

**BOZEMAN TRAIL CONFLICT SITES LIDAR DATA
GATHERING PROJECT**

JOHNSON AND SHERIDAN COUNTY, WYOMING

**AMERICAN BATTLEFIELD PROTECTION PROGRAM
GRANT P19AP00443**

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Prepared for:

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Introduction

The Fort Phil Kearny/Bozeman Trail Association (FPK/BTA) acquired an American Battlefield Protection Program (ABPP) Grant (P19AP00443) to use Light Detection and Ranging (LiDAR) technology to record and analyze three nationally significant battle and military sites associated with the Bozeman Trail in Wyoming. LIDAR is a remote-sensing system that uses rapid light bursts to map the surface at high detail, even through existing vegetation. The digital data created by the technology created a 3D model of the terrain which can assist in identifying specific localities within historic sites. FPK/BTA partnered with the Fort Phil Kearny State Historic Site and the Bureau of Land Management, Buffalo Field Office (BFO) to provide digital data from the project to better identify and more effectively preserve and protect these significant resources. A portion of the grant was also

Purpose and Need

The digital data created through LIDAR sensing will assist in the identification of unknown features within significant battle and military sites. The Fetterman Battle, the Crazy Woman Creek Battle, and Cantonment Reno are all listed on the National Register of Historic Places based on their significant associations with US Army and Native American conflicts between the 1860's and 1870's. Each site was recorded through varying degrees of field inspection and metal detection; however, they may contain physical features (rifle pits, trail ruts, building foundations, etc.) that were not easily identified by surface examination, or through analysis of aerial photography. For example, there is documentation indicating that rifle pits were dug at the Crazy Woman Creek Battle, but previous fieldwork hadn't identified them. Additionally, the locations of specific buildings and the exact layout of Cantonment Reno is uncertain. Additionally, a portion of the grant was used to retrieve and copy military records and pension files from the National Archives and Records Administration (NARA) that may be able to clarify inconsistencies in the accounts of up to seven fights and skirmishes that took place the Crazy Woman Creek Crossing of the Bozeman Trail

Research Goals and Questions

Fetterman Battle

The battle is well documented, and most localities are identified through archeological pedestrian and metal detecting inventory. An unmanned aerial system (UAS) with a mounted LIDAR sensor can be used to map approximately 550 acres of the battle site and the data can be used to create a highly accurate 3D model and maps of the terrain. The data may also be able to reveal the location of the Bozeman Trail, which the battle was primarily centered upon. The maps and data gathered by the LIDAR flights can be used to study how the battle progressed, and to assist the state agency tasked with protecting the site, the Fort Phil Kearny State Historic Site, in its ongoing preservation and interpretation efforts.

Crazy Woman Creek Battle

The conflict is documented by a few primary sources, military records, and many later reminiscences. However, its exact location is still undetermined. Part of the grant included obtaining military documents

from the National Archives and Records Administration (NARA) through a qualified archivist to retrieve and copy military records and pension files from the that could clarify inconsistencies in the historic record of the battle. Exact locations of events are uncertain but features from the battle may still exist - the final location of the battle was a defensive wagon corral with associated rifle pits. A UAS with a mounted LIDAR sensor can be used to map any potential remnants of the rifle pits in an area of approximately 200 acres on BLM and State surface. If the rifle pits are identified through the LIDAR project, the actual boundary of the battle can be delineated. The project is necessary since pedestrian and metal detecting inventories failed to locate actual battle localities. BFO is committed to using any data from the work to evaluate, preserve and protect the site.

Cantonment Reno

Precise georeferenced maps would reveal surface features that would otherwise be nearly impossible to document. Thick riparian vegetation currently obscures the majority of the site making accurate mapping by hand extremely difficult. The laser capability of a LIDAR flight would allow for the site to be accurately mapped and interpreted while allowing for the creation of a 3-D model of the fort to be created. The project is necessary because LIDAR data may discover additional features that are currently not documented, such as the actual location of the Bozeman Trail in relation to the structures of the fort. The LIDAR flight will also preserve data and assist in evaluating the threat of erosion from actively meandering oxbow channels of the Powder River.

