CONCRETE CLOTH ARCHAEOLOGICAL SITE PROTECTIVE CAPS: A PRELIMINARY EVALUATION AT FORT WAINWRIGHT, DONNELLY TRAINING AREA, AK.

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Archaeological Site Capping Experiment on Fort Wainwright, Alaska

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Executive Summary

5-8 July 2016 Dr. Julie Esdale, Fort Wainwright and Donnelly Training Area (DTA) Site Archaeologist with Colorado State University-Center for Environmental Management of Military Lands (CEMML), the Salcha Delta Soil and Water Conservation District (SDSWCD), and Chuck Burns (CSU-CEMML), TCM-Ranges/ Integrated Training Area Management (ITAM) Program Land Rehabilitation and Maintenance Lead, implemented tests to assess concrete cloth's ability to protect National Register eligible archaeological sites from the effects of light and heavy maneuver training missions in DTA, AK. Two tests were piloted. Test 1 consisted of installing a temporary traditional cap (geotextile and gravel) adjacent to a temporary concrete cloth cap and evaluating how well each protected replicated stone tools and flaking debris from simulated HMMWV movement and maneuver. Results from this test are detailed in the section of this report titled, "Test 1: Simulated HMMWV Movement/Maneuver over Gravel and Concrete Cloth Test Plots". Test 2 entailed capping a portion of a National Register eligible archaeological site with traditional archaeological site capping materials and another portion of the site with concrete cloth. The Archaeological site chosen for Test 2 is located in DTA East and adjacent to the tactical use, maneuver and movement trail locally known as 33 Mile Loop. This trail will serve as a primary maneuver and movement route for Arctic Anvil, an extremely large scale, multinational training event beginning 22 July. The archaeological site chosen for Test 2 is a short-term prehistoric Alaska Native occupation containing stone tool production debris. Site artifacts range from surface level to approximately 35 centimeters below surface (cmbs). Replicated stone tools and flaking debris were marked and scattered atop the site to assist in gauging surface level maneuver training effects. Training exercises conducted during Arctic Anvil will place the archaeological site caps under stress, providing quick opportunity to determine the effectiveness of concrete cloth and traditional site capping materials. Dr. Esdale and her team of CSU-CEMML archaeologists, along with soil scientists and engineers from the SDSWCD, will also administer monitoring protocols that assess the effectiveness of the concrete cloth and traditional capping materials long-term. Dr. Esdale consulted with the Alaska State Historic Preservation Office (SHPO) prior to conducting the tests and received concurrence. Details for Test 2 are found in in the section of this report titled, "Gravel and Concrete Cloth Archaeological Site Caps-Long-Term Analysis".

Background

FEB 2016 Dr. Esdale met with Engineer Research and Development Center-Construction Engineering Research Laboratory (ERDC-CERL) and TCM-Ranges/ITAM to discuss innovative site capping techniques for Alaska. The discussion revealed potential for utilizing concrete cloth as a means to protect prehistoric lithic reduction sites and subsurface Alaska Native occupation sites determined eligible for nomination to the National Register. 10 May 2016 Dr. Anne Koster, ERDC-CERL and Chuck Burns, TCM-Ranges/ITAM, CSU-CEMML presented on archaeological site capping methodologies at the ITAM Conference held at Fort Eustis, VA. Koster and Burns' briefing discussed traditional capping techniques (geotextile overlain with fill and gravel) and the potential for using concrete cloth to cap archaeological sites. Because HQDA/DAMO-TRS has placed emphases on understanding how climate change affects military training lands, Alaska, a region where the effects of warming trends are measurable, was presented as a candidate site for evaluating concrete cloth's site capping capabilities. Proposed research initiatives included: 1) Determining how concrete cloth measures against traditional site capping materials; 2) Evaluating concrete cloth's resistance to forest fires resulting from warmer temperatures and dryer fuel loads; and 3) Assessing concrete cloth's ability to withstand flooding conditions exacerbated by abnormal glacial warming. Following the ITAM conference, TCM-Ranges/ITAM, in cooperation with Dr. Esdale, DTA Range and ITAM staff, and the SDSWCD, developed

and organized field trials for using concrete cloth on DTA. Target timeframe for installing both a traditional archaeological site cap and a concrete cloth archaeological site cap was slated for early July to ensure both caps were in place prior to Arctic Anvil.

