



# Measuring Hydrological and Ecological Functioning of Vernal Pool Wetlands



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## Background

Vernal pool wetlands are seasonal wetlands with complex hydrological processes related to geology, soils, and regional climate. They provide habitat for a diverse set of native species of plants, invertebrates, and vertebrates, some of which are threatened or endangered.

Department of Defense (DoD) facilities meet various challenges in meeting their mission when projects potentially impact vernal pools. Changes to the landscape beyond direct changes to a vernal pool basin can cause hydrological impacts resulting in altered ecological functioning.

Our study uses four key technologies and methods to provide more precise and accurate field data on the hydrology of vernal pools and their watersheds:

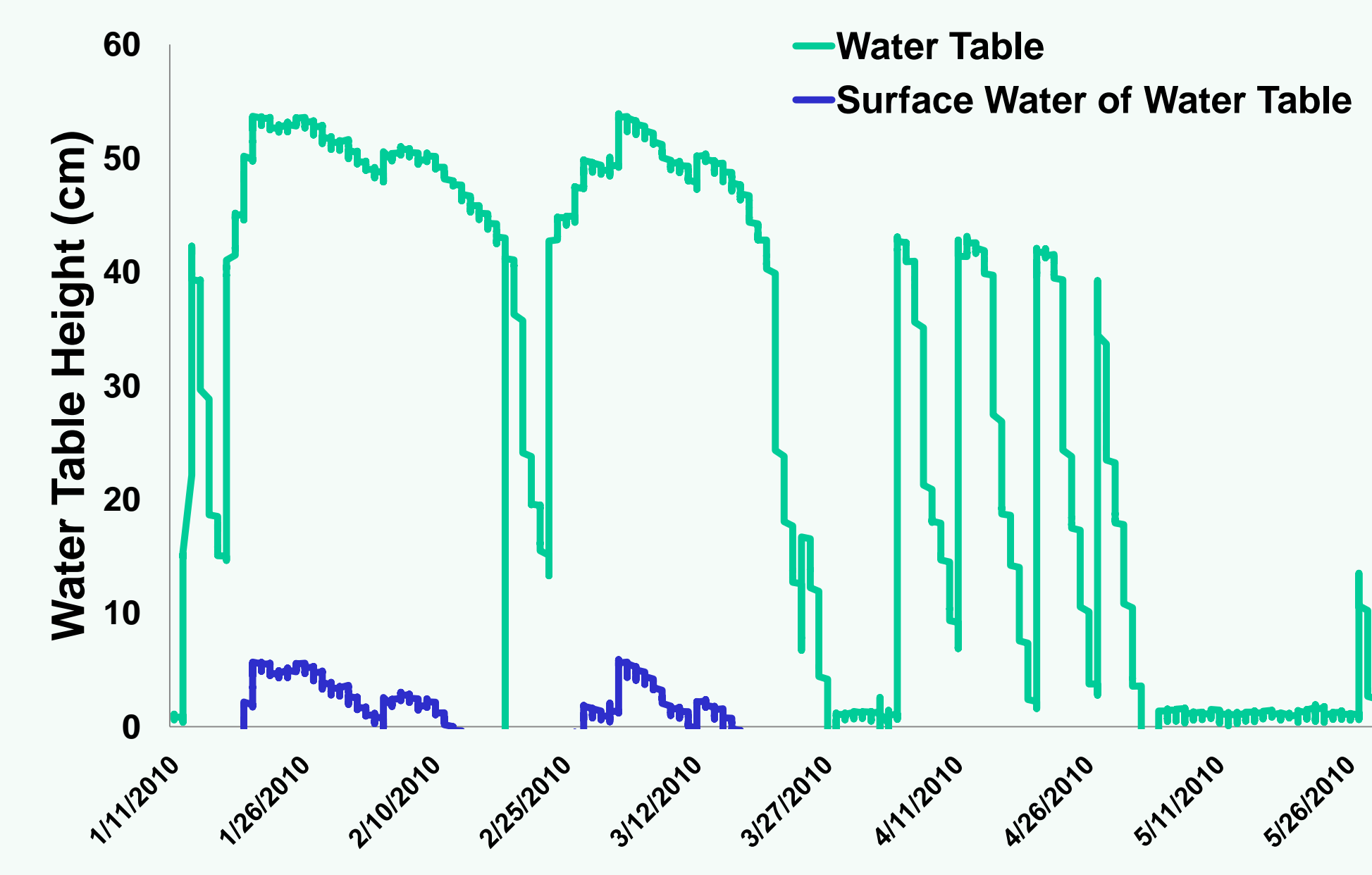
- 1) Water level pressure transducers (Levelloggers)
- 2) Soil moisture sensors
- 3) Real Time Kinematic GPS
- 4) Ground Penetrating Radar



