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Viewscales and Soundscapes

By Ruth M. Van Dyke, Timothy De Smet, and R. Kyle Bocinsky

In Keith Basso's (1996) famous ethnography, *Wisdom Sits in Places*, he and his Apache interlocutors eloquently demonstrated the importance of a sensory, human experience of the landscape for Native inhabitants of the American Southwest. Yet, despite the presence of vibrant descendant communities and awe-inspiring topography, there has been relatively little archaeological work on the Chacoan landscape focused specifically on the senses. There are good reasons for this. The study of sensory experience is difficult and problematic on many levels (see for example Day 2013; Hamilakis 2012). Phenomenological research is often (and perhaps justifiably) viewed with a healthy dose of skepticism by Southwest archaeologists trained in processual traditions. But Chacoan ceremonialism, like Pueblo and Navajo ceremonialism today, must have had vibrant sensory dimensions. We will never understand Chaco without explorations into the sensory human experience on the Chaco landscape.

In this chapter, we forge a productive path forward combining systematic data collection, ArcGIS modeling, and video footage. We focus on viewscales and soundscapes. We use the term *viewscale* rather than the more familiar *viewshed* to underscore that – although our techniques incorporate GIS modeling – we move beyond the model to encompass lived, experiential dimensions of sight on the landscape. In the first part of the chapter, we provide background for our work, describing previous research on viewscales and soundscapes in the Chaco world. We then turn to two case studies on the greater Chacoan landscape: the outliers of Bis sa'ani, and Pierre's (Figure 8.1). We use the two case studies to illustrate our methods, and to demonstrate the impact of oil and gas extraction on sensory experience within outlier communities. Bis sa'ani is in a relatively pristine environment with little energy extraction infrastructure. Pierre's, by contrast, is in the center of the Mancos Shale oil and gas development area. The chapter concludes with our recommendations for archaeologists and land managers to better record, study, understand, and protect the visual and auditory dimensions of the greater Chaco landscape.

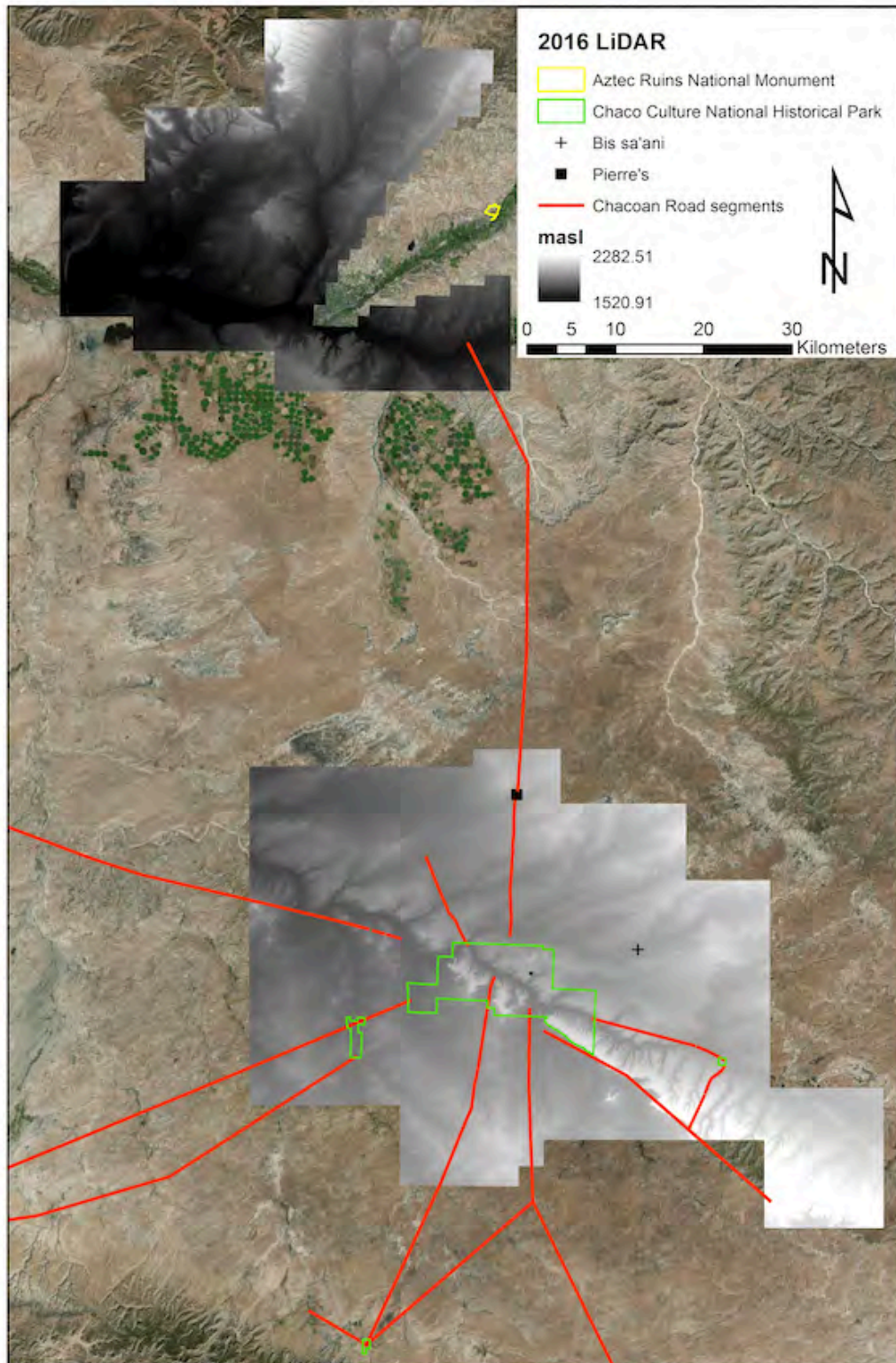


Figure 8.1. The central Chaco Canyon area, showing locations of Bis sa'ani and Pierre's great house communities.

Chacoan Viewscapes

Viewscapes are an important part of the Chacoan experience, past and present. The human eye can see for great distances on the Colorado Plateau, where many high places are intervisible due to the elevated topography and the clear, open skies. Although the name Chaco Canyon suggests depth, Fajada Butte and the mesas that form the canyon walls are some of the highest points in the surrounding San Juan Basin, affording spectacular visibility for over 100 km in nearly all directions. From these high places, Huerfano Mountain, the San Juan Mountains, the Nacimiento Mountains, Mount Taylor, the Dutton Plateau, Hosta Butte, the Chuska Mountains, and Shiprock punctuate Chaco's horizons. Archaeoastronomers, GIS-based scholars, and phenomenologists are among those interested in the study of visibility — who can see whom, and what can be seen — across the Chaco landscape. We know that viewscapes are critical for understanding Chaco, because (1) descendant communities incorporate dramatic topography into their cosmographies and ideologies; (2) descendant communities value the dualistic opposition between highly visible and hidden elements of the landscape and the material world; (3) Chacoans frequently positioned great houses and other features on highly visible terrain; and (4) Chacoans marked solar and lunar phenomena.

In Pueblo and Navajo worldviews, dramatic topographic features such as highly visible mountain peaks and hidden canyons mark mythic events, homelands and sacred directions. The rugged Colorado Plateau topography contains landmarks by which to measure the movements of celestial bodies throughout the year (e.g., Parsons 1939). We know that Chacoans carefully marked solstices, equinoxes, and lunar standstills with great house alignments and with rock art, such as the Sun Dagger petroglyph atop Fajada Butte (Sofaer 2007) and the Chimney Rock outlier great house in southwest Colorado (Malville 2004). At Chimney Rock, during a major lunar standstill year on the full moonrise nearest the winter solstice, the full moon ascends directly between the two natural rock pinnacles that tower over the great house, moving through a narrow passage from the earth into the sky.

Chacoan great houses often are situated in visually prominent locations on elevated terrain (Van Dyke 2007:169-199). Enigmatic features such as shrines, stone circles, and cairns in high places further enhance intervisible connections among Chacoan sites (Van Dyke et al. 2016; Van Dyke, this volume). For example, Chacoans positioned a stone circle atop the canyon's north rim to create a line of sight through South Gap to Hosta Butte (Van Dyke 2007:155, Figure 6.6). There could be many reasons for this Chacoan emphasis on elevated positions, and these may have involved desires both *to see* and *to be seen* (Van Dyke et al. 2016:3). At the local level, Chacoans may have wanted to surveil or keep an eye on others in the community, and /or people on high places may have wanted to be seen by others in the community. At the regional level, Chacoans may have wanted to create visual connections beyond local communities, linking neighboring communities and/or linking themselves to Chaco Canyon. These connections could have been for communication, or to foster a sense of common identity, or both (see for example Bernardini et al. 2013; Bernardini and Peebles 2015). It is likely that intervisibility among high places, great houses, and communities helped weave together the fabric of the Chacoan world.