Concrete Cloth Overview

Concrete cloth is classified as a Geosynthetic Cementitious Composite Mat (GCCM), meaning it is a cement impregnated woven canvas fabric with a PVC backing that is fire resistant. Common uses for concrete cloth include: slope stabilization, ditch lining, shoreline berm protection, and culvert invert protection. Other applications include creating stable surfaces for heavy equipment movement on construction sites (trackways) and emergency helicopter landing pads. The cloth hardens after hydration. It can't be overhydrated and is capable of setting up underwater. Thickness range includes five millimeters (mm), eight mm and 13 mm. Or, 3/16 inch, 5/16 inch, and 1/2 inch. After hydration, and setting 24 hours, the cloth reaches an 80% strength rate.

The installation process includes unfurling two rolls of the cloth at a time and overlapping the edge of one full length of concrete cloth five inches over the edge of the other full length of concrete cloth (Figure 1). Once the five inch overlap is set, the top strip of cloth is pulled back to allow enough room for applying two beads of clear, waterproof, polymer adhesive along the entire edge of the bottom section of concrete cloth. The polymer adhesive is applied using a standard calk gun and tube (Figure 2). Once applied, the top strip of concrete cloth is pressed over the two beads of adhesive running the length of the bottom section of cloth. Walking along the seam helps to ensure a tight seal. Immediately after establishing a snug seal, 5/8 inch tapping screws are affixed along the top edge of cloth directly along the seam line. Screws are spaced approx. one foot apart (Figure 3). Once the concrete cloth is assembled, it is hydrated. The cloth can't be overwatered, but a standard for watering the material is using a water hose with a fan spray nozzle and spraying water approx. six (6) to eight (8) inches above the cloth in a circular motion for about 15 minutes (Figure 4). If time allows, repeat the process two more times, once per hour.

Figure 1. Deploying two rolls of concrete cloth and establishing a five inch overlap.

Figure 2. Earl McNabb and Lori Richter, SDSWCD, Applying two beads of polymer adhesive along the edge of the concrete cloth.

Figure 3. Screws affixed along the top edge of cloth directly along the seam line. Screws are spaced approx. one foot apart.

Considering vast amounts of DTA's archaeological sites are located in remote, access challenged, corners of Training Areas (TAs), it was determined that concrete cloth might be possible viable solution for capping hard to reach sites. Doing so would limit the need for large, gravel filled dump trucks to traverse uncertain terrain. Keeping with this determination, the lightest variety of the cloth, 3/16 inch, was tested. Each roll of concrete cloth weighs 150 lbs., which equates to a two person carry job (Figure 5). When fully deployed from the roll, the cloth length is 30 feet long and 3.5 feet wide.

Figure 4. Hydrating concrete cloth with spray nozzle six to eight inches above the material in a circular motion

Figure 5. Two rolls of packaged concrete cloth weighing 150 lbs. each.

Test 1: Simulated HMMWV Movement/Maneuver over Gravel and Concrete Cloth Test Plots

5 July 2016 Dr. Esdale, the SDSWCD, and TCM-Ranges/ITAM installed two test plots at Observation Point (OP) 7 in DTA East. One plot consisted of concrete cloth (3/16 inch thick) and the other 10 yards of pit-run gravel, applied four (4) to six (6) inches thick (Figures 6 and 7). The gravel test plot measured 15 feet X 15 feet and was underlain with geotextile fabric. The concrete cloth test plot measured 15 feet X 10 feet and was underlain with geotextile fabric. Replicated artifacts, obsidian tools and flakes, were situated beneath the geotextile at ground level for both plots. 26 total artifacts were used, 13 for the pit-run gravel plot and 13 for the concrete cloth plot. Replicated artifacts measured 1-4 cm^2 (Table 1). Each faux artifact was painted florescent orange. The orange paint was applied to distinguish the imitation artifacts from existing gravel deposits at OP 7 and to accentuate fracture lines that might occur in the artifacts resulting from the weight of the HMMWV (Figure 8). A HMMWV's wheel base is approximately 14 feet long and seven feet wide. 15 feet X 15 feet and 15 feet X 10 feet plot dimensions were chosen to ensure the total weight of the HMMWV was exerted on replicated artifacts for 10 passes over the pit-run material and 10 passes over the concrete cloth.

