10 centimeters below the ground surface and a slab metate fragment and stone bin are present. A large midden (Feature 9) between the central and western feature clusters contains Gobernador Polychrome, Dinétah Gray and Rio Grande glazeware sherds, as well as abundant flaked lithic materials. Another large midden in the southeastern portion of the site (Feature 12) surrounds a low, flat-topped boulder and contains a variety of material including obsidian, Gobernador Polychrome and Dinétah Gray ceramics,

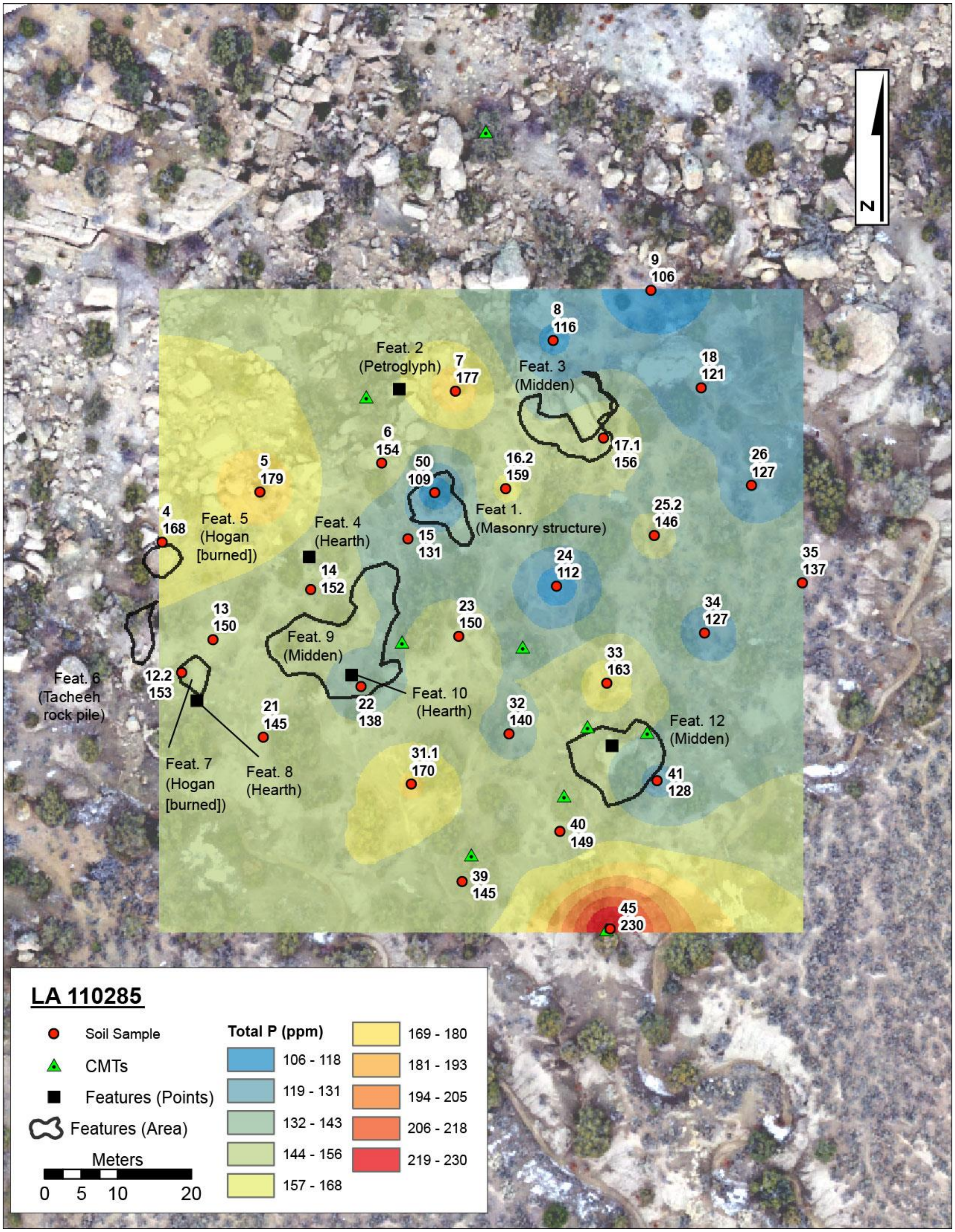

Figure 29 - LA 110285 soil phosphorus overlay analysis results (soil sample labels note sample number [upper] and total phosphorus content [lower]).

lithic flakes, and burned bone. A fire-reddened area and two shallow divots on top of the low boulder are suggest that an unknown structure was located on top similar to LA 110271's Feature 8, another example of possible non-masonry boulder-top constructions in the area.

Soil sampling along a 15 meter interval grid constrained by the triangular shape of the site landform resulted in the recovery of 32 soil samples that were submitted to Envirotech Analytical Laboratory for total phosphorus analysis. Only a single sample (sample 45) possessed a phosphorus concentration higher that 200 ppm; however, the sample is located on the edge of the site's the eastern arroyo and does not appear to be associated with any notable features (Figure 29). As a result, no samples from LA 110285 were chosen for inclusion in the dung spherulite analysis.

LA 110271

LA 110271 is a multi-component site with elements from a Rosa/Piedra Phase (AD. 700-950) Pueblo I period Ánaasází occupation and a Gobernador Phase Navajo occupation. The site is located on the valley floor 400 meters south of LA 83529, the Morris Site 1 pueblito, and extends along the base of the first bench talus slope at the point where the piñon-juniper woods transition to more open sagebrush flats. The site was first recorded in 1995 as part of the MENLUS surveys (Dykeman 2003a). ENPLP Phase 3 crews re-recorded the site and collected a series of soil and tree-ring samples. Given the lack of previous chronometric data and the presence of both faunal remains and non-local pottery at the site, a strong effort was made to identify suitable dendrochronological samples. In the end, six samples were collected from the site Table 14) and although none cross-dated, one sample dud cross-match with a pair from LA 110285 nearby, a relationship that likely reflects a sensitivity to specific localized microclimate or soil moisture conditions within their shared drainage setting

The LA 110271 site resurvey succeeded in relocating eight of nine previously identified features, as well as recording one new feature. The most notable cluster of features related to the early Navajo component consisted of Features 1 and 2, a pair of middens associated with Feature 8, a boulder-top construction at the southern edge of the site. The middens contained a particularly rich and diverse artifact assemblage, including sherds of Dinétah Gray, Gobernador Polychrome, Rio Grande Glaze E, Hopi, and Jemez Black-on-white pottery, as well as the partially buried skeletal remains of what was later determined to be a coyote (Appendix A). The Feature 2 midden was previously interpreted as burned structural debris from several possible masonry structures; however, reevaluation of the feature suggests that the two potential stone alignments are simply natural debris. Feature 8 is the remains of a presumed structure atop a two-meter-tall boulder accessed via a set of eleven hand and foot holds pecked into the eastern face. Considering the lack of substantial architectural debris and the presence of subtle features atop the boulder (shallow pecked sockets and a line of flat stones), an impermanent structure like a windbreak or tent is more plausible than a masonry construction.

The sampling strategy at LA 110271 was modified to account for both the talus slope to the west and the sagebrush plain to the east. A total of 42 soil samples were recovered from the site and submitted to Envirotech Analytical Laboratory for total phosphorus analysis. Although, none of the samples returned concentration levels above 200 ppm, samples 24.2, 27, 33, and 38 possessed relatively higher total phosphorus values and were situated in the general vicinity of the southern feature cluster (Figure 30). Given this association, these samples were included as part of the dung spherulite sample pool. During the course of the survey recording work at LA 110271, a roughly 10 square meter concentration of wolfberry was noted in the northern portion of the site in the immediate vicinity of sample 12. Although wolfberry is known to be a

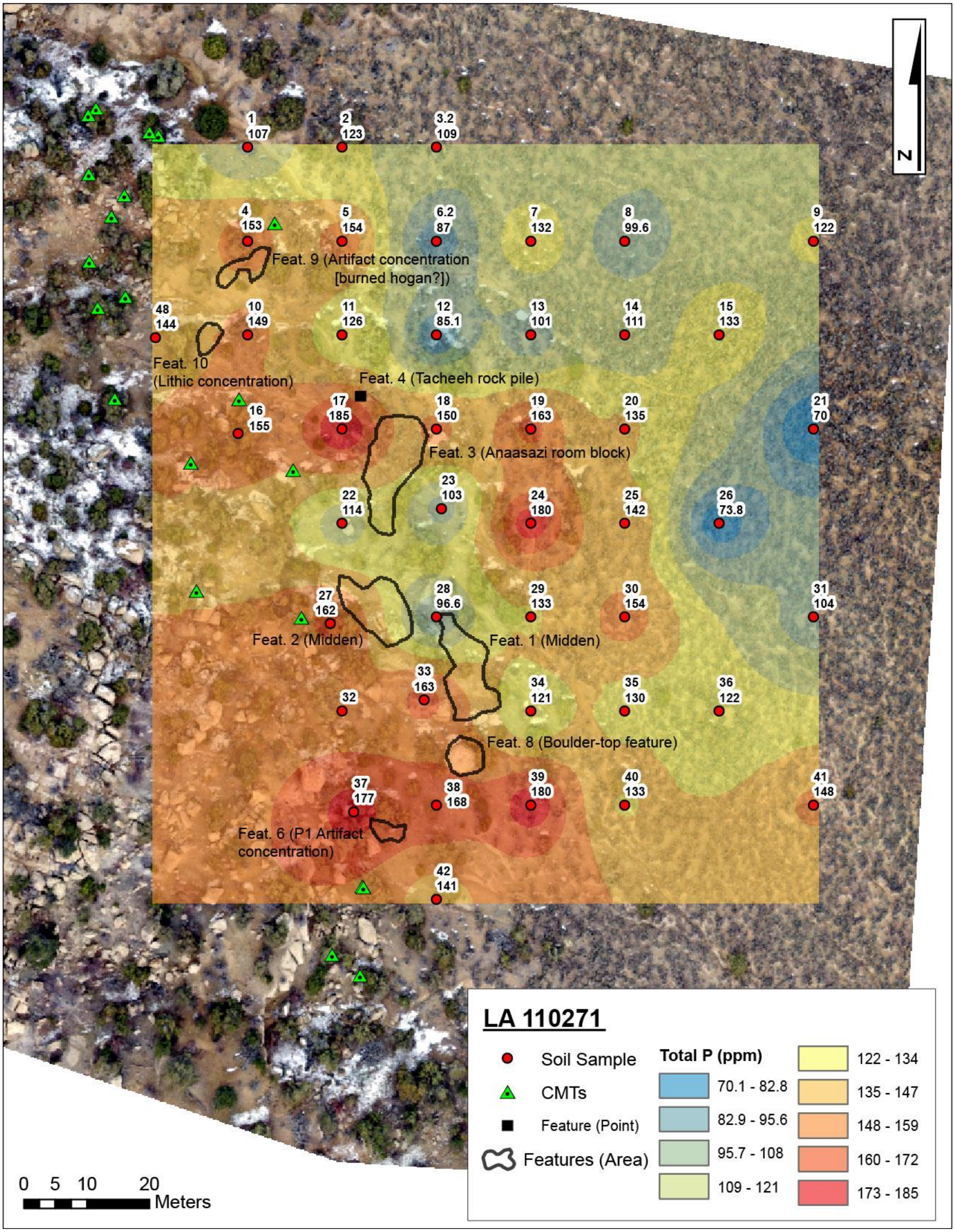

Figure 30 - LA 110271 soil phosphorus overlay analysis results (soil sample labels note sample number [upper] and total phosphorus content [lower]).

colonizing plant that favors nutrient rich disturbed soils, the phosphorus reading associated with sample 12 was one of the lowest at the site and it was not chosen for follow-up spherulite analysis.

The Romine Canyon Pueblito Neighborhood

LA 55836 (Romine Canyon Ruin)

Although the ENPLP Phase 3 work did not sample Romine Canyon Ruin, the site was visited in the course of fieldwork activities. Romine Canyon Ruin is a multi-room pueblito site located midway up the east side of Romine Canyon's first bench on a rocky promontory that extends out into the valley. The site was described by Powers and Johnson (1987:111) as a semi-intact single-story pueblito consisting of six rooms with a courtyard and midden area separated from the rest of the mesa bench by a defensive wall; today, online a single short course of masonry remains standing. Middens, tumbled architectural debris, and a petroglyph panel are arranged along the base of the bluff. The site was revisited as part of the MENLUS project and nine tree-ring samples were taken; a weak cluster of non-cutting dates suggest the pueblito was constructed during the early to mid AD 1720s (Towner 1997:259-261).

Romine Canyon Ruin is located approximately 1.35 kilometers east of LA 83529, the Morris Site 1 pueblito. Like its counterpart, it appears to act as the focal point for a local cluster of Gobernador Phase Navajo sites in the valley and surrounding area. At least six non-pueblito habitation sites are situated within eyesight of the pueblito along the benches on either side of Romine Canyon and on the valley floor itself. Additionally, the western edge of LA 78825 - the large mesatop hogan site – is less than 50 meters from one possible path through the talus slopes that could have linked the benches along the eastern side of Romine Canyon with the top of Frances Mesa above.

LA 109396

LA 109396 is a multi-component site on the west side of Romine Canyon approximately 350 meters northwest of Romine Canyon pueblito. There is evidence for a buried Rosa/Piedra Phase (AD 700-950) Pueblo I period Ánaasází occupation in the valley proper as well as a multi-habitation Gobernador Phase occupation along the wooded portions of the first bench talus slope. LA 109396 was chosen as one of the initial ENPLP Phase 3 sites because the earlier MENLUS project interpreted two rock alignment features at the site as the possible remains of early Navajo corrals (Dykeman 2003:75). Given this identification and the fact that the earlier work did not include dendrochronological sampling, four CMT samples (two from the same stump) were submitted to the University of Arizona Laboratory of Tree-Ring Research for analysis (Table 14). Although the wood surfaces indicated good potential for dating, none of the samples resulted in dates.

All six features at LA 109396 were relocated during the survey work. The most notable consisted of Features 1 and 2, the suggested corral/pen remnants. Feature 1 comprises a natural jumble of seven large 2-3 meter tall sandstone talus boulders with an angled rock alignment closing a 7 meter gap on the eastern side (Figure 31, upper image). The southeast-facing portion of the alignment consists of five large sandstone blocks (~35 cm wide, 50 to 75 cm long), while the northeast-facing portion consists of ten smaller purple-colored sandstone boulders. The feature was initially interpreted as the remains of a masonry room and later expanded to include the possibility that it might have functioned as an animal enclosure, with the rock alignment presumably serving as basal supports for a brush wall. Upon resurvey, the pen/corral-type identification remains a viable option for Feature 1, although it is noted that the boulder jumble also opens to the north and no potential barrier features were noted in this area.

Figure 31 - Image showing the previously noted possible corral alignments at LA 109396.

Similar to Feature 1, Feature 2 was originally described as a 5 meter long two-course wall alignment linking two talus boulders and creating a small enclosure or room. No artifacts were noted. Upon reexamination, however, the apparent feature area does not match well with the original surveyors' map and description (Figure 31, lower image). Although eight sandstone blocks form an alignment on the northern edge of the presumed feature area, it is not 5 meters long nor does it form a readily discernable enclosure. Additionally, two Gobernador Polychrome sherds and a pair of lithic fragments were identified at the foot of the slope. This sparse scatter continues approximately 20 meters upslope and includes Dinétah Grey and Gobernador Polychrome sherds, as well as a possible Northern Rio Grande polychrome sherd (Jemez Black-on-white was previously reported from this upslope region as well). In summary, the general Feature 2 area appears to be an artifact scatter that reflects some sort of non-midden activity area rather than any sort of potential stone alignment or masonry structure.

A total of 43 soil samples were collected from across 0.75 hectares of the Romine Canyon valley floor and sent to Envirotech Analytical Laboratory for total phosphorus analysis. The GIS-based overlay analysis highlighted that while several samples returned concentration values above 200 ppm, many of those were from samples in the sagebrush flats that were unassociated with any readily identified surface features (Figure 32). As a result, only the two samples most closely associated with the potential pens enclosures (sample 9, Feature 1; sample 14, Feature 2) were selected for inclusion in the dung spherulite analysis. In particular, the phosphorus concentration of sample 14 was over 400 ppm, effectively double the next highest samples, indicating that it was good candidate to test the relationship between the remains of a surface feature, its survey identification, geochemical data, and microremains data.

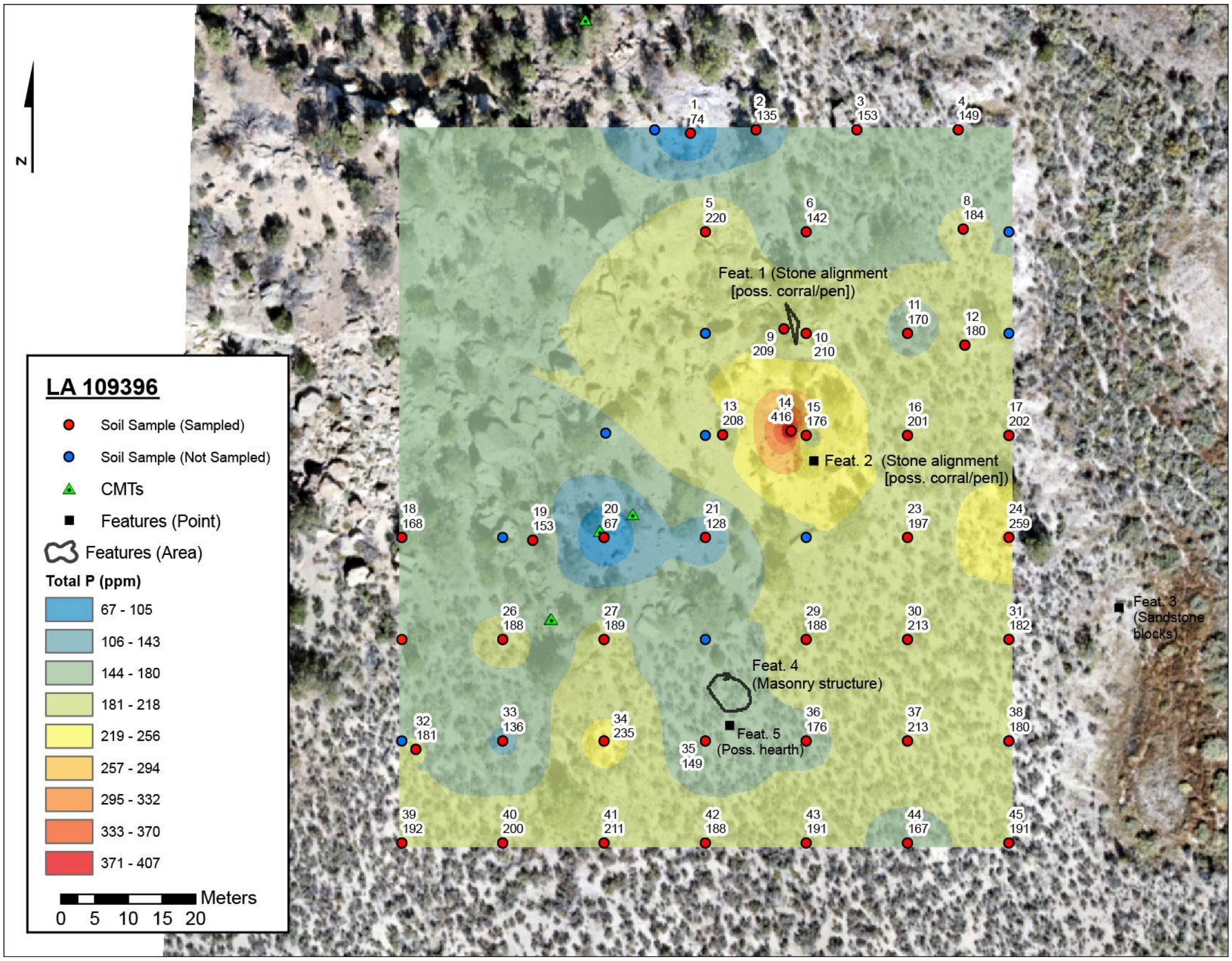

Figure 32 - LA 109396 soil phosphorus overlay analysis results (soil sample labels note sample number [upper] and total phosphorus content [lower]).

LA 106201

LA 106201 is a multi-habitation site consisting of one collapsed forked stick hogan, one burned hogan feature, and five ancillary features on the first bench of Frances Mesa. The site lies in open piñon-juniper woods near the head of Romine Canyon and is set back against the eastern talus slope. The site was originally described by the MENLUS project as an undifferentiated Dinétah Phase or Gobernador Phase site due to the lack of diagnostic artifacts or chronometric data. This situation is quite common within early Navajo archaeology and the site was chosen for

ENPLP Phase 3 study in part because of this reason, as well as its proximity to other sites in the Romine Canyon site cluster.

Project activities at LA 106201 consisted of site recording and dendroarchaeological sampling, as well as systematic soil sampling. Due to the poor temporal control of the site, a particular effort was made to obtain tree-ring samples from CMT features around the greater site. Five samples were sent to the University of Arizona Laboratory of Tree-Ring Research for analysis (Table 14), resulting in a single near-cutting date of 1746+*v* from a collapsed pine tree eight meters from the collapsed and heavily weathered forked stick hogan. The close spatial association suggests the structure and cutting event are related and correspond to a Gobernador Phase occupation, although it is possible that the cutting event post-dates the use of the hogan.

Two main feature clusters are present at the site, with the first organized around Feature 4, the collapsed forked stick hogan. The clearly visible main radial timber alignment measures approximately 7 meters in diameter, although portions are being eroded down an ephemeral drainage. A hearth feature and sparse artifact scatter are located nearby, as are a pair of trees with ax-cut limb scars, one of which resulted in the tree-ring date. The second cluster consists of Feature 6, the remains of a burned hogan, as well as a nearby pot drop and CMT. Evidence for the burned hogan consists of a 4.5 meter diameter concentration of rock and artifacts with a halo of ash staining and scattered juniper fragments extending out another four meters. Artifacts include a broken metate fragment and nine highly polished cream-colored body sherds. The exterior surfaces are spalled and painted red, while the interior depicts a feather-type design. It is possible these are Gobernador Polychrome sherds, although they bear similarities to Hopi ceramics as well.

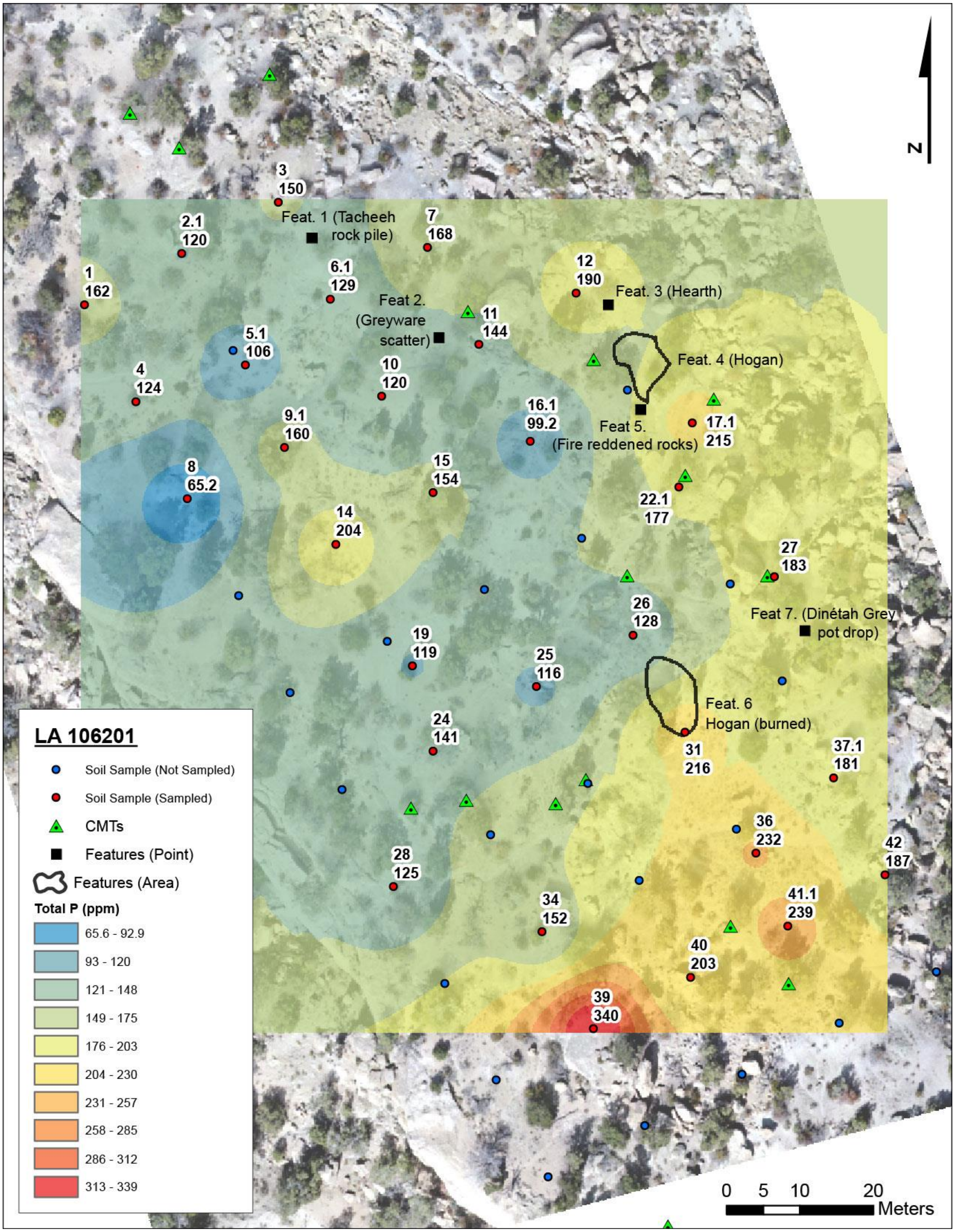

Figure 33 - LA 106201 soil phosphorus overlay analysis results (soil sample labels note sample number [upper] and total phosphorus content [lower]).