GIS has proven to be an excellent tool for examining and modeling visible connections over large areas such as greater Chaco. GIS-based visibility studies usually focus on determining lines-of-sight, viewnets, and viewsheds (Wheatley 1995; Wheatley and Gillings 2002). Lines-of-sight involve the reciprocal ability of people at two locations to see one another. For example, GIS analysis predicts (and experiments have confirmed) that a person standing atop Pueblo Alto and a person standing atop Pierre's El Faro can signal to one another using mirrors (Chacoans probably used selenite). Viewnet analysis uses GIS modeling to identify networks of locations connected by lines of sight. Bocinsky (Van Dyke et al. 2016:222, Figure 7) generated viewnets to demonstrate that 74% of Chacoan great houses can see at least one other great house, for example. Viewshed analysis identifies the surrounding terrain and features that can be seen from a particular location. Many Chaco scholars are working with GIS line-of-sight and viewshed analyses in attempts to look at visibility within Chacoan communities, within areas of 10 – 25 sq km. See for example Kantner and Hobgood (2003) at Kin Ya'a, Dungan (2009) at Kin Bineola, and Ellenberger (2012) at Kin Klizhin. Bocinsky (Van Dyke et al. 2016:222) used cumulative viewshed analysis to learn that 258 Chacoan great houses can see 30% of all the terrain within an 160,000 sq mi area of the Chacoan world. These kinds of analyses, involving hundreds of potential viewpoints and thousands of sq mi in area, can only practically be carried out using GIS.

Although GIS studies and remote aerial data are undeniably useful, GIS analyses can never tell us whether visibility was meaningful (Frieman and Gillings 2007; Hacgüzeller 2012; Llobera 2007). Top-down modeling studies are useful at reconstructing past connections and pinpointing possible relationships, but because we are ultimately interested in the experiences of human bodies, we consider it best to combine GIS analyses with phenomenological, on-the-ground, embodied field-based investigations. Again, we here employ the term *viewscape* to move the conversation beyond viewshed or line-of-sight modeling within GIS, to encompass the lived, experiential dimension of visibility on the Chacoan landscape.

In this study, we study viewsapes using GIS analyses in tandem with phenomenological methods. Early critics of phenomenology in archaeology were concerned with subjectivity and lack of replicability (Brück 2005), but good phenomenological research can be both systematic and replicable (see for example Hamilton and Whitehouse 2006). Van Dyke has developed a method for documenting viewsapes that incorporates still and video photography as well as paper forms, top-down maps, and DEMs. She first establishes locations that are likely to have been important viewsapes – these are usually pinnacles or high places such as great houses or unusual topographic features topped with ERFs (see Chapter 5, this volume). For comparison, she also chooses locations with more restricted viewsapes, such as a small community site at the base of a pinnacle. From each point, she uses digital and video cameras to record the 360 degree panorama. Video camera offers the added benefit that she can narrate what her human eye can see as the camera turns. On paper, she sketches the visible attributes of the near, intermediate, and far horizons using a modified version of Hamilton and Whitehouse's (2006) circle maps. We then juxtapose this information with top-down maps of archaeological features and digital elevation models of the terrain. The result is a comprehensive digital record of a viewscape from a particular location, such as a great house. The different kinds of

information can be combined in programs such as iMovie to show how different recording techniques highlight different kinds of visible attributes, and to make the results accessible to a reader or viewer.

In the second half of this chapter, we illustrate these techniques at the Chaco outliers of Bis sa'ani and Pierre's. But first, we turn to a short review of the study of Chacoan soundscapes.

Chacoan Soundscapes

Archaeologists have only recently begun to study soundscapes (e.g., Miller 2008; Scarre and Lawson 2006; Schofield 2014; Till 2014; Villanueva-Rivera et al. 2011). A soundscape is defined as “any sonic environment, with particular emphasis on the way it is perceived and understood by an individual or by a society” (Truax in Elliot and Hughes 2014:306). In the Chacoan world, sounds created by human voices, animals, water, wind, thunderstorms, daily activities and musical instruments would have been part of the fabric of life. Previous researchers have thought a lot about sound from the perspective of musical instruments. Pueblo peoples used a wide variety of percussion and wind instruments: drums, copper bells, kiva bells, tinklers, rasps, bullroarers, conch shell trumpets, flutes, and whistles (see Brown 2005 for a comprehensive discussion). Acoustic researchers at Chaco have been particularly interested in conch shell trumpets – an instrument likely employed in the context of ritual events at Chaco. By removing the pointed end and then blowing through the whorls of these exotic shells, it is possible to create a very loud blast. Trumpets made from the shells of Pacific ocean conch, particularly *Strombus* sp. and *Murex* sp., are found in very small numbers from contexts across the Southwest (Brown 2005:291-305; Mills and Ferguson 2008; Vokes and Gregory 2007). Out of 46 known conch shells or fragments in the Southwest, 17 were found in Chaco Canyon, and one was found with Chaco's most elaborate burial under a plank floor in Room 33 of Pueblo Bonito (Brown 2005:299-300; Mills and Ferguson 2008:347, Table 1).

Richard Loose and his colleagues have used experiments to explore the resonance of conch shell trumpets in Chacoan settings. Loose (2012) recreated a shell trumpet using a *Strombus galeatus* shell, and he used digital software to measure the pitch and loudness when blown. His 20 cm long experimental shell trumpet produced a 96 decibel sound at 329.84 Hz, with harmonic overtones at 650 and 974.4 Hz. (This is approximately the decibel level produced by a motorcycle or a handheld drill). Loose notes that pitch and loudness would vary, however, depending on each shell's bore configuration as well as the volume of air forced through the bores. Loose deployed his experimental trumpet in acoustic research carried out with John Stein, Richard Friedman and others in front of a toric sandstone cliff face in downtown Chaco Canyon, between the great houses of Pueblo Bonito and Chetro Ketl (Loose 2008, 2010; Stein et al. 2007). In Navajo oral traditions, this cliff face is called Tse' Biinaholts'a Yalti, or Curved Rock That Speaks, and it is where deities taught Navajo hero twins how to produce the vocal tones used in ritual chants, accompanied by shell trumpet, eagle bone whistle, and reed flute. The investigators measured the sandstone cliff at approximately 150 m long x 25 m high and dubbed the region in front of it “the amphitheatre,” due to the interesting acoustic effects they observed. Over multiple occasions, the researchers played amplified

music, sine waves, flutes, and conch shell trumpets in the amphitheatre, acquiring 5 hours of experimental recordings. Reverberations in the amphitheatre last for 2 seconds (comparable to a concert hall), and there is a secondary echo with a 3.5 second delay from across the canyon to the south. The torus curve of the cliff causes unusual effects, including virtual sound image, in which sounds seemed to be emanating from within the cliff, and acousma, in which sounds produced nearby were heard as garbled or spooky, unintelligible noises. Stein et al. (2007) conclude that the amphitheatre was intentionally used by Chacoans during ritual performance events.

GIS is a useful tool for acoustic studies, just as with visibility studies. It is very challenging to study archaeo-acoustics across open-air areas such as a Chacoan outlier community, but GIS modeling can help. Working towards this end, Primeau and Witt (2018) developed a soundshed analysis tool for ArcGIS that takes into account distances, physical barriers, air temperature, relative humidity, and ambient sound pressure. After evaluating their tool in a controlled setting, they employed it to replicate and analyze the sound of a conch shell trumpet blown at dawn from outside Pueblo Bonito in downtown Chaco Canyon. Primeau and Witt discovered that certain features such as stone circles on the canyon rims might be positioned to be able to hear this kind of event. Primeau and Witt's work offers a promising way forward to evaluate speculations regarding the performative resonances of musical instruments and chants during ceremonies and processions in Chaco Canyon (Van Dyke 2013; Weiner 2015).

In our study, De Smet followed Primeau and Witt's (2018) procedures to model soundscapes in the Bis sa'ani and the Pierre's communities. He specifically focused on the reach of three kinds of sounds: a (male?) human shout, a blast from a conch shell trumpet, and the noise produced by an active drill rig. To model the spread and attenuation of sound, he input nine model parameters: a 1 m LiDAR digital elevation model (DEM) raster, sound source location points, and 7 user-determined variables. He used the frequency (Hz), source sound level (dB), source sound height (m), source measurement distance (m), temperature (°C), and relative humidity (%) variables to calculate the resulting A-weighted sound pressure levels (dBA) at a specified receiver measurement height (human ear height) of 1.524 m, or about 5 feet (Table 8.1). These input variables allow the model to calculate for attenuation of the sound source signal, namely: spherical spreading loss (distance), atmospheric absorption loss (temperature, humidity, elevation), and terrain effects (ground and barrier loss). These models assume no wind speed or direction. The results of DeSmet's modeling exercises are striking, and we present them within the context of our two case studies below.

Table 8.1. Sound model variables for raised voice, conch trumpet, and pump jack sources.