Pit-Run Gravel Test Plot Installation Process:

- Gravel purchased from local quarry and dumped at OP 7
- 15 feet X 15 feet plot dimensions measured on the ground and marked with florescent orange spray paint
- 13 Replicated artifacts measuring approx. 1-4 cm^2 painted florescent orange and placed within the measured plot dimensions
- 15 feet X 15 feet section of geotextile cut and placed over plot area and replicated artifacts
- Skid-Steer used to apply 10 yards of pit-run gravel four (4) to six (6) inches thick over the geotextile
- Skidsteer used to compact and smooth pit-run gravel application

Concrete Cloth Test Plot Installation Process:

- 15 feet X 10 feet plot dimensions measured on the ground and marked with florescent orange spray paint
- 13 Replicated artifacts measuring approx. 1-4 cm^2 painted florescent orange and placed within the measured plot dimensions
- 15 feet X 10 feet section of geotextile cut and placed over plot area and replicated artifacts
- 15 feet X 10 feet of concrete cloth applied over the geotextile and then hydrated as described in the application process detailed in the "Concrete Cloth Overview" (Figure 9).

Figure 6. Applying 10 yards of gravel over faux artifacts and geotextile to establish a 4 to 6 inch gravel cap.

Figure 7. Chuck Burns, ITAM, Deploying concrete cloth over geotextile and replicated artifacts (prior to the hydration process.)

Size Class	Pit-Run Gravel Test Plot	Concrete Cloth Test Plot	Concrete Cloth XMH-891	Pit-Run Gravel XMH-891
< 1 cm^2	5	5	14	12
< 2 cm^2	5	6	20	22
< 4 cm^2	3	2	12	13
< 16 cm^2			4	3
TOTAL flakes/tools	13	13	50	50

Table 1. Number of artifacts by size classes used on the surface of all tests.

Figure 8. Replicated obsidian artifacts painted florescent orange and distributed over capping plots prior to material

Figure 9. Hydrated concrete cloth; Dr. Julie Esdale hydrating the concrete cloth cap using a portable water tank and pump.

7 July 2016, after approx.48 hours of concrete cloth cure time, the two plots were tested against simulated HMMWV movement and maneuver. Following 10 HMMWV passes over each test plot, the pit-run gravel and the concrete cloth were removed to observe conditions of the replicated artifacts (Figures 10-13). (HMMWV weight approx. 5,000 lbs.)

Concrete Cloth Test Plot:

- After 10 passes, nine (9) of the 13 replicated artifacts were fractured.
- No damage to the concrete was observed.

Pit-Run Gravel Test Plot Result:

- After 10 passes, four (4) of 13 replicated artifacts were fractured.
- No damage to the gravel cap was observed.

Figure 10. Simulated HMMWV movement/maneuver over the concrete cloth.

Figure 11. Simulated HMMWV movement/maneuver over the gravel (pit-run) cap

Figure 13. Replicated artifacts following simulated HMMWV movement/maneuver over the gravel cap. 4 out of 13 surface artifacts were fractured.

Figure 12. Replicated artifacts following simulated HMMWV movement/maneuver over the concrete cloth cap. 9 out of 13 surface artifacts were fractured.

Test 1- Conclusion Based on Assumptions:
This test was qualitative and based entirely on in-field observation. Applying and removing the concrete cloth by hand was a gentle process. Conversely, applying and removing the pit-run gravel with a skidsteer was considerably more invasive. The ratio of fractured to non-fractured artifacts for the concrete cloth test plot points largely to the crushing weight of the HMMWV (approx. 5,000 lbs.) passing over an only 3/16 inch protective barrier. The four (4) to six (6) pit-run gravel test plot provided much better protection to the replicated artifacts placed at ground level. The ratio of fractured to non-fractured artifacts for the pit-run gravel test plot can likely be attributed to the aggressive gravel application and removal process.