Historic Background

In the early 1860's conflicts, sometimes deadly, with the resident Lakota, Cheyenne and Northern Arapaho escalated as miners and settlers worked their way along the Bozeman Trail toward Montana Territory during what is referred to as "Red Clouds War". Emigrant use of the trail was an illegal incursion into territory controlled by several tribes. Those travelling the Bozeman Trail used it as a shortcut, saving two weeks of difficult travel compared to the safer route along the Oregon Trail. In the summer of 1865 the US Army intervened, constructing Fort Reno where the Bozeman Trail crossed the Powder River and campaigning against the tribes into the fall. By the spring of 1866 peace negotiations started at Fort Laramie as the Lakota, Cheyenne and Northern Arapaho warriors paused the defense of their territory. Negotiations were going well with promising discussions of a new treaty until over 600 soldiers of the 18th Infantry arrived at Fort Laramie and proceeded north into the Powder River Basin. The tribes broke off their discussions and prepared for a continuation of the war as soldiers moved up the Bozeman Trail once more into their homeland.

The 18th Infantry relieved the troops garrisoned at Fort Reno and constructed two additional forts along the Bozeman Trail, building Fort Phil Kearny near the crossing of Piney Creek and Fort C.F. Smith at the crossing of the Bighorn River. Although the soldiers had orders to take offensive actions against the tribes, no major efforts were attempted in the following years. Isolated in hostile territory and contending with limited troops and supplies, soldiers primarily performed escort duty of wagon trains and defended the three forts. Approximately 150 conflicts and battles occurred along the Bozeman Trail between 1866 and 1868 as tribal warriors raided, skirmished, and battled with soldiers and emigrants. One of the earliest battles of the occupation, the Crazy Woman Battle, was a small-scale attack against an Army

wagon train in July of 1866. One of the most significant battles of Red Clouds War, the Fetterman Battle, was fought in December of 1866 near Fort Phil Kearny where an entire detachment of 81 were killed, officers, soldiers and civilians

Fetterman Battle Site:

The Fetterman Battle (48SH127) was fought on December 21, 1866, between warriors from the Lakota, Cheyenne, and Arapaho tribes and soldiers of the United States Army based at Fort Phil Kearny, Wyoming. A few warriors, feigning a retreat from an attack on wagons near the fort, led a detachment of soldiers into an ambush. The entire detachment of 80 men, under the command of Captain William J. Fetterman were killed by an estimated 1000 to 2000 warriors. At the time, it was the worst military disaster suffered by the U.S. Army versus the combined forces of the Lakota, Cheyenne, and Arapaho tribes. The battle was the largest engagement during Red Cloud's War and is a National Historic Landmark with national significance, with most of the surface owned by the State of Wyoming.

Battle on Crazy Woman Creek:

The Crazy Woman Battle (48JO93) was fought on July 20th, 1866, near the Bozeman Trail crossing of Crazy Woman Creek in northeast Wyoming between the US Army and most likely Sioux warriors. The fight was one of the earliest skirmishes in the Powder River Basin during Red Cloud's War. A small party of five officers, approximately twenty enlisted men and fifteen civilians in two military ambulances, and seven supply wagons, led by 1st Lieutenant George Murray Templeton on their way Fort Phil Kearny were attacked at the crossing of Crazy Woman Creek. Two soldiers were killed in the half day long fight and Indian casualties are uncertain. The battle site is listed on the National Register of Historic Places (NRHP) and is significant on a national level as the first major conflict after a failed attempt at a peace treaty at Fort Laramie in June of 1866.