Due to the narrow nature of LA 106201's upper canyon setting and the shallow soils of the bench, only 36 samples were collected from the site (Figure 33). The results of Envirotech Analytical Laboratory's subsequent total phosphorus analysis revealed that the majority of the samples from the site possessed phosphorus concentrations below 200 ppm. The GIS overlay analysis revealed that those high phosphorus areas that are present do not correspond to any of the early Navajo features identified at the site. As a result, no samples from LA 106201 were selected for additional testing.

LA 106199

LA 106199 is a complex multi-habitation Gobernador Phase Navajo site on the first bench of Frances Mesa overlooking Romine Canyon. The MENLUS project noted twenty-one separate features at the site, including three hogans, two large middens with a number of non-local ceramics and unburned bone, and three sweatlodge-related features. Three tree-ring samples were taken from CMT contexts and returned near-cutting dates of AD 1731+vv, AD 1747vv, and AD 1750B (Dykeman 2003a).

The ENPLP Phase 3 work sought to build on this rich dataset by re-inventorying the site features and collecting additional dendrochronology samples. Nineteen ax-cut limbs or stumps were noted around the site and five of the most promising samples were sent for analysis (Table 14); unfortunately, none of the samples resulted in dates. The site resurvey component succeeded in relocating the majority of the previously identified features at the site, as well as one new feature. The site's main components consist of a loose cluster of three burned or dismantled habitation structures (Features 9, 16, and 22), two large middens (Features 11 and 12), and a series of interspersed activity areas. Obsidian, other fine lithic materials, and pieces of Dinétah Grey, Gobernador Polychrome, and Jemez Black-on-white pottery are all associated with these

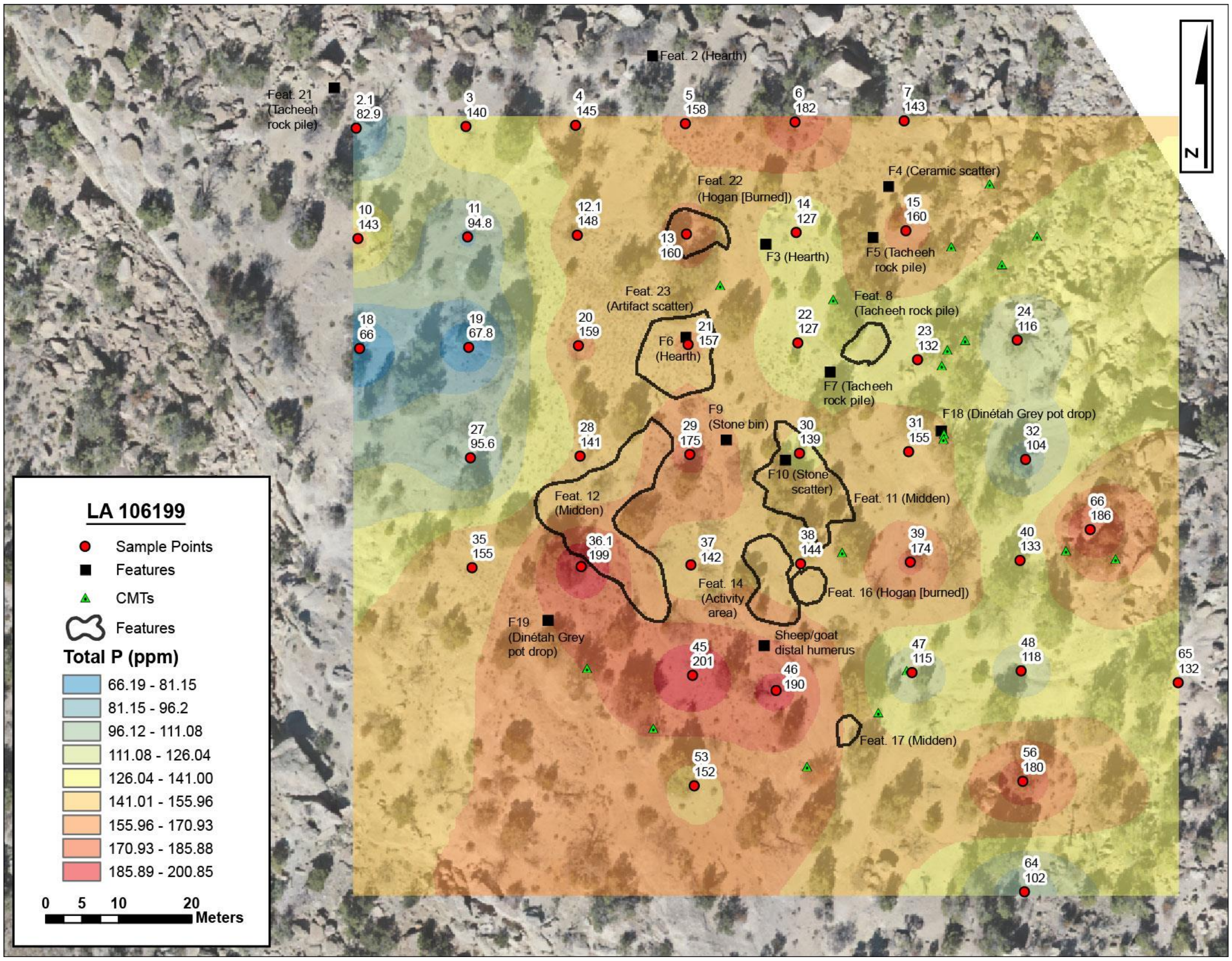

Figure 34 - LA 106199 soil phosphorus overlay analysis results (soil sample labels note sample number [upper] and total phosphorus content [lower]).

various features. One extremely weathered distal humerus was found on the surface of an ephemeral drainage 10 meters south of the Feature 16 hogan. The bone's morphometric attributes and the presence of cut and burn marks indicates that the remains are likely that of a juvenile sheep that was processed and consumed at the site (Appendix A).

Several sweatlodge events occurred at LA 106199 as evidenced by the remains of four heated rock piles (Features 5, 7, 8, and 21). The rock piles are located away from nearby likely habitation feature and sit near the talus slope or along the edges of ephemeral drainages. Feature 8 is notable for both its large size (roughly 4 by 7 meters) and the presence of a small number of undecorated Jemez whiteware sherds interspersed throughout the feature. These data attest to the sustained use of multiple sweatlodges and suggest a potential ceremonial aspect to the site that is not evidenced through other means (e.g., rock art).

A total of 36 soil samples were collected along a 15 meter interval grid that was adjusted to account for the shape of the mesa bench and areas of shallow bedrock. The material was sent to Envirotech Analytical Laboratory for total phosphorus analysis and the resulting data incorporated in a GIS database for spatial analysis (Figure 34). A comparison of the overlaid phosphorus heatmap and the site features highlighted a set of six high phosphorus concentration samples that seemed suitable for dung spherulite analysis. Specifically, sample 13 was chosen to test Feature 22's hogan identification (the feature is distinguished by thermally altered rock and a scatter of weathered juniper limbs), while samples 29, 36.1, 45, and 46 were selected to test the status of off-midden areas. Sample 6 was included to test the possibility that higher phosphorus concentration areas near the talus-base areas might represent ad hoc sheep bedding areas.

LA 106203

LA 106203 is a Gobernador Phase Navajo single habitation site on the eastern side of Romine Canyon. The site is the southernmost of the three that occupy the first mesa bench and is located 175 meters northeast of LA 55836, the Romine Canyon pueblito. The site was first recorded by MENLUS crews in 1995 who identified a burned hogan, three middens, a sweatlodge area, and six additional features. A test unit in the one of the middens recovered ovicaprid faunal remains, while obsidian and a variety of local and non-local ceramics (including Jemez Black-on-white, Rio Grande Glaze E, Biscuit Ware, and Hopi Yellow Ware sherds) were noted throughout the site. One tree-ring sample was taken from the site but it did not cross-date (Dykeman 2003a).

Phase 3 activities at LA 106203 included both soil and dendroarchaeological sampling in addition to site resurvey. In an attempt to obtain baseline chronometric data, five tree-ring samples were taken from three CMTs at the site; however, none of the samples dated (Table 14). The resurvey work successfully relocated the eight primary features previously identified at the site. Feature 1 is a 4 meter diameter burned hogan distinguished by a scatter of fragmented juniper poles, several of which have partially burned ends, and a collection of eight fire-reddened sandstone blocks that likely represent the remnants of a hearth, mealing bin, or basal pole supports. Features 2 and 4 are a pair of middens to the south of Feature 1 whose charcoal-rich ashy soils contain a large amount of oxidized sandstone, obsidian and chert lithic fragments, Gobernador Polychrome and Dinétah Grey pottery sherds, and faunal remains. A previous test unit in Feature 2 recovered 78 burned and unburned bone fragments; identifiable species included domestic sheep, elk, and burro (Goodman II 2003:308-310).

Two other features at the site are not as readily identifiable, however, and warrant closer study. Feature 3 is a 5.5 by 4.5 meter scatter of partially aligned sandstone blocks located 15 meters north of Feature 1. Although the feature was originally interpreted as a possible hogan, the area is covered in sagebrush and it is difficult to clearly discern the ground surface or evaluate other potential relationships with nearby cultural features. Its size, proximity to the hogan structure, and uncertain nature suggest a similarity to the context of LA 113103's Structure 2 and suggest this feature might be the remains of a brush corral enclosure or other activity area structure. The area around Feature 9, a small midden approximately 25 meters northeast of the hogan feature, is of similar interest. The midden contains burned bone fragments, obsidian and chert lithics, and Gobernador Polychrome sherds. A cluster of CMT features lie five meters to the north and include two ax-cut poles at the foot of a tree. These

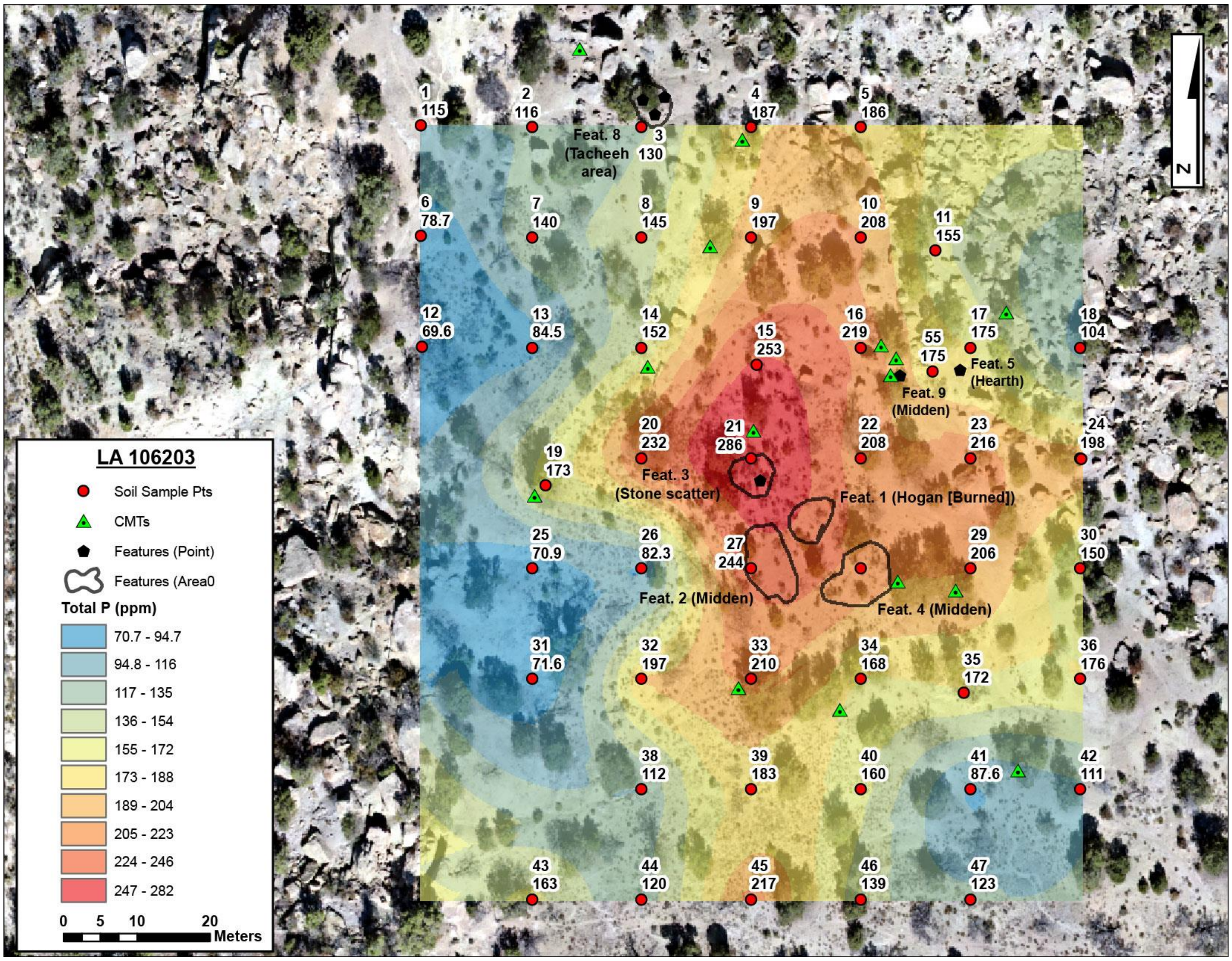

Figure 35 - LA 106203 soil phosphorus overlay analysis results (soil sample labels note sample number [upper] and total phosphorus content [lower]).

combined features are less than 10 meters from the base of the talus slope and it is possible that the area was used for bedding animals.

A total of fifty soil samples were collected from a 15 meter interval grid extended across the site. They were submitted to Envirotech Analytical Laboratory for total phosphorus analysis and the resulting data used to evaluate potential relationships between site features and areas of high phosphorus concentrations (Figure 35). In contrast to a sample (no. 55) taken from the middle of the Feature 9 area which returned a moderate reading of 175 ppm, four cores from the center of the site – samples 15, 21, 27.1, and 28 – returned readings above 200 ppm. Notably, samples 15 and 21 are associated with the mysterious Feature 3 while samples 27.1 and 28 are associated with the two middens. The high phosphorus content of these four samples and the distinction between midden and potential corral/pen-related contexts presented an ideal opportunity to evaluate whether microremains analyses could be further distinguished between the samples. All four samples were included in the dung spherulite sub-sample.

THE ENPLP PHASE 3 WORK: FECAL SPHERULITE ANALYSIS & RESULTS

Overview

Fecal spherulites – microscopic vegetal-derived calcium oxalate concretions that form in the digestive system of herbivores, particularly ruminants like sheep and goats – represent the strongest direct indicator for dung presence in archaeological contexts (Canti 1997; Gur-Arieh and Shahack-Gross 2020:128). Recent research across Eurasia and Africa has demonstrated that soils recovered from corral/pen features frequently possess high fecal spherulite concentrations (e.g., Dalton and Ryan 2020; Dunseth et al. 2018; Portillo et al. 2021), offering a line of direct evidence that can potentially confirm dung-rich corral/pen enclosures initially identified through other indirect means (e.g., geochemical or isotopic soil studies [Shahack-Gross 2011]). Despite the potential for multi-method approaches incorporating fecal spherulite analyses to better understand the history of pastoralism in the Americas, the technique has rarely been employed, with only single sets of studies from the Southwest (Church et al. 2012) and Peru (Korstanje 2005; Korstanje and Cuenya 2010) documented.

The final component of the Early Navajo Pastoral Landscape Project focused on evaluating soils associated with potential pastoral enclosure features or other areas of interest at eight Phase 3 sites in order to determine whether fecal spherulites were present. The ENPLP fecal spherulite analysis was conducted by Dr. Chad Yost of Paleoscapes Archaeobotanical Services Team (PAST) between October 2020 and July 2021. A total of 28 samples from eight sites in the Phase 3 study area were examined for fecal spherulites and other microremains (e.g., phytoliths and diatoms). In addition, soil samples from two corrals in the Phase 1 study area, one in-use and one dating circa 1960, as well as recent elk and rabbit dung from the greater Dinétah region were evaluated for comparative purposes. The full PAST report is available as Appendix B while the analysis and results are summarized below. Observations on the fecal spherulite analysis and an interpretation of the resulting data are discussed in Chapter 7.

Sample Preparation and Analysis

Processing and analysis of the ENPLP materials began with the modern comparative samples. The two sets of samples – modern dung and known modern and historic corral soils – were processed using a variety of different methods. The modern dung samples were soaked in bleach to remove the surrounding organic material before being centrifuge-rinsed with water; the resulting mixture was stored in ethyl alcohol prior to ~1 mg being mixed with immersion oil and mounted on a microscope slide. The soil samples from the twentieth/twenty-first century Black Mesa corrals were processed using two distinct extraction protocols with the goal of determining which approach would be better suited to the archaeological soil samples. The first extraction method, a simple soil smear approach, involved sieving 1 gram of soil through a 50 µm mesh to remove larger inclusions and mixing ~1 mg of the screened material in immersion oil before slide mounting.

The second extraction method consisted of a heavy liquid protocol used by PAST to conduct phytolith analyses and similar to the spherulite protocol outlined by Gur-Arieh and

Shahack-Gross (2020). The extraction involved subjecting 1 gram of soil to the bleach and water process described above before mixing the resulting sediment with a pH-neutral lithium metatungstate heavy liquid set to a density of 2.3 g/ml. The heavy liquid supernatant was then decanted, spun, rinsed, and ~1 mg mounted on a slide. Each of the final ~1 mg slides were then examined under plane and cross-polarized light using a microscope at 500x magnification to identify various isotropic and anisotropic remains, including phytoliths and fecal spherulites.

The examination of the modern dung samples highlighted that while the Black Mesa sheep dung samples contained high concentrations of fecal spherulites (estimated in the thousands per gram), the fecal spherulite concentration of the Dinétah elk dung sample was noticeably lower (estimated at less than 100 per gram).[35] The difference between the two sets of ruminant dung from two different regions highlighted that the relationships between different vegetation types in locals environments, the effects of seasonal foddering shifts, and differences in fecal spherulite production between species are all factors that need to be taken into consideration when evaluating fecal spherulites (e.g., Canti 1999; Dalton and Ryan 2020).

Most notably, PAST's examination of the Black Mesa corral soil samples revealed drastic differences in the success of the two extraction methods. While the soil smear approach allowed for the identification of fecal spherulites at concentrations of between 50-100 per gram, the heavy liquid processing of the same samples failed to identify *any* fecal spherulites. This was interpreted as the result of density differences between the heavy liquid and the fecal spherulites that prevented their capture in the solution. As a result, the remaining 28 soil samples from the ENPLP Phase 3 sites were processed following the first extraction protocol.

[35] The rabbit dung contained no fecal spherulites. Rabbits, like equids, are cecal digesters and do not produce spherulites (Canti 1999:254-255).

ENPLP Phase 3 Fecal Spherulite Analysis Results

A total of 28 samples were selected from the larger pool of ENPLP Phase 3 soil samples and examined for the presence of fecal spherulites. Eight out of twelve Phase 3 sites were included in the subsample; LA 78825, LA 83529, LA 105530, LA 106199, LA 106203, LA 109396, and LA 110271 are all early Navajo sites that most likely date to the first half of the eighteenth century, while LA 113276 is a mid-twentieth century sheepherding camp. These samples were chosen based on spatial relationships with potential corral/pen features identified at the study sites or because they serve as control samples intended to help evaluate the effectiveness of the approach.

The analysis identified a small number of diagnostic fecal spherulites and non-diagnostic possible fecal spherulites in a total of five soil samples from LA 78825, LA 83529, and LA 106203. No other fecal spherulites, diagnostic or otherwise, were noted in any of the other soil samples, although nearly all the samples contained a variety of phytoliths, diatoms, non-coprophilic fungi, and other microremains. A large number of phytoliths and diatoms were identified in the soil samples from the twentieth century brush corral feature at LA 113276, as were some of the soil samples containing fecal spherulites at LA 83529 and LA 106203, raising questions about the difference between phytolith and fecal spherulite concentrations as indicators of dung presence (Table 17).

The archaeological associations of the fecal spherulite-positive soil samples at both the inter-site and intra-site level are noteworthy. Of the diagnostic fecal spherulites identified, one was from a sample from LA 83529, the Morris Site 1 pueblito, while two others were identified in a single sample from LA 106203, the southernmost study site in Romine Canyon. Four other soil samples – one apiece from LA 83529 and LA 106203 and two from samples at LA 78825, the large multi-hogan site atop Frances Mesa – each yielded a single possible fecal spherulite (Figure 36). Intriguingly, LA 106203's diagnostic sample 21 originates from within the suspect Feature 3 rock alignment area, while LA 83529's diagnostic sample 8.1 is associated with a slightly sheltered area along the pueblito boulder's western faces. LA 78825's sample 70.1 comes from within the boundaries of the Feature 2 timber scatter, while sample 49 comes from the adjacent midden feature. The final sample from LA 83529, sample 57.1, was collected from a midden 15 meters from the pueblito boulder that contains sheep bone.