Model inputs	Raised Voice	Conch Trumpet	Pump Jack
Sound source height (m)	1.524	1.8288	1.828
Frequency (Hz)	325	330	500
Source sound level (dB)	84	96	82
Source measurement distance (m)	0.9144	0.30483	15.24
Temperature (°C)	32	32	32
Relative humidity (%)	30	30	30
Receiver measurement height (m)	1.524	1.524	1.524

Case Studies: Bis sa’ani and Pierre’s

The Chaco outliers of Bis sa’ani and Pierre’s are ideal cases upon which to demonstrate our viewscape and soundscape study methods. Both communities are well-studied, with accurate and detailed community site information. Both are relatively close to Chaco, on terrain with striking topographic features, and both were most intensively occupied during the early AD 1100s. However, there is one important difference between the two communities. The terrain surrounding Bis sa’ani has not been subjected to intensive oil and gas infrastructure development, while the terrain surrounding Pierre’s is at the center of Mancos Shale energy development. Thus, the two communities form an ideal pair within which to contrast the impacts of energy development on viewscales and soundscapes.

Bis sa’ani

The Bis sa’ani outlier is situated approximately 12 km northeast of Chaco Canyon. East Great House and West Great House structures perch atop a prominent shale ridge on the south side of Escavada Wash (Figure 8.2). Sixteen small habitations and field houses form an associated community in the aeolian dunes to the south (Figure 8.3). Powers et al. (1983:21-54) intensively surveyed a 3.2 diameter area around the great houses and mapped the great houses and community. Breternitz et al. (1982) conducted extensive excavations at the great houses and some of the small sites. No known road segments connect Bis sa’ani to Chaco Canyon.

The two south-facing great houses are “rather precariously situated” atop an isolated 750 m-long shale ridge; the narrow ridge measures at least 20 m high but only 20-50 m wide (Powers et al. 1983:21). The West House contains 12 rooms and a kiva. A little over 100 m to the east, the East House contains at least 25 rooms and 4 kivas with a total floor area of at least 1040 sq m. Breternitz et al. organized the East House into 4 substructures: Casa Hormiga (to the east), Casa Quemada (in the center), South House (to the south), and Rabbit House (to the west) (Figure 8.4). Builders erected Casa Hormiga, South House, and Rabbit House using sandstone core-and-veneer,

but they used burned adobe – a highly unusual Chacoan construction technique – to construct the aptly named Casa Quemada.



Figure 8.2. Bis sa'ani great house, looking north. Photo by Ruth Van Dyke.

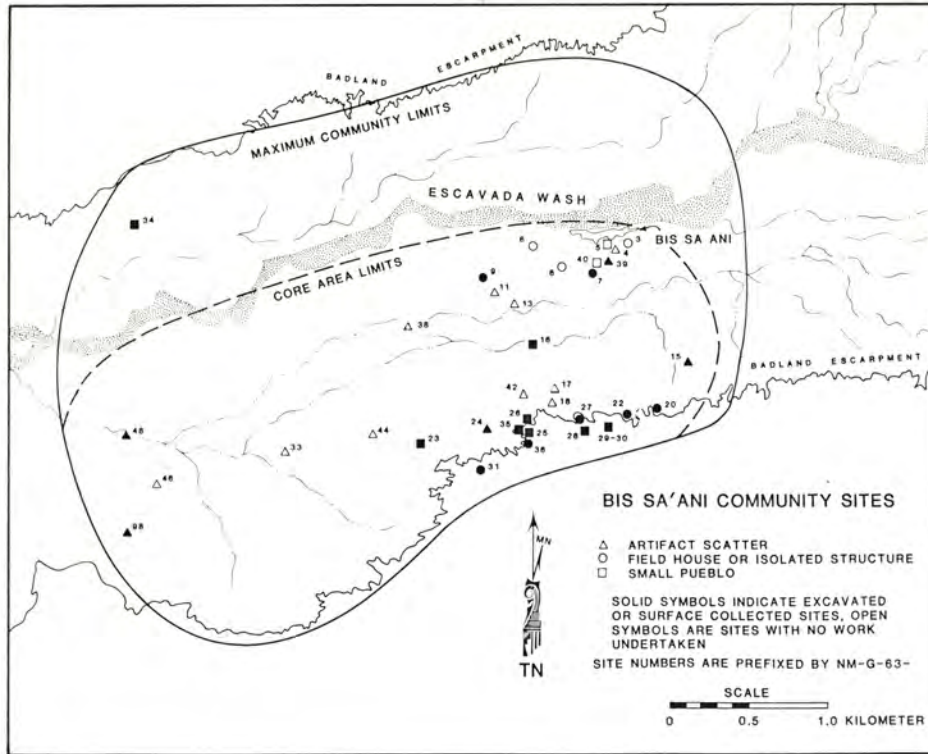


Figure 8.3. Map of the Bis sa'ani community, from Breternitz et al. 1982.

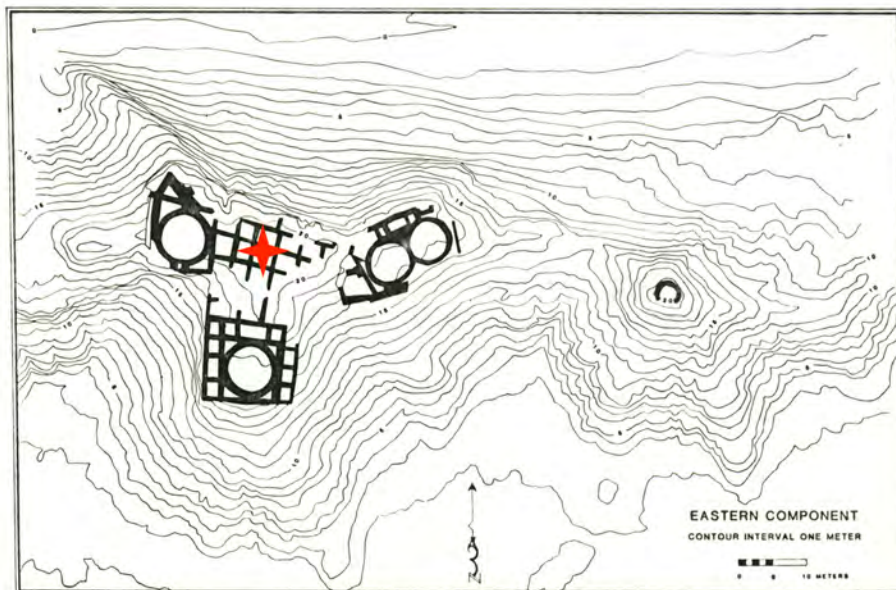


Figure 8.4. Eastern component of Bis sa'ani great house, with Casa Quemada denoted by red star. Modified from Breternitz et al. 1982.

Van Dyke visited Bis sa’ani on a clear summer morning in June 2017. She chose Casa Quemada – the highest and most central area – as the representative viewpoint for the East House at Bis sa’ani. Van Dyke recorded the 360° panoramic viewscape from Casa Quemada atop the East House at Bis sa’ani using three techniques: circle drawings; still photography; and digital video. She confirmed the coordinates of her location using a handheld GPS, and she established cardinal directions using a Silva Ranger compass calibrated to true north. First, she used a graphic method of field recording developed by Hamilton and Whitehouse (2006) to create 360° circular drawings of the prominent visible elements from each location (Figure 8.5).

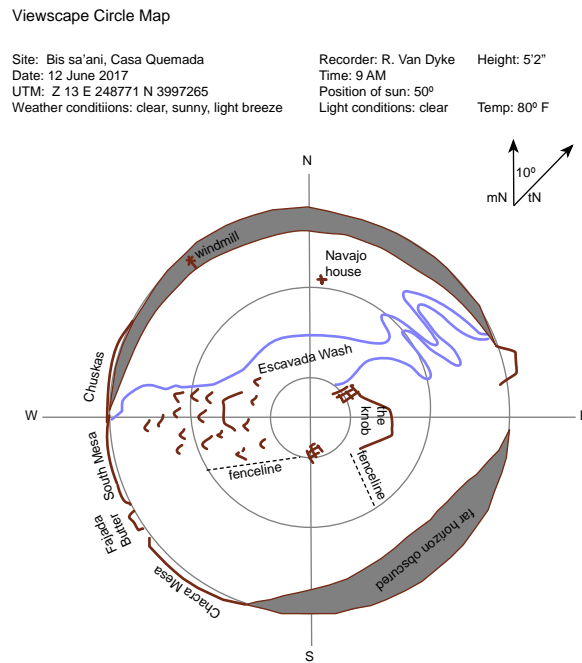


Figure 8.5. Example of a circle map: viewscape from Casa Quemada, Bis sa’ani. Graphic by Ruth Van Dyke.