Cantonment Reno:

Cantonment Reno (48JO91) served as a strategic supply base on the Bozeman Trail crossing of the Powder River in northeast Wyoming for the 1876 and 1877 campaigns conducted by Brigadier General George Crook against the Sioux and Cheyenne during what has been referred to as the Great Sioux War. After the Battle of Little Bighorn, Crook started a search for "hostile" tribes in the fall of 1876 from Cantonment Reno, resulting in his troops discovery of a Northern Cheyenne winter camp that ended in the Dull Knife Battle. In the winter of 1876 and 1877, Crook started from Cantonment Reno on an unsuccessful search of the Powder River Basin for Lakota camps. No standing structures remain at the site, which is entirely on BLM surface, but foundations of the infantry quarters, a hospital, guard house, bakery, stables and trail ruts still exist. The site is listed on the NRHP and is significant on a regional and state level.

Methodology

Quantum Spatial Incorporated (QSI) collected high-resolution topographic LiDAR data using a Riegl miniVUX-1UAV LiDAR sensor mounted in a small unmanned aerial system (sUAS) of each project

location. The flight plan was designed to achieve a first return density of ≥ 30 ppsm (pulses per sq. meter). The flight crew included a licensed pilot (FAA Part 107) and observer. QSI processed the collected LiDAR data to include kinematic corrections, calculation of laser point position, relative accuracy testing and calibrations, classification of ground and non-ground points, assessments of statistical absolute accuracy, and creation of ground surface models.

Survey Control

Simultaneous to the LiDAR data collection mission, field crew conducted a static (1 Hz recording frequency) survey over a set control point using dual-frequency GNSS base stations. The static GNSS data was used for kinematic correction of the UAS position. Maximum baseline lengths between control points and the aircraft did not exceed 5 nautical miles.

Quality control ground check points (GCPs) were collected using real-time kinematic (RTK) survey methods. The GCPs were collected within the project area, with an established Root Mean Square Error (RMSE) of less than 2-cm. Absolute laser spot accuracies were statistically analyzed based upon a suitable number (for statistical rigor) of hard, bare earth ground check points (GCPs) on level slope throughout project areas, as feasible given road access and GPS conditions.

Processing

The LiDAR data processing began after receipt of data from the acquisition mission. QSI processed the collected LiDAR data to include kinematic corrections, calculation of laser point position, relative accuracy testing and calibrations, classification of ground and non-ground points, assessments of statistical absolute accuracy, and creation of ground surface models. QSI also processed aircraft trajectories and raw point data into geolocated swaths.

Initial processing tasks included GPS control computations, smoothed best estimate trajectory (SBET) calculations, kinematic corrections, and calculation of laser point position. Ground control data, collected by NOAA, was used in the data calibration and accuracy assessment workflows. Processing tasks relative accuracy testing, classification of ground and non-ground points, and assessments of statistical absolute accuracy. Following calibration, QSI initiated a suite of automated and manual techniques to classify the LiDAR points and create the requested deliverables. Processing methodologies were tailored for the landscape. The general workflow was as follows:

- Resolve GPS kinematic corrections for aircraft position data using kinematic aircraft GPS and static ground GPS data collected over geodetic controls.
- Develop an SBET file that blends post-processed aircraft position with attitude data. Sensor heading, position, and attitude are calculated throughout the survey.
- Calculate laser point position by associating SBET information to each laser point return time, with offsets relative to scan angle, intensity, etc. included. This process creates the raw laser point cloud data for the entire survey in *.las (ASPRS v. 1.4) format, in which each point maintains the corresponding scan angle, return number (echo), intensity, and x, y, z information. These data are converted to orthometric elevation (NAVD88) by applying a Geoid 99 correction.

- Import raw laser points into subset bins (less than 500 megabytes, to accommodate file size constraints in processing software). Filter for noise and perform manual relative accuracy calibration.
- Classify ground points and test relative accuracy using ground classified points per each flight line. Perform automated line-to-line calibrations for system attitude parameters (pitch, roll, heading), mirror flex (scale), and GPS/IMU drift. Calibrations are performed on ground classified points from paired flight lines. Every flight line is used for relative accuracy calibration.
- Assign headers (e.g., projection information, variable length record, project name, GEOTIFF tags) to *.las files.