The concrete cloth was not damaged by the simulated HMMWV movement and maneuver. Nor, was there any noticeable soil disturbance beneath the concrete cloth. Concrete cloth capping for the purpose of protecting sub-surface artifacts, and minimizing site erosion exacerbated by tactical vehicle tire rutting, has potential merit. Test 2, discussed below, will in time prove or disprove these assumptions.

Test 2: Gravel and Concrete Cloth Archaeological Site Caps-Long-Term Analysis
Test 2 is a long-term monitoring effort at Site XMH-891, a prehistoric lithic reduction site having characteristics indicative of short-term prehistoric Native Alaskan occupation. Site XMH-891 is located in DTA East and adjacent to the tactical use, maneuver and movement trail locally known as 33 Mile Loop (Figure 14). The site was discovered during a 2002 survey. Flakes were found scattered across the surface and buried up to 35 cmbs. The site is approx. 45 meters north to south and 20 meters east and west. The capping parameter is approx. 30 meters X 15 meters. This 30 meter X 15 meter section of the site, due to its proximity to 33 Mile Loop, is most susceptible to movement and maneuver damages.

33 Mile Loop will serve as a primary maneuver and movement route during Arctic Anvil. Training exercises conducted during Arctic Anvil will place the archaeological site caps under measurable stress, providing quick opportunity to determine the effectiveness of concrete cloth and traditional site capping materials. 33 Mile Loop is also a regularly traversed movement and maneuver trail used outside of Arctic Anvil, providing opportunity for long-term monitoring.

Test 2 will assess protective qualities for both a traditional gravel cap and a concrete cloth cap. The two caps are adjacent to one another. Site assessments will entail monitoring and recording effects from wheeled movement and maneuver, both light (HMMWV) and heavy (Stryker), as well as, monitoring and recording changes, if any, to the capped site occurring due to natural erosion and wildfire. Timeframe for monitoring efforts is not yet specified, but will be better determined following the 22 July Arctic Anvil training event. Long-term monitoring will be conducted by Dr. Esdale, her team of archaeologists, and agronomists and engineers from the SDSWCD. Prior to prepping the site for installing the two caps, SDSWCD recorded survey grade GPS points for the project area (Figure 15).

5 July 2016, following SDSWCD initial topographic survey, Dr. Esdale, her team, and TCM-Ranges prepared Site XMH-891 for long term site cap monitoring. Site preparation included creating a replicated, surface level, lithic scatter for the portion of the site to be capped with gravel and the portion of the site to be capped with concrete cloth. Each replicated lithic scatter was comprised of tools and flake debris fashioned from obsidian. Just as in Test 1, each imitation artifact was painted florescent orange to be easily distinguishable from existing gravel deposits and to emphasize fracture lines that might occur due to vehicular movement and maneuver. A total of 100 replicated artifacts were scattered atop the surface. 50 for the gravel capped potion of the site and 50 for the concrete cloth portion of the site. Each scatter measured approx. five meters by five meters (Figure 16). Artifacts ranged in size from large bifaces (up to 16 cm long) to small re-sharpening flakes (<1 cm2) (Table 1). Once each faux artifact was in place, Fort Wainwright archaeology (CSU-CEMML) recorded fixed points for all 100 artifacts using a Sokkia Set600 total station (Figure 17).

6-7 July the SDSWCD, Wainwright Archeology, and TCM-Ranges, capped Site XMH-891. Geotextile was placed over the replicated artifacts and atop the entire site cap parameter. Following the geotextile application, gravel, delivered by dump truck, was spread six (6) to eight (8) inches over the northern two-thirds of the capping parameter. A skidsteer was used to spread, smooth, and compact the gravel. Simultaneously, 3/16 inch thick concrete cloth was applied atop the faux artifacts and geotextile that covered approximately one-third of the capping parameter. Prior to placing the concrete cloth over the geotextile, a thin layer of sand was spread to create a level surface (Figure 18). The concrete cloth was

installed as specified in the "Concrete Cloth Overview" and hydrated (Figure 19). Final site cap dimensions are as follows: 18 x 17 m area gravel pad and a 9.5 x 11 m concrete pad (Figure 20).