Table 17 - Microfossil counts from ENPLP Phase 3 sites (Yost 2021 [Appendix B])

Site No.	Soil Sample No.	Fecal Spherulites	Phytoliths: Elongates	Bulliforms	Trichomes	Rondels (C3 & C4)	Bilobates (C4 mesic)	Stipa-type bilobates (C3)	Crenate (C3)	Saddles (C4 xeric)	TOTAL PHYTOLITHS	Diatoms: Pennate forms	*Aulacoseira* sp.	*Hantzschia* sp.	TOTAL DIATOMS	Fungi: Spores	Hyphae**	Pollen***	Chrysophyte cysts	Sponge spicules
LA 78825	**38**		4		4				1	4	**13**			4	**4**	4	C			
	70.1	**1***	2						2	2	**6**				**0**	1	R			
	49	**1***	1	1							**2**			7	**7**	1	C			
LA 113276	**1.1**		20	3	2	1	4		13	3	**46**		1	6	**7**		R			
	6.1		21		4	3	1	1	7		**37**	3		15	**18**	1	R			
LA 105530	**55**										**0**	1			**1**	1	R			
	60		2								**2**			4	**4**	1	R			
LA 83529	**7**										**0**				**0**					
	8.1	**1**	4		1	1	2	1	5	4	**18**				**0**	1	R		1	
	9		1		1				2	2	**6**	1		2	**3**		R			
	56.1		2				3				**5**			1	**1**		R			
	57.1	**1***	4				1		1	1	**7**			3	**3**		R			
LA 110271	**24.2**		1						1		**2**				**0**	1	C			
	27						1			1	**2**				**0**	5	A			
	33						1				**1**				**0**					
	38		3	1							**4**				**0**					
LA 109396	**9**		1		1		1				**3**				**0**		C			
	14.1										**0**				**0**	1	A	P, G		
LA 106199	**6**		5	2	2			1		1	**11**	2		3	**5**	1	C			
	13		8	3	1		2	1	1	3	**19**				**0**		R			
	29				2					1	**3**			9	**9**	4	A	U	3	
	36.1		3						1	1	**5**	4			**4**		A	G		1
	45		1								**1**				**0**		R			
	46		2								**2**			1	**1**	1	C			
LA 106203	**15**	**1***	1								**1**			8	**8**	5	A	U		
	21	**2**	9	5	2	5	4	1	1	11	**38**			3	**3**		A	G, U	1	
	27.1		2	2			1		3		**8**			6	**6**	1	R			
	28		6	2	3	2			1		**14**			6	**6**		C	U		

* Possible fecal spherulite but positive identification limited due to degradation/alteration.
** A = abundant, C = common, R = rare
*** P = Pine pollen, G = Grass pollen, U = Unknown pollen

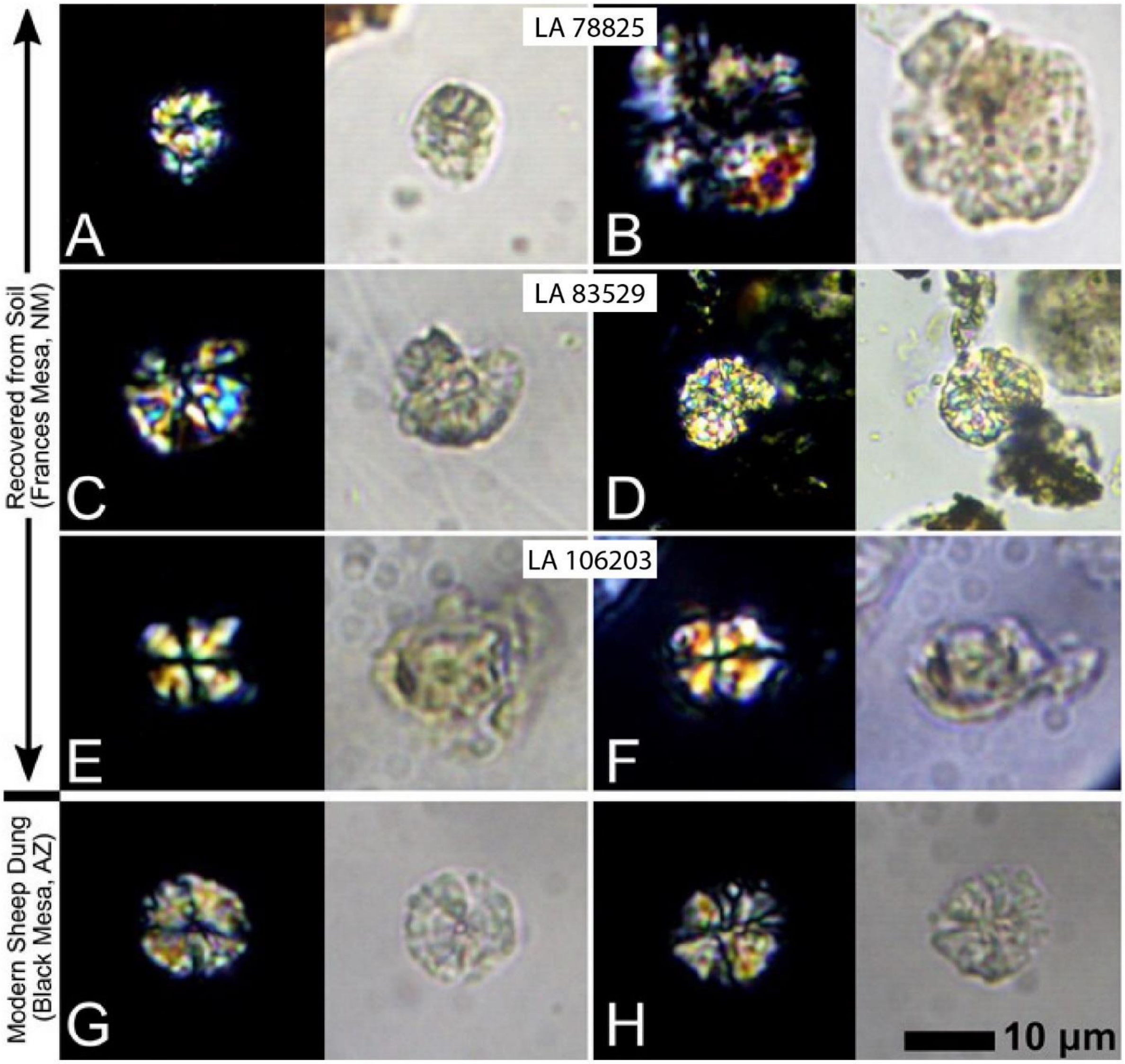

Figure 36 - Micrographs of fecal spherulites identified in soil samples from early Navajo sites in the ENPLP Phase 3 study area, as well as comparative examples from modern sheep dung. **A)** Possible fecal spherulite from sample 49, LA 78825. **B)** Possible fecal spherulite from sample 70.1, LA 78825. **C)** Fecal spherulite from sample 8.1, LA 83529. **D)** Possible fecal spherulite from sample 57.1, LA 83529. **E-F)** Fecal spherulites from sample 21, LA 106203. **G-H)** Fecal spherulites from modern sheep dung for comparison. All micrographs were taken at 500x magnification. Images with black backgrounds were captured using cross-polarized light, the other images were captured with plane-polarized light; all images are scaled the same. Image derived from Yost 2021 (Appendix B).

Chapter 7 – The Navajo Pastoral Landscape Over Time: Analyzing the ENPLP Findings

THINKING ABOUT NAVAJO PASTORALISM IN THE FOUR CORNERS FROM THE 18TH TO 21ST CENTURIES AD

ENPLP Phase 1 - Historic Diné Herding Practices in Northeastern Black Mesa

The methodology employed during the ENPLP Phase 1 work resulted in a unique ethnoarchaeological dataset whose details capture the dynamism and resilience of the R/T/H family's traditional sheepherding activities in the Kits'iilí area throughout the twentieth century. When considered alongside past political developments and economic trends, four distinct periods of shifting pastoral land use strategies are evident in the ENPLP Phase 1 study area and provide a framework suitable for comparison with other studies of Navajo pastoral land use (Figure 37). The periods are summarized as follows:

Period 1 (c. AD 1880-1940)

This phase represents that late 1800s period of "classic" highly mobile Navajo herding detailed in "Son of Old Man Hat" (Dyk 1938). A single family group most commonly identified themselves with a particular home region but frequently (re)occupied different camps while moving herds between pastures over a multiweek transhumant cycle. Land tenure was fluid with multiple family groups using the same areas and structures at various times as part of larger mobile herding rounds; access was secured through kin or clan relationships (Kelley and Francis 2019b). Oral traditions describe members of the F.H. family descending the north rim of Black Mesa in the summer to graze their herd in the Laguña Creek drainage below Chilchinbito, where

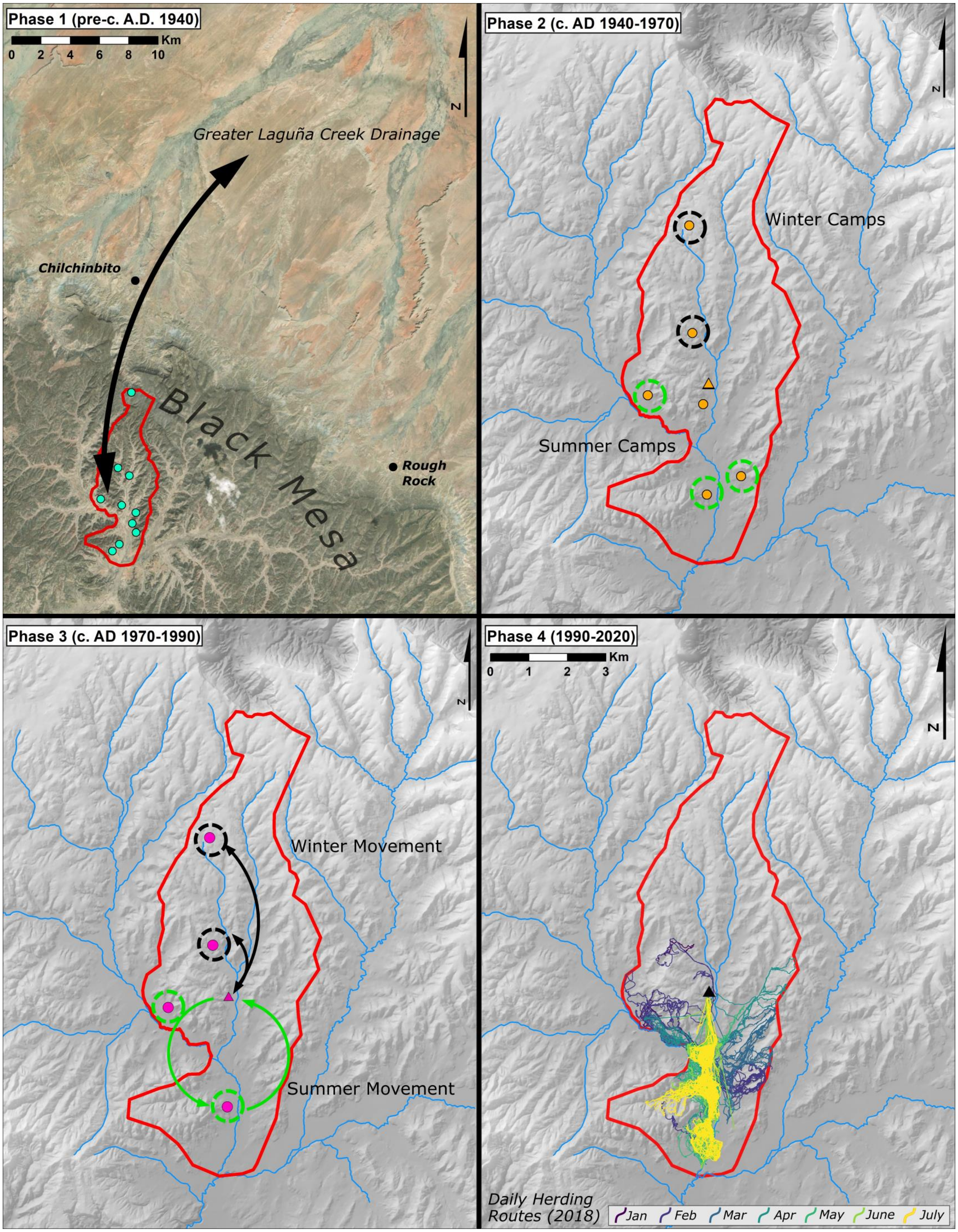

Figure 37 - Four-part figure showing the herding movements associated with each of the four grazing periods (taken from Campbell 2021).

they had relatives. These roughly 50-mile roundtrip journeys appear to have ended around 1940 following the establishment of the BIA grazing districts (1936) and permitting system (1940), which defined the north rim of Black Mesa as the boundary between District 4 (Black Mesa) and District 8 (Kayenta) and prohibited movement between them.

Period 2 (c. AD 1940-1970s)

The contraction of family herding to current grazing areas saw greater investment in camp infrastructure, although habitation continued to be spread across different camps. A local seasonal round developed utilizing multiple summer camps in the main Oraibi Wash valleys with movement to specialized winter camps in the forested uplands near the mesa rim. The return of Navajo World War II veterans initiated a postwar development boom across the reservation (Iverson 2002:180–226). ENPLP Phase 1 tree-ring dates document increased domestic construction activities throughout the study area at the same time that roads and large earthen reservoirs were being built in Kits'iilí under the leadership of W.H., a returned veteran and son of F.H. Oral traditions recount shifting herd composition in response to wool and mohair prices at trading posts, as well as federal wool incentive payments.

During the 1950s and 1960s, consideration of factors like access to modern infrastructure, legal land-use constraints, and the availability of Western-style housing options increasingly led families to depart from the older multi-camp system that had previously structured land-use practices during late nineteenth and early twentieth century. The eventual result was the designation and formalization of a "primary" camp as the principal homesite, a pattern noted elsewhere on Black Mesa (Russell 1983:57-64). Following the opening of Peabody Coal's Black Mesa and Kayenta Mines in 1967 and 1973 and the Black Mesa Community School in 1977, the transition away from herding as the primary economic opportunity increased as local wage work and education became options.

Period 3 (AD 1970s-1990s)

The local multi-day summer herding round and upland winter camps continued to be used throughout the 1970s, although the primary homesite area now served as the center for long term habitation and corralling. The family's grazing permits were cancelled as part of an October 1973 court order leading to the 1974 creation of the Navajo Partitioned Lands [*Hamilton v. MacDonald*, Civ. 579-PCT (D. Ariz. 1972)]. While herding continued throughout the NPL, wage work and education away from Black Mesa emerged as primary activities for most families in the region. This combination of factors increasingly led to herding activities being conducted by older family members, with support from relatives (especially children) during the summer months or for larger communal tasks like shearing.

Period 4 (AD 1990s-Today)

Period 4 has been characterized by an intensification of the Period 3 conditions over the past three decades. Currently, wage work and education away from Kits'iilí form the primary focus for the majority of the extended family. As a result, daily herding is now conducted by one or two individuals using the primary homesite as the year-round "home base." As experienced during the 2018 fieldwork, persistent drought conditions during this period (Woodhouse et al. 2010) have also influenced herding practices and herd management strategies. Combined with lower wool prices and the end of wool subsidy payments, these factors have influenced a shift towards smaller sized herds comprising meat goats and churro sheep. In 2018, A.R.'s herd of approximately 250 sheep and goats represented one of the largest collections of livestock in the

Kits'iilí area. The majority of the other families in the area that did keep livestock maintained between 5-50 sheep and goats. As of August 2020, the reissuance of NPL grazing permits remains stalled due to concerns about proposed range management and herd size policies conflicting with basic livelihood concerns (Krisst 2020).

Observations on Navajo Pastoral Archaeology in the Reservation-era

Over the past four centuries, the intensity and practices associated with Navajo herding in the greater Four Corners region have varied substantially across time and space. The ENPLP Phase 1 work illustrated the fact that the sizes of contemporary sheep herds on Black Mesa are considerably less than what was common as recently as a few decades ago, let alone since the turn of the twentieth century. These smaller herd management practices arguably provide good analogs to explore the actions of incipient Navajo pastoralists building herds circa AD 1700. Observing the patterns and choices underlying the locations of contemporary/historic herding infrastructure can help identify potential archaeological signatures of pastoral activities at older Navajo sites. The sheep camp corral forms the central focus of this effort, as the repeated use of an area for animal containment increases visibility through a series of transformations, including the construction of penning structures, dung deposition, chemical alteration of soils, and the introduction of nonlocal plant species (Chang & Koster 1986:115-119; Kuznar 2001; Russell & Dean 1985).

In the ENPLP Phase 1 study area, sheep camps were most commonly located in the following four landscape settings:

1. on moderate (0-13º) slopes along treelines overlooking valleys;

2. at the base of steep ridges, rocky outcrops, or overhangs, all of which form partial natural enclosures that can be augmented with additional materials if necessary;
3. at the head of narrow draws with openings blocked off; and
4. on heavily wooded hilltops.

The first three locations were most commonly associated with summer camps, while the latter setting is linked to winter usage due to the natural windbreaks and fuelwood provided by the tree cover (Russell & Dean 1985:10-13).

Within sites, the position of a sheep camp corral can vary substantially; ENPLP Phase 1 corrals were located between 10-100 meters from the nearest associated habitation, with half being within 30 meters. The condition of the corrals in the study area ranged from in-use to deteriorated and near-invisible. Recognizing spatially discrete vegetation differences (e.g., dense stands of forage plants like saltbrush or colonizing plants like wolfberry) with associated structural remains (e.g., semi-buried timber or rock alignments) represents the best in-field identification method for low-visibility animal enclosures. All corrals identified during the Phase 1 fieldwork were less than ~110 years old, suggesting that additional methods (e.g., geochemical or micromorphological analyses [Shahack-Gross 2011]) are needed to more confidently identify similar features at older Navajo sites.

ENPLP Phase 3 - Early Navajo Community Organization and Incipient Pastoralism in Pericolonial Dinétah

The results of the Early Navajo Pastoral Landscape Project provide evidence for varying degrees of potential animal husbandry practices at a handful of Gobernador Phase Navajo sites in Dinétah circa AD 1750. These data strengthen our ability to engage with the puzzle that is early

Navajo pastoralism on a more confident footing while simultaneously emphasizing the need for more research into the long-standing questions of just when, why, and how Navajo communities successfully developed the novel pastoral character that eventually came to typify Diné culture. Although the ENPLP Phase 3 data are admittedly limited in terms of sample size and their spatiotemporal extent, when discussed in concert with existing theories about Navajo social organization and land use practices in Dinétah developed over the past thirty years, they shed some light on the ways in which early Navajo pastoralists may have fit into Diné society during the tumult of eighteenth century New Mexico.

Since the early 1990s, archaeologists working within the context of the greater Fruitland Project have suggested that the classic four-tiered system of Diné kinship and social organization that was studied by generations of twentieth century ethnographers and continues to underpin contemporary Diné society also served to organize the rhythms of early Navajo life at the turn of the eighteenth century (see Chapter 3 for more detail). Specifically, when the distribution of Gobernador Phase Navajo residential sites in Dinétah is examined at different scales, the spatiotemporal clustering of these sites across the landscape delineates a nested settlement system of single-family hogan-based households, multi-family residence groups or "hogan camps," and larger regional communities comprising multiple residence groups and (post-AD 1700) small numbers of pueblito fortresses (Dykeman 2003d:398–414; Sesler et al. 2000:223–253; Towner 2003:161–169; cf. Rocek 1995).

In the wider region surrounding the ENPLP Phase 3 project area, a dozen possible residence group clusters have been identified atop Frances Mesa with another five to fifteen residential clusters potentially dispersed along the mesa's southwestern edge (Dykeman

2003c:398–414; Sesler et al. 2000:223–226).[36] Two of the ENPLP-3 sites, LA 113103 and LA 78825, appear to be integral components of two mesatop residential clusters that were occupied from the 1710s or 1720s to the late 1740s or early 1750s (Sesler et al. 2000:230, 235). The remaining nine ENPLP-3 sites located below the mesa rim appear to form the greater portions of two topographically distinct residential clusters organized around the Morris Site 1 and Romine Canyon pueblitos, respectively (Figure 38).

Although the majority of the sites that comprise the Romine Canyon and Morris Site 1 residential clusters lack detailed chronometric data, the combined results of the ENPLP and MENLUS dendrochronology work indicate that both areas possessed a generally bimodal occupation history that first peaked in the 1710s and 1720s and again in the late 1740s and early 1750s. The Romine Canyon pueblito was built during this first period while the Morris Site 1 pueblito was built towards the end of the second period. Although LA 106203 is not tree-ring dated, its proximity to the other sites on Romine Canyon's eastern bench suggest that it too dates either the 1720s or 1740s. Interestingly, the mesatop residential cluster anchored by LA 78825 overlooks Romine Canyon and appears to be contemporaneous with the LA 106201 and LA 106199 hogan sites directly below, which are associated with the later 1740s/50s period. As the

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[36] The FMATP mesatop residential clusters were identified visually and consisted of topographically bounded groups of 5-20 residential sites spaced ~200 meters apart and included at least one sweatlodge feature and water source (Sesler et al. 2000:226). The MENLUS mesa edge residential clusters were identified geostatistically using a combination of K-means cluster analysis and Thiessen polygons. A pair of six cluster and fifteen cluster options were considered, with the fifteen cluster option preferred as a better test of an explicitly residential clustering pattern as opposed to a more general site clustering pattern (Dykeman 2003d:406–414). Although this approach delineated a final set of twelve residential site clusters in the MENLUS project area, it does not appear to have taken into account the setting's complex topography, which includes portions of the Gobernador valley bottom, three tiers of mesa benches, and the heads of three minor drainages, including Romine Canyon. As a result, the distribution of possible residential clusters in the lower mesa edge portion of the ENPLP Phase 3 study area was reevaluated following a visual approach similar to that of Sesler and colleagues (2000). A total of five possible residential clusters were identified: 1) the upper portion of Romine Canyon; 2) the valley bottom and first bench area around Morris Site 1; 3) the valley bottom and first bench area at the mouth of the minor drainage west of Morris Site 1; 4) the upper bench area at the head of the minor drainage west of Morris Site 1; and 5) the upper bench at the far edge of Frances Mesa's southwestern point. The proposed Romine Canyon and Morris Site 1 residential clusters were the main foci of the ENPLP's work.

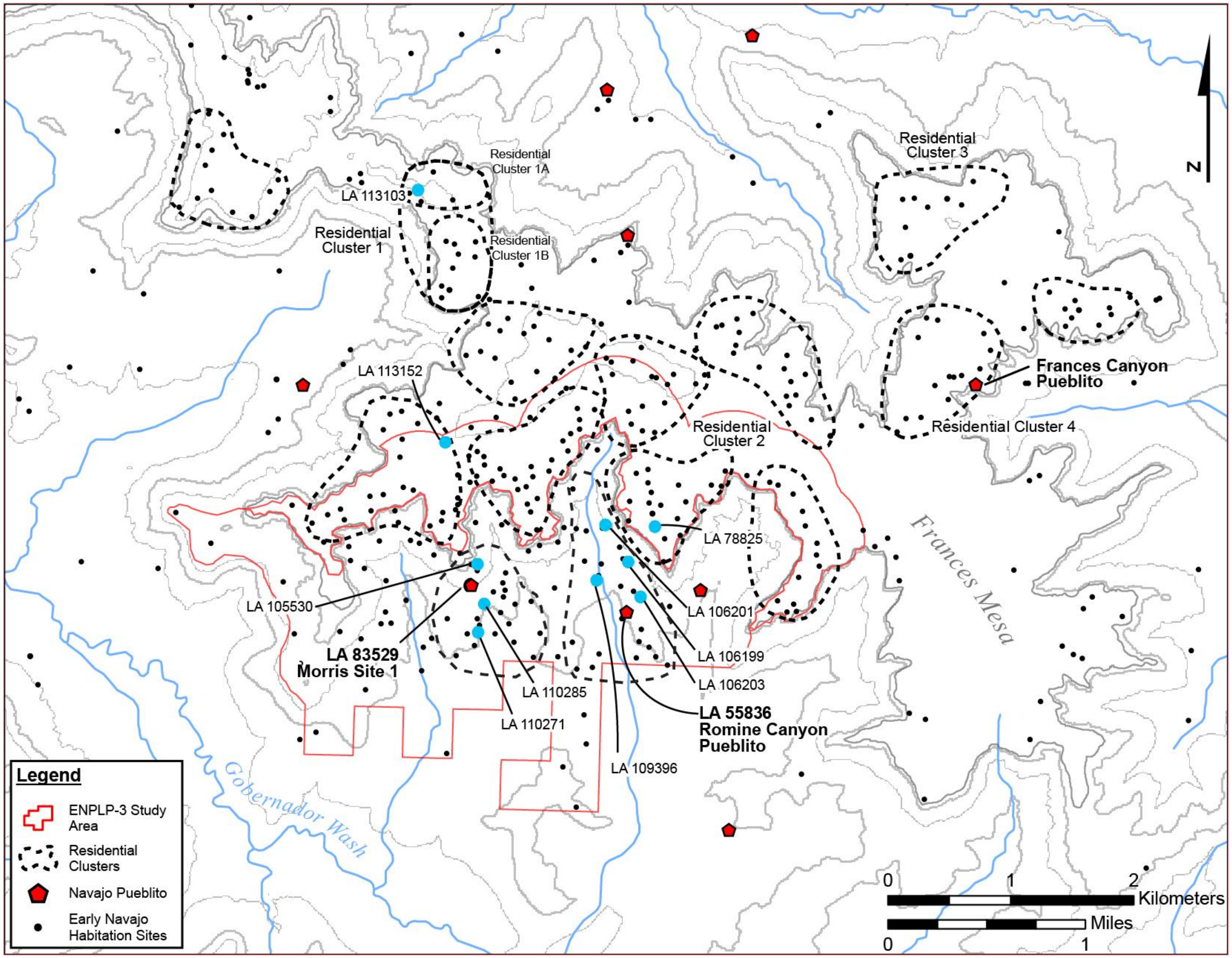

Figure 38 - Map showing early Navajo residential clusters in the greater Frances Mesa/Gobernador Canyon region, the locations of the ENPLP-3 early Navajo sites, and other features of interest (Adapted from Sesler et al. 2000:Figure 9.17).

ENPLP Phase 3 fieldwork highlighted, numerous semi-formal trails pick their way across the benches and talus slopes of Frances Mesa, linking the water and plains of the greater Gobernador valley system with the mesatop woodlands (Dykeman 2003e:94). Although none of the identified trails possess the formalized attributes of the Moss Trail in Largo Canyon (Leckman et al. 2013:4.123-4.141), their presence on the landscape serves as a reminder that topics like potential highland-lowland connections between contemporaneous residential clusters (i.e., family groups) need to be taken in to account when discussing key themes in Gobernador Phase Navajo society.

The results of the ENPLP pastoral landscape analysis indicate that the topic of early Navajo pastoralism is increasingly becoming one such avenue of discussion. Combined with the existing evidence for sheep/goat husbandry practices at LA 113103 (Hovezak 2004), the dung-based identification of three potential livestock enclosure features at sites that form parts of four different Gobernador Phase Navajo residential clusters presents an opportunity to explore the potential ways pastoralism influenced early Navajo community life circa AD 1750. In particular, the tiered relationships between archaeological settlement patterns and traditional Diné social organization enable one to consider the ways in which incipient pastoral practices might be connected to hypothetical shifts in early Navajo land use strategies and political hierarchies.

ENPLP Phase 3 Pastoral Site Distributions, Early Navajo Socio-political Organization, and Gobernador Phase Sheepherding at Different Landscape Scales

When one steps back to consider potential relationships between pastoralism and the organization of early Navajo society as revealed by the ENPLP data, the first observation to be made is rather simple and unsurprising – not everyone is involved in the active care or maintenance of sheep or other Western animal domesticates! Granted, the ENPLP-3 sample size is limited, but seven of the eleven early Navajo sites examined during the Phase 3 work (64%) did not reveal any presence of low-visibility corral/pen features despite the majority being selected because they displayed some evidence suggesting they might be sites with potential pastoral infrastructure (e.g., previous faunal evidence attested to the consumption of sheep, cattle, and other animals). Out of those four sites that *do* possess evidence for potential animal enclosures, however, it is noteworthy that they are the only known sites within their respective residential clusters to do so. At least two of these sites also appear to reflect a certain elevated status within the greater Frances Mesa regional community, with the collection of six hogans at LA 78825 marking it out the largest non-pueblito habitation site on the mesatop, and the boulder-top pueblito at the Morris Site 1 complex potentially serving as a local storage and defensive center for the surrounding community.