These drawings include 3 sight horizons (near distance, middle distance, and final horizon). Within each horizon, and using the compass for accuracy, she noted major topographic and architectural features. Second, from the same location, she used a Pentax K200D 10.2 mega-pixel digital SLR camera to capture a series of still photographs in 360° circumference. Third, she used an iPhone 6 with a 29-mm lens and 8 mega-pixel resolution to shoot high definition (1080 pixel) video in 360° at 60 frames/second. She mounted the iPhone on a tripod for stability and rotated it by hand, while narrating a description of the views. The background narration provides notes useful in pulling together the final viewscape. Back from the field, Van Dyke used iMovie to create a short video illustrating the Casa Quemada viewscape. The resulting short video combines Van Dyke’s field data with Breternitz et al.’s (1982) top-down maps and Bocinsky’s GIS-modeled viewsheds and line-of-sight analyses to present a short,

seamless illustration of what a human observer standing atop Casa Quemada can see. The video is available at: <https://youtu.be/RyRTn5ThINE>

The viewscape at Bis sa'ani linked the community with the greater Chacoan world. Upon initial entry, Bis sa'ani seems its own self-enclosed world on the banks of the Escavada. From the valley floor within Bis sa'ani, the shale ridge with the great houses is a prominent location, but a viewer can see neither Chaco Canyon nor any of its familiar landmarks (e.g., Fajada Butte, Huerfano Mesa). Furthermore, not all of the community sites are intervisible with the great houses. However, the viewscape afforded by the great houses on the ridge tells a different story. From this vantage point, someone walking to Bis sa'ani from Chaco along the Escavada Wash would see the great house silhouetted against the sky long before they arrived in the community. And, someone standing atop any of the great houses could see Fajada Butte, central Chaco Canyon, and ERF locations atop Chacra Mesa and South Mesa. The viewscape also links Bis sa'ni to communities far beyond Chaco Canyon. Not only could a viewer standing atop Casa Quemada see 90 km west to the Chuska Mountains, but (perhaps more importantly) this viewer could see White Rock, a landform 40 km to the west. Van Dyke et al. (2016) identified White Rock as a major node in the Chacoan great house viewnet – in other words, the great houses at Bis sa'ani were linked to scores of Chacoan outliers in the western San Juan Basin and beyond, through intervisibility with White Rock. So, although early 1100s Bis sa'ani residents may have moved east up the Escavada Wash and out of Chaco Canyon's direct purview, they were not by any means visually separated from doings in Chaco Canyon or more distant outliers. The builders of Bis sa'ani appear to have intentionally situated their great houses atop the "precarious" shale ridge not for intervisibility with the immediate community of small sites, but to maintain connections with the greater Chacoan world.

The soundscape at Bis sa'ani tells a different, but equally compelling story. As with the viewscape, we were interested in exploring how the position of the great houses atop the shale ridge might, or might not, affect acoustics across the community. Using the procedures outlined previously and the variables presented in Table 8.1, DeSmet created a GIS model for the reach of a human shout (Figure 8.6) and the blast of a conch shell trumpet (Figure 8.7) emanating from atop the West Great House. We found that both sounds traveled outward for distances up to 3 kilometers. The shout extended across most of the community, but it failed to reach two small pueblos, two field houses, and an artifact scatter situated on the outskirts. The conch shell trumpet blast, however, reached every one of the 34 sites in the community. In fact, the extent of the conch shell trumpet blast mapped surprisingly well onto the boundaries of the Bis sa'ani community as previously defined by archaeological survey.

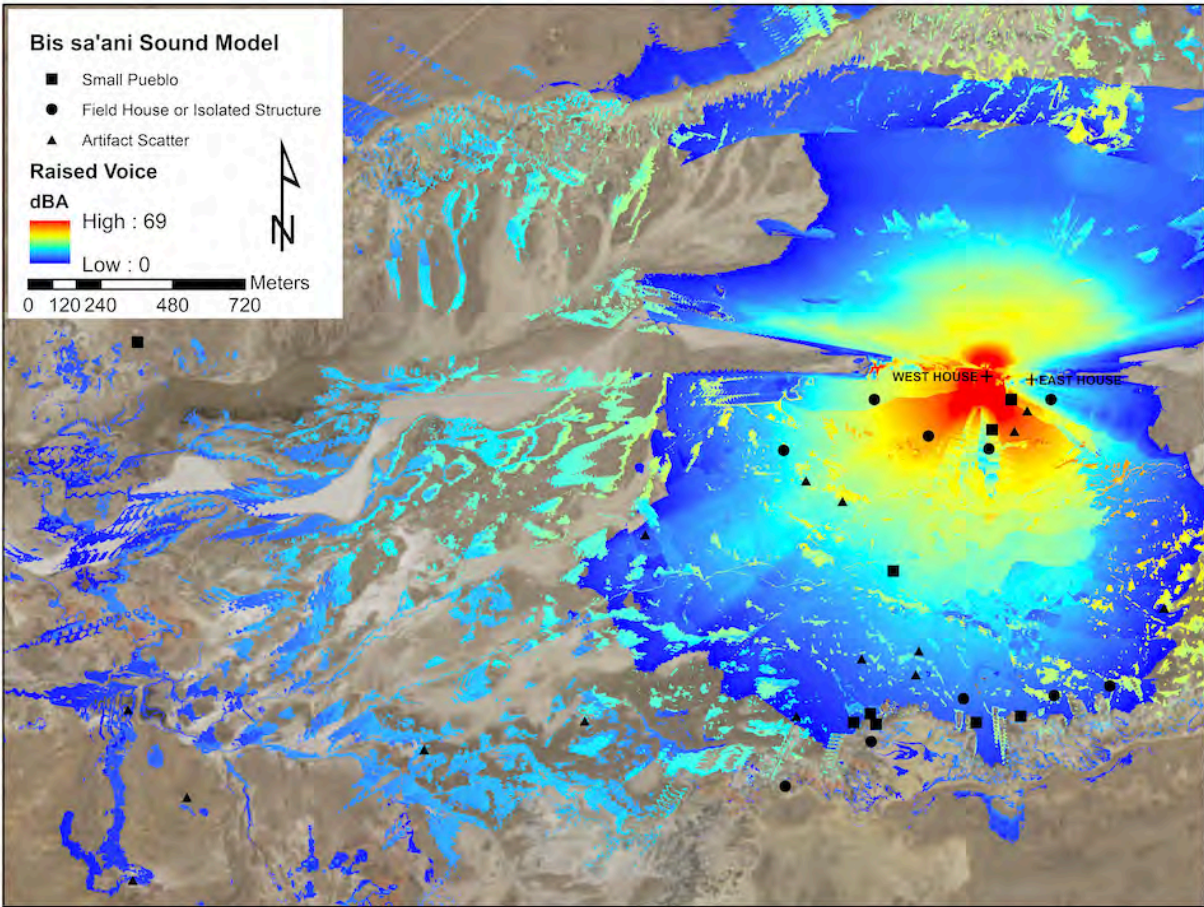


Figure 8.6. Reach of a human shout emanating from the West Great House at Bis sa'ani. Model and graphic by Tim DeSmet.