A vernal pool during the wet (top) and dry (bottom) season, showing the surface exposure of the water table in the vernal pool depressions and locations of piezometers (Levelloggers).

## Four key technologies in the demonstration:

### 1) Water level pressure transducers (Levelloggers)



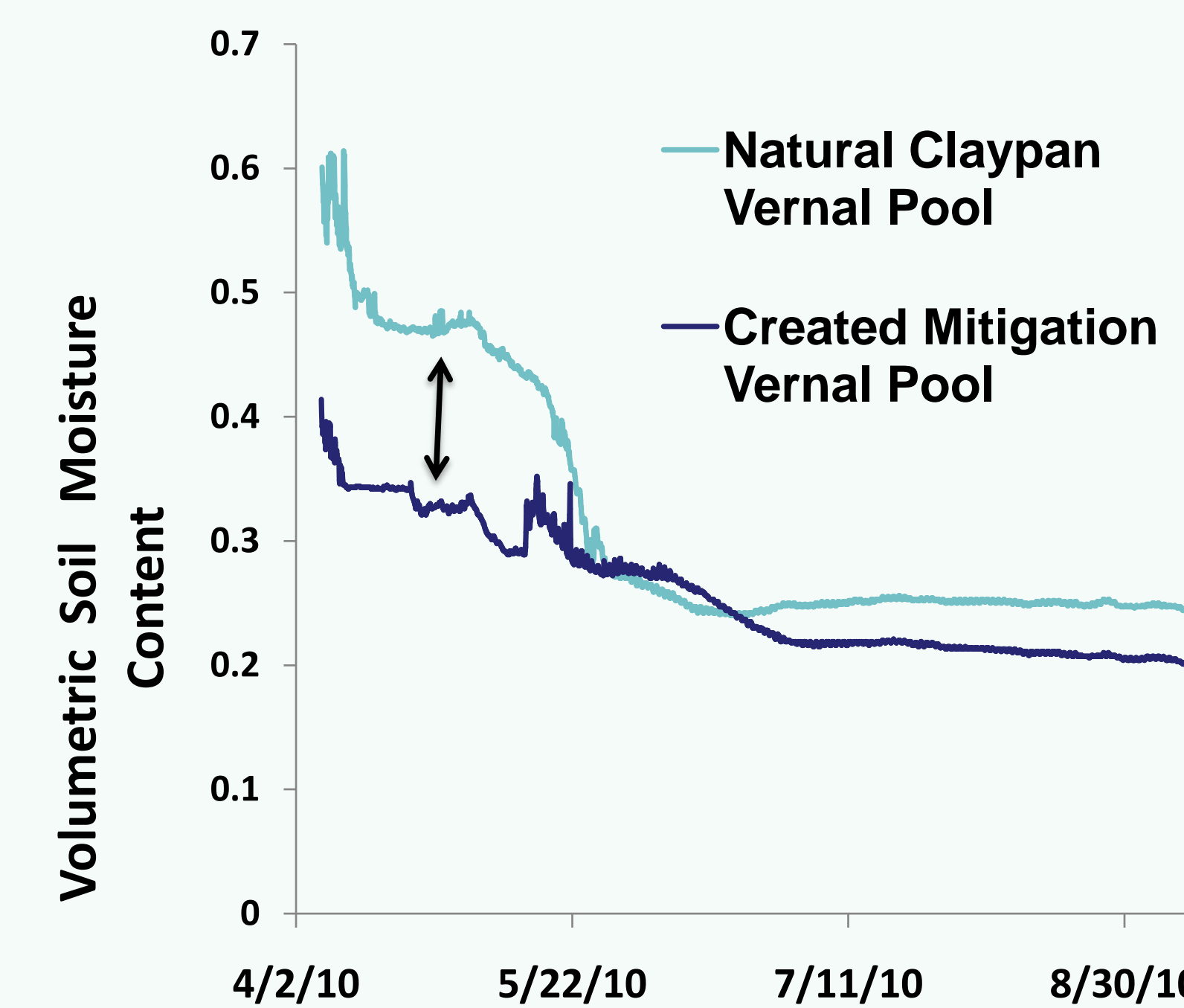
Above: A hydrograph showing water table height and depth of surface water in a created mitigation vernal pool at Beale AFB.