One potential interpretation for the apparent differentiation in the distribution of individual pastoral sites is a nascent hierarchical distinction between pastoral families and their presumably non-pastoral neighbors associated with some type of distinct social or economic status. This status could conceivably be obtained through a particular individual's or family's accumulation of political power won via successful raiding and the mastery of ceremonial knowledge (i.e., attaining *naat'áanii* status) or by preferential access to economic resources achieved by cultivating unique *k'é*-based ties with members of non-local communities (e.g., Pueblo or New Mexican villages, other Apache/Navajo bands). One possible way of evaluating these distinctions at the site/household level would be to assess the relative frequency of non-local ceramic types and other exotic materials at the individual pastoral sites compared to nearby non-pastoral sites (Hill 1999; Reed and Reed 1992).

A review of the materials previously identified at the four pastoral sites, however, reveals that only Dinétah Grey ceramics were recovered from LA 113103 while the Morris 1 pueblito possessed only Dinétah Grey and Gobernador Polychrome ceramics (Dykeman 2003a:Appendix J; Hovezak 2004:149). Sites LA 78825 and LA 106203 predominantly contained the two early Navajo pottery types along with small one-to-two sherd quantities of non-local Rio Grande glazeware and Zuni-Acoma pottery or Rio Grande Glaze E, Jemez Black-on-white, and Hopi yellow-ware pottery, respectively (Dykeman 2003:Appendix J; Wilshusen et al. 2000:388). These pale in comparison to the size and variety of non-local assemblages recovered from the largest pueblitos in the greater Dinétah region (e.g., Frances Canyon and Three Corn [Carlson 1965]), while Langenfeld's (2003) ceramic analysis indicates that assemblages of the individual pastoral sites do not substantially distinguish themselves from the general distribution of ceramics in the greater MENLUS study area. Indeed, a handful of sites in at least one other likely mesa edge residential cluster display several clear groupings of non-local glazeware types (Langenfeld 2003:280-285), although they were not investigated as part of the ENPLP work. These findings suggest that site level distinctions in the distribution of non-local materials do not preferentially favor pastoral sites, suggesting that alternative models for the incorporation of pastoralism into Navajo society be considered.

One such alternative interpretation can be explored if the scale of analysis is widened to consider the relationships between different residence clusters rather than individual habitation sites. Based on previous work in the greater Frances Mesa region, researchers have argued that Navajo "outfits," those *k'é*-driven middle-level social units whose existence and function were widely debated by anthropologists throughout the twentieth century, formed an established part of Diné society during the eighteenth century (Dykeman 2003c:433–441; Sesler et al. 2000:244–

251; Rocek 1995). Specifically, the presence of outfits is held to be visible through phenomena that attest to the collection and application of communal labor for tasks beyond the means of any single extended family group. Potential archaeological examples include: the construction of pueblito structures for a variety of purposes beyond simple defense, including habitation and storage (Dykeman 2003c:443–447; Sesler et al. 2000:244–251; Towner 2003); evidence for Gobernador Phase ceremonial activities at hogan and non-hogan sites in Dinétah that clearly link to different types of large Navajo ceremonies practiced today (Copeland and Rogers 1996; Wheeler et al. 1996); as well as ethnohistoric accounts of Navajo raiding parties throughout the seventeenth and eighteenth centuries (Correll 1979).

Seen in such a light, the variable distribution of pastoral sites can be taken as evidence for a level of *k'é*-mediated interdependence and collaboration within and between larger networks of extended families as opposed to differences between individual persons or family groups. In particular, this approach suggests that clusters of related families might be engaged in communal herding practices similar to those documented ethnographically during the twentieth century, albeit at a scale and intensity that is vastly reduced. Kelley's ethnoarchaeological study of reservation-era Diné herding practices in the McKinley Mine lease area noted an average corral capacity of approximately one square meter per animal (Kelley 1982:59–65, 71). Applied to the three most clearly delineated potential corral/pen areas at the ENPLP-3 pastoral sites (LA 113103's Structure 2 [12.5 square meters], LA 106203's Feature 3 [24.75 square meters], and LA 78825's Feature 2 [80 square meters]), this metric suggests that the size of any Gobernador Phase sheep herds being managed at these sites were quite small, potentially ranging between 13 and 80 animals.[37]

[37] Kelley's 1982 analysis details, however, that corral capacity varied over time as factors like the Great Depression, livestock reduction, and access to the nearby Gallup, NM market influenced the decisions the families made about

Referencing the ENPLP Phase 1 discussion of shifting trends in reservation-era herding practices on Black Mesa presented earlier in this chapter, these suggested Gobernador Phase herd sizes accord well with the 5 to 50 animal range described for the most recent pastoral period (i.e., Period 4). In this system, herding is a "home-based" practice, with single individuals taking family herds out on localized daily rounds and returning to a primary corral/pen areas on a daily basis. Adjusted to better fit the social context of Gobernador Phase Navajo life (e.g.., no competing demands from the wage economy), it is possible that herding rounds could also include visits to other residential sites or site clusters whose inhabitants belong to the same outfit, raising the possibility of a multi-sited strategy akin to that noted for the second and third Black Mesa pastoral periods. Like Kelley and Francis (2019b) describe for the reservation period, the *k'é* ties underlying these hypothesized relationships between and within Gobernador Phase outfits would be particularly important for Diné families negotiating the shifting social landscape of the greater Frances Mesa area, which experienced a high degree of population growth over the course of the first half of the eighteenth century (Sesler et al. 2000:223).

Taken together, the evidence for the roughly contemporaneous occupation of all four ENPLP Phase 3 pastoral sites beginning in the mid to late 1740s and continuing into the early 1750s can potentially be interpreted as a pastoral landscape generated by the actions of an early Navajo outfit whose member families occupied sites along Frances Mesa's southern escarpment. In this model, the different extended family groups cooperated in the construction of the Morris Site 1 pueblito (and other activities) while maintaining their primary residences at hogan sites that secured access to key upland and lowland environments suitable for a range of economic

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their livestock. Calculations of the total corral area per animal accordingly varied from 0.6 to 9.7 m^2/animal, and she notes that Richard Van Valkenburgh typically used a figure of 2 m^2/animal as a rule of thumb (Kelley 1982:Note 6). Were Van Valkenburgh's metric to be applied to the ENPLP-3 features instead of Kelley's, potential herd sizes would be between 6 and 40 animals.

activities, including small-scale herding. Conceivably, an individual family's increasing familiarity with animal husbandry and herding practices would eventually spread throughout their associated outfit, presenting increasing numbers of Navajo families with a new economic practice to add to the traditionally flexible suite of farming, foraging, trading, and raiding (Dykeman 1999). As Dinétah communities grappled with the increased pressure of Ute raiding post-AD 1750, pastoralism presented the Diné with the option to more confidently move to regions away from Dinétah without a complete loss of subsistence, property, or social resources.

HISTORICAL ARCHAEOLOGY ON THE NAVAJO NATION: INSIGHTS ON RESERVATION-ERA NAVAJO SOCIETY FROM BLACK MESA

Despite the fact that northeastern Dziłíjiin is often described as one of the most remote portions of the Navajo Nation (e.g., Russell 1983; Yurth 2012), the Early Navajo Pastoral Landscape Project's findings attest to the Kits'iilí area's continued entanglement in a range of broader social, political, and economic developments throughout the reservation period, as well as the resilience of the traditional pastoral lifeway through these events. The imposition of the reservation system on the Navajo community by the United States government in the late 1800s represents an important moment in Diné history whereby Diné individuals, families, and communities were forced to grapple with external *and* internal forces that placed traditional social structures and cultural values under intense pressures.

When combined with information from ethnographic and historical sources, the archaeological data obtained during Phase 1 of the ENPLP reveal a set of interdecadal trends that help expand our knowledge of the connections between the communities of northeastern Black Mesa and various local, regional, and national events over the past two hundred years. The following sub-sections discuss archaeology's value to studies of nineteenth century pre-reservation Navajo society, the localized impact of global events like the 1918 influenza pandemic, and evidence for U.S. extractive energy development activities and the disruption of the centuries-old relationship between Diné and Hopi communities on Black Mesa.

19th Century Navajo Life on Northeastern Black Mesa, Pre- & Post-Long Walk (AD 1868)

Detailed understandings of Navajo life across Black Mesa and points further west prior to and shortly after the Long Walk era represent an important yet elusive goal for students of Navajo history. In the case of the greater Kits'iilí area, the region's position near the head of the natural travel corridor formed by Oraibi Wash appears to have strongly influenced the choices and actions of nineteenth century Diné communities. Notably, family oral histories and highly descriptive Diné bizaad placenames[38] from across northeastern Black Mesa document the dangers posed by both Ute and Hispanic raiders in this seemingly "remote" area throughout the late 1700s and 1800s (Callaway et al. 1968; Kelley and Francis 2019a:122–130; Roessel and Johnson 1973). Archaeologically, it is possible that the enigmatic "1841" rock art inscription identified at the ENPLP1-32 sheep camp might document an otherwise unknown pre-1868 Euro-American incursion onto Black Mesa,[39] while the remains of two post-AD 1790 "pueblito"-style fortified crags located eight miles south of the ENPLP Phase 1 study area illustrate one of the defensive strategies employed by Diné families during this period (NLC Site W-LLC-UO-DD [Towner 2003:188-189; Kelley and Francis 2019:125]).

[38] For example, the modern road linking Rough Rock with Kits'iili (Navajo Route 8066) follows an old trail up the side of Black Mesa into an arm of Upper Oraibi Wash known as *Hajibai'i* or "Warpath Valley," while a large hill near Forest Lake is known variously as *Naakai/Nóóda'í Haznání* or "Where the Spanish/Utes Went Up" (Kelley and Francis 2019a:124).

[39] As noted in the Background section of this chapter, Euro-American records document two formal "government" campaigns on Black Mesa – Vizcarra's 1823 punitive mission and an 1859 U.S. Army expedition. However, private slaving/militia campaigns by Hispanic New Mexicans into Navajoland were common and at least two are known to have reached Black Mesa in 1850 and 1860 (Brugge and Wilson 1978:281,283 in Kelley and Francis 2019:124). It is not improbable that a similar entrada traveled Oraibi Wash in 1841 and used the ENPLP1-32 area as a campsite.

The oldest securely dated Navajo site identified in the ENPLP-1 study area is ENPLP1-30, a small camp traditionally identified as one of the first homesites built by F.H. in the Kits'iilí area. A cluster of growth season cutting dates from five ax-cut limbs at the site indicate that the site's cribbed hogan was built in the spring of 1884 or 1885, sixteen years after the end of the Navajo internment at Fort Sumner. Another small camp, ENPLP1-18, returned a single non-cutting date of 1871+*vv*; oral traditions also describe it being built during the 1880s by a separate family group. Although ENPLP1-18 is clearly associated with an adjacent 20 meter diameter corral structure, no similarly sized corral feature was noted at ENPLP1-30, suggesting that either a different economic strategy or herding strategy was being employed. Notably, neither site is located in the main West Fork valley area but instead sit some 3.5 kilometers away up a pair of tributary drainages, a distinct contrast with the main valley margin settings of the large multicomponent sheep camps, all of which date to the first half of the twentieth century.

This settlement pattern echoes Kremer's (1974:126–140) observation that pre-Long Walk Navajo sites across Black Mesa were frequently positioned in naturally hidden or defensible locations due to the constant threat of Ute and Euro-American raids. Intriguingly, the ENPLP also identified four small single habitation sites (ENPLP1-4, 15, 27, and 28) that occupy various "hidden" locales like the heads of small wooded rincons or the tops of high wooded ridges. The analysis of sixteen tree-ring samples from the four sites resulted in a single cutting date of 1920, which is interpreted as dating to a later occupation of one site.[40] All four site share a general lack of Euro-American artifacts (including items like glass, nails, or baling wire that are commonly

[40] A total of 10 tree-ring samples were taken from the ENPLP1-15 site, which consists of a *standing* sweatlodge superstructure and a *collapsed* forked stick hogan built into a tree. None of the 13 log elements at the hogan were suitable for sampling and six ax-cut limbs on nearby live trees were chosen instead, resulting in the single 1920*B* cutting date. A single non-cutting date of 1731++*vv* was obtained from the four samples associated with the nearby sweatlodge; however, the presence of a single closely associated large tin can combined with the structure's standing status suggests that the sweatlodge and nearby cut limb are more recent than the collapsed hogan. The hogan is interpreted here as potentially representing a pre-Long Walk occupation.

found at twentieth century Navajo sites) as well as an absence of any readily identifiable non-habitation structures. Those structures that are present appear to be the remains of forked stick hogans or cribbed log shelters distinguished by their incorporation of live trees as key architectural elements, a type of "natural camouflage" noted at many of the pre-1868 Navajo sites previously identified on Black Mesa (Kemrer 1974:138-139).

Taken together, these factors offer a window on the uncertain and potentially unsafe nature of Navajo life throughout much of the nineteenth century even as regional conflicts ebbed. Despite the lack of secure dendrochronological data, the archaeological site characteristics of ENPLP1-4, 15, 27, and 28 match well with what has been described previously for pre-Long Walk era Navajo sites and – potentially – Long Walk internment-era refugee sites. Their hidden nature and uncomplicated site composition help frame a model for future work that might attempt to identify Navajo sites associated with periods when security and concealment were held at a premium, including the Long Walk/internment-era refugee sites that are said to have existed on Black Mesa. The fact that two sites, ENPLP1-18 and 30, were constructed in the years following the end of U.S.-Navajo wars yet maintain some similarities with earlier pre-Long Walk sites raises the question of how secure early reservation-era life truly was. Do these 1880s sites represent the resettlement and reuse of old homesites or pragmatic settlement planning in the uncertain decades following internment?

The Impact of the 1918-1920 Influenza Pandemic on Black Mesa

The ongoing COVID-19 coronavirus pandemic has greatly affected the Navajo Nation due not only to the current loss of life, but also to memories of the severe impacts of the 1918-1920 influenza pandemic. Beginning in the fall of 1918, the highly contagious disease spread throughout Navajo communities across the reservation, resulting in an estimated 2,000 to 3,500 deaths out of a total population of less than 30,000 (Brady and Bahr 2014:484). The writings of the federal Indian Service administrator and avocational archaeologist Albert Reagan provide some account of the illness's onset in the fall of 1918 at federal boarding schools and administrative centers in Tuba City, Kayenta, and elsewhere (Reagan 1919; 1921). The illness rapidly spread from population centers to isolated areas like Black Mesa and was inadvertently assisted in at least one instance by a traditional Night Way ceremony that was attended by numerous people (Russell 1985:385–386).

Although the relatively dispersed nature of early twentieth century Navajo settlement provided some buffer against the disease, the same distancing meant that once an individual contracted the flu, its quickly left whole families infected and without assistance (Brady and Bahr 2014; Russell 1985). As Louisa Wade Wetherill, the wife of the Kayenta trading post operator John Wetherill, described, the result was that even as the illness ran its course and cases receded:

> …still word came to the trading post at Todanestya [Tódínéeshzhee'; Kayenta, AZ] of those who had died during the epidemic, and still, riding out to remote hogans, the Wetherills found the bodies of the dead. Etai Yazi, riding alone, came upon a hogan containing the body of a woman. She buried the woman and went on. Ben on the height of Zilhlejini [Dziłíjiin; Black Mesa] found a hogan with five bodies in it. He closed up the doorway and left them there with the hogan as their tomb." (Gillmor and Wetherill 1934:228)

Although it is unclear where on Black Mesa Ben Wetherill discovered the stricken family, it is clear that the effects of the 1918 influenza were severely felt in the Kits'iilí area. Oral histories state that two of the large sheep camp complexes in the main valley, ENPLP1-8 and 32, were abandoned due to widespread illness and death sometime prior to 1930 and as such, contain several *hook'ééghan*, or burial hogans.[41] Archaeological recording work at the sites was limited and dendroarchaeological sampling focused on non-habitation features like shadehouses or CMTs; however, a miscommunication led to five tree-ring cores being mistakenly taken from the northern hogan at ENPLP1-32.[42] Although none of the samples taken from the shadehouse or ax-cut limbs in the corral at ENPLP1-8 dated, four dates resulted from the samples taken from the shadehouse and forked stick hogan at ENPLP1-32. These reveal that the shadehouse (1910+*vv*; 1912*vv*) and forked stick hogan (1917*vv*; 1910+*v*) were likely built between 1912 and 1918, strongly suggesting that they were abandoned during the 1918-1920 pandemic.

Other characteristics of the ENPLP1-8 and 32 sites help to shed additional light on events relating to this period. Reflecting their status as early twentieth century sheep camps, these site complexes contain an array of additional elements that speak to the importance of herding in Navajo society, including two large corrals at each site. ENPLP1-32 is particularly notable as it is the largest historic site identified in the study area, covering 7.5 hectares and containing four hogans. However, each site also contains a unique structure that is unlike any others identified in the study area. ENPLP1-8 contains the remains of a standing forked stick hogan that is the largest in the study area. Measuring nearly seven meters in diameter and three meters tall, its northern side appears to have been intentionally collapsed and a nearby shovelhead made unusable and discarded. At ENPLP1-32, a short structure combining cribbed walls with the remains of long, thin leaning brush elements sits in the middle of the main hogan cluster. While no attempt was made to date either structure, it is possible that their "atypical" nature reflects

[41] Two other *hook'ééghan* sites – ENPLP1-21 and 48 – were identified during the Phase 1 work; however, these sites were not ethnographically associated with a pre-1930 epidemic event and are thus not discussed here.
[42] Note: Because the northern forked stick hogan at ENPLP1-32 is a *hook'ééghan*, these five samples, their results, and any accompanying discussion were intentionally left out of Campbell's 2021 Kiva article to avoid promoting the intentional sampling of these specific funerary structures by other parties in the future.

their use in ceremonies organized by the camps' former residents to treat an influenza patient (e.g., Mitchell 2001:128–134).

The Shifting Nature of Diné/Hopi Interactions throughout the 20th Century

Since the 1950s, popular mentions of the names "Navajo" and "Hopi" together have often been followed by words like "conflict," "land dispute," or "relocation." The origins of this association can be largely traced back to the imposition of the reservation system by the United States on these two neighboring Native groups during the latter decades of the nineteenth century, which saw the drawing of arbitrary straight lines across large tracts of land with little regard for the histories of the communities involved or how their livelihoods might be affected. Periodic low-grade conflicts (e.g., trespass and livestock theft), between Hopi farmers and Diné herders during the late 1800s and early 1900s rapidly spiraled into something larger and more difficult to manage when, during the 1950s and 1960s, the behind-the-scenes machinations of the U.S. government and the coal industry led a "progressive," pro-development faction of the Hopi tribe to begin preparations for mining coal on Black Mesa.

These efforts were complicated by the fact that Hopi claims to "exclusive use" of their entire 1882 reservation area contrasted with the reality that the vast majority of everyday Hopi life had long been concentrated in and around their main cluster of mesatop villages on the southern edge of Black Mesa. Those areas to the north were overwhelmingly settled by Navajo families and were only periodically visited as part of Hopi hunting, gathering, or ceremonial activities, including the visitation and blessing of various springs along the entirety of the five main drainages (Jeddito, Polacca, Oraibi, Dinnebito, and Moenkopi) that originate in the uplands of northeastern Black Mesa and travel past the Hopi villages, supplying them with water

(Hedquist et al. 2021; Kuwanwisiwma 2002). Legal battles raged throughout the 1960s and 1970s in an attempt to clarify these land use questions even as Peabody Coal opened two massive open-pit mines on the northern edge of the mesa. The decisions handed down by the courts were generally unfavorable to the Navajo Nation, with tens of thousands of Navajos either forced to relocate from homes judged to be on Hopi land or caught up in the imposition of a unilateral infrastructure freeze that would end up lasting over forty years.

If one steps away from the "peaceful Hopis, aggressive Navajos" tropes employed during the trials and looks past the debris of now-defunct American capitalist interests, however, the longstanding interwoven nature of earlier Navajo-Hopi relations emerges as a key point of discussion for understanding past inter-tribal relationships in the Southwest.[43] While the Hopi villages were admittedly the occasional target of Navajo raids prior to the Long Walk, they also represented important trading and social partners for Diné communities. Navajo and Hopi families occasionally intermarried and a small collection of Navajo sub-clans from the diverse Táchii'nii clan group are held to be of Hopi origin, including the Nát'oh Dine'e Táchii'nii, or Tobacco People Táchii'nii (Brugge 1999:4; Kelley and Francis 2019a:88–89).[44] Oral histories dating from the late 1800s through the mid-twentieth century describe Navajos periodically traveling to different Hopi villages in order to exchange goods like mutton, wool, and animal skins for Hopi pottery and agricultural goods like corn and peaches (Dyk 1938:49–51; Mitchell

[43] See Chapters 2 and 3 of David M. Brugge's excellent *The Navajo-Hopi Land Dispute: An American Tragedy* (1999) for a fuller description of the role played by archaeologists and other researchers in providing evidence and (perhaps unintentionally) working to sway public opinion during the early stages of the Navajo-Hopi legal battle (e.g., Everett Edward Dale's book *The Indians of the Southwest*, which portrayed Hopis the victims of their "traditional enemy," the Navajo, was released in 1949, a few years before the legal efforts began in 1958).

[44] Specifically, five Táchii'nii sub-clans – Nát'oh Dine'e Táchii'nii, Yé'ii Dine'e Táchii'nii, Bį́įh Dine'e Táchii'nii, Gah Dine'e Táchii'nii, Dolii Dine'e Táchii'nii – are thought to correspond to the Hopi Tobacco, Kachina, Deer, Rabbit, and Bluebird clans, respectively. Members of these clans are described as fleeing the destruction of the largest and easternmost Hopi village, Awatovi, in 1700 and taking shelter with friendly Navajo families living in the nearby Antelope Mesa and Tachee areas, after which they were incorporated into greater Diné society (Brugge 1999:9).

2003:40; Bingham et al. 1982). Likewise, as described above, Hopi parties occasionally ventured outside their villages into the uplands of Black Mesa to hunt, gather wood and other forest products, and conduct prayers and rituals at the springs that fed their own water sources further downstream.

With these factors in mind, a mix of archaeological and ethnographic information gathered during the ENPLP Phase 1 work offers a path towards evaluating the nature of Navajo-Hopi relations in the Upper Oraibi region. In particular, the history of the two Hopi inscriptions found at ENPLP1-16 is unclear. The site consists of a large boulder rock art panel with several scratched or incised elements that sits along the old road on the west side of the West Fork of Oraibi Wash approximately 300 meters south of the ENPLP1-40 summer camp (Figure 39). A cluster of three deeply incised inscriptions read: *Herbert Yestewa*, *Fred Lomayesva*, and *JaN 19 35*, while the other fainter inscriptions include the names *Joe D*, *Mary G*, and various indecipherable words.

Figure 39 - Hopi inscriptions at the ENPLP1-16 site.

After initial discussions with relatives and attempts to contact the Hopi Cultural Preservation Office both resulted in no information about Yestewa, Lomayesva, or what they might be doing in Kits'iilí in the winter of 1935, archival research led to the following discoveries. Herbert Yestewa (1889-1980) was a resident of Oraibi who traveled across the United States as part of various Hopi "Indian crafts" delegations, including a 1929 weaving exhibition in San Francisco and the 1933 "Century of Progress" demonstration in Chicago (Ancestry.com; Markwyn 2020:344). He appears to have been well-regarded by the local trading post operator, Lorenzo Hubbell, due in part to his experiences in San Francisco, and is noted in the 1930 census as working as a chauffer for a general store, likely Hubbell's Oraibi trading post (Ancestry.com; Stubblefield 1929:44). Fred Lomayesva (1899/1900-1952) was a decade younger than Yestewa and likewise a resident of Oraibi. Records indicate he began working at the U.S. Army's Navajo Ordnance Depot in Bellemont, Arizona at some point following its construction in 1942 until his passing in 1952 (Ancestry.com).

Nothing about these two Oraibi villagers indicates an obvious connection with the R/T/H family during the 1930s, although the deep nature of the inscriptions and the relative proximity to one of FH's summer camp locations suggest some degree of potential interaction. Two possible scenarios come to mind: first, F.H. – a Nát'oh Dine'e Táchii'nii clansman who family oral histories describe as having traveled to trade with the Hopis at some point(s) in his past – may have possessed an existing relationship of some sort (e.g., economic, social, or kin) with one of the two Hopi men. Second, Yestewa and Lomayesva may have simply rested at the ENPLP1-16 site while engaged in a ritual Hopi pilgrimage to the Upper Oraibi region, perhaps to visit Kits'iilí Ruin itself (located 1.3 kilometers due east on the opposite of the West Fork of Oraibi Wash) or to visit springs in the area. Although no history of Hopi visits to the springs in the upper portion of the study area was noted, AR, WMH, and Navajo archaeologist William Tsosie, Jr. have all shared stories of locals' encounters with parties of donkey-riding Hopi visitors circa 1950 or finding the remains of prayers sticks at two springs a few miles further down the Upper Oraibi drainage: Cliff Spring (known as Tsénííʼ Tó in Navajo and as *Ki'isiwu* in Hopi), located near the W-LLC-UO-DD pueblito, and Replacing Cover Spring (Tó Dadit'aa in Navajo or *Mong'va* or *Mòngpa* in Hopi), located near the intersection of the N-41 and N-8066 roads.[45]

In later decades, these outlying springs became points of contention between Navajos and Hopis due to their central role in furthering Hopi claims to the larger 1882 reservation area. In Kits'iilí, this seems to have a particular point of distress, as the western half of Black Mesa chapter was initially located in the Joint Use Area. Although Kits'iilí was eventually designated part of the Navajo Partitioned Lands, the twelve-year period between the JUA declaration and the 1974 Land Settlement Act undoubtedly engendered a great deal of uncertainty and bitterness toward the Hopi. The passage of Public Law 93-531 in 1974 affirmed Hopi use of Cliff Spring and allowed it to be fenced, creating a set of antagonizing factors that eventually came to a head in the early 1990s as the relocation of Navajo families off the Hopi Partitioned Lands unfolded nearby (Kuwanwisiwma et al. 2003:55–56). Indeed, the Navajo family that currently lives at Cliff Spring reportedly located their homesite beneath the spring in order to limit persons looking to access the site. The recent 2019 closure of Peabody Coal's Kayenta Mine, however, offers hope that the turbulent relationship between the tribes and the United States that served to disrupt and obscure many of the long-standing traditional relationships that once existed between Hopi villagers and Navajo families across the greater Black Mesa region might soon start coming to an end.