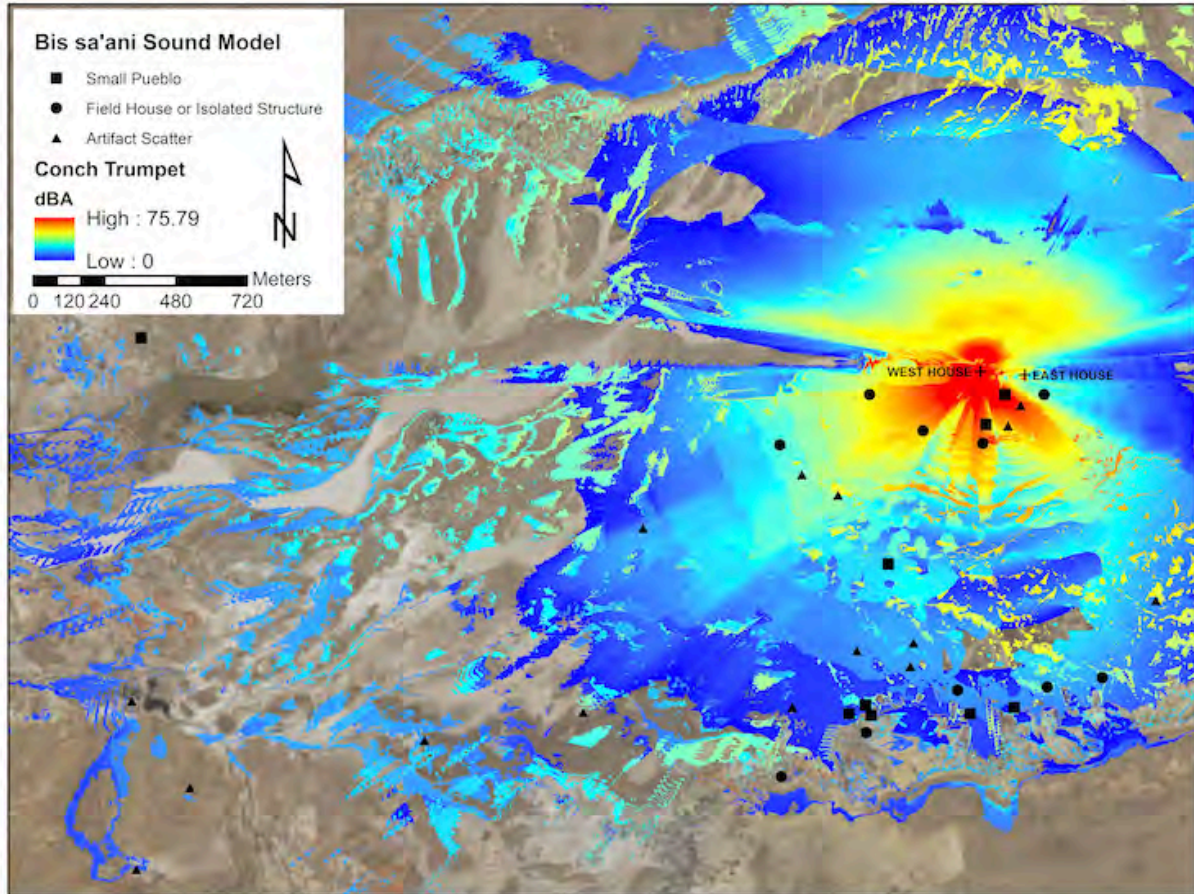


Figure 8.7. Reach of a conch shell blast emanating from the West Great House at Bis sa'ani. Model and graphic by Tim DeSmet.

To date, most Chaco researchers interested in the sensory dimensions of outlier communities have focused exclusively on the intervisibility of great houses with community sites. Our experimental soundscape results suggest that the acoustic reach of a conch shell blast may be even more important. If leaders atop great houses needed to quickly communicate with all community residents, a conch shell blast would have been a much more effective method than relying upon community residents to look in the right direction at the right time. It is possible that community boundaries map onto the extent of the conch shell blast because community members did not wish to live where they could not be reached.

We were able to examine viewsapes and soundscapes at Bis sa'ani with little interference from modern landscape intrusions. The Bis sa'ani area is remote and sparsely populated, and there has been little to no impact from energy development in the area. Although we are aware that the ancient visual and acoustic landscapes would have differed from the contemporary landscape, there was no need for us to attempt to remove or counterbalance modern intrusions such as those created by gas wells. For counterpoint, we

turn now to the Pierre's community, situated in the midst of Mancos Shale energy development.

Pierre's

The Chacoan outlier of Pierre's is situated 19 km north of Chaco Culture National Historical Park, on the southern edge of the break between the Chaco Slope and the mesas and badlands of the Denazin and Ah-shi-sle-pah Washes, on the USGS 7.5' Pueblo Bonito NW quadrangle. The outlier is clearly articulated with the Great North Road, which leaves the vicinity of Pueblo Alto and, in a series of stages, heads north to Kutz Canyon, 50.5 km distant (Figure 8.8). Powers et al. (1983:94-122) and Harper et al. (1988) both conducted intensive survey and recording in the Pierre's community during the 1980s. The community was also investigated by the Chaco Roads Project (Stein 1983) and the Solstice Project (Marshall and Sofaer 1988). The Pierre's community is spatially distributed over an area of approximately 1.6 sq km. Powers et al. documented 17 Ancient Pueblo sites in the surrounding community, and Harper et al. added an additional nine. All but one small Basketmaker III - Pueblo I artifact scatter date from the Late Pueblo II or Early Pueblo III period.

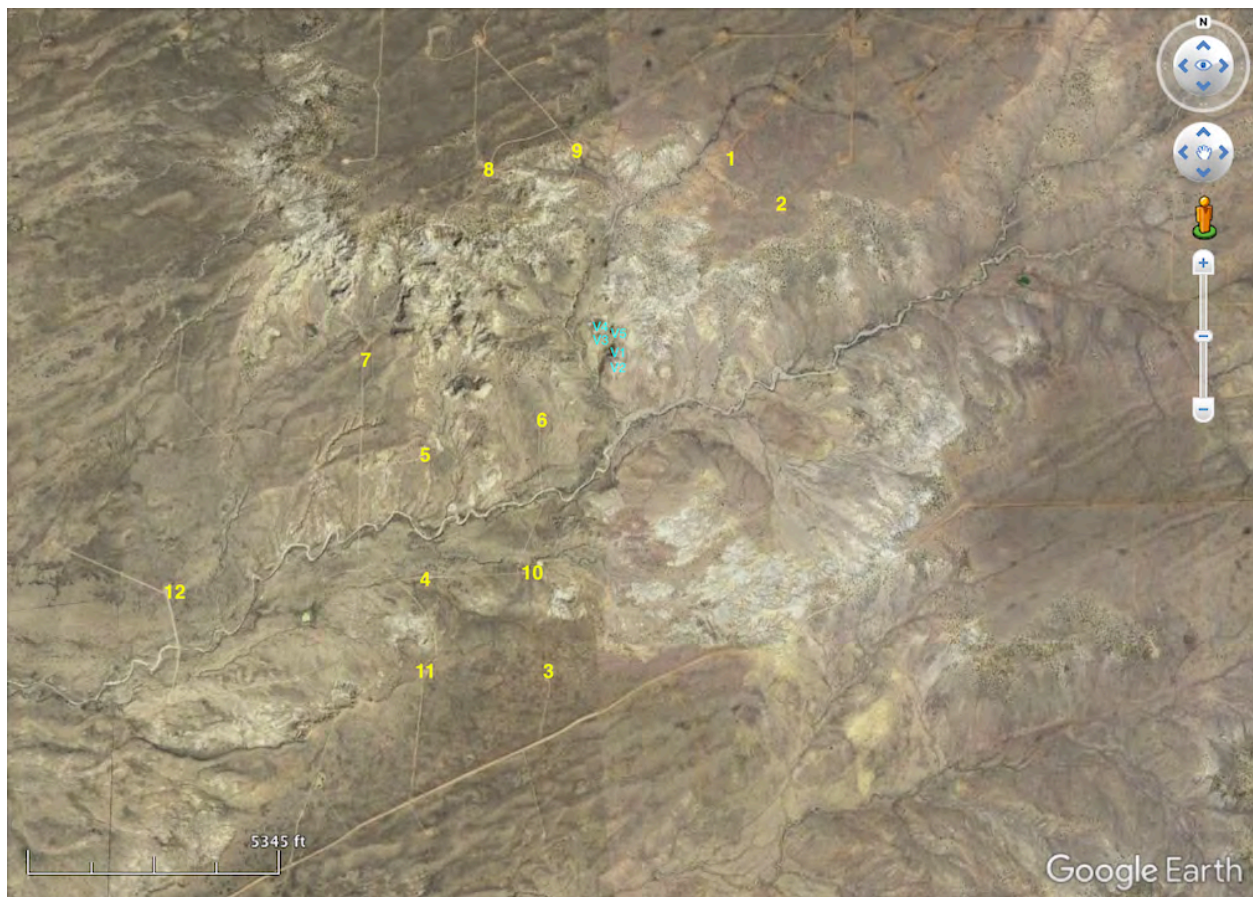


Figure 8.8. The Pierre's landscape, with numbered viewpoints and drill rigs corresponding to Van Dyke's viewscape videos.

There are several Bonito style structures in the community (Figure 8.9). The "Acropolis" cluster consists of two core-and-veneer structures (LA 16509, House A and LA 16508, House B) atop a large butte near the center of the community. House A contains an estimated 15 ground floor rooms and 3 enclosed kivas over an area of 255 sq m. House B is located 30 m to the north/northeast of LA 16509. House B contains an estimated 13 ground floor rooms and a single enclosed kiva and covers 315 sq m. An additional structure, House C (LA 35423), is an isolated room located approximately 5 m northwest of LA 16509; although the room was given a separate site number by the Chaco Roads Project, Harper et al. (1988:119) contend that House C should be considered part of LA 16508.



Figure 8.9. Pierre's Great House B (LA 17508), as seen from Great House A (LA 17509), looking north, with three drill rigs prominently on the horizon. Photo by Ruth Van Dyke.

"El Faro," or "The Lighthouse," consists of a pinnacle on the valley floor that is topped by a small, 3- room structure including an exposed hearth (LA 16514, Powers et al.'s P-5). At the base of this pinnacle, there is another massive core-and-veneer building covering 505 sq m, estimated to contain 18 rooms and one enclosed kiva (LA 16515, Powers et al.'s P-6). A neighboring pinnacle 80 m ESE of El Faro hosts at least two small roomblocks, LA 16518 (P-9) and LA 16519 (P-10). LA 16519 is situated directly on top of this second pinnacle and might be considered to represent an "atalaya" or watchtower, following Marshall and Sofaer (1988).