The following deliverables were produced for the BLM and for FPK/BTA:

Point Cloud

- Classified Point Clouds (one file per site), Las 1.4 format. Point files will include the following fields: X,Y,Z, Return Intensity, Return Number, Point Classification (unclassified, ground, default, error), Scan Angle, GPS Time

Elevation Models

- Bare Earth Digital Terrain Model (DTM), 1- ft resolution, GeoTIFF format
- First return Digital Surface Model (DSM), 1-ft resolution, GeoTIFF format

Vectors

- Areas of Interest, ESRI shapefile format

Feature Visual Identification Analysis

BFO staff performed a cursory visual analysis of the LiDAR point cloud and digital terrain model data using ArcMap. The analysis showed that the 3D model clearly revealed that existing constructed roads, two-track roads, fence lines, pipeline routes and other modern constructed features. All the known historic features associated with each of the three sites were clearly portrayed on the LiDAR data as well, including Bozeman Trail swales and building foundations. The known historic features were used as a basis for making comparisons to other undiscovered or unrecorded features that were revealed the 3D model. Features such as rifle pits are not known to occur at any of the sites, so the basis for identifying those types of features was based on the assumption that rifle pits minimally would be approximately two to three feet in diameter and a few inches deep, potentially with a low back dirt mound built up on one side. Since the size and depth of the rifle pits was not described in any of the historic records, it was also assumed that the rifle pits could potentially be much larger, perhaps up to several feet deep and wide. It was also assumed that rifle pits would be in a circular or ovoid pattern that corresponds with the circumference of any corralled wagons that may have taken part in any battle.

Fetterman Battle Site 3D Model Analysis:

Modern constructed features such as the highway, parking lot, monument, irrigation ditches, pipeline scars, interpretive trails, signage and fence lines all were clearly evident on the 3D model. The only known historic feature associated with the Fetterman Battle is the Bozeman Trail, which represented a central locality for most of the battle. The location of the trail is known and recorded, and it is evident by a single shallow swale that runs the length of the ridge where the battle took place. The known trail ruts are clearly evident on the 3D model. However, the LiDAR data also revealed several parallel swales to the known swale. The newly discovered swales closely parallel the known route and are braided with it for the length of the ridge. This is not unusual in that much of the Bozeman Trail throughout Wyoming is evident by multiple parallel or braided routes. Wagon masters using the trail (and most other historic trails) seem to have made short parallel routes to avoid difficult, rutted or obstructed portions of the main route, and the new Bozeman Trail routes discovered in the Fetterman Battle site by the LiDAR are likely a reflection of this practice. The new routes are all confined to the flat top portions of the ridge within approximately ten meters of the known route and are represented as very shallow “u” shaped ruts. Most of the new routes are only a few inches in depth and are not readily apparent to a visual analysis at the site.

Crazy Woman Creek Battle 3D Model Analysis:

Modern constructed features such as county roads, a parking lot, monuments, and fence lines all were clearly evident on the 3D model. The only known historic feature associated with the Crazy Woman Battle is the Bozeman Trail. The location of the trail is known and recorded on a low ridge that descends into the Crazy Woman Creek drainage. It is evident by a single shallow swale (or occasionally by parallel braided swales) that run the length of the top of ridge. The battle began on the Bozeman Trail, on a low rise between the crossing of an ephemeral drainage and Crazy Woman Creek and ended up moving approximately 1 mile upstream as the soldiers sought the protection of higher ground. The known and recorded Bozeman Trail ruts are evident on the 3D model. However, the LiDAR revealed what appears to be a parallel swale that diverges from main trail approximately a half of a mile from the crossing of the ephemeral drainage, getting as far from the trail as a quarter of a mile before rejoining the known route near the crossing of Crazy Woman Creek. Most of the newly discovered route appears on the 3D model as very shallow and “u” shaped rut, except for the crossing of the ephemeral drainage. The drainage crossing of the new route has a set of two deep ruts on either side that connect to the shallow swales on either side. A visual analysis revealed that the ruts at the drainage crossing are evident, but some portions of the shallow swale are evident as well, primarily visible as rows of sagebrush growing within the route. This assumption may have bearing on the interpretation of the battle site. If the wagon train used the newly discovered route, it would shift the crossing of the ephemeral drainage nearly a ¼ mile from the known trail crossing.