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[45] Hopi placenames derived from Table 2.1 in Bernadini et al.'s (2021) *Becoming Hopi: A History*.

Chapter 8: Concluding Thoughts on Pastoral Landscapes & Diné Pastoralism

While earthshaking statements as to just how pericolonial Navajo pastoralism impacted the internal dynamics of early Diné communities and helped reshape the natural environment of the Four Corners all remain tantalizingly out of reach, the findings of the Early Navajo Pastoral Landscape Project represent an important intervention in the world of Navajo archaeology. As detailed in Chapter 7, each phase of the project allowed for a series of long-term and inter-connected archaeological, historical, and ethnographic insights whose relevance extends beyond the narrow boundaries of the Spanish colonial period in the Southwest. These include discussions about archaeological evidence for Long Walk-era refugee sites on Black Mesa, the far-reaching social disruptions of the Navajo-Hopi Land Dispute, and how the historic trajectory of Diné pastoralism from the eighteenth to twenty-first centuries charts a transition from mobile "pericolonial" Diné herding practices to the constrained pastoral systems seen today on the Navajo reservation.

This final chapter details the ENPLP's relative success and ways in which the pastoral landscape approach presented here can be improved and expanded to better address the topic of early Navajo pastoralism in the American Southwest, as well as a reflection on the longstanding nature of the modern Diné community's relationship with the humble sheep.

EVALUATING THE ENPLP'S "PASTORAL LANDSCAPE" METHODOLOGY

This project represents the first sustained attempt to archaeologically investigate the topic of Navajo pastoralism during the Spanish colonial period. Certain aspects of the early Navajo archaeological record, notably small sample size, intensive initial resource use, and a history of competing research methodologies, have historically stymied traditional zooarchaeological attempts to empirically assess the role of incipient pastoralism within the larger framework of early Navajo society. In keeping with traditional Diné attitudes that discourage the disturbance of archaeological sites, the ENPLP chose to eschew excavation-dependent faunal analyses in favor of developing a minimally invasive multi-scalar "pastoral landscape" approach consisting of a cascading series of analyses designed to winnow out those early Navajo sites in Dinétah unlikely to possess the potential remains of corral or pen-type enclosures.

The ENPLP findings demonstrate that a low-impact methodology melding experiential ethnoarchaeology, geospatial modeling, and archaeological field and lab work is capable of generating a series of datasets that enable one to engage with an array of questions regarding Navajo pastoral practices and their roles in Diné society at various points throughout history. In particular, the results from the microremains analysis show that fecal spherulites are present in five soil samples from three Gobernador Phase early Navajo sites, strengthening the argument that a landscape-based approach offers an effective tool for studies of colonial-era pastoralism in the Southwest. Specifically, at each of the LA 78825, LA 83529, and LA 106203 sites, at least one positive soil sample derives from a discrete non-midden area that possesses elevated soil phosphorus concentrations and is associated with a potential feature of interest, e.g., a timber scatter, rock alignment, or sheltering boulder wall. Combined, these data suggest that: a) these areas/features can be interpreted as the likely remains of small buried animal pens like the one identified at LA 113103; and b) other early Navajo sites that display similarly patterned features might be suitable targets for this type of investigation in the future.

Single spherulites do not a concentration make, however, and while the ability to determine the presence/absence of fecal spherulites in centuries-old soil smears is remarkable in its own way, looking ahead it is clear that steps need to be taken to further strengthen confidence in the ability to confirm a potential corral/pen identification. One clear option is to either forgo or supplement the soil smear work by conducting a heavy liquid-based microremains analysis optimized for fecal spherulite capture and quantification à la Dunseth and colleagues (2018). The heavy liquid test originally conducted as part of the ENPLP microremains analysis followed a modified phytolith analysis protocol whose density was slightly too low (2.3 g/ml) to capture most fecal spherulites. Gur-Arieh and Shahack-Gross (2020) detail an optimized protocol that has been successfully employed in several settings worldwide and would likely provide a more accurate assessment of the Dinétah soils' fecal spherulite content, thereby lessening the potential for false feature identifications.

The composite nature of the ENPLP's landscape-based approach also opens the door to future methodological or technical shifts should they arise. One possible option that might help to streamline the ENPLP workflow and more feasibly allow for increases in the number of sampled sites is a shift to using portable x-ray fluorescence (pXRF) technology rather than an analytical laboratory service, lessening the potential for additional budgetary and scheduling variables to arise. Several recent studies have highlighted the speed and cost-efficiency of pXRF as a landscape-level geochemical prospection tool capable of characterizing phosphorus and other chemical elements with a minimum of site disturbance (e.g., Biagetti et al. 2021; Frahm et al. 2016; Save et al. 2020). The fragile nature of many early Navajo archaeological sites and the desire to minimize any impacts to them mean pXRF's potential benefits would be particularly welcome in modern Dinétah-area archaeological research.

Seen in such a light, the general "pastoral landscape" framework used by the ENPLP presents other Navajo-area researchers with a viable blueprint for gathering data about potential pastoral practices at Navajo archaeological sites, both "early" and later. The core archaeological workflow employed by this project – site (re)assessments with a focus on potentially misidentified structures, systematic soil sampling, total phosphorus analysis, and selective dung spherulite analysis – are all techniques that are available to and feasibly within the budget of interested academic and CRM archaeologists. The implementation of the pastoral landscape approach at additional sites both within and beyond the boundaries of Dinétah (e.g., those previously identified sites described at the start of Chapter 5) would allow for further refining of the method and hopefully identify additional sites to include in new analyses of pastoralism's social and economic impacts on the greater Navajo community during the seventeenth through twenty-first centuries.

K'É AND THE PERSISTENCE OF DINÉ-DIBÉ RELATIONSHIPS IN THE 21ST CENTURY

In 1973, Gary Witherspoon, an anthropologist who lived and worked on the Navajo Nation and eventually married into a Diné family, wrote an article in American Anthropologist titled "Sheep in Navajo Culture and Social Organization." In it, he riffed on the earlier work of Gladys Reichard, an anthropologist famous for her studies of Navajo society and culture who had described early twentieth century Navajo society as invariably "sheep-minded," with families focused on the care of their animals from dawn to well beyond dusk (Reichard 1936:6). In his article, Witherspoon highlighted how, four decades later, sheep and sheepherding continued to occupy an important place in Navajo thought and social organization. In particular, he described how the act of communally caring for a herd created a web of multi-scalar relationships that helped structure interactions between different Diné individuals and family groups, between people, animals, and the environment, and even within individuals themselves at a moral level. This is *k'é* in action, that network of solidarity and inter-personal relationships that ties the entire Diné community together, and within this framework, sheep – *dibé* – are just as much kin as one's relatives.

Nowadays, some fifty years later, sheep and sheep herding still play a prominent role in Navajo culture, even as their economic and social roles have diminished in the twenty-first century. Greater incorporation into the American colonial state has meant that access to education and wage work opportunities – albeit frequently in areas off the reservation – have replaced large-scale herding on the Navajo Nation. Further, the decline of the wool industry has diminished one of the primary economic drivers for herding, although secondary pastoral economies like intensive Navajo rug weaving continue to provide a livelihood for some Navajo families. Despite this shift, "sheep-mindedness" and the historic image of the classical Navajo individual out herding sheep persists among Navajo people today as a particularly notable marker of Diné cultural authenticity and "traditionalness." Traveling around the reservation, one frequently encounters the phrase "Sheep is Life" in a wide range of settings and discussions, including cultural preservation, traditional crafts, ecological knowledge, and traditional diet and lifeways.

Anecdotal evidence from informal conversations with other Diné individuals in their 20s and 30s reveals that many of the historical trends noted during the ENPLP's first phase of work in the Black Mesa region are broadly echoed by the experiences of other families across the reservation. Most notably, even though formal ranching operations are relatively uncommon and the practice of sheepherding has diminished in scale, many family groups today continue to maintain small numbers of livestock, often for ceremonial, culinary, or weaving purposes. Hand in hand with these various functional reasons, however, goes another consideration – working with sheep mandates Diné individuals carry out activities that have been tailored over the course of centuries to meet the unique social and natural demands of the Southwestern environment, thereby reaffirming *k'é* and one's ties to Diné Bikéyah in the twenty-first century.

Appendix A: ENPLP Phase 3 Zooarchaeological Analysis Report

ENPLP Phase 3 Zooarchaeological Analysis –

Dr. Sadie L. Weber
January 2021

TAXON	LA 83529	LA 105530	LA 110271	LA 106199
Canis sp. (likely *Canis latrans*)	-	-	X	-
Ovis sp. (likely *Ovis aries*)	-	-	-	X
Bovina (*Bison* or *Bos*)	-	X	-	-
Large Artiodactyl	-	X	-	-
Medium Artiodactyl	X	-	-	-

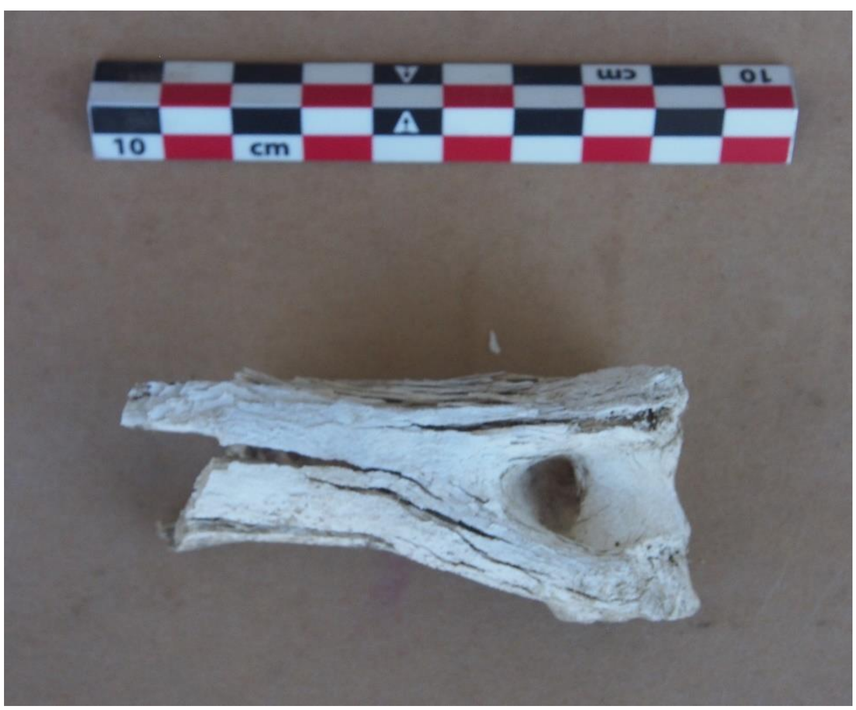
Site: LA 83529
All bones are Medium Artiodactyl, i.e., a sheep or deer-sized animal. The vertebral body fragments are calcined and burned (e.g., photo P7190758), while some of the fragments from the same context are not. This suggests that the trash in this midden was not generally burned, but these burned bones could have been tossed into the hearth after cooking OR that this part of the animal was roasted. These are the portions of the animal that are analogous to the t-bone cut in large bovids or oxtails. Furthermore, the vertebral bodies carry marrow making them ideal stew bones. The rest of the vertebral fragments do not bear any significant modification beyond weathering.

LA 83529, Photo P7190758

Site: LA 110271
Several of the bones are diagnostic to the genus *Canis* and are likely coyote (*Canis latrans)*. While not all of the bones are diagnostic to anything beyond carnivore, given that they were found largely articulated, it can be assumed that these are all from one individual. While the context has undergone significant weathering, it seems that at least the anterior portion of the animal (without the skull) was present.

Site: LA 106199

This is a humerus of what is very likely a sheep. Fusing of the distal humerus indicates that the animal was at least 6 months old, but it is hard to be more certain, as this is just one bone. In terms of modification, there is a probable cut mark on the trochlea as well as some light burning on the medial aspect of the bone. The mark is unlike the rest of the weathering cracks and is located at a spot commonly associated with disarticulation. Together, these modifications suggest that the humerus was roasted with meat on (i.e., cooking refuse).



Site: LA 105530

Both bones present in this assemblage are from large artiodactyls (e.g., cattle-sized). While the fragmentary long bone (P7190759) is unidentifiable to taxon, it is likely a humerus, given its morphology.

The distal metapodial (P7190764), however, is likely *Bos* or *Bison*. Both bones exhibit green breaks, meaning that they were broken shortly after the animal died. The metapodials and long bones are reliable sources of marrow and fat (when rendered by boiling). The metapodial in particular demonstrates classic splitting to access one of the medullary cavities (there are two in metapodials). Below is a photo of a modern Bison metacarpal (posterior view) with a line indicating where the ancient metapodial was split.

Appendix B: Fecal Spherulite Analysis Report

Fecal spherulite analysis of soils from modern and historic Navajo (Diné) sheep corrals, Black Mesa, Arizona, and Frances Mesa, New Mexico

by

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Technical report 20032 prepared for

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1. Introduction

Soil samples from modern and possible historic Navajo (Diné) sheep corral features were submitted for fecal spherulite analysis. Two modern sheep corral samples, one from a corral used until the 1960s, and another from a corral used until the 1990s, were collected from Black Mesa, Arizona. The purpose of analyzing these samples was to assess the preservation and recovery of fecal spherulites as an archaeological marker of sheep corrals. A total of 28 soil samples collected from possible Diné sheep corral features from Frances Mesa, New Mexico, were analyzed primarily for fecal spherulites, but phytoliths, diatoms, and other microfossils were also identified. The purpose of analyzing these samples was to determine if fecal spherulites could be recovered to positively identify these features as corrals, and to explore the possibility that other microfossils such as phytoliths and diatoms could serve as proxies for historic sheep corrals.

2. Microfossil background

2.1 Fecal spherulites

Fecal spherulites are radially forming crystalline microscopic spheres between 5 and 20 µm in diameter that are found in the dung of some animals. Fecal spherulites are comprised of calcite ($CaCO_3$; density 2.71 g/cm^3) or monohydrocalcite ($CaCO_3 \bullet H_2O$; density 2.38 g/cm^3); however, their exact composition has not been determined (Kohatsu and McCauley 2019; Shahack-Gross et al. 2003). Fecal spherulites are identified using light microscopy typically at magnifications between 200x and 500x. When viewed under cross-polarized light, they exhibit low-order interference colors with a fixed cross of extinction, which is a polar-oriented dark cross that stays approximately in position regardless of stage rotation.

Depending on their diet, fecal spherulites can be produced in large numbers by ruminants such as sheep, goats, cows, and deer (Canti 1998, 1999; Dalton and Ryan 2018). However, they are not diagnostic of any particular animal that produces them. Fecal spherulites are comprised of a hydrated form of calcium carbonate (monohydrocalcite) that is best preserved in dry and alkaline soils (Gur-Arieh and Shahack-Gross 2020). Fecal spherulites do not preserve well in wet and acidic soils and will readily dissolve when frequently exposed to rain water or snowmelt (Gur-Arieh and Shahack-Gross 2020). Thus, fecal spherulites may not preserve under many environmental and depositional contexts.

The recovery of dung spherulites from archaeological sites are an indicator for the presence and use of dung from a variety of contexts, including the use of dung as a fuel for cooking and heating, the use of dung as a building material constituent, and the presence of dung as a marker of animal pens and corrals (Henry et al. 2016; Morandi 2018; Shahack-Gross et al. 2003).

2.2 Diatoms

Diatoms are single-celled algae with a biogenic silica cell wall. They grow in a wide range of habitats, including the surfaces of wet plants and rocks, damp soils, marshes, wetlands, mudflats, and all types of standing and flowing aquatic habitats (Spaulding et al. 2010). Their silica cells (frustules) are often preserved in sedimentary deposits. Because individual taxa have specific requirements and preferences with respect to water chemistry, hydrologic conditions, and substrate characteristics, the presence of diatoms on the surfaces of ground stone and pottery, and in dung, soils, and sediments can provide information about the nature of the local environment or the sources of water used for drinking, cooking and food processing (Stone and Yost 2020).

2.3 Chrysophyte cysts

Chrysophyte stomatocysts (cysts) are reproductive structures produced by chrysophycean algae (classes Chrysophyceae and Synurophyceae) during the resting stage of their life cycle (Wilkinson et al. 2001). Like diatoms, these structures are comprised of biogenic silica, are often preserved in soils and sediments, and can be used to reconstruct past environmental conditions. Chrysophytes are related to diatoms, but are distinct organisms. Chrysophyte stomatocysts are most common in fluctuating freshwater habitats of low (acidic) to moderate pH and that experience some winter freezing. Many stomatocyst types are found in specific habitats, such as montane lakes, wet meadows, ephemeral ponds, perched bogs, and the moist surfaces of rock and plant substrates. Chrysophyte stomatocysts can also be found in sites that are only wet during certain seasons, such as snowmelt ponds and low swales (Adam and Mahood 1981).

2.4 Phytoliths

Phytoliths are biogenic silica ($SiO_2 \bullet nH_2O$) in-fillings and casts of plant cells (Blinnikov 2013). They are produced by many plants, including grasses, sedges, and many economically important plants such as maize and squash (Piperno 2006). Phytoliths range in size between 5 and 200 µm, and a single grass plant can produce 10^5 to 10^6 phytoliths (Yost and Blinnikov 2011). When plant matter decays, phytoliths are released and incorporated into soils and sediments.

Because of their decay-in-place taphonomy, phytoliths tend to represent a localized vegetation record, whereas pollen records are influenced by both local and regional vegetation. However, depending on the geomorphology of the study area, a proportion of the phytolith record may have been deposited some distance from its initial place of formation due to wind or water transport. Phytoliths also differ from pollen in that they can be produced in many different plant tissues such as roots, stems, leaves, and seeds. When recovered from soils, sediments, dung, charred cooking residue, and the surfaces of pottery and ground stone tools, phytoliths can provide environmental and subsistence information (Piperno 2006).

2.5 Fungal spores

The Ascomycota are the largest division of the fungi kingdom and contain organisms such as mold, smut, rust, yeast, and mushrooms. These organisms produce microscopic sexual structures called ascospores (fungal spores), which can often be used to identify the fungus from which they arose. Fungal spores can persist for long periods of time in the environment and can be recovered using many pollen, starch and phytolith extraction methods. In paleoecological and archaeological investigations, fungal spores can be used to identify the presence of crop damaging molds like ergot (*Claviceps* sp.), wheat smut (*Ustilago* sp.), and corn smut (*Ustilago* *maydis*), or the presence of dung or coprophilic fungi like *Sporormiella*, which further indicates the presence of browsing and grazing animals (Davis and Shafer 2006; van Geel et al. 2003).

3. Methods

Soils and modern dung samples were subjected to several different fecal spherulite extraction protocols. One gram each of modern dung from sheep, elk, and rabbit were soaked in 7% bleach for 48 hours to oxidize the organic matter and release any fecal spherulites present. The remaining material was mixed and rinsed with water via centrifugation (mix, centrifuge at 3000 rpm for 5 min, decant) for a total of four times, followed by a final rinse with 95% ethyl alcohol (EtOH). Each of the processed modern dung samples were stored in EtOH. A few drops of the sample mixture in EtOH were placed on a microscope slide, allowed to dry, and then mixed and mounted with Cargill Type-A immersion oil. The coverslip was attached to the slide using fingernail polish.

The two modern corral samples from Black Mesa, Arizona, were subjected to two different extraction protocols. For the first protocol, one gram of each sample was disaggregated using a metal spatula and then dry sieved through a 50-micron mesh. Approximately 1 mg of the material that passed though the sieve was placed dry on a microscope slide and then mixed and mounted for microscopy with Cargill Type-A immersion oil as described above. For the second protocol, one gram of each sample was placed in bleach for 48 hours to oxidize the organic fraction. The remaining material was mixed and rinsed with water via centrifugation as described above a total of four times, followed by a final rinse with 95% ethyl alcohol (EtOH). The samples were allowed to dry completely and then were mixed with lithium metatungstate heavy liquid (LMT) buffered to a pH of 8.0 and set to a density of 2.3 g/mL, which is a standard density used for phytolith extractions. The material that floated in the LMT was removed by decanting and was rinsed four times with water via centrifugation followed by a final rinse in EtOH. A few drops of the sample mixture in EtOH were mounted for microscopy as described for the modern dung samples above.

The 28 soil samples from archaeological features possibly representing historic Diné sheep corrals from Frances Mesa, New Mexico, were processed for fecal spherulites using the first protocol for the two modern corral soil samples described above, where one gram of each sample was disaggregated using a metal spatula and then dry sieved through a 50-micron sieve. Approximately 1 mg of the material that passed though the sieve was placed dry on a microscope slide and then mixed and mounted for microscopy with Cargill Type-A immersion oil.

For microscopy, the entirety of each ~1 mg subsample that was mounted was scanned at 500x for fecal spherulites, diatoms, phytoliths, and other microfossils. Partially polarized light was used so that isotropic microfossils like phytoliths and diatoms could still be observed, while still allowing visualization of birefringence for crystalline microremains such as fecal spherulites.

Multivariate ordination using correspondence analysis (CA) was conducted using PAST ver. 4.03 (Hammer et al. 2001). The 10 column (count) variables were comprised of eight phytolith morphotypes, total phytoliths counted, and total diatoms counted (Table 1). The individual samples (rows) were organized by site. On the CA biplot, all row data points were plotted using row principle scaling, and only the four most significant column variables for the first two axes (dimensions) plus total phytoliths counted were plotted as vectors.

4. Results and Discussion

4.1 Modern dung samples

Modern sheep, elk, and rabbit dung from Black Mesa, Arizona were analyzed for fecal spherulites. Only the sheep dung yielded large quantities of fecal spherulites (Figure 1*G-H*), and they were rarely observed in the Elk dung. No fecal spherulites were observed in the rabbit dung, which is consistent with cecal digesters (Canti 1999). The paucity of fecal spherulites in the elk dung sample was surprising, given that a modern reference sample from Colorado produced high concentrations of fecal spherulites. However, seasonal changes in diet have been observed to affect fecal spherulite production (Canti 1999; Dalton and Ryan 2018). For example, a diet high in grasses and sedges is expected to produce fewer fecal spherulites than a diet high in leaves from trees, shrubs, and herbaceous plants. Also, soils high in calcium carbonates (alkaline soils) are more conducive to the formation of calcium oxalate crystals in certain plants, which when consumed can lead to fecal spherulite production. Thus, because of seasonal changes in plant availability or soil conditions, it is necessary to consider that not all corral locations may be situated in areas dominated by plants conducive to fecal spherulite production.

4.2 Modern corral soil samples

4.2.1 Simple extraction method

The two modern corral soil samples both yielded fecal spherulites; however, the sample from the corral that was abandoned in the 1990s had a significantly higher concentration (Figure 1*D-F*). In addition to having fewer spherulites, the soil sample from the corral abandoned in the 1960s yielded fecal spherulites that were typically more altered in appearance (Figure 1*A-B*). This alteration is most likely from exposure to more acidic soil conditions, or rain water and snowmelt, which is naturally acidic. The 1960s corral sample also yielded some well-preserved diatoms (*Hantzschia* sp.; Figure 1*C*), which suggests that this area was wetter than the 1990s-era corral. However, a more plausible explanation is that these diatoms were derived from the sheep herd's primary water source, as siliceous diatom frustules readily pass through the digestive tracts of animals (Stone and Yost 2020). Also, diatoms are best preserved in acidic soils, which is a setting detrimental to fecal spherulite preservation, so the lower recovery in the 1960s sample may be more the result of the depositional setting rather than diet, less intensive corral use, or other factors.

These findings suggest that relatively high concentrations of diatoms could be a proxy for sheep corrals, especially if environmental conditions are not conducive to fecal spherulite production or preservation. Regardless, the recovery of fecal spherulites from these two abandoned corral soil samples that have been exposed to seasonal precipitation for 30 to 60 years is confirmation that this approach can be used to identify historic Diné sheep corrals.

4.2.2 Bleach/heavy liquid extraction method

Surprisingly, the oxidation (bleach) and density (heavy liquid) separation method did not produce any fecal spherulites, as some researches have used a similar density separation approach. This is most likely explained by the fact that pure calcite has a density of 2.71 g/cm^3, so even a monohydrated fecal spherulite form (density 2.38 g/cm^3), would still be too heavy to float in a heavy liquid set here to 2.3 g/cm^3. Even if the fecal spherulites were originally comprised of monohydrocalcite, over time they would likely lose water and increase in density. Thus, heavy liquids used to concentrate microfossils such as pollen and phytoliths may not be effective at concentrating fecal spherulites, which have a density that overlaps with many types of common soil minerals.