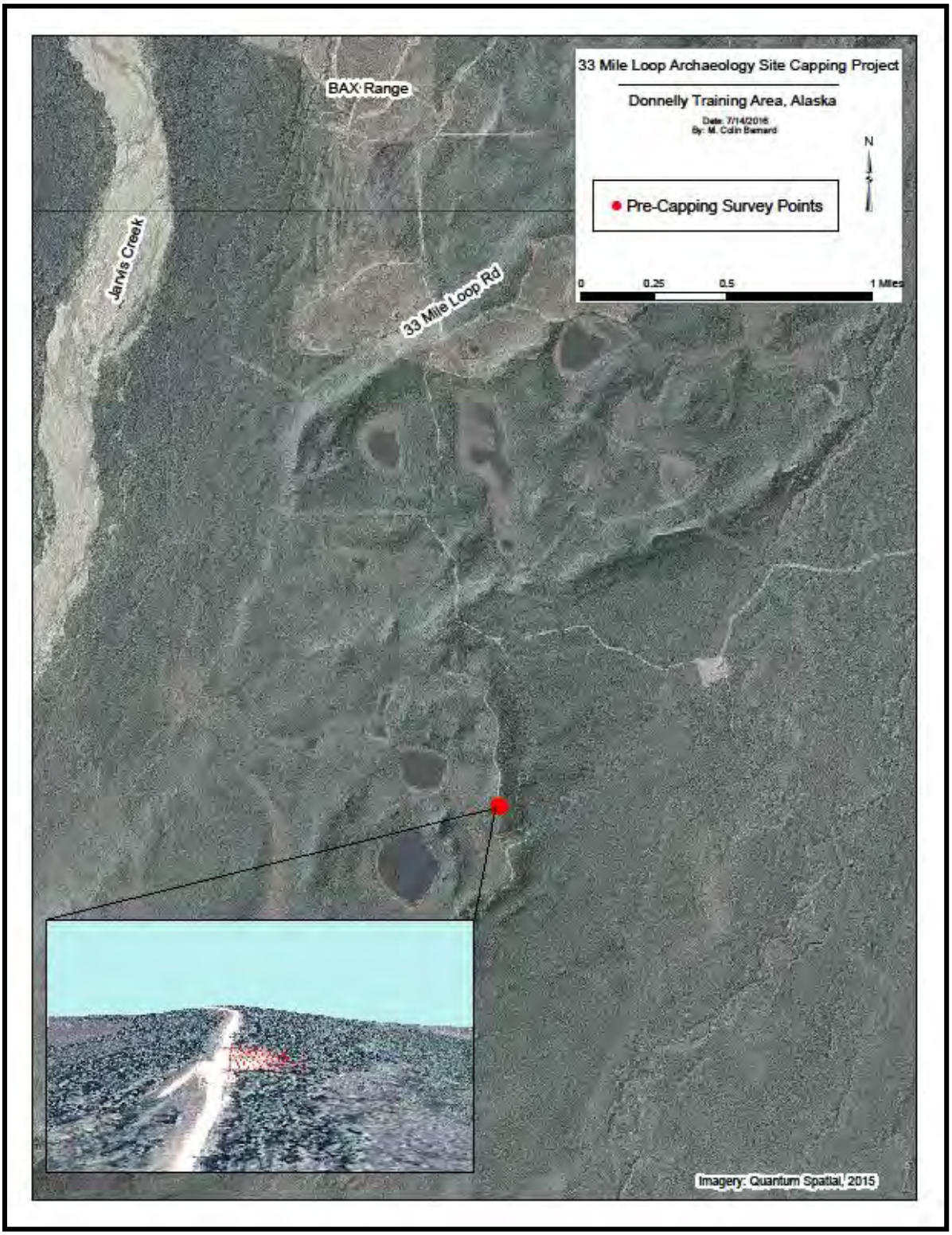

Figure 14. Archaeological Site XMH-891 capping location adjacent to 33 Mile Loop in DTA East. (Map prepared by Colin Barnard, SDSWCD.)