The analysis of the 3D model for rifle pits unfortunately proved fruitless. No shallow depression (or deep) features were noted in the entire analysis area. However, this does not mean that the rifle pits associated with the battle do not exist. As indicated by the discovery of the new Bozeman Trail swale, the rifle pits may have been further upstream than was originally assumed and may be outside the LiDAR analysis area.

Cantonment Reno 3D Model Analysis:

Modern constructed features such as two track roads and fence lines are evident on the 3D model. All known and recorded historic features (primarily building foundations) associated with Cantonment Reno are also evident on the 3D Model. The imagery seems to reveal small round shallow depression features behind many of the previously identified building foundation that were not recorded. These depressions may be privy pits associated with the buildings, but further field analysis needs to be done before it can be verified. The 3D model also appears to reveal the location of the access route through the cantonment, which has not been recorded in the past. The route appears as a wide, shallow swale that enters the and exits the square of the cantonment along the north edge. The access route is not evident beyond the floodplain that the cantonment was built on. The LiDAR mapping also seems to have located several additional unrecorded building foundations outside of the main cantonment area. A defined set of foundations are recorded to the west of the cantonment, and it has been assumed during previous recordings that they represented the camp sutlers buildings. The new unrecorded foundations are further to the east and south and appear to be four very large buildings in a row, each with what appear to be privy pits behind them. They may be associated with the sutlers buildings, but further field research may reveal their actual function.

NARA Records Review

Lieutenant George Templeton’s fight at Crazy Woman’s Fork on July 20, 1866, was one of over a hundred and fifty battles, fights and skirmishes that took place along the Bozeman Trail between 1864 and 1868, and like most of them, its exact location is unknown. Templeton’s fight at Crazy Woman Creek was the first of a total of seven confrontations that took place on the Bozeman Trail’s crossing of Crazy Woman Creek.

Wagon Train party or military commander	Military Presence	Type of Confrontation
(Crazy Woman Battle) Templeton Fight - July 20, 1866	18 th Infantry	Skirmish and sieged wagon train at crossing of Crazy Woman Creek
Cheney Train - July 25, 1866	None	Stock Raid of camp on Crazy Woman Creek
Jackson Train – September 4, 1866	None	Skirmish at crossing of Crazy Woman Creek
Lang Train – May 1, 1867	None	Skirmish near Crazy Woman Creek
Capt. H.B. Freeman – August 13, 1867	27 th Infantry	Skirmish near Crazy Woman Creek
Capt. H.E. Noyes – October 20, 1867	2 nd Cavalry	Skirmish near Crazy Woman Creek
Capt. Andrew S. Burt – November 15, 1867	27 th Infantry	Stock raid and skirmish near Crazy Woman Creek
Sgt. George Gillaspay – December 1-3, 1867	27 th Infantry	Three-day siege of wagon train near Crazy Woman Creek

There are four primary individuals who gave accounts of the Templeton Fight. Templeton recorded the events in his personal diary, and in a short military report. Private Samuel Peters wrote a lengthy account of the battle a few days later that was published in a newspaper in Columbus Ohio. A civilian, Ridgeway Glover, also summed up the battle in a few sentences in a letter that was published in a photographic magazine a few months afterwards. Additionally, Lieutenant Alexander Wands briefly described the events of the Templeton Fight in his testimony related to a military inquiry into the Fetterman Battle. All

these accounts contain clues that may verify the ongoing archeological work at the trail crossing can verify the actual locations of the specific battle. However, the other six confrontations likely could have left the same types of archeological evidence. To make accurate interpretations of the archeological evidence, knowledge of all the other conflicts that took place at the crossing is necessary.