4.3 Possible historic corral soils

Of the 28 soil samples analyzed from archaeological contexts, four samples yielded one possible spherulite each (Table 1; Figure 2*A,B,D*). Two samples yielded diagnostic fecal spherulites, with sample 8.1 from LA 83529 yielding one (Figure 2*C*), and sample 21 from LA 106203 yielding two (Figure 2*E,F*). The samples with diagnostic fecal spherulites were two of three samples that yielded chrysophyte cysts (Figure 3*C*), and they had the fifth and second highest phytolith counts out of 28 samples, respectively. No probable or possible fecal spherulites were observed in any of the other samples.

The complete absence of fecal spherulites in 79% of the samples may be due to any one or a combination of the following scenarios: 1) the features were never used as corrals, 2) the features were not used enough to have left a recoverable fecal spherulite record, 3) the plants consumed at the time of corral use were not favorable to fecal spherulite production in the animal's digestive tracts, and 4) fecal spherulites were present at the time of corral use but have since dissolved due to unfavorable preservation conditions. Because fecal spherulites are relatively unstable when exposed to water, there is a strong possibility that their complete absence in most samples and rarity in other samples is primarily due to poor preservation conditions in the soil.

Fungal spores were observed in approximately half of the samples, but were generally rare. Fungal hyphae were more common (Table 1). Because animal dung can support the growth of dung-dependent fungi, coprophilic or dung fungi can be an indicator for the presence of animal dung. No coprophilic fungal spore types were observed in any of the samples. It is possible that pollen separation methods, which are optimized for pollen and spore recovery but were not used with this study, may be able to better concentrate coprophilic spores, if present.

4.4 Fecal spherulite recovery summary

Fecal spherulites were recovered from the three types of samples analyzed: modern dung, modern corral soils, and possible historic corral soils; however, their observed concentrations varied between the samples. The modern dung samples yielded fecal spherulites at estimated concentrations of thousands per gram (sheep) to less than 100 per gram (elk) of dry dung. For the soil samples, the modern corral samples from Black Mesa yielded fecal spherulites in the 50–100 per gram dry soil concentration range. The possible Diné corral samples, when present, yielded fecal spherulites at estimated concentrations of less than 10 per gram of soil. Thus, for the semi-arid southern Colorado Plateau, there appears to be a reduction by two orders of magnitude in fecal spherulite concentrations as the spherulites essentially age from fresh dung, to modern corral soils, to ancient corral soils. This is most likely a preservation issue related to the breakdown of organic matter over time that can protect spherulites from rain and snow melt, which are slightly acidic and corrosive to spherulites.

4.5 Diatoms and phytoliths as potential markers for ancient sheep corrals

Phytoliths derived from grasses were observed in all but three of the 28 soil samples analyzed (Table 1). The '*Stipa*-type bilobate' and 'Crenate' morphotypes are diagnostic of cool climate C3 grasses that grow in higher elevations during the summer or during the spring and fall seasons in lower elevations with high summer temperatures. Grasses that produce these morphotypes are typically in the Pooideae grass subfamily. The 'Bilobate' phytolith morphotype is typically produced by warm season C4 grasses in the Panicoideae subfamily that rely on some summer precipitation to grow. The 'Saddle' phytolith morphotype is typically diagnostic of grass subfamily Chloridoideae grasses that thrive under warm and arid (xeric) conditions. The 'Rondel' morphotype is produced by a wide variety of both cool climate C3 grasses and warm climate C4 grasses. The remaining grass phytolith morphotypes observed (Trichomes, Elongates, Bulliforms) are typical of grass leaves and stems but cannot be ascribed to subfamily or lower taxonomic levels. Absent are dendriform (dendritic) long cells that are diagnostic of grass inflorescence structures. However, since a heavy liquid density separation was not conducted, there may be some bias in the observed phytolith assemblages.

Given the relatively arid environments that the modern and historic soil samples were derived, the recovery of numerous siliceous algal remains in the form of diatoms and chrysophyte cysts was surprising (Figure 3). However, the recovery of diatoms from the modern (1960s-era) corral sample suggests that the consumption of diatom-laden water and subsequent deposition of those diatoms within a corral after they pass though the animal's digestive tract could produce diatom concentrations that are higher than that in the soils outside of a corral. It is also possible that grass phytolith concentrations could be higher in soils within corrals than outside of corrals, as they could become concentrated over time from the breakdown of dung within a confined area.

One way to test these hypotheses would be to collect soil samples along a transect that bisects a modern corral to see if diatom and phytolith concentrations are higher in corral soils than non-corral soils. In the absence of such samples, a multivariate correspondence analysis (CA) was conducted on the phytolith morphotype counts and total diatom counts as an exploratory analysis to see if there was any correspondence between phytoliths, diatoms, and samples with fecal spherulites. Also, the resultant CA biplot (Figure 4) indicates which samples have similar diatom and phytolith counts.

For interpretation of the CA biplot, samples close to the origin (x, y = 0, 0) are less distinct from one another, and those that are far from the origin are more distinct. Because the biplot axes used row principle normalization and equal scales, sites that plot close together (cluster) have similar phytolith and diatom compositions. The CA plot also shows the relationship between sites and individual variables. In Figure 4, only the four most significant variables for the first two axes (dimensions) and 'Total phytoliths' were plotted as vectors. The distance from the origin to the tip of the vector is proportional to its contribution to the axis it is closest to. Sites are associated with a particular variable if there is a small angle connecting a site (point) and variable (vector) to the origin.

The first axis (x-axis), which is positively associated with the number of diatoms, explains 44% of the variability. The second axis (y-axis) is positively associated with bilobate and saddle phytoliths (warm season and low elevation grasses) and negatively associated with crenate phytoliths (cool season and high elevation grasses), and explains 14% of the variability. Samples 8.1 and 21 with well-preserved fecal spherulites had no and low diatom abundances, respectively. Samples 15 and 49, with what appear to be poorly preserved fecal spherulites, had high abundances of diatoms. This actually makes sense because conditions that are favorable to fecal spherulite preservation (alkaline soils) are detrimental to diatom preservation.

Because the modern (1960s- and 1990s-era) corral soil samples were from Black Mesa, AZ, which has different soil characteristics than the historic corral soil samples from Frances Mesa, NM, their phytolith and diatom compositions could not be directly compared using CA analysis. However, the results of the CA analysis are suggestive that diatoms could serve as such a marker when poor preservation precludes fecal spherulite recovery. For the phytolith data, the CA analysis does not provide any insight on whether a particular phytolith morphotype assemblage is indicative of a corral. However, phytolith abundance is strongly associated with samples 8.1 and 21 that both yielded diagnostic fecal spherulites. These samples had the second and fourth highest phytolith counts, respectively. Thus, in the absence of fecal spherulites, high phytolith abundance also shows promise as a potential marker for historic corral samples.

5. Conclusions

The analysis of 28 soil samples from possible historic Diné sheep corral features yielded a few diagnostic fecal spherulites in samples 8.1 (LA 83529) and 21 (LA 106203), and possible spherulites in samples 70.1 and 49 (LA 78825), sample 57.1 (LA 83529), and sample 15 (LA 106203). The low recovery of fecal spherulites may be the result of poor preservation, which can result from deposition in acidic soils or exposure to rain and snowmelt. However, analysis of soils from modern corrals abandoned in the 1960s and 1990s did yield fecal spherulites. Thus, low or no fecal spherulite recovery may be due to the intermittent or seasonal use of historic corrals or from the consumption of vegetation that is not conducive to fecal spherulite production. Correspondence analysis and the count data suggest that relatively high diatom and phytolith abundances and the presence of chrysophyte cysts in soils could serve as markers of historic corrals in the absence of diagnostic fecal spherulites.

Table 1. Microfossil counts from possible historic Diné sheep corral soil samples

Site No.	Soil Sample No.	Fecal Spherulites	Phytoliths: Elongates	Phytoliths: Bulliforms	Phytoliths: Trichomes	Phytoliths: Rondels (C3 & C4)	Phytoliths: Bilobates (C4 mesic)	Phytoliths: Stipa-type bilobates (C3)	Phytoliths: Crenate (C3)	Phytoliths: Saddles (C4 xeric)	Phytoliths: TOTAL PHYTOLITHS	Diatoms: Pennate forms	Diatoms: *Aulacoseira* sp.	Diatoms: *Hantzschia* sp.	Diatoms: TOTAL DIATOMS	Fungi: Spores	Fungi: Hyphae**	Pollen***	Chrysophyte cysts	Sponge spicules
LA 78825	**38**		4		4				1	4	**13**			4	**4**	4	C			
	70.1	**1***	2						2	2	**6**				**0**	1	R			
	49	**1***	1	1							**2**			7	**7**	1	C			
LA 113276	**1.1**		20	3	2	1	4		13	3	**46**		1	6	**7**		R			
	6.1		21		4	3	1	1	7		**37**	3		15	**18**	1	R			
LA 105530	**55**										**0**	1			**1**	1	R			
	60		2								**2**			4	**4**	1	R			
LA 83529	**7**										**0**				**0**					
	8.1	**1**	4		1	1	2	1	5	4	**18**				**0**	1	R		1	
	9		1		1				2	2	**6**	1		2	**3**		R			
	56.1		2				3				**5**			1	**1**		R			
	57.1	**1***	4				1		1	1	**7**			3	**3**		R			
LA 110271	**24.2**		1						1		**2**				**0**	1	C			
	27						1			1	**2**				**0**	5	A			
	33						1				**1**				**0**					
	38		3	1							**4**				**0**					
LA 109396	**9**		1		1		1				**3**				**0**		C			
	14.1										**0**				**0**	1	A	P, G		
LA 106199	**6**		5	2	2			1		1	**11**	2		3	**5**	1	C			
	13		8	3	1		2	1	1	3	**19**				**0**		R			
	29				2					1	**3**			9	**9**	4	A	U	3	
	36.1		3						1	1	**5**	4			**4**		A	G		1
	45		1								**1**				**0**		R			
	46		2								**2**			1	**1**	1	C			
LA 106203	**15**	**1***	1								**1**			8	**8**	5	A	U		
	21	**2**	9	5	2	5	4	1	1	11	**38**			3	**3**		A	G, U	1	
	27.1		2	2			1		3		**8**			6	**6**	1	R			
	28		6	2	3	2			1		**14**			6	**6**		C	U		

* Possible fecal spherulite but positive identification limited due to degradation/alteration.
** A = abundant, C = common, R = rare
*** P = Pine pollen, G = Grass pollen, U = Unknown pollen

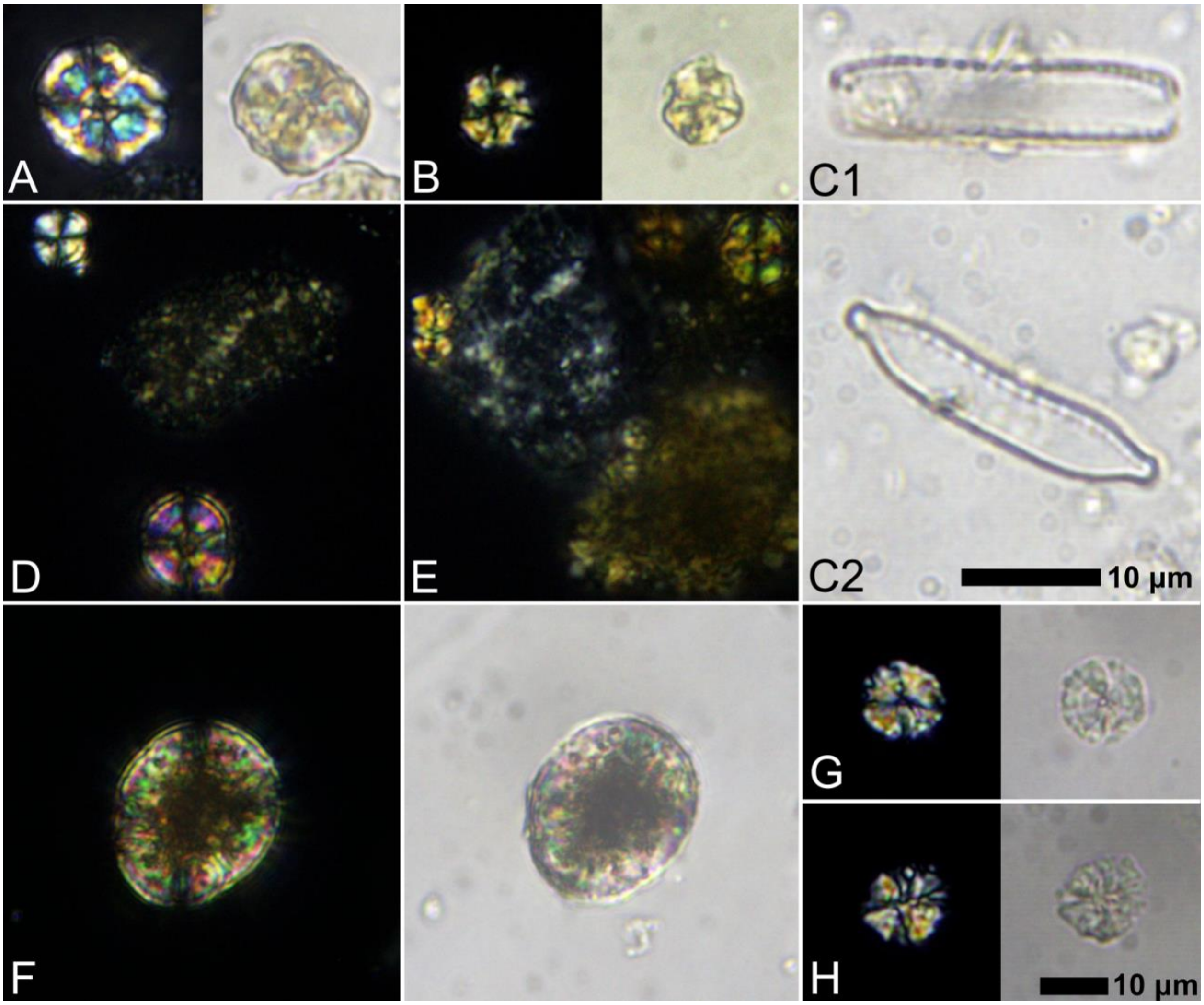

Figure 1. Micrographs of selected microfossils recovered from modern samples, Black Mesa, Arizona. **A-C)** Fecal spherulites and a diatom (*Hantzschia* sp.) in valve view (C1) and girdle view (C2) from a 1960s-era sheep corral. **D-F)** Fecal spherulites from a 1990s-era sheep corral. Several clusters of spherulites (some faint) are visible in E. **G-H)** Fecal spherulites from sheep dung collected in 2020. All micrographs were taken at 500x magnification. Images with black backgrounds were captured using cross-polarized light, the other images were captured with plane-polarized light. The scale bar in image H applies to all others except for C1 and C2.

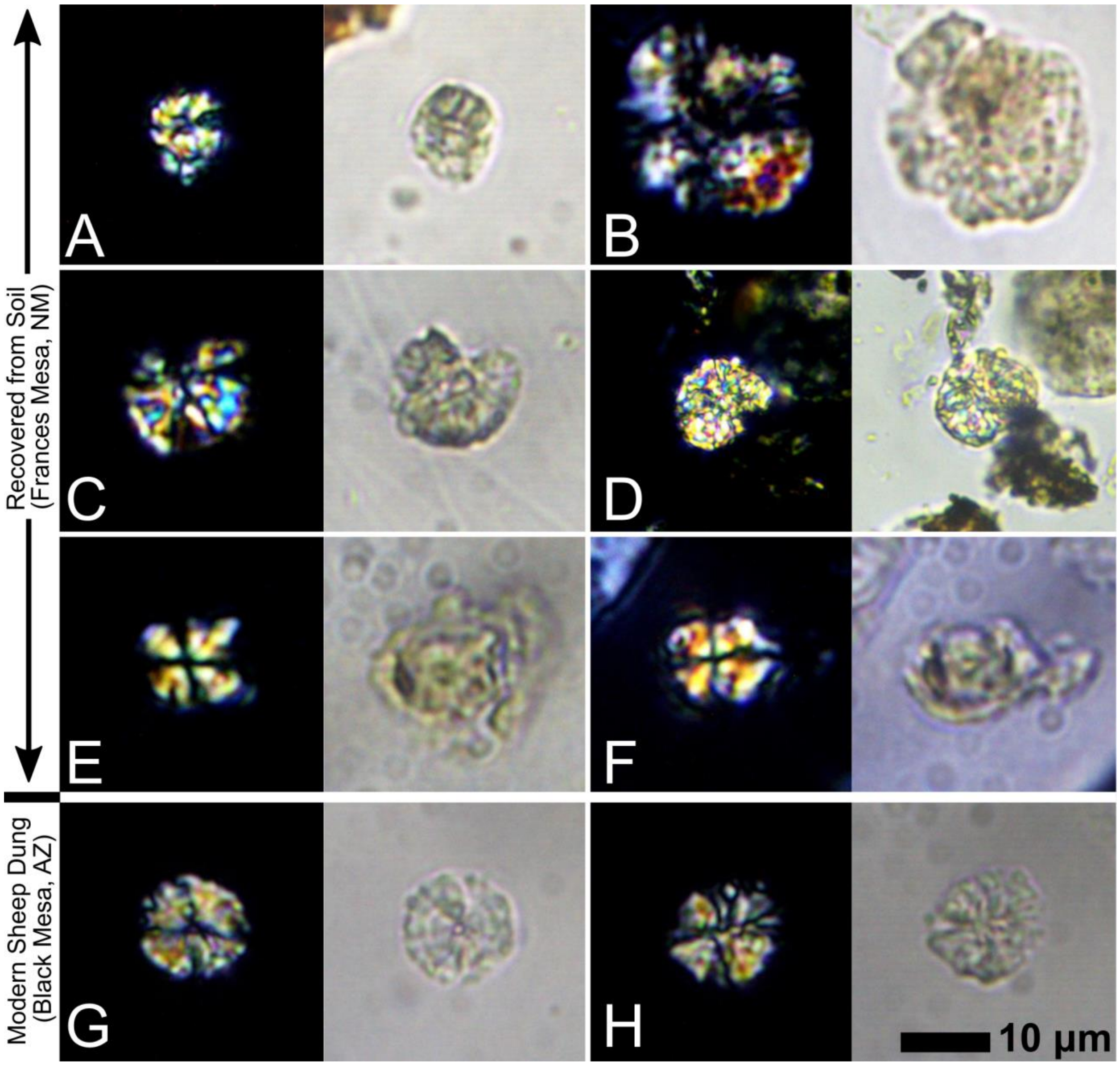

Figure 2. Micrographs of selected fecal spherulites recovered from soils collected at possible historic Navajo (Diné) sheep corrals, Frances Mesa, NM. **A)** Possible fecal spherulite from sample 49, LA 78825. **B)** Possible fecal spherulite from sample 70.1, LA 78825. **C)** Fecal spherulite from sample 8.1, LA 83529. **D)** Possible fecal spherulite from sample 57.1, LA 83529. **E-F)** Fecal spherulites from sample 21, LA 106203. **G-H)** Fecal spherulites from modern sheep dung for comparison. All micrographs were taken at 500x magnification. Images with black backgrounds were captured using cross-polarized light, the other images were captured with plane-polarized light. The scale bar in image H applies to all others.

Figure 3. Micrographs of selected siliceous algae microfossils recovered from soils collected from possible historic Navajo (Diné) sheep corral features, Frances Mesa, NM. **A)** Diatom frustule (*Hantzschia* sp.) from sample 57.1, LA 83529. **B)** Diatom frustule (cf. *Gomponema* sp.) from sample 60, LA 105530. **C)** Chrysophyte cyst from sample 29, LA 106199. All micrographs were taken at 500x magnification. The scale bar in image C applies to all others.

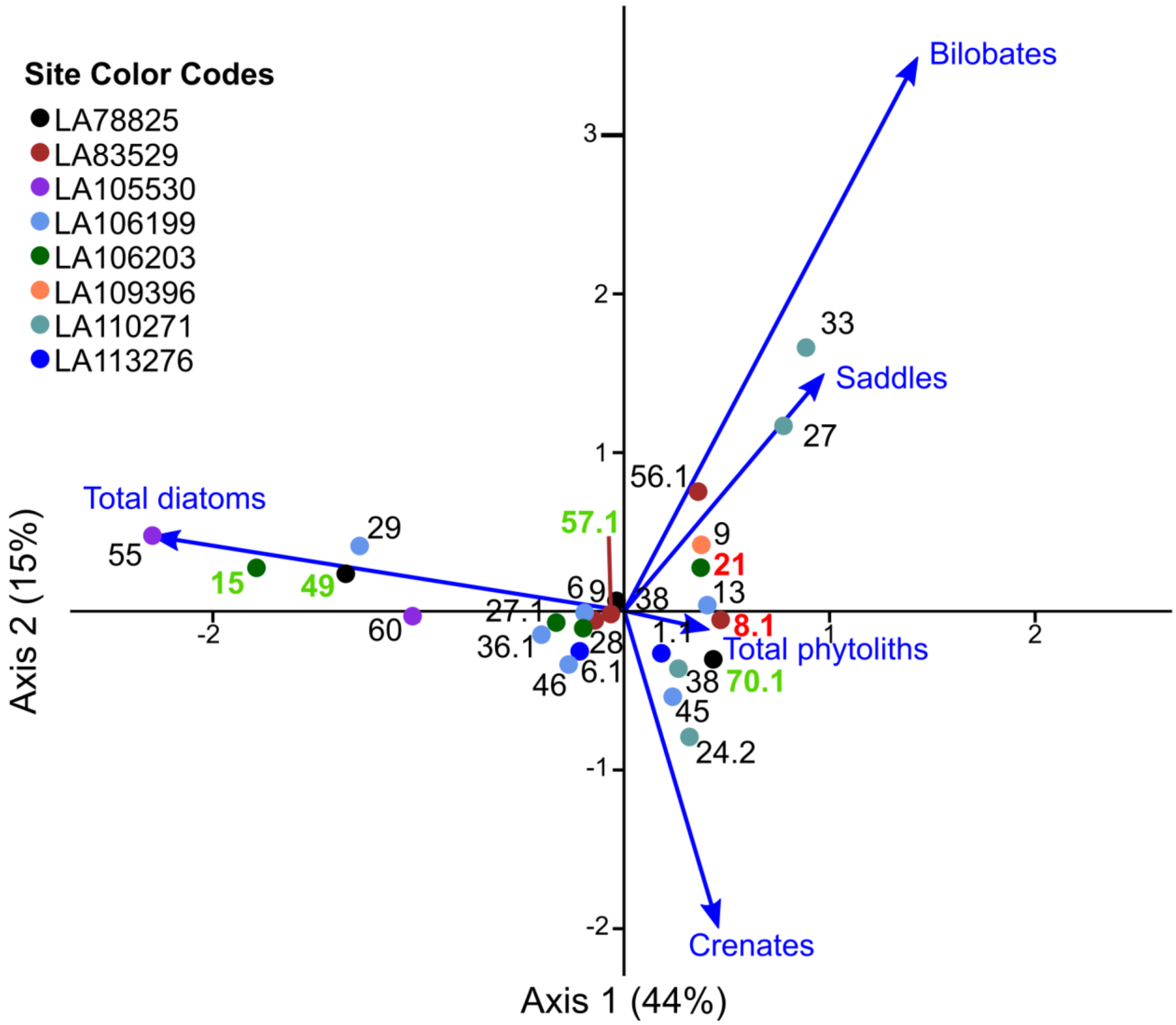

Figure 4. Correspondence analysis biplot of phytolith and diatoms counts from possible historic Diné sheep corral soil samples, Frances Mesa, New Mexico. Eight phytolith morphotypes, total phytoliths counted, and total diatoms counted are column variables and individual samples are row variables. Red sample numbers signify presence of diagnostic fecal spherulites. Bright green sample numbers signify presence of possible fecal spherulites. All row data points were plotted using row principle scaling, and only the four most significant column variables for the first two axes (dimensions) and 'Total phytoliths' were plotted as vectors. The first two dimensions explain 59% of the variance.