There is little doubt that Chacoans located Pierre's in this place because of the Great North Road and because of specific visible attributes of the local topography. The Great North Road originates at Pueblo Alto. Ancient engineers could have used a simple gnomon device to derive the road's northern bearing (Lekson 2015), but as road surveyors moved north, they likely engineered road segments using backsights. Road construction would have required a clear line of sight, and Pierre's is located on the first major topographic break in the landscape moving north from Chaco Canyon. The pinnacles and butte of Pierre's are visible from Pueblo Alto, and vice versa. Gwinn Vivian and Doug Palmer have conducted experiments with mirrors flashed in the sunlight to establish line-of-sight connections between Pierre's and Pueblo Alto; Van Dyke participated in one of these experiments in September 2015. Hearths atop high places at Pierre's (El Faro, LA 16514, and LA 16519) suggest that the Chacoans were, indeed, interested in signaling between these locations. Looking north along the Great North Road past Pierre's, the next topographic break is Carson Divide (Marshall and Sofaer 1988), also topped by a potential signaling feature. Thus, visibility between Pierre's and Pueblo Alto in Chaco Canyon was a key part of the construction of the Great North Road, and likely continued to be important for signaling between the two areas.

For extended discussions of the possible functions of Chacoan roads and associated features, see Chapters 3, 5, and 10 (this volume). It seems likely that ritual processions or other movements of people took place along Chacoan road segments, particularly when those segments are in the vicinity of outlier great houses. Marshall (1997) suggests that Chacoans processed north along the Great North Road to deposit vessels (and perhaps, symbolically, the dead) in Kutz Canyon. Such possibilities are understudied and could benefit from experimental reconstruction. The Pierre's community, with its clear and strong relationship to the Great North Road, is protected as part of the Chaco Protection Sites group, and was included as part of Chaco's entry on UNESCO's World Heritage List. However, despite the obvious importance of viewsapes at Pierre's, the sensory aspects of this landscape have been little-studied. And, although the Pierre's Chacoan outlier is itself protected from development as part of the Chaco Protection Sites federal legislation, existing laws do little to counter the indirect cumulative adverse sensory impacts of ongoing oil and gas production in the surrounding area.

On a cold, sunny autumn day in November 2016, Van Dyke visited Pierre's to assess these sensory impacts. Following the same procedures as at Bis sa'ani, Van Dyke used digital still photography and video, as well as a variation of Hamilton and Whitehouse's (2006) circle maps, to record 360 degree panoramas from five Chacoan structures in the community. She observed that twelve pumpjacks and five drilling containers are visible from the high places in the community. The nearest pumpjack, Dugan Production Corp Hoss Com #95, is located just outside the Pierre's community only 650 m southwest of the great house butte (Figure 8.10). Because the Pierre's sites – particularly LA 16509 (House A), LA 16508 (House B), LA 16514 (El Faro), and LA 16519 (the atalaya) – are significant in terms of visibility along the Chacoan road, Van Dyke chose these 4 locations for 360 degree viewscape investigation. She also included LA 16515, the large Bonito style structure at the base of El Faro on the basin floor. As at Bis sa'ani, Van Dyke determined cardinal directions using a Silva Ranger compass oriented to magnetic north. She then recorded the 360° viewsapes at each of these locations using circle drawings,

still photography and digital video. She numbered the pumpjacks within the viewsapes from #1 to #12. Back from the field, Van Dyke used the collected data to create 5 short videos in iMovie 10.1.4.



Figure 8.10. Hoss Com #95 (pumpjack #6), 650 m southwest of the Pierre’s community, with LA 16514 (left pinnacle), LA 16519 (labeled), LA 16509 and LA 16508 (top of butte on right) in background. Photo by Ruth Van Dyke.

Viewscape 1 records the 360 degree view from the highest point on LA 16508, Pierre’s Great House B, and Viewscape 2 records the 360 degree view from the highest point on LA 16509, Pierre’s Great House A. The two viewsapes are similar. There are a total of 12 pumpjacks visible. To the north, there are two pumpjacks on the horizon (#1 and #2); the closest of these is approximately 900 m away. There are also three drilling tanks. To the northwest, pumpjack #9, which is painted camouflage colors, is visible on the horizon next to a drill tank. Pumpjack #7, which is dark red, stands out against yellow caprock and is visibly moving – it is also accompanied by a tank on the horizon. To the southwest, a viewer can see the knob on the other side of the Pierre’s community with the Chuska Mountains on the far horizon, and White Rock visible in the foreground. There are two pumpjacks labeled #10 and #12 visible on the valley floor just south of the knob. On the valley floor 650 m to the

southwest is pumpjack #6, or Hoss Com #95. Looking across the landscape towards Chaco Canyon, there is a string of pumpjacks in view positioned along rig roads: # 5, 12, 11, 4, and 3. Behind them, the major topographic landmarks of Chaco Canyon are visible to the south: West Mesa, Hosta Butte, South Gap, South Mesa, Fajada Butte, and Chacra Mesa. To the east on the far horizon there are a few tanks as well as a Navajo settlement.

Viewscape 3 records the 360 degree panorama from LA 16515, the large masonry house on the valley floor, at the base of the El Faro pinnacle. Because LA 16515 is on the valley floor, there are only three pumpjacks visible from this spot (#3, 4, & 8), but all three can be seen bobbing up and down on the horizon. Viewscapes 4 and 5 record the 360 degree views from the sites at the tops of two pinnacles – El Faro (LA 16514) and the atalaya (LA 16519), respectively. Nine pumpjacks are visible from these locations. To the east, the badlands topography blocks the long-distance horizon, although in the far distance, buildings and vehicle on the horizon represent a Navajo settlement. To the east-southeast is the large butte crowned by the two great houses. To the south is the landscape of Chaco Canyon, with Mount Taylor, South Mesa, South Gap, Hosta Butte, West Mesa, and Little Hosta Butte. Looking southwest down the valley towards the Chaco River there are three pumpjacks (#3, 4, & 5) flashing in the sun as their arms pump up and down. Pumpjack #6 is located 750 m to the southwest. This rig, labeled Hoss Com #95, was reportedly placed perpendicular to Houses A & B so that it would be less visible from the Pierre’s community; however, the pumpjack is not perpendicular to either of the two pinnacle sites. To the south-southwest, there is another pinnacle in the middle distance, and the Chuska Mountains and Narbona Pass on the horizon. Pumpjack #7 bobs up and down on the valley rim that blocks the far western horizon. To the north-northwest, the dark red pumpjack #8 is below the yellow sandstone caprock. Pumpjack #9 is on the horizon but less visible since it is painted in camouflage colors; both are accompanied by storage tanks.

Viewscape 5 may be viewed at <https://www.youtube.com/watch?v=SBRfbwhWI0U>. These viewscapes illustrate several important observations. First, the Pierre’s sites on high places are situated to maximize visibility with the major topographic features of Chaco Canyon. Elsewhere Van Dyke (2007) has argued that major landforms such as Mount Taylor and Hosta Butte were storied places for ancient Chacoans, just as they are for today’s descendant communities. An individual standing atop Pierre’s great houses, atalaya, or El Faro, looks south towards the striking landscape of South Mesa, South Gap, and West Mesa – downtown Chaco Canyon. And, on the horizon behind Chaco Canyon, an ancient viewer would have seen Mount Taylor, Hosta Butte, and Little Hosta Butte. If, as Marshall (1997) and Van Dyke (2007:pp) have argued, the Great North Road and the South Road are meant as a dualistic pair that counterbalance one another, then the visibility of Hosta Butte from Pierre’s could have been particularly important for ancient Chacoans. As noted earlier, it is possible for viewers at Pueblo Alto and Pierre’s to pinpoint one another’s locations using bright light created by mirrors or flames. Van Dyke et al. (2016) and many others have argued that these connections may have been important for signaling, tying together the greater Chacoan world.

Unfortunately, the flashes seen during our November 2016 visit to Pierre's represented the sunlight glinting off a series of pumpjacks, with arms moving up and down. And, while pumpjacks do not actually impede a modern viewer's ability to see distant peaks such as Hosta Butte, they are certainly distracting. Particularly those pumpjacks silhouetted against the near horizon – numbers 1, 2, 7 and 9 in our study – make a modern viewer feel as if s/he has stumbled into an industrial park. The National Environmental Policy Act states that environmental assessments must consider the "cumulative effects" of developments. While oil and gas rigs did not erase or disturb the ground at archaeological sites in or around the Pierre's community, we argue that the positioning of 12 rigs within the great house viewscape falls into the "cumulative effects" category, as these wells clearly constitute "a pattern of actions whose effects are significant." The general viewscape of the Pierre's community has been irreparably damaged by failure to consider these wells' obtrusive visibility.