Provide accurate measurement of saturated soil or surface ponding ( $\pm 1$  mm per meter depth) every 15 min to create detailed hydrographs of the watershed.

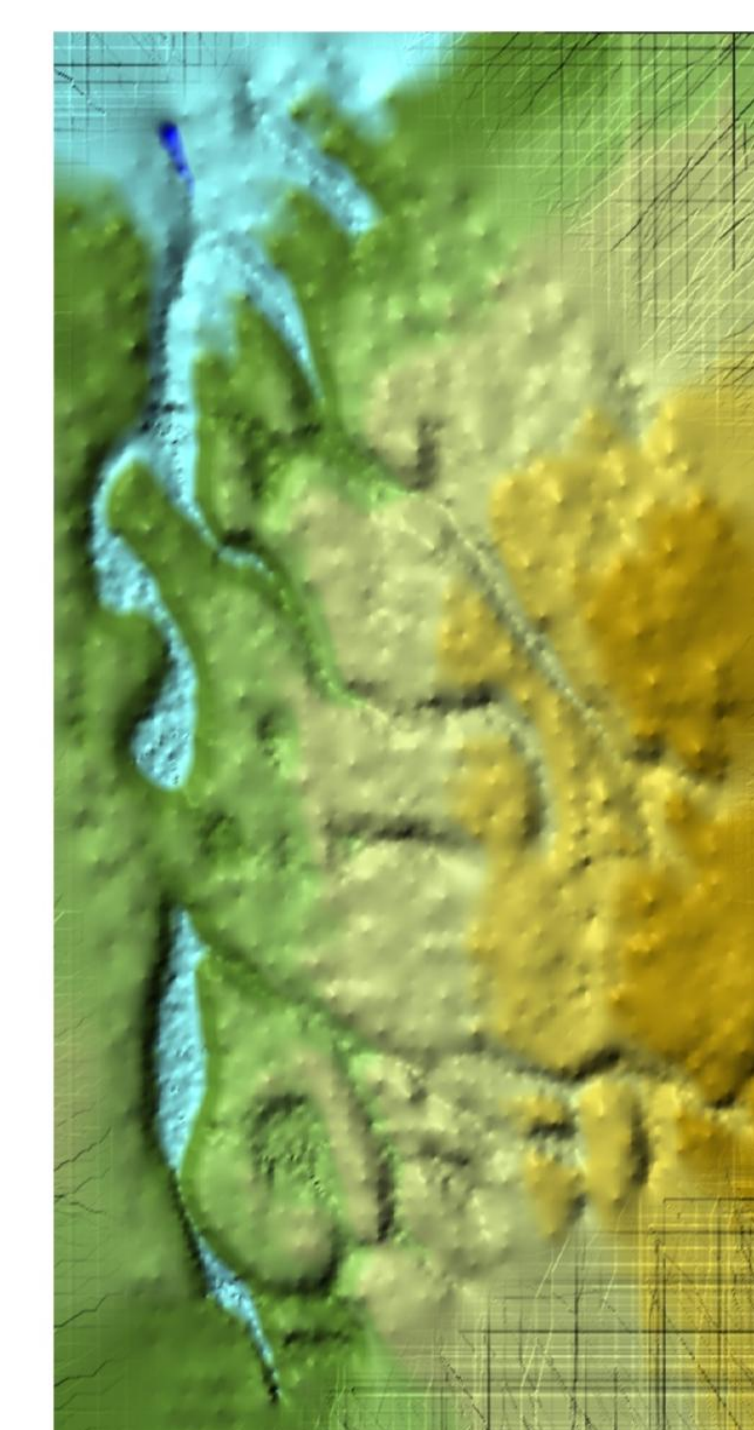
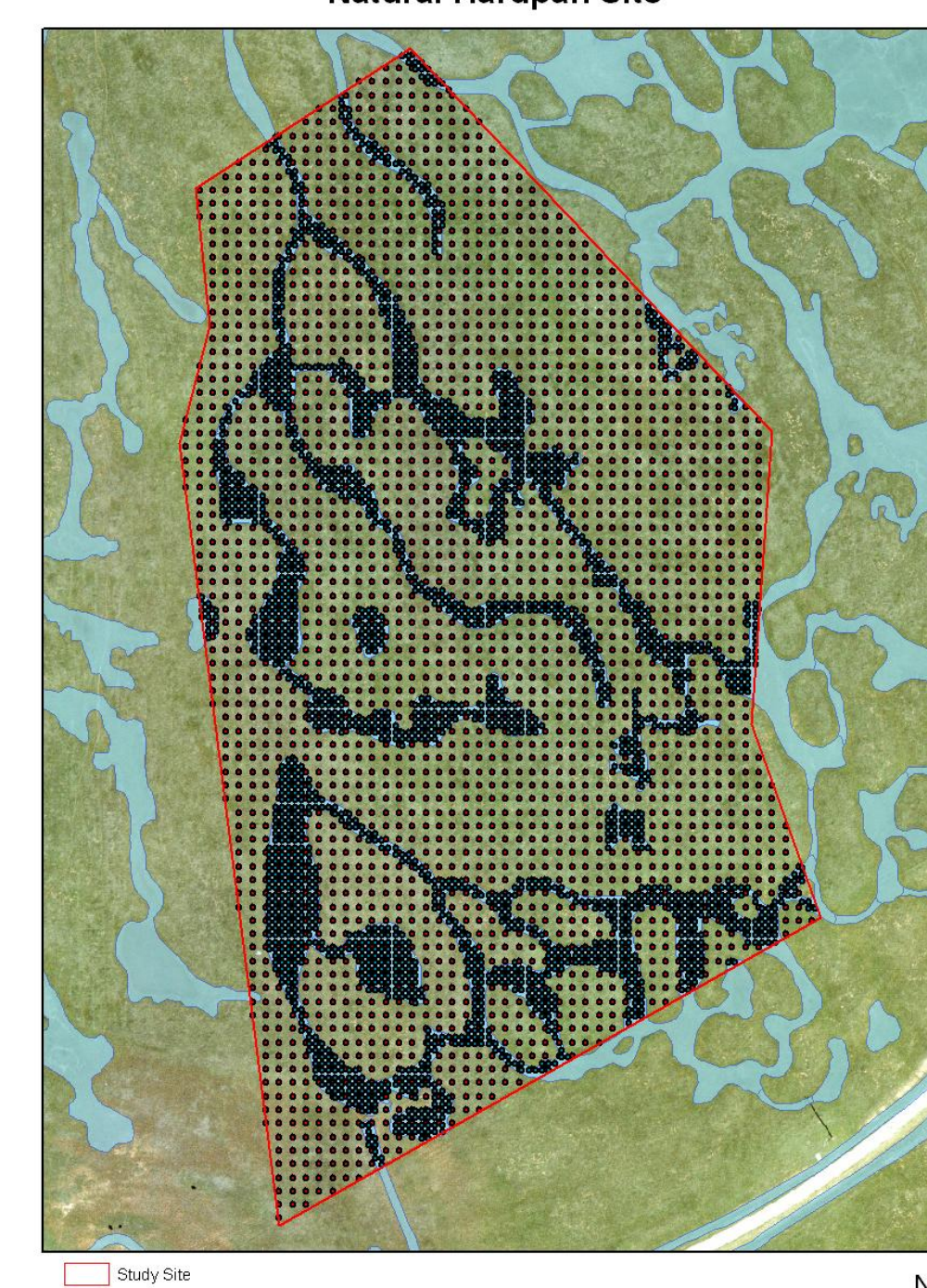
### 2) Soil moisture sensors

Provide additional information on unsaturated conditions in the watershed, including during the drying down stage.



Above: Volumetric soil moisture differences in a natural versus a created mitigation vernal pool at Beale AFB.