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Appendix C: Soil Phosphorus Analysis Reports

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Analytical Report

Report Summary

Client: Wade Campbell
Samples Received : 10/23/2019
Work Order: P910161
Project Name/Location: ENPLP 3

Report Reviewed by: Walter Hinchman **Date:** 12/10/19
Walter Hinchman, Laboratory Director

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/23/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910161	Date Reported:	12/10/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 113152- Sample 48 P910161-01	Phosphorus	169	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 49 P910161-02	Phosphorus	145	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 50 P910161-03	Phosphorus	161	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 51 P910161-04	Phosphorus	118	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 52 P910161-05	Phosphorus	136	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 53 P910161-06	Phosphorus	197	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 54 P910161-07	Phosphorus	178	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 55 P910161-08	Phosphorus	154	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 56.2 P910161-09	Phosphorus	160	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 57 P910161-10	Phosphorus	152	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 58 P910161-11	Phosphorus	156	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 59 P910161-12	Phosphorus	166	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 60 P910161-13	Phosphorus	171	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 61 P910161-14	Phosphorus	156	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 62 P910161-15	Phosphorus	174	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 63 P910161-16	Phosphorus	158	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 64 P910161-17	Phosphorus	192	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113152- Sample 65.1 P910161-18	Phosphorus	240	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/23/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910161	Date Reported:	12/10/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID:	LA 113152- Sample 65.2									
Lab ID	P910161-19	Phosphorus	155	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID:	LA 113152- Sample 66.1									
Lab ID	P910161-20	Phosphorus	204	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID:	LA 113152- Sample 66.2									
Lab ID	P910161-21	Phosphorus	115	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID:	LA 113152- Sample 67.1									
Lab ID	P910161-22	Phosphorus	180	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	
Client ID:	LA 113152- Sample 67.2									
Lab ID	P910161-23	Phosphorus	135	2.5 mg/kg	1	1949012	10/20/2019	12/3/2019	12/9/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	12/10/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 12/3/2019

Analyzed: 12/09/2019

Batch 1949012 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD %	RPD Limits	Notes
Blank (1949012-BLK)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1949012-BS1)										
Phosphorus	60.3	2.5	mg/kg	62.5		96.4	80-120			
Matrix Spike (1949012-MS1)		Source: P910160-01								
Phosphorus	244	2.5	mg/kg	62.5	192	83	75-125			
Matrix Spike Dup (1949012-MSD1)		Source: P910160-01								
Phosphorus	227	2.5	mg/kg	62.5	192	55	75-125	7.29	20%	M2

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/MS/MSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

M2 - Matrix spike recovery was outside quality control limits. The associated LCS spike recovery was acceptable.

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Analytical Report

Report Summary

Client: Wade Campbell
Samples Received : 10/23/2019
Work Order: P910160
Project Name/Location: ENPLP 3

Report Reviewed by: Walter Hinchman, Laboratory Director **Date:** 12/10/19

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Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/23/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910160	Date Reported:	12/10/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 113103- S66.1 P910160-01	Phosphorus	192	2.5 mg/kg	1	1949012	10/19/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113103- S66.2 P910160-02	Phosphorus	100	2.5 mg/kg	1	1949012	10/19/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113103- S67.1 P910160-03	Phosphorus	112	2.5 mg/kg	1	1949012	10/19/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113103- S67.2 P910160-04	Phosphorus	106	2.5 mg/kg	1	1949012	10/19/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113276-S1.1 P910160-05	Phosphorus	171	2.5 mg/kg	1	1949012	10/21/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113276-S1.2 P910160-06	Phosphorus	165	2.5 mg/kg	1	1949012	10/21/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113276-S2 P910160-07	Phosphorus	126	2.5 mg/kg	1	1949012	10/21/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113276-S3 P910160-08	Phosphorus	172	2.5 mg/kg	1	1949012	10/21/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113276-S4 P910160-09	Phosphorus	109	2.5 mg/kg	1	1949012	10/21/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113276-S5 P910160-10	Phosphorus	121	2.5 mg/kg	1	1949012	10/21/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113276-S6.1 P910160-11	Phosphorus	210	2.5 mg/kg	1	1949012	10/21/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 113276-S6.2 P910160-12	Phosphorus	155	2.5 mg/kg	1	1949012	10/21/2019	12/3/2019	12/9/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	12/10/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 12/3/2019

Analyzed: 12/09/2019

Batch 1949012 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD %	RPD Limits	Notes
Blank (1949012-BLK)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1949012-BS1)										
Phosphorus	60.3	2.5	mg/kg	62.5		96.4	80-120			
Matrix Spike (1949012-MS1)		Source: P910160-01								
Phosphorus	244	2.5	mg/kg	62.5	192	83	75-125			
Matrix Spike DUP (1949012-MSD1)		Source: P910160-01								
Phosphorus	227	2.5	mg/kg	62.5	192	55	75-125	7.29	20%	M2

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/MS/MSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

M2 - Matrix spike recovery was outside quality control limits. The associated LCS spike recovery was acceptable.

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Analytical Report

Report Summary

Client: Wade Campbell
Samples Received : 10/17/2019
Work Order: P910083
Project Name/Location: ENPLP 3

Report Reviewed by: Walter Hinchman **Date:** 11/14/19

Walter Hinchman, Laboratory Director

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received: 10/17/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910083	Date Reported: 11/14/2019
City, State, Zip:	Bloomfield, NM 87413					

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 106203- Sample 1 P910083-01	Phosphorus	115	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 2 P910083-02	Phosphorus	116	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 3 P910083-03	Phosphorus	130	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 4 P910083-04	Phosphorus	187	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 5 P910083-05	Phosphorus	186	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 6 P910083-06	Phosphorus	78.7	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 7 P910083-07	Phosphorus	140	5 mg/kg	2	1942046	10/12/2019	11/8/2019	11/12/2019	
Client ID: Lab ID	LA 106203- Sample 8 P910083-08	Phosphorus	145	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 9 P910083-09	Phosphorus	197	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 10 P910083-10	Phosphorus	208	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 11 P910083-11	Phosphorus	155	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 12 P910083-12	Phosphorus	69.6	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 13 P910083-13	Phosphorus	84.5	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 14 P910083-14	Phosphorus	152	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 15 P910083-15	Phosphorus	253	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 16 P910083-16	Phosphorus	219	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 17 P910083-17	Phosphorus	175	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 18 P910083-18	Phosphorus	104	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/17/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910083	Date Reported:	11/14/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 106203- Sample 19 P910083-19	Phosphorus	173	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 20 P910083-20	Phosphorus	232	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 21 P910083-21	Phosphorus	286	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 22 P910083-22	Phosphorus	208	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 23 P910083-23	Phosphorus	216	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 24 P910083-24	Phosphorus	198	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 25 P910083-25	Phosphorus	70.9	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 26 P910083-26	Phosphorus	82.3	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 27.1 P910083-27	Phosphorus	244	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 27.2 P910083-28	Phosphorus	176	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 28 P910083-29	Phosphorus	214	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 29 P910083-30	Phosphorus	206	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 30 P910083-31	Phosphorus	150	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 31 P910083-32	Phosphorus	71.6	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 32 P910083-33	Phosphorus	197	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 33 P910083-34	Phosphorus	210	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 34 P910083-35	Phosphorus	168	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 35 P910083-36	Phosphorus	172	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/17/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910083	Date Reported:	11/14/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 106203- Sample 36 P910083-37	Phosphorus	176	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 38 P910083-38	Phosphorus	112	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 39 P910083-39	Phosphorus	183	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 40 P910083-40	Phosphorus	160	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 41 P910083-41	Phosphorus	87.6	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 42 P910083-42	Phosphorus	111	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 43.1 P910083-43	Phosphorus	81.9	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 43.2 P910083-44	Phosphorus	163	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 44 P910083-45	Phosphorus	120	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 45 P910083-46	Phosphorus	217	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 46 P910083-47	Phosphorus	139	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 47 P910083-48	Phosphorus	123	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 55.1 P910083-49	Phosphorus	127	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	
Client ID: Lab ID	LA 106203- Sample 55.2 P910083-50	Phosphorus	175	2.5 mg/kg	1	1942046	10/12/2019	11/8/2019	11/8/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	11/14/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 11/08/2019

Analyzed: 11/08/2019

Batch 1942046 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD %	RPD Limits	Notes
Blank (1942046-BLK)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1942046-BS1)										
Phosphorus	61.8	2.5	mg/kg	62.5		99	80-120			
Laboratory Control Sample (1942046-BSD1)										
Phosphorus	67	2.5	mg/kg	62.5		106	80-120	7.44	20%	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/LCSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

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Analytical Report

Report Summary

Client: Wade Campbell
Samples Received : 11/15/2019
Work Order: P911072
Project Name/Location: ENPLP 3

Report Reviewed by: Walter Hinchman **Date:** **12/5/2019**

Walter Hinchman, Laboratory Director

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	11/15/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P911072	Date Reported:	12/5/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 105530- S2 P911072-01	Phosphorus	94	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S3 P911072-02	Phosphorus	39	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S4 P911072-03	Phosphorus	134	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S8 P911072-04	Phosphorus	58	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S9 P911072-05	Phosphorus	134	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S10 P911072-06	Phosphorus	66	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S11 P911072-07	Phosphorus	58	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S13 P911072-08	Phosphorus	103	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S14 P911072-09	Phosphorus	63	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S16 P911072-10	Phosphorus	163	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S20 P911072-11	Phosphorus	109	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S21 P911072-12	Phosphorus	56	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S22 P911072-13	Phosphorus	94	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S23 P911072-14	Phosphorus	86	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S25 P911072-15	Phosphorus	94	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S27 P911072-16	Phosphorus	207	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S28 P911072-17	Phosphorus	83	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S29 P911072-18	Phosphorus	128	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	11/15/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P911072	Date Reported:	12/5/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 105530- S30 P911072-19	Phosphorus	90	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S32 P911072-20	Phosphorus	102	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S33 P911072-21	Phosphorus	146	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S34 P911072-22	Phosphorus	161	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S35 P911072-23	Phosphorus	96	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S36 P911072-24	Phosphorus	81	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S39 P911072-25	Phosphorus	111	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S40 P911072-26	Phosphorus	105	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S41 P911072-27	Phosphorus	84	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S42 P911072-28	Phosphorus	188	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S43 P911072-29	Phosphorus	116	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S44 P911072-30	Phosphorus	90	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S55 P911072-31	Phosphorus	155	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	
Client ID: Lab ID	LA 105530- S60 P911072-32	Phosphorus	110	2.5 mg/kg	1	1949007	11/2/2019	12/2/2019	12/3/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	12/5/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 12/02/2019

Analyzed: 12/03/2019

Batch 1949007 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD	RPD Limits	Notes
Blank (1949007-BLK1)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1949007-BS1)										
Phosphorus	59.3	2.5	mg/kg	62.5		94.9	80-120			
Matrix Spike (1949007-MS1)				Source: P911072-01						
Phosphorus	146	2.5	mg/kg	62.5	94	83	75-125			
Matrix Spike Dup (1949007-MSD1)				Source: P911072-01						
Phosphorus	156	2.5	mg/kg	62.5	94	98.8	75-125	6.55	20	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/MS/MSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

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Analytical Report

Report Summary

Client: Wade Campbell
Samples Received : 10/17/2019
Work Order: P910082
Project Name/Location: ENPLP 3

Report Reviewed by: [signature] **Date:** 11/11/19
Walter Hinchman, Laboratory Director

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/17/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910082	Date Reported:	11/8/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 113103- Sample 1 P910082-01	Phosphorus	71.2	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 2.1 P910082-02	Phosphorus	63.2	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 2.2 P910082-03	Phosphorus	67.9	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 3 P910082-04	Phosphorus	121	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 4.1 P910082-05	Phosphorus	155	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 4.2 P910082-06	Phosphorus	133	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 5.2 P910082-07	Phosphorus	148	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 6 P910082-08	Phosphorus	102	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 7 P910082-09	Phosphorus	138	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 8 P910082-10	Phosphorus	141	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 9 P910082-11	Phosphorus	141	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 10 P910082-12	Phosphorus	122	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 11 P910082-13	Phosphorus	140	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 12 P910082-14	Phosphorus	158	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 13 P910082-15	Phosphorus	126	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 14 P910082-16	Phosphorus	172	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 15 P910082-17	Phosphorus	177	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 16 P910082-18	Phosphorus	215	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/17/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910082	Date Reported:	11/8/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 113103- Sample 17 P910082-19	Phosphorus	120	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 18.1 P910082-20	Phosphorus	162	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 18.2 P910082-21	Phosphorus	91	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 19 P910082-22	Phosphorus	136	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 20 P910082-23	Phosphorus	133	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 21 P910082-24	Phosphorus	122	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 22 P910082-25	Phosphorus	196	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 23 P910082-26	Phosphorus	133	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 24 P910082-27	Phosphorus	141	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 25 P910082-28	Phosphorus	204	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 26 P910082-29	Phosphorus	158	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 27 P910082-30	Phosphorus	170	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 28 P910082-31	Phosphorus	105	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 29 P910082-32	Phosphorus	128	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 30 P910082-33	Phosphorus	131	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 31 P910082-34	Phosphorus	164	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 32 P910082-35	Phosphorus	155	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID: Lab ID	LA 113103- Sample 33 P910082-36	Phosphorus	106	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/17/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910082	Date Reported:	11/8/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID:	LA 113103- Sample 34									
Lab ID	P910082-37	Phosphorus	175	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID:	LA 113103- Sample 35									
Lab ID	P910082-38	Phosphorus	105	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID:	LA 113103- Sample 36									
Lab ID	P910082-39	Phosphorus	153	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID:	LA 113103- Sample 37									
Lab ID	P910082-40	Phosphorus	155	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID:	LA 113103- Sample 38									
Lab ID	P910082-41	Phosphorus	170	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID:	LA 113103- Sample 39									
Lab ID	P910082-42	Phosphorus	106	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	
Client ID:	LA 113103- Sample 40									
Lab ID	P910082-43	Phosphorus	185	2.5 mg/kg	1	1942045	10/14/2019	10/18/2019	11/7/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	11/8/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 10/18/2019

Analyzed: 11/7/2019

Batch 1942045 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD	RPD Limits	Notes
Blank (1942045-BLK)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1942045-BS)										
Phosphorus	62.5	2.5	mg/kg	62.5		100	80-120			
Matrix Spike (1942045-MS1)				Source: P910082-01						
Phosphorus	118	2.5	mg/kg	62.5	71.2	74.8	75-125			M2
Matrix Spike Dup (1942045-MSD1)				Source: P910082-01						
Phosphorus	125	2.5	mg/kg	62.5	71.2	86.8	75-125	6.19	20	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/MS/MSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

M2 - Matrix spike recovery was outside quality control limits. The associated LCS spike recovery was acceptable.

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Analytical Report

Report Summary

Client: Wade Campbell
Samples Received : 11/15/2019
Work Order: P911077
Project Name/Location: ENPLP 3

Report Reviewed by:	Walter Hinchman	**Date:**	**12/5/2019**
	Walter Hinchman, Laboratory Director		

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	11/15/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P911077	Date Reported:	12/5/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID:	LA 83529-S48.1									
Lab ID	P911077-01	Phosphorus	58	2.5 mg/kg	1	1949007	11/6/2019	12/2/2019	12/3/2019	
Client ID:	LA 83529-S49									
Lab ID	P911077-02	Phosphorus	9.8	2.5 mg/kg	1	1949007	11/6/2019	12/2/2019	12/3/2019	
Client ID:	LA 83529-S50									
Lab ID	P911077-03	Phosphorus	96	2.5 mg/kg	1	1949007	11/6/2019	12/2/2019	12/3/2019	
Client ID:	LA 83529-S51.1									
Lab ID	P911077-04	Phosphorus	148	2.5 mg/kg	1	1949007	11/6/2019	12/2/2019	12/3/2019	
Client ID:	LA 83529-S52.1									
Lab ID	P911077-05	Phosphorus	127	2.5 mg/kg	1	1949007	11/6/2019	12/2/2019	12/3/2019	
Client ID:	LA 83529-S54.1									
Lab ID	P911077-06	Phosphorus	119	2.5 mg/kg	1	1949007	11/6/2019	12/2/2019	12/3/2019	
Client ID:	LA 83529-S55.1									
Lab ID	P911077-07	Phosphorus	89	2.5 mg/kg	1	1949007	11/6/2019	12/2/2019	12/3/2019	
Client ID:	LA 83529-S56.1									
Lab ID	P911077-08	Phosphorus	135	2.5 mg/kg	1	1949007	11/6/2019	12/2/2019	12/3/2019	
Client ID:	LA 83529-S56.2									
Lab ID	P911077-09	Phosphorus	140	2.5 mg/kg	1	1949007	11/6/2019	12/2/2019	12/3/2019	
Client ID:	LA 83529-S57.1									
Lab ID	P911077-10	Phosphorus	655	2.5 mg/kg	1	1949007	11/6/2019	12/2/2019	12/3/2019	
Client ID:	LA 83529-S57.2									
Lab ID	P911077-11	Phosphorus	48	2.5 mg/kg	1	1949007	11/6/2019	12/2/2019	12/3/2019	
Client ID:	LA 83529-S57.3									
Lab ID	P911077-12	Phosphorus	37	2.5 mg/kg	1	1949007	11/6/2019	12/2/2019	12/3/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	12/5/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 12/02/2019

Analyzed: 12/03/2019

Batch 1949007 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD	RPD Limits	Notes
Blank (1949007-BLK1)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1949007-BS1)										
Phosphorus	59.3	2.5	mg/kg	62.5		94.9	80-120			
Matrix Spike (1949007-MS1)				Source: P911072-01						
Phosphorus	146	2.5	mg/kg	62.5	94	83	75-125			
Matrix Spike Dup (1949007-MSD1)				Source: P911072-01						
Phosphorus	156	2.5	mg/kg	62.5	94	98.8	75-125	6.55	20	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/MS/MSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

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Analytical Report

Report Summary

Client: Wade Campbell
Samples Received : 10/17/2019
Work Order: P910084
Project Name/Location: ENPLP 3

Report Reviewed by: ______________________ **Date:** **12/5/2019**

Walter Hinchman, Laboratory Director

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/17/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910084	Date Reported:	12/5/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 109396- Sample 1 P910084-01	Phosphorus	74	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 2 P910084-02	Phosphorus	135	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 3 P910084-03	Phosphorus	153	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 4 P910084-04	Phosphorus	149	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 5 P910084-05	Phosphorus	220	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 6 P910084-06	Phosphorus	142	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 8 P910084-07	Phosphorus	184	5 mg/kg	2	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 9 P910084-08	Phosphorus	209	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 10 P910084-09	Phosphorus	210	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 11 P910084-10	Phosphorus	170	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 12 P910084-11	Phosphorus	180	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 13 P910084-12	Phosphorus	208	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 14.1 P910084-13	Phosphorus	416	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 14.2 P910084-14	Phosphorus	333	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 15 P910084-15	Phosphorus	176	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 16 P910084-16	Phosphorus	201	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 17 P910084-17	Phosphorus	202	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 18 P910084-18	Phosphorus	168	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/17/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910084	Date Reported:	12/5/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 109396- Sample 19 P910084-19	Phosphorus	153	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 20 P910084-20	Phosphorus	67	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 21 P910084-21	Phosphorus	128	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 23 P910084-22	Phosphorus	197	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 24 P910084-23	Phosphorus	259	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 26 P910084-24	Phosphorus	188	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 27 P910084-25	Phosphorus	189	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 29 P910084-26	Phosphorus	188	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 30 P910084-27	Phosphorus	213	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 31 P910084-28	Phosphorus	182	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 32 P910084-29	Phosphorus	181	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 33 P910084-30	Phosphorus	136	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 34 P910084-31	Phosphorus	235	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 35 P910084-32	Phosphorus	149	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 36.1 P910084-33	Phosphorus	164	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 36.2 P910084-34	Phosphorus	176	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 37 P910084-35	Phosphorus	213	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 38 P910084-36	Phosphorus	180	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/17/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910084	Date Reported:	12/5/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 109396- Sample 39 P910084-37	Phosphorus	192	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 40 P910084-38	Phosphorus	200	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 41 P910084-39	Phosphorus	211	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 42 P910084-40	Phosphorus	188	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 43 P910084-41	Phosphorus	191	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 44 P910084-42	Phosphorus	167	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	
Client ID: Lab ID	LA 109396- Sample 45 P910084-43	Phosphorus	191	2.5 mg/kg	1	1946007	10/13/2019	11/12/2019	12/2/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	12/5/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 11/12/2019

Analyzed: 12/02/2019

Batch 1946007 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD %	RPD Limits	Notes
Blank (1946007-BLK)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1946007-BS1)										
Phosphorus	65.6	2.5	mg/kg	62.5		105	80-120			
Laboratory Control Sample (1946007-BSD1)										
Phosphorus	67	2.5	mg/kg	62.5		107	80-120	2.3	20%	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/LCSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

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Analytical Report

Report Summary

Client: Wade Campbell

Samples Received : 11/15/2019

Work Order: P911074

Project Name/Location: ENPLP 3

Report Reviewed by: _______________ **Date:** **12/5/2019**

Walter Hinchman, Laboratory Director

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	11/15/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P911074	Date Reported:	12/5/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID:	LA 78825- S1									
Lab ID	P911074-01	Phosphorus	272	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019 12/4/2019	
Client ID:	LA 78825- S2									
Lab ID	P911074-02	Phosphorus	310	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S3									
Lab ID	P911074-03	Phosphorus	168	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S4.1									
Lab ID	P911074-04	Phosphorus	190	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S4.2									
Lab ID	P911074-05	Phosphorus	148	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S5.1									
Lab ID	P911074-06	Phosphorus	219	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/4/2019	
Client ID:	LA 78825- S5.2									
Lab ID	P911074-07	Phosphorus	169	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/4/2019	
Client ID:	LA 78825- S6									
Lab ID	P911074-08	Phosphorus	147	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/4/2019	
Client ID:	LA 78825- S7									
Lab ID	P911074-09	Phosphorus	240	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/4/2019	
Client ID:	LA 78825- S8									
Lab ID	P911074-10	Phosphorus	228	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/4/2019	
Client ID:	LA 78825- S9									
Lab ID	P911074-11	Phosphorus	190	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/4/2019	
Client ID:	LA 78825- S10									
Lab ID	P911074-12	Phosphorus	144	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/4/2019	
Client ID:	LA 78825- S11									
Lab ID	P911074-13	Phosphorus	165	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/4/2019	
Client ID:	LA 78825- S12.1									
Lab ID	P911074-14	Phosphorus	153	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/4/2019	
Client ID:	LA 78825- S12.2									
Lab ID	P911074-15	Phosphorus	148	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/4/2019	
Client ID:	LA 78825- S13.1									
Lab ID	P911074-16	Phosphorus	175	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/4/2019	
Client ID:	LA 78825- S13.2									
Lab ID	P911074-17	Phosphorus	228	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/4/2019	
Client ID:	LA 78825- S15									
Lab ID	P911074-18	Phosphorus	181	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/4/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/17/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910084	Date Reported:	12/5/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID:	LA 78825- S16									
Lab ID	P911074-19	Phosphorus	203	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S17									
Lab ID	P911074-20	Phosphorus	162	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S18									
Lab ID	P911074-21	Phosphorus	205	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S19									
Lab ID	P911074-22	Phosphorus	116	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S22									
Lab ID	P911074-23	Phosphorus	138	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S23									
Lab ID	P911074-24	Phosphorus	116	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S24									
Lab ID	P911074-25	Phosphorus	198	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S25									
Lab ID	P911074-26	Phosphorus	188	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S26									
Lab ID	P911074-27	Phosphorus	241	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S27									
Lab ID	P911074-28	Phosphorus	185	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S28									
Lab ID	P911074-29	Phosphorus	316	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S29									
Lab ID	P911074-30	Phosphorus	243	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S31									
Lab ID	P911074-31	Phosphorus	153	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S35									
Lab ID	P911074-32	Phosphorus	213	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S36									
Lab ID	P911074-33	Phosphorus	152	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S37.1									
Lab ID	P911074-34	Phosphorus	184	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S37.2									
Lab ID	P911074-35	Phosphorus	135	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S38									
Lab ID	P911074-36	Phosphorus	234	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/17/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910084	Date Reported:	12/5/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID:	LA 78825- S40									
Lab ID	P911074-37	Phosphorus	218	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S41									
Lab ID	P911074-38	Phosphorus	163	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S42									
Lab ID	P911074-39	Phosphorus	154	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S43									
Lab ID	P911074-40	Phosphorus	219	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S44									
Lab ID	P911074-41	Phosphorus	156	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S45									
Lab ID	P911074-42	Phosphorus	168	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S46									
Lab ID	P911074-43	Phosphorus	160	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S47									
Lab ID	P911074-44	Phosphorus	167	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S48									
Lab ID	P911074-45	Phosphorus	249	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S49									
Lab ID	P911074-46	Phosphorus	307	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S50									
Lab ID	P911074-47	Phosphorus	220	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S51									
Lab ID	P911074-48	Phosphorus	234	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S52									
Lab ID	P911074-49	Phosphorus	103	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	
Client ID:	LA 78825- S53									
Lab ID	P911074-50	Phosphorus	110	2.5 mg/kg	1	1949011	11/3/2019	12/3/2019	12/3/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	12/5/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 12/02/2019

Analyzed: 12/03/2019

Batch 1949011 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD	RPD Limits	Notes
Blank (1949011-BLK1)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1949011-BS1)										
Phosphorus	62.2	2.5	mg/kg	62.5		99.6	80-120			
Matrix Spike (1949011-MS1)				Source: P911074-01						
Phosphorus	307	2.5	mg/kg	62.5	272	56.8	75-125			
Matrix Spike Dup (1949011-MSD1)				Source: P911074-01						
Phosphorus	312	2.5	mg/kg	62.5	272	64	75-125	1.46	20	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/MS/MSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

M2 - Matrix spike recovery was outside quality control limits. The associated LCS spike recovery was acceptable.