In our study, we were keen to also investigate the Pierre's soundscape, particularly because noise from nearby mineral extraction is audible within the Pierre's community. During Van Dyke's site visit in November 2016, we could hear the clanking and periodic backfire of the engine driving Hoss Com #95. Van Dyke used a Roland Edirol digital recorder to capture periodic bursts of sound from Hoss Com #95 that measured up to 60 decibels higher than the ambient background. When the BLM was subsequently notified of this noise disturbance, they required the drilling company to outfit the rig with a new muffler.

We investigated the Pierre's soundscape using the same acoustic modeling experiments that we had employed at Bis sa'ani. DeSmet again followed the detailed procedures set out in the first part of this chapter. DeSmet modeled a human shout and a conch shell trumpet blast emanating from Great House A (LA 16509). In both experiments, the sounds reached distances nearly 2 kilometers. As at Bis sa'ani, in our model, the conch shell trumpet was more effective than a human shout at reaching the entire Pierre's community. A human shout traveled to all but one limited use site in the Pierre's community (Figure 8.11). The conch shell trumpet blast – as at Bis sa'ani -- reached all 28 habitation and limited use sites in the Pierre's community (Figure 8.12). Both sounds would have been heard by travelers up to 1 km away along the North Road.

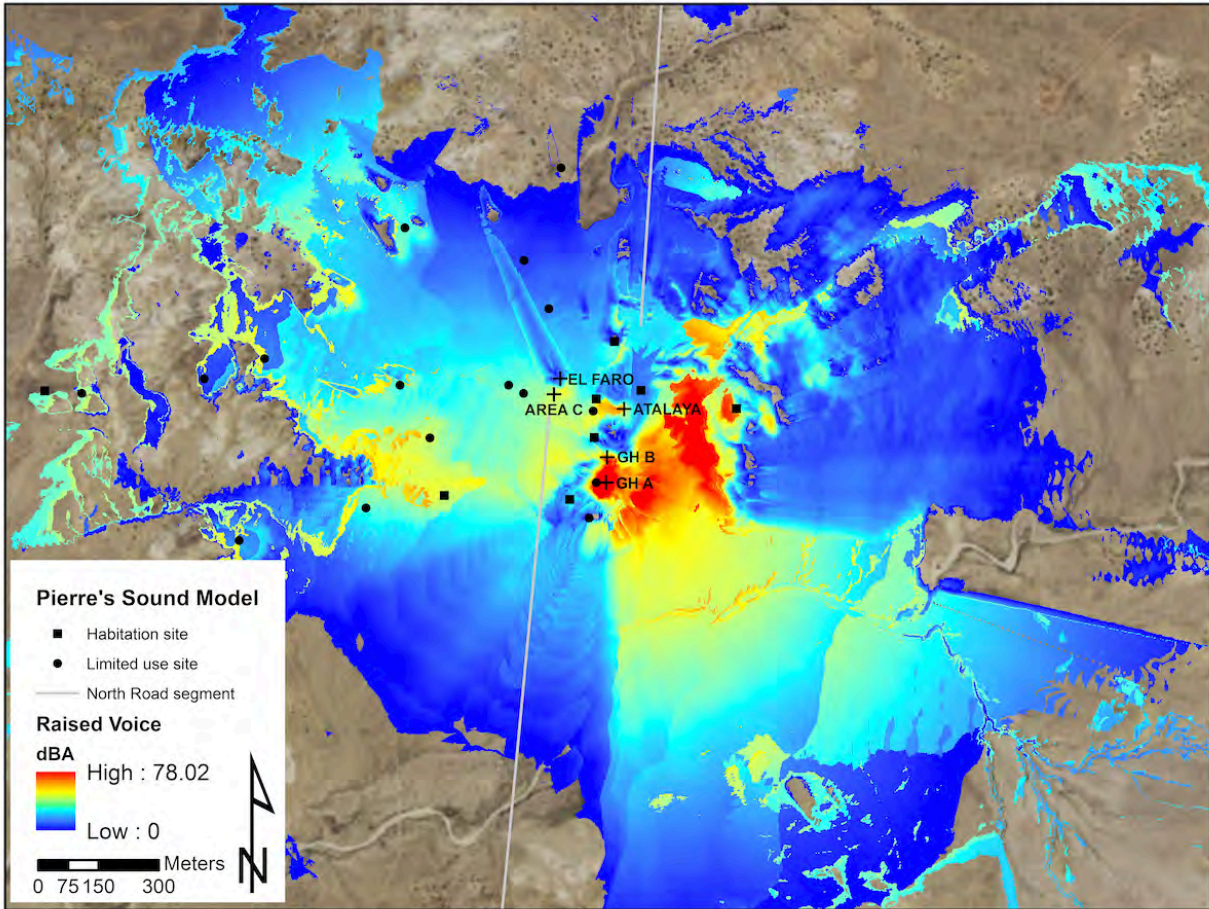


Figure 8.11. Reach of a human shout emanating from Pierre's great house A (LA 17509). Model and graphic by Tim DeSmet.

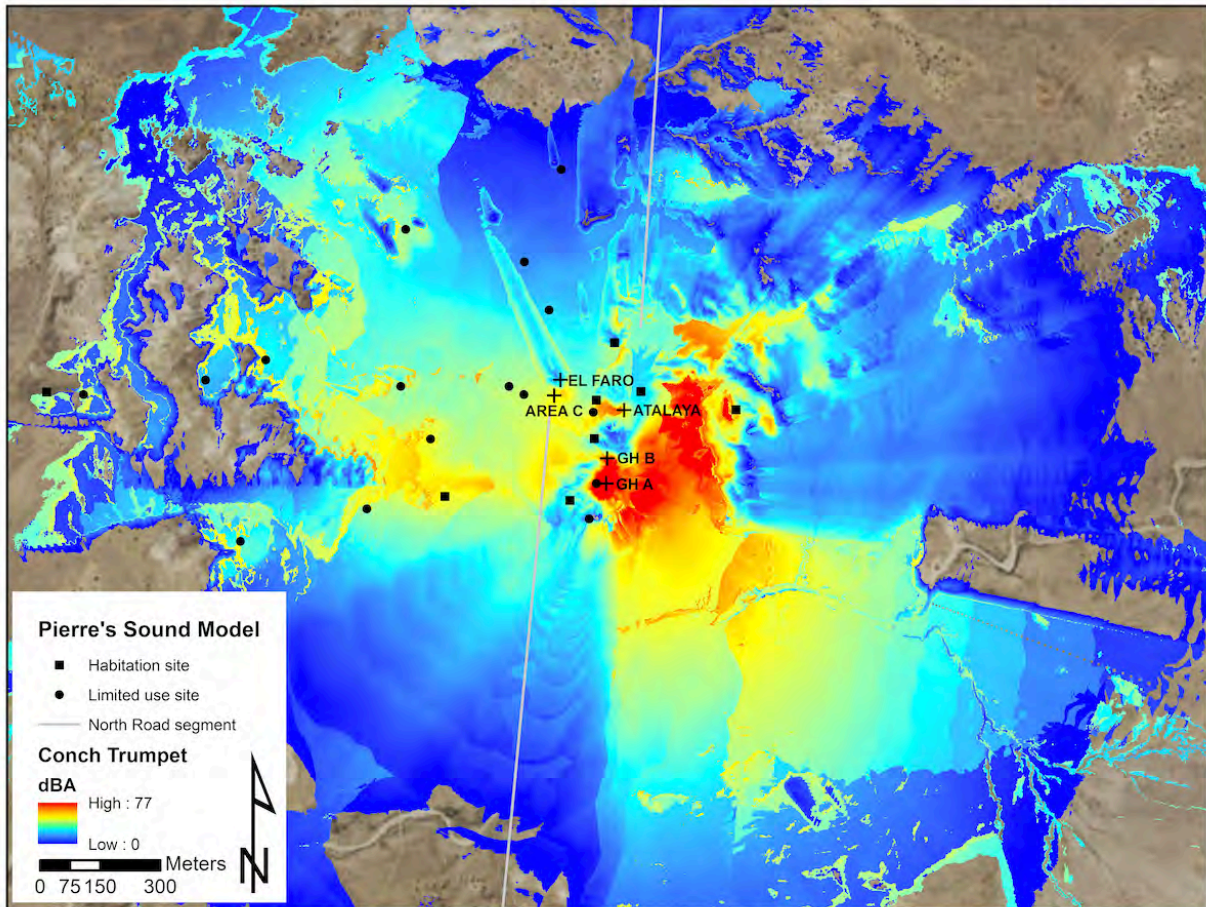


Figure 8.12. Reach of a conch shell blast emanating from Pierre’s Great House A (LA 17509). Model and graphic by Tim DeSmet.