The other six confrontations that took place at the Bozeman Trail crossing of Crazy Woman Creek are only occasionally referred to in historic manuscripts, and each conflict has very few primary sources to draw on to compare with the Templeton Fight. To gain more perspective on all of the confrontations that occurred at the crossing, numerous military records on file at NARA in Washington DC were copied and analyzed to determine if additional primary source information is available. The following military records from forts and military units stationed on the Bozeman Trail between 1866 and 1868 were copied and reviewed to determine if they had any information relating to any of the conflicts that occurred at the Bozeman Trail's crossing of Crazy Woman Creek.

Copies of Letters Received, Mountain District

Letters Received, Mountain District

Register of Letters Received, Rocky Mountain District

Letters Sent, Mountain District

List of Civilians Employed at Posts, Division of the Missouri

Reports of Trains Passing Through Posts, Division of the Missouri

List of Persons Interred in Post Cemeteries Division of the Missouri

Registers of Letters Received, Fort Philip Kearny

Letters Sent, Fort Phil Kearny

Proceedings of Boards of Survey Fort Philip Kearny

Register of Wagon Trains Passing Through the Post Fort Philip Kearny

Guard Reports, Fort Phil Kearny

Proceedings of Boards of Survey Fort C.F. Smith

Letters, Orders, and Reports Received From or Relating to Enlisted Men and Officers, 27th Infantry

Letters Sent 27th Infantry

From Military Pension Files for Winfield Seaman, Florival Smith (Alias Frank A Smith), Andrew Hannibal, George T Galespy

Volunteers from the FPK/BTA (JoAnne Puckett, HB Puckett, Sonny Reisch, Mary Ellen McWilliams, Bob Wilson, Katie Curtiss, Rick Newton and Mary Jo Newton) reviewed all the records retrieved from

NARA and found several new references for some of the six conflicts, including new references for the Templeton Fight. Thanks to the volunteers, the below newly discovered references can now be associated with the following conflicts:

Wagon Train party or military commander	References
(Crazy Woman Battle) Templeton Fight - July 20, 1866	Letters Sent 27th Infantry
Jackson Train – September 4, 1866	Proceedings of Boards of Survey, Fort Philip Kearny
Capt. H.B. Freeman – August 13, 1867	Frank A. Smith (Alias Florival Smith) Pension Record Winfield Seaman Pension Record
Capt. Andrew S. Burt – November 15, 1867	Letters Sent 27th Infantry
Sgt. George Gillaspay – December 1-3, 1867	Proceedings of Boards of Survey, Fort Philip Kearny

The most significant information related to the records review was the discovery of testimony in a Board of Survey related to the Sgt. George Gillaspay December 1-3, 1867, fight on Crazy Woman Creek. Not only did the testimony reveal the approximate location of the conflict, but it also described how several items from the wagon train were unloaded and used as breastworks in the three-day long siege. Some of the items were abandoned at the battlefield, which could have interesting implications if archeological research were to occur at the site.

Conclusions

The LiDAR data collection at each of the three localities revealed previously unknown archeological features. The discovery of a new Bozeman Trail segment at the Crazy Woman Battle has significant implications on the interpretation of the site and presents new field investigation opportunities. The possible addition of several new foundations at Cantonment Reno can add to the historic significance of the site and help guide BLM's future preservation efforts. The LiDAR data from the Fetterman Battle verified the location of previously identified Bozeman Trail ruts and led to the discovery of nearby parallel trail routes. The military records research has already proven fruitful, even after a cursory examination. The previously unknown location of a significant battle was likely revealed, and the records also indicate the unique types of artifacts that archeologists can expect to find if they locate the site.