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Analytical Report

Report Summary

Client: Wade Campbell

Samples Received : 11/15/2019

Work Order: P911073

Project Name/Location: ENPLP 3

Report Reviewed by: Walter Hinchman, Laboratory Director **Date:** 12/2/19

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	11/15/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P911073	Date Reported:	12/20/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA110271-S1 P911073-01	Phosphorus	107	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S2 P911073-02	Phosphorus	123	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S3.2 P911073-03	Phosphorus	109	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S4 P911073-04	Phosphorus	153	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S5 P911073-05	Phosphorus	154	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S6.2 P911073-06	Phosphorus	87	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S7 P911073-07	Phosphorus	132	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S8 P911073-08	Phosphorus	99.6	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S9 P911073-09	Phosphorus	122	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S10 P911073-10	Phosphorus	149	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S11 P911073-11	Phosphorus	126	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S12 P911073-12	Phosphorus	85.1	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S13 P911073-13	Phosphorus	101	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S14 P911073-14	Phosphorus	111	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S15 P911073-15	Phosphorus	133	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S16 P911073-16	Phosphorus	155	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S17 P911073-17	Phosphorus	185	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S18 P911073-18	Phosphorus	150	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	11/15/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P911073	Date Reported:	12/20/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA110271-S19 P911073-19	Phosphorus	163	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S20 P911073-20	Phosphorus	135	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S21 P911073-21	Phosphorus	70	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S22 P911073-22	Phosphorus	114	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S23 P911073-23	Phosphorus	103	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S24 P911073-24	Phosphorus	180	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S25 P911073-25	Phosphorus	142	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S26 P911073-26	Phosphorus	73.8	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S27 P911073-27	Phosphorus	162	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S28 P911073-28	Phosphorus	96.6	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S29 P911073-29	Phosphorus	133	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S30 P911073-30	Phosphorus	154	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S31 P911073-31	Phosphorus	104	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S33 P911073-32	Phosphorus	163	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S34 P911073-33	Phosphorus	121	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S35 P911073-34	Phosphorus	130	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S36 P911073-35	Phosphorus	122	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA110271-S37 P911073-36	Phosphorus	177	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/11/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/28/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P911073	Date Reported:	12/20/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 110285-38 P911071-37	Phosphorus	168	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/18/2019	
Client ID: Lab ID	LA 110285-39 P911071-38	Phosphorus	180	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/18/2019	
Client ID: Lab ID	LA 110285-40 P911071-39	Phosphorus	133	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/18/2019	
Client ID: Lab ID	LA 110285-41 P911071-40	Phosphorus	148	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/18/2019	
Client ID: Lab ID	LA 110285-42 P911071-41	Phosphorus	141	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/18/2019	
Client ID: Lab ID	LA 110285-48 P911071-42	Phosphorus	144	2.5 mg/kg	1	1950006	10/30/2019	12/9/2019	12/18/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	12/20/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 12/9/2019

Analyzed: 12/11/2019

Batch 1950006 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD %	RPD Limits	Notes
Blank (1950006-BLK)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1950006-BS1)										
Phosphorus	62.7	2.5	mg/kg	62.5		10	80-120			
Matrix Spike (1950006-MS1)		Source: P911073-01								
Phosphorus	160	2.5	mg/kg	62.5	107	83.7	75-125			
Matrix Spike Dup (1950006-MSD1)		Source: P911073-01								
Phosphorus	155	2.5	mg/kg	62.5	107	76.6	75-125	2.83	20%	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/MS/MSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

R1 - Precision calculated as %RPD exceeded the acceptance limit.

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Analytical Report

Report Summary

Client: Wade Campbell
Samples Received : 11/15/2019
Work Order: P911071
Project Name/Location: ENPLP 3

Report Reviewed by: Walter Hinchman (signature) **Date:** 12/12/19

Walter Hinchman, Laboratory Director

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	11/15/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P911071	Date Reported:	12/12/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 110285-S4 P911071-01	Phosphorus	168	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S5 P911071-02	Phosphorus	179	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S6 P911071-03	Phosphorus	154	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S7 P911071-04	Phosphorus	177	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S8 P911071-05	Phosphorus	116	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S9 P911071-06	Phosphorus	106	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S12.1 P911071-07	Phosphorus	144	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S12.2 P911071-08	Phosphorus	153	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S13 P911071-09	Phosphorus	150	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S14 P911071-10	Phosphorus	152	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S15 P911071-11	Phosphorus	131	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S16.1 P911071-12	Phosphorus	121	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S16.2 P911071-13	Phosphorus	159	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S17.1 P911071-14	Phosphorus	156	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S17.2 P911071-15	Phosphorus	122	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S18 P911071-16	Phosphorus	121	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S21 P911071-17	Phosphorus	145	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-S22 P911071-18	Phosphorus	138	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/28/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P911071	Date Reported:	12/12/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 110285-23 P911071-19	Phosphorus	150	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-24 P911071-20	Phosphorus	112	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-25.2 P911071-21	Phosphorus	146	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-26 P911071-22	Phosphorus	127	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-31.1 P911071-23	Phosphorus	170	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-32 P911071-24	Phosphorus	140	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-33 P911071-25	Phosphorus	163	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-34 P911071-26	Phosphorus	127	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-35 P911071-27	Phosphorus	137	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-39 P911071-28	Phosphorus	145	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-40 P911071-29	Phosphorus	149	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-41 P911071-30	Phosphorus	128	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-45 P911071-31	Phosphorus	230	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 110285-50 P911071-32	Phosphorus	109	2.5 mg/kg	1	1950005	10/30/2019	12/9/2019	12/11/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	12/12/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 12/9/2019

Analyzed: 12/11/2019

Batch 1950005 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD %	RPD Limits	Notes
Blank (1950005-BLK)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1950005-BS1)										
Phosphorus	63.7	2.5	mg/kg	62.5		102	80-120			
Matrix Spike (1950005-MS1)		Source: P911071-01								
Phosphorus	212	2.5	mg/kg	62.5	168	69.9	75-125			
Matrix Spike Dup (1950005-MSD1)		Source: P911071-01								
Phosphorus	332	2.5	mg/kg	62.5	168	261.0	75-125	44	20%	M2, R1

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/MS/MSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

R1 - Precision calculated as %RPD exceeded the acceptance limit.

M2 - Matrix spike recovery was outside quality control limits. The associated LCS spike recovery was acceptable.

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Analytical Report

Report Summary

Client: Wade Campbell
Samples Received : 10/28/2019
Work Order: P910182
Project Name/Location: ENPLP 3

Report Reviewed by: Walter Hinchman **Date:** 12/12/19

Walter Hinchman, Laboratory Director

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/28/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910182	Date Reported:	12/12/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 106199-2.1 P910182-01	Phosphorus	82.9	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-2.2 P910182-02	Phosphorus	19.8	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-3 P910182-03	Phosphorus	140	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-4 P910182-04	Phosphorus	145	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-5 P910182-05	Phosphorus	158	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-6 P910182-06	Phosphorus	182	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-7 P910182-07	Phosphorus	143	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-10 P910182-08	Phosphorus	143	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-11 P910182-09	Phosphorus	94.8	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-12.1 P910182-10	Phosphorus	148	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-12.2 P910182-11	Phosphorus	102	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-13 P910182-12	Phosphorus	160	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-14 P910182-13	Phosphorus	127	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-15 P910182-14	Phosphorus	160	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-18 P910182-15	Phosphorus	66.0	2.5 mg/kg	1	1950004	10/22/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-19 P910182-16	Phosphorus	67.8	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-20 P910182-17	Phosphorus	159	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-21 P910182-18	Phosphorus	157	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	

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Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/28/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910182	Date Reported:	12/12/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 106199-22 P910182-19	Phosphorus	127	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-23 P910182-20	Phosphorus	132	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-24 P910182-21	Phosphorus	116	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-27 P910182-22	Phosphorus	95.6	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-28 P910182-23	Phosphorus	141	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-29 P910182-24	Phosphorus	175	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-30 P910182-25	Phosphorus	139	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-31 P910182-26	Phosphorus	155	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-32 P910182-27	Phosphorus	104	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-35 P910182-28	Phosphorus	155	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-36.1 P910182-29	Phosphorus	199	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-37 P910182-30	Phosphorus	142	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-38 P910182-31	Phosphorus	144	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-39 P910182-32	Phosphorus	174	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-40 P910182-33	Phosphorus	133	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-44 P910182-34	Phosphorus	128	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-45 P910182-35	Phosphorus	201	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 106199-46 P910182-36	Phosphorus	190	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/28/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910182	Date Reported:	12/12/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 113152-S47 P910162-37	Phosphorus	115	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S48 P910162-38	Phosphorus	118	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S56 P910162-39	Phosphorus	180	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 113152-S63 P910162-40	Phosphorus	152	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 113152-S64 P910162-41	Phosphorus	102	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 113152-S65 P910162-42	Phosphorus	132	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/11/2019	
Client ID: Lab ID	LA 113152-S66 P910162-43	Phosphorus	186	2.5 mg/kg	1	1950004	10/25/2019	12/9/2019	12/11/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	12/12/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 12/9/2019

Analyzed: 12/10/2019

Batch 1950004 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD %	RPD Limits	Notes
Blank (1950004-BLK)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1950004-BS1)										
Phosphorus	60.7	2.5	mg/kg	62.5		97.2	80-120			
Matrix Spike (1950004-MS1)		Source: P910182-01								
Phosphorus	140	2.5	mg/kg	62.5	82.9	92.0	75-125			
Matrix Spike Dup (1950004-MSD1)		Source: P910182-01								
Phosphorus	137	2.5	mg/kg	62.5	82.9	86.5	75-125	2.47	20%	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/MS/MSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

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Analytical Report

Report Summary

Client: Wade Campbell
Samples Received : 10/28/2019
Work Order: P910175
Project Name/Location: ENPLP 3

Report Reviewed by:	*(signature)* Walter Hinchman, Laboratory Director	Date:	12/10/2019

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envirotech Analytical Laboratory

Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/28/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910175	Date Reported:	12/10/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID:	LA 106201-S1									
Lab ID	P910175-01	Phosphorus	162	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/9/2019	
Client ID:	LA 106201-S2.1									
Lab ID	P910175-02	Phosphorus	120	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/9/2019	
Client ID:	LA 106201-S3									
Lab ID	P910175-03	Phosphorus	150	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/9/2019	
Client ID:	LA 106201-S4									
Lab ID	P910175-04	Phosphorus	124	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/9/2019	
Client ID:	LA 106201-S5.1									
Lab ID	P910175-05	Phosphorus	106	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S6.1									
Lab ID	P910175-06	Phosphorus	129	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S6.2									
Lab ID	P910175-07	Phosphorus	129	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S7									
Lab ID	P910175-08	Phosphorus	168	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S8									
Lab ID	P910175-09	Phosphorus	65.2	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S9.1									
Lab ID	P910175-10	Phosphorus	160	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S10									
Lab ID	P910175-11	Phosphorus	120	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S11									
Lab ID	P910175-12	Phosphorus	144	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S12									
Lab ID	P910175-13	Phosphorus	190	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S14									
Lab ID	P910175-14	Phosphorus	204	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S15									
Lab ID	P910175-15	Phosphorus	154	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S16.1									
Lab ID	P910175-16	Phosphorus	99.2	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S16.2									
Lab ID	P910175-17	Phosphorus	91.5	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S17.1									
Lab ID	P910175-18	Phosphorus	215	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	

Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/28/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910175	Date Reported:	12/10/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID:	LA 106201-S17.2									
Lab ID	P910175-19	Phosphorus	197	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S19									
Lab ID	P910175-20	Phosphorus	119	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S22.1									
Lab ID	P910175-21	Phosphorus	177	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S22.2									
Lab ID	P910175-22	Phosphorus	73.3	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S24									
Lab ID	P910175-23	Phosphorus	141	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S25									
Lab ID	P910175-24	Phosphorus	116	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S26									
Lab ID	P910175-25	Phosphorus	128	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S27									
Lab ID	P910175-26	Phosphorus	183	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S28									
Lab ID	P910175-27	Phosphorus	125	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S31									
Lab ID	P910175-28	Phosphorus	216	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S34									
Lab ID	P910175-29	Phosphorus	152	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S36									
Lab ID	P910175-30	Phosphorus	232	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S37.1									
Lab ID	P910175-31	Phosphorus	181	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S39									
Lab ID	P910175-32	Phosphorus	340	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S40									
Lab ID	P910175-33	Phosphorus	203	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S41.1									
Lab ID	P910175-34	Phosphorus	239	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S41.2									
Lab ID	P910175-35	Phosphorus	236	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 106201-S42									
Lab ID	P910175-36	Phosphorus	187	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	

Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/28/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910175	Date Reported:	12/10/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID:	LA 113152-S47									
Lab ID	P910162-37	Phosphorus	267	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S48									
Lab ID	P910162-38	Phosphorus	257	2.5 mg/kg	1	1950002	10/26/2019	12/9/2019	12/10/2019	

QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	12/10/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 12/9/2019

Analyzed: 12/09/2019

Batch 1950002 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD %	RPD Limits	Notes
Blank (1950002-BLK)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1950002-BS1)										
Phosphorus	62	2.5	mg/kg	62.5		99.2	80-120			
Matrix Spike (1950002-MS1)		Source: P910175-01								
Phosphorus	167	2.5	mg/kg	62.5	162	7.36	75-125			M2
Matrix Spike Dup (1950002-MSD1)		Source: P910175-01								
Phosphorus	117	2.5	mg/kg	62.5	162		75-125	34.7	20%	M2, R1

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/MS/MSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

M2 - Matrix spike recovery was outside quality control limits. The associated LCS spike recovery was acceptable.

R1 - Precision calculated as %RPD exceeded the acceptance limit.

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Analytical Report

Report Summary

Client: Wade Campbell
Samples Received : 10/23/2019
Work Order: P910162
Project Name/Location: ENPLP 3

Report Reviewed by: Walter Hinchman, Laboratory Director **Date:** 12/11/19

The results in the report are based on the samples as received unless otherwise noted.
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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/23/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910162	Date Reported:	12/11/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 113152-S1 P910162-01	Phosphorus	220	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S2.1 P910162-02	Phosphorus	246	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S2.2 P910162-03	Phosphorus	218	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S3 P910162-04	Phosphorus	250	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S4 P910162-05	Phosphorus	314	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S5.1 P910162-06	Phosphorus	227	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S5.2 P910162-07	Phosphorus	261	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S6 P910162-08	Phosphorus	196	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S7 P910162-09	Phosphorus	295	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S8 P910162-10	Phosphorus	254	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S9 P910162-11	Phosphorus	237	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S10 P910162-12	Phosphorus	254	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S11 P910162-13	Phosphorus	155	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S12 P910162-14	Phosphorus	137	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S13 P910162-15	Phosphorus	214	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S14.1 P910162-16	Phosphorus	185	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S15.1 P910162-17	Phosphorus	239	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID: Lab ID	LA 113152-S15.2 P910162-18	Phosphorus	116	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/23/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910162	Date Reported:	12/11/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID:	LA 113152-S16									
Lab ID	P910162-19	Phosphorus	148	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S17									
Lab ID	P910162-20	Phosphorus	189	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S18									
Lab ID	P910162-21	Phosphorus	254	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S19.1									
Lab ID	P910162-22	Phosphorus	244	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S20									
Lab ID	P910162-23	Phosphorus	247	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S21									
Lab ID	P910162-24	Phosphorus	216	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S22									
Lab ID	P910162-25	Phosphorus	180	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S23									
Lab ID	P910162-26	Phosphorus	181	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S24									
Lab ID	P910162-27	Phosphorus	171	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S25									
Lab ID	P910162-28	Phosphorus	201	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S26									
Lab ID	P910162-29	Phosphorus	183	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S27									
Lab ID	P910162-30	Phosphorus	221	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S28									
Lab ID	P910162-31	Phosphorus	180	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S29									
Lab ID	P910162-32	Phosphorus	155	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S30									
Lab ID	P910162-33	Phosphorus	205	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S31									
Lab ID	P910162-34	Phosphorus	160	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S32									
Lab ID	P910162-35	Phosphorus	202	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S33									
Lab ID	P910162-36	Phosphorus	169	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	10/23/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P910162	Date Reported:	12/11/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID:	LA 113152-S34									
Lab ID	P910162-37	Phosphorus	185	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S35									
Lab ID	P910162-38	Phosphorus	241	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S36									
Lab ID	P910162-39	Phosphorus	155	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S37									
Lab ID	P910162-40	Phosphorus	181	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S38									
Lab ID	P910162-41	Phosphorus	153	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S39									
Lab ID	P910162-42	Phosphorus	176	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S40									
Lab ID	P910162-43	Phosphorus	169	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S41									
Lab ID	P910162-44	Phosphorus	151	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S42									
Lab ID	P910162-45	Phosphorus	160	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S43									
Lab ID	P910162-46	Phosphorus	256	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S44.2									
Lab ID	P910162-47	Phosphorus	152	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S45									
Lab ID	P910162-48	Phosphorus	176	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S46									
Lab ID	P910162-49	Phosphorus	209	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	
Client ID:	LA 113152-S47									
Lab ID	P910162-50	Phosphorus	172	2.5 mg/kg	1	1950001	10/20/2019	12/9/2019	12/10/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	12/11/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 12/9/2019

Analyzed: 12/10/2019

Batch 1950001 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD %	RPD Limits	Notes
Blank (1950001-BLK)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1950001-BS1)										
Phosphorus	64.9	2.5	mg/kg	62.5		104	80-120			
Matrix Spike (1950001-MS1)		Source: P910162-01								
Phosphorus	261	2.5	mg/kg	62.5	220	64.7	75-125			M2
Matrix Spike Dup (1950001-MSD1)		Source: P910162-01								
Phosphorus	265	2.5	mg/kg	62.5	220	70.7	75-125	1.43	20%	M2

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/MS/MSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

M2 - Matrix spike recovery was outside quality control limits. The associated LCS spike recovery was acceptable.

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Analytical Report

Report Summary

Client: Wade Campbell
Samples Received : 11/15/2019
Work Order: P911075
Project Name/Location: ENPLP 3

Report Reviewed by: Walter Hinchman **Date:** 12/10/19

Walter Hinchman, Laboratory Director

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	11/15/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P911075	Date Reported:	12/10/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 78825-S55 P911075-01	Phosphorus	146	2.5 mg/kg	1	1949012	11/3/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 78825-S57 P911075-02	Phosphorus	203	2.5 mg/kg	1	1949012	11/3/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 78825-S58 P911075-03	Phosphorus	152	2.5 mg/kg	1	1949012	11/3/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 78825-S59 P911075-04	Phosphorus	168	2.5 mg/kg	1	1949012	11/3/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 78825-S60.1 P911075-05	Phosphorus	206	2.5 mg/kg	1	1949012	11/3/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 78825-S60.2 P911075-06	Phosphorus	182	2.5 mg/kg	1	1949012	11/3/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 78825-S61 P911075-07	Phosphorus	127	2.5 mg/kg	1	1949012	11/3/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 78825-S62 P911075-08	Phosphorus	142	2.5 mg/kg	1	1949012	11/3/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 78825-S67 P911075-09	Phosphorus	177	2.5 mg/kg	1	1949012	11/3/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 78825-S70.1 P911075-10	Phosphorus	251	2.5 mg/kg	1	1949012	11/3/2019	12/3/2019	12/9/2019	
Client ID: Lab ID	LA 78825-S70.2 P911075-11	Phosphorus	155	2.5 mg/kg	1	1949012	11/3/2019	12/3/2019	12/9/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	12/10/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 12/3/2019

Analyzed: 12/09/2019

Batch 1949012 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD %	RPD Limits	Notes
Blank (1949012-BLK)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1949012-BS1)										
Phosphorus	60.3	2.5	mg/kg	62.5		96.4	80-120			
Matrix Spike (1949012-MS1)		Source: P910160-01								
Phosphorus	244	2.5	mg/kg	62.5	192	83	75-125			
Matrix Spike Dup (1949012-MSD1)		Source: P910160-01								
Phosphorus	227	2.5	mg/kg	62.5	192	55	75-125	7.29	20%	M2

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/MS/MSD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

M2 - Matrix spike recovery was outside quality control limits. The associated LCS spike recovery was acceptable.

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Analytical Report

Report Summary

Client: Wade Campbell
Samples Received : 11/15/2019
Work Order: P911076
Project Name/Location: ENPLP 3

Report Reviewed by: Walter Hinchman **Date:** 12/30/19

Walter Hinchman, Laboratory Director

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Analytical Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received: 11/15/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P911076	Date Reported: 12/20/2019
City, State, Zip:	Bloomfield, NM 87413					

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA83529-S1 P911076-01	Phosphorus	111	10 mg/kg	4	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S2 P911076-02	Phosphorus	161	10 mg/kg	4	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S3 P911076-03	Phosphorus	187	10 mg/kg	4	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S4.1 P911076-04	Phosphorus	159	10 mg/kg	4	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S4.2 P911076-05	Phosphorus	137	10 mg/kg	4	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S5 P911076-06	Phosphorus	234	10 mg/kg	4	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S6 P911076-07	Phosphorus	205	10 mg/kg	4	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S7 P911076-08	Phosphorus	207	10 mg/kg	4	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S8.1 P911076-09	Phosphorus	222	10 mg/kg	4	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S8.2 P911076-10	Phosphorus	648	10 mg/kg	4	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S8.3 P911076-11	Phosphorus	174	10 mg/kg	4	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S9 P911076-12	Phosphorus	205	10 mg/kg	4	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S10 P911076-13	Phosphorus	270	10 mg/kg	4	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S11 P911076-14	Phosphorus	89.9	2.5 mg/kg	1	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S12 P911076-15	Phosphorus	63.7	2.5 mg/kg	1	1952012	11/5/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S13.1 P911076-16	Phosphorus	82.1	2.5 mg/kg	1	1952012	10/30/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S14 P911076-17	Phosphorus	48.7	2.5 mg/kg	1	1952012	10/30/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA83529-S15.1 P911076-18	Phosphorus	101	2.5 mg/kg	1	1952012	10/30/2019	12/24/2019	12/27/2019	

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Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	11/15/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P911076	Date Reported:	12/30/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 83529-16 P911076-19	Phosphorus	214	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529-17.1 P911076-20	Phosphorus	80.3	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529-18 P911076-21	Phosphorus	162	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-19.2 P911076-22	Phosphorus	170	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-20 P911076-23	Phosphorus	150	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-21 P911076-24	Phosphorus	145	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-22.1 P911076-25	Phosphorus	129	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-22.2 P911076-26	Phosphorus	95.4	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-23 P911076-27	Phosphorus	170	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-24.1 P911076-28	Phosphorus	228	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-25 P911076-29	Phosphorus	115	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-26.1 P911076-30	Phosphorus	109	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-27.1 P911076-31	Phosphorus	21.5	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-27.2 P911076-32	Phosphorus	779	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-28 P911076-33	Phosphorus	151	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-29.1 P911076-34	Phosphorus	121	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-30.1 P911076-35	Phosphorus	177	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	
Client ID: Lab ID	LA 83529-31.1 P911076-36	Phosphorus	191	2.5 mg/kg	1	1952012	11/6/2019	12/18/2019	12/27/2019	

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Client:	Wade Campbell	Project Name:	ENPLP 3	Job Number:		Date Received:	11/15/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell	Work Order:	P911076	Date Reported:	12/30/2019
City, State, Zip:	Bloomfield, NM 87413						

Total Metals
EPA Method 6010C - M*

Sample ID		Parameter	Concentration	Reporting Limit	Dilution	Batch	Date Sampled	Date Prepared	Date Analyzed	Notes
Client ID: Lab ID	LA 83529- S32 P911076-37	Phosphorus	86.5	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529- S33.1 P911076-38	Phosphorus	169	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529- S34.1 P911076-39	Phosphorus	92.5	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529- S35.1 P911076-40	Phosphorus	146	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529- S36 P911076-41	Phosphorus	163	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529- S37 P911076-42	Phosphorus	97.8	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529- S38 P911076-43	Phosphorus	121	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529- S40 P911076-44	Phosphorus	75.1	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529- S42 P911076-45	Phosphorus	117	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529- S43.1 P911076-46	Phosphorus	88.4	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529- S44.1 P911076-47	Phosphorus	113	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529- S45 P911076-48	Phosphorus	66.9	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529- S46 P911076-49	Phosphorus	82.9	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	
Client ID: Lab ID	LA 83529- S47.1 P911076-50	Phosphorus	104	2.5 mg/kg	1	1952012	11/6/2019	12/24/2019	12/27/2019	

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QC Summary Report

Client:	Wade Campbell	Project Name:	ENPLP 3	Date Reported:	12/30/2019
Street Address:	1501 Saiz Lane Apt 1	Project Manager:	Wade Campbell		
City, State, Zip:	Bloomfield, NM 87413				

Total Metals
EPA Method 6010C - M*

Prepared: 12/24/2019

Analyzed: 12/30/2019

Batch 1952012 - Metals Block Digestion EPA 3050B

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	Rec %	% Rec Limits	RPD %	RPD Limits	Notes
Blank (1952012-BLK)										
Phosphorus	ND	2.5	mg/kg							
Laboratory Control Sample (1952012-BS1)										
Phosphorus	62.8	2.5	mg/kg	62.5		101	80-120			
Laboratory Control Sample DUP (1952012-BSD1)										
Phosphorus	62.7	2.5	mg/kg	62.5		100	80-120	0.239	20	

Comments:

Calculations are based off of raw (non-rounded) data. However, for reporting purposes, all QC data is rounded to three significant figures. Therefore, hand calculated values may differ slightly.

*Method 6010C batch volumes were modified from the typical 20 sample set to batches of 50 samples or less to include a MB/LCS/LCD.

Notes and Definitions:

ND - Analyte NOT DETECTED at or above the reporting limit

RPD - Relative Percent Difference

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Bibliography

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