As at Bis sa’ani, the Pierre’s community boundaries map rather neatly onto the reach of the sound of a conch shell trumpet, suggesting that it may have been important for residents to live and work within hearing distance of the Pierre’s great houses. People at Pierre’s could have seen Chacoan landmarks and could have signaled with Pueblo Alto, suggesting that viewscape is most important for long-distance interactions; by contrast, soundscape seems most important for local, community interactions. Although we need to replicate these experiments at additional outliers with good community data, our work suggests that soundscape modeling may prove useful to land managers and archaeologists as a means with which to predict Chacoan community boundaries.

Noise from the surrounding drill rigs did not impact our ability to model Pierre’s soundscape, but it is always present at a low level, and it is affecting visitors’ sensory experiences of this community. To measure this impact, De Smet obtained pumpjack sound decibel data from the BLM (2000). Following Primeau and Witt’s (2018) procedures, DeSmet modeled the extent of the noise emanating from 16 pumpjacks located in the immediate area of the Pierre’s community. This model demonstrates that between 40-60 dBA reach most of

the archaeological sites in the community (Figure 8.13). For reference, 40 dBA is the ambient noise of a suburban area at night, and 60 dBA is normal conversational speech (Yale University 2018). By contrast, a natural area with no wind has an ambient decibel level of 20 dBA. Clearly the pumpjacks are producing low-level background noise pollution that constitutes “cumulative effects” under NEPA and adds to visitor’s sense of walking through an industrial area.

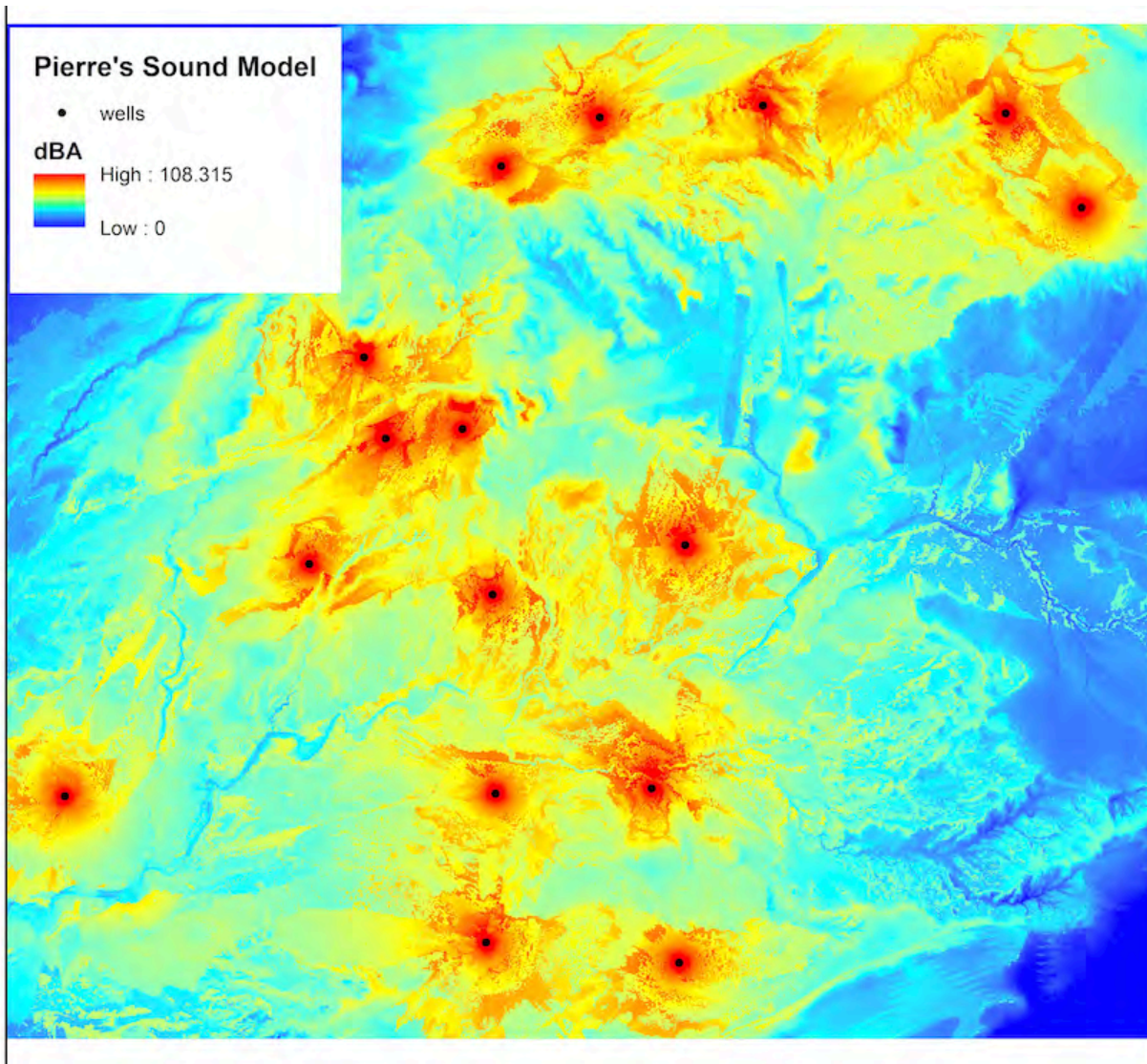


Figure 8.13. Cumulative soundscape showing reach of noise from 16 drill rigs in the Pierre’s vicinity. Model and graphic by Tim DeSmet.

Conclusions and Management Implications

Sense of place is a difficult concept to quantify. It will be different for different people. A sense of place incorporates aspects that archaeologists cannot study easily, such as meaning and memory. But in this study we hope to have shown that sensory experiences – what can be

seen and what can be heard on an archaeological landscape – *can* be approached by archaeologists. Our comparison of viewscales and soundscapes in the Bis sa’ani and Pierre’s communities has given us tantalizing ideas about interactions across the Chacoan world. Intervisibility was important for reaching beyond community boundaries and making connections to Chaco Canyon and other outliers, and the acoustic reach of a conch shell trumpet was one way that outlier communities were held together. Colleagues (e.g., Mills et al. 2018) are studying the “social networks” represented by moving objects, but connections also were made through sight and sound. We have the ability to study these connections, but only if we do not destroy the visual and acoustic landscapes in which they are embedded. While today’s landscape is not synonymous with the Chacoan past, neither is today’s potsherd synonymous with a Chacoan vessel. Like artifact analysts, phenomenological archaeologists take the fragments we can get, and we ask questions that we can answer. Phenomenological methods such as we have demonstrated here, working in tandem with powerful GIS mapping and modeling programs, have tremendous untapped potential for Chacoan scholarship.

However, because these kinds of studies are relatively new in archaeology, we lack robust legislation to help landowners and agencies figure out how to evaluate, study, and mitigate potentially damaging effects from oil and gas drilling or other types of destructive development. The Pierre’s community is a poster child for what can go wrong when land managers do not assess the potential for indirect and cumulative adverse impacts to viewscales and soundscapes. Despite efforts made by the Bureau of Land Management and the National Park Service to minimize the effects of mineral extraction on the Pierre’s community, the Pierre’s community today has the feeling of an industrial park.

We offer the following recommendations that would help prevent adverse effects across other areas of the greater Chaco landscape:

1. We cannot protect archaeological sites where we do not know about them. Site data availability and recording across the greater Chaco world is piecemeal at best. Thus, land managers should require comprehensive Class III survey across areas intended for leasing, and this survey should take place at a regional, not a local or piecemeal, scale. In other words, large-scale landscape archaeology is needed as part of a Master Leasing Plan in the greater San Juan Basin. Discrete site protection is not enough.
2. Archaeological surveys should include assessment of viewscales and soundscapes. We have laid out here some simple and effective techniques for recording viewscales and soundscapes in the field. These methods or similar should become part of every survey archaeologist’s toolkit.
3. Land managers should use the available technology to create predictive models of potential adverse impacts. They could use ArcGIS modeling to delineate the extents of great house viewscales. Similar, they could use our methods to predict the potential impacts of drill rigs on soundscapes. Land managers could then require mining companies to locate their machinery outside the potentially impacted areas. The areas covered by a drilling moratorium thus would vary based on the local situation at each

great house – a blanket protection of 1-2 km, for example, is not sufficient, because every great house’s topography and community configuration is different.

4. Where avoidance is not possible, land managers should require mineral extraction companies to camouflage equipment and to provide sound-dampening equipment to mitigate the noise.

In an era of rapidly advancing economic development on the Colorado Plateau, it is imperative for archaeologists to help government personnel and legislators develop good management strategies for the fragile and understudied aspects of the ancient sensory world.

Viewscapes and soundscapes are important dimensions of the ancient Chacoan landscape. If we are ever to understand a Chacoan sense of place, archaeologists need to continue to devise creative (yet rigorous and systematic!) methods for studying sensory experiences. And, we need to ensure that the visual and acoustic dimensions of Chacoan communities are protected, not only for our current study but to ensure that future generations of scholars and visitors will be able to experience the greater Chaco landscape.

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