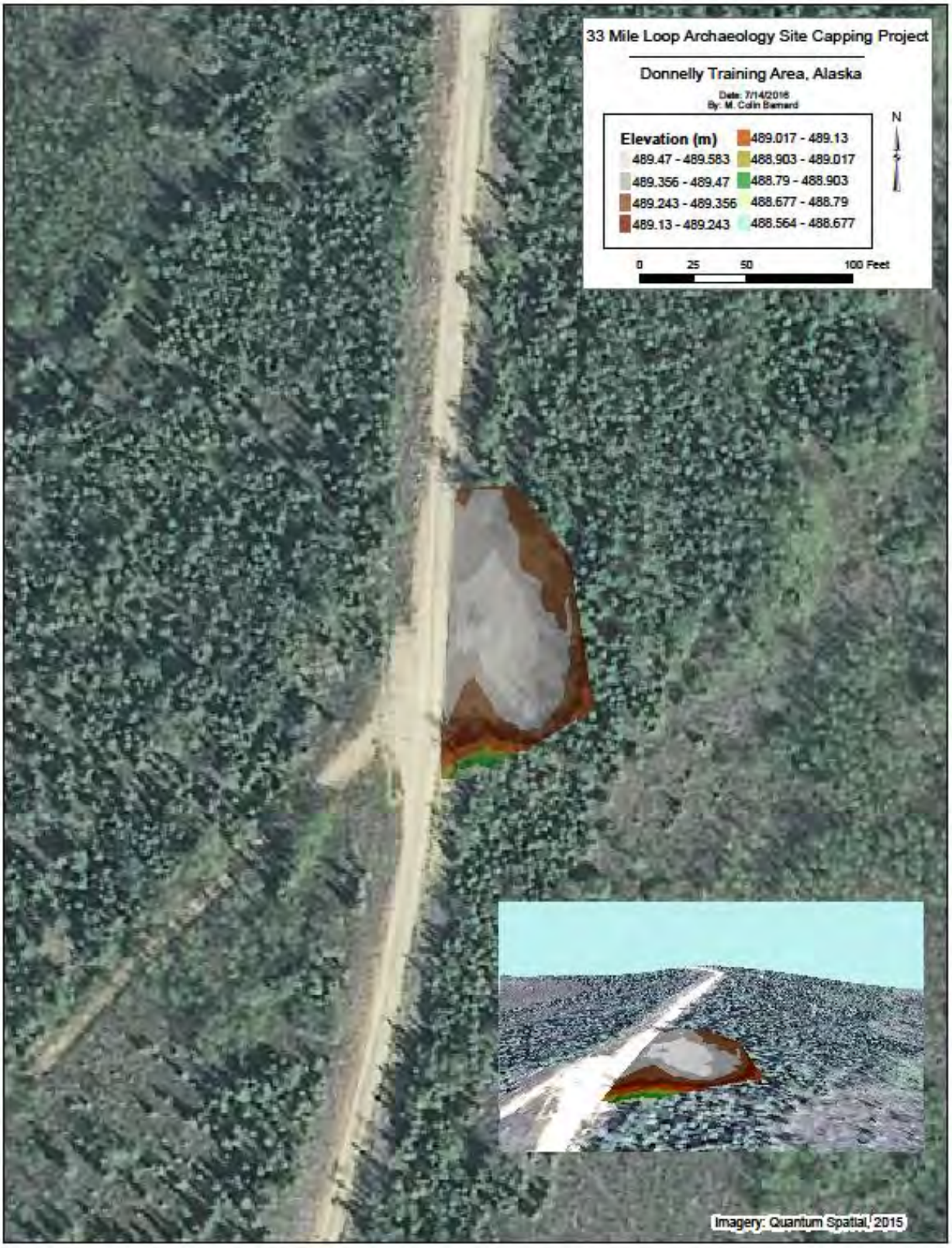

Figure 15. 33 Mile Loop Site Capping Project Survey Grade GPS. (Map prepared by Colin Barnard, SDSWCD.)