### 3) Real Time Kinematic Global Positioning System (RTK GPS)



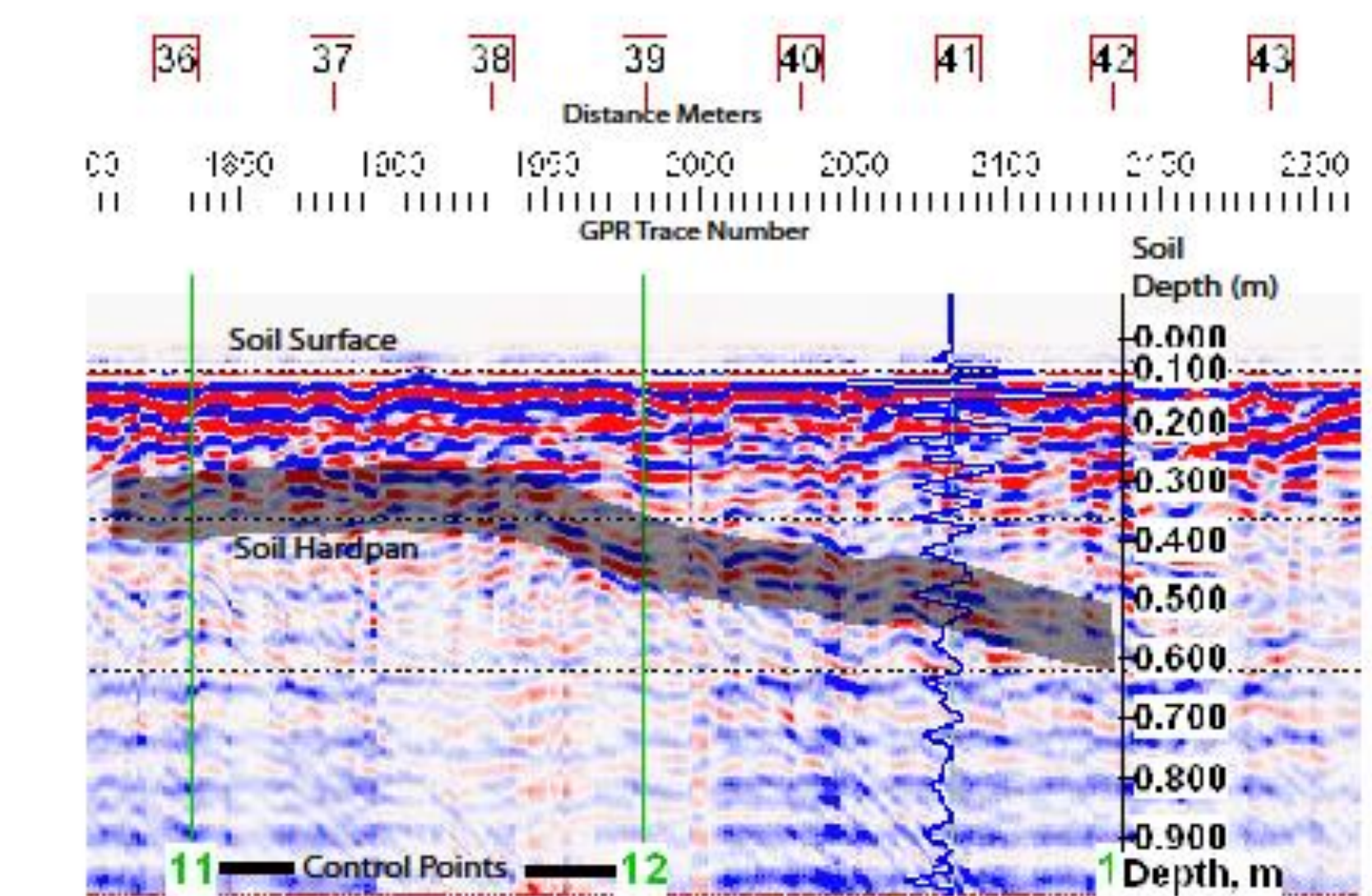
Surveys accurate elevations ( $\pm 1$  cm), providing details on slopes, pool basin areas, pool depths, and watershed discharge points.

### 4) Ground Penetrating Radar (GPR)

Provides accurate measurements of changes in soil texture identifying depth and thickness of clay layers and depth to hardpan or other water restricting layer.