Figure 16. A total of 100 replicated artifacts were scattered atop the surface. 50 for the gravel capped potion of the site and 50 for the concrete cloth portion of the site.

Figure 17. The Wainwright/DTA archaeology team (CSU-CEMML) recording fixed points for all 100 artifacts using Sokkia Set600 total station.

Figure 18. Prior to placing the concrete cloth over the geotextile, sand was delivered to the site and a thin layer was spread by hand and skidsteer to create a level surface. SDSWCD's Earl McNabb relaxes while overseeing shovel work performed by Chuck Burns, TCM-Ranges/ITAM.

Figure 19. Concrete cloth installed prior to completing the hydration process. Cloth was hydrated using the featured water truck and attached hose.

Figure 20. Gravel and concrete caps over XMH-891. This panorama photo projects a curve in the area of the concrete cloth. However, the cloth is parallel to the road and both are on a north-south axis. Cap dimensions: 18 x 17 m area gravel pad and a 9.5 x 11 m concrete pad.

Conclusion

Test 1 indicated the 3/16 inch concrete cloth is not adequate for protecting surface level artifacts. Test 1 also revealed capping archaeological sites using traditional means and materials may create collateral damages to cultural resources present at surface level. Test 1 showed the 3/16 inch cloth has potential for protecting sub-surface cultural resources from a HMMWV's weight. Test 1 also indicated concrete cloth's potential for minimizing site erosion exacerbated by tactical vehicle tire rutting. However, traditional, more affordable capping methods, can do the same.

Cost Analysis:

A single roll of 3/16 inch concrete cloth, 30 feet long and 3.5 feet wide, is $672. The concrete cloth materials cost for capping an area similar to what is featured in Figures 19 and 20, is $6,720 (10 rolls). The concrete cloth distributor nearest DTA is in Seattle, Washington. Costs associated with shipping 10 rolls of concrete cloth is approx. $750. Total = $7,470. Approximate surface area capped when considering the concrete cloth installation process requires a five-inch overlap per strip of cloth applied, is 30 feet X 30 feet.

The cost associated with covering the entire capping parameter (approx. 100 feet X 50 feet) with approx. seven inches of pit-run gravel is $2,527.25. This cost factor includes $700 for a two day skid-steer rental, $1,260 dump truck delivery charge (1.5 hours per trip X 7 loads at $120 per hour), and $567.25 for 113.45 tons of pit run grave ($5.00 per ton).

Concrete cloth's practicability is in its mobility to remote archaeological sites subject to incurring training damages. For example, where it is not possible to carriage traditional capping materials to National Register eligible archaeological sites using large commercial transport vehicles, small, four wheel-drive trucks and jeeps can haul multiple 150 lbs. rolls of 3/16 inch concrete cloth to the site. The concrete cloth can be installed with only two people and be hydrated using a portable water tank and pump.

Concerning traditional gravel caps, it's important to note the four (4) to six (6) pit-run cap used in Test 1 held up well to simulated HMMWV movement and maneuver. But, the Test 2 gravel cap along 33 Mile Loop will have to withstand Stryker movements and maneuvers. Stryker vehicles are much heavier, having a weight range from 16 to 20 tons and are prone to producing greater damage to training lands. Because of this, the pit-run gravel cap thickness was increased from four (4) to six (6) inches to six (6) to eight (8) inches.

Test 2 will confirm or disprove concrete cloth's ability to guard against ruts caused by tactical vehicles and its capability to provide sub-surface artifact protection. Knowing the 3/16 inch concrete cloth isn't capable of protecting surface level artifacts, it will be useful to evaluate the material solely on if it can withstands Stryker movement and maneuvers for the purpose of rut protection and sub-surface artifact protection. Additionally, Test 2 will evaluate the concrete cloth's ability to protect cultural resources from natural erosion and adverse effects created by wildfires. The effects of run-off from the concrete cloth and potential subsequent erosion in the area surrounding the cloth will also be part of the long term study.

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