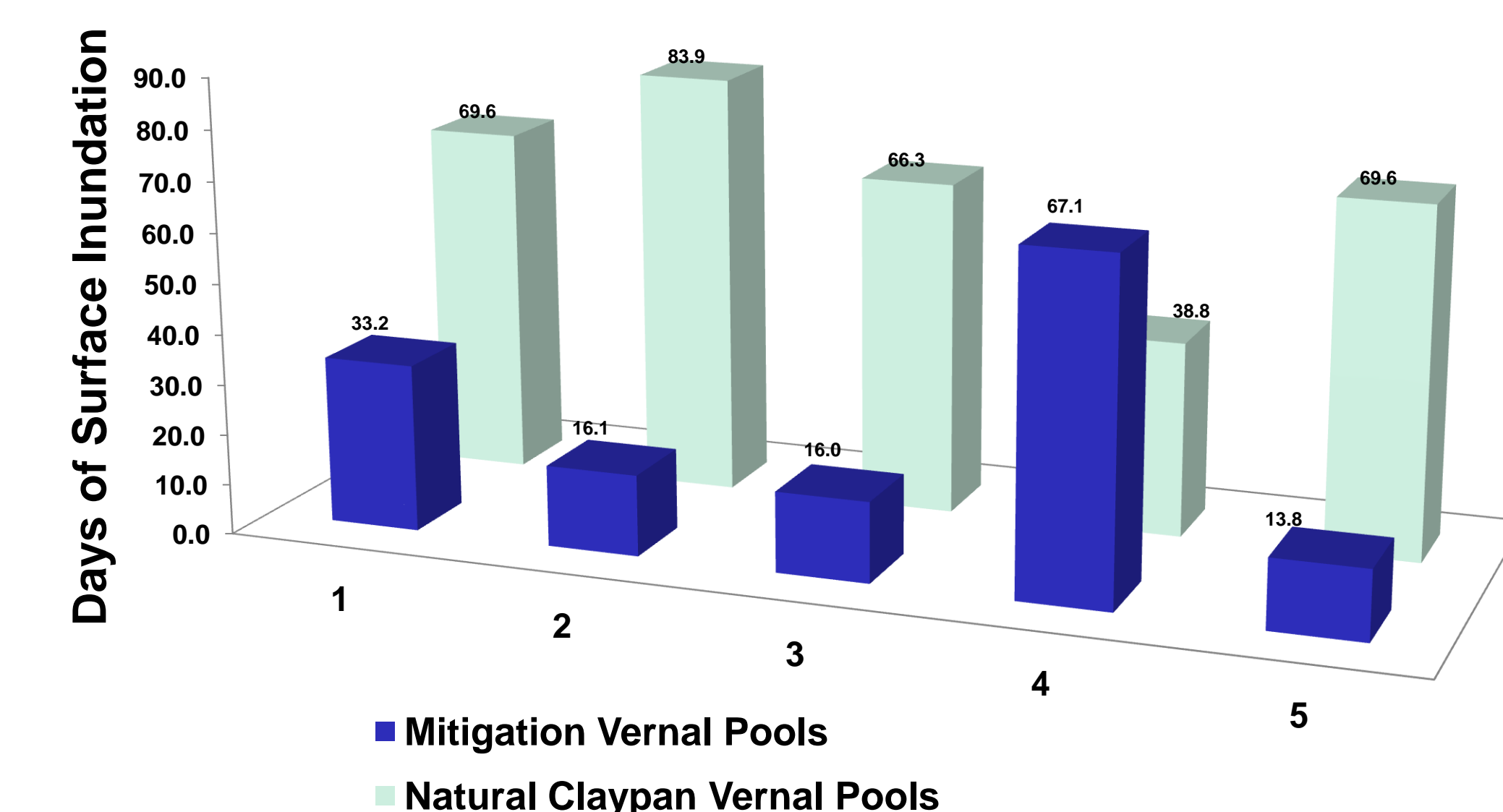
Above: GPR measurement in progress.



Right: Example output obtained from GPR measurements.

## Key results

- The use of these four technologies identified important hydrological differences in the pools on different soil types, and in natural versus created mitigation pools.
- Soil moisture sensors indicated >15% difference in soil moisture between natural and created pools during the growing season (see left).
- Levelloggers show that the number of days of surface inundation differ considerably between natural and created pools (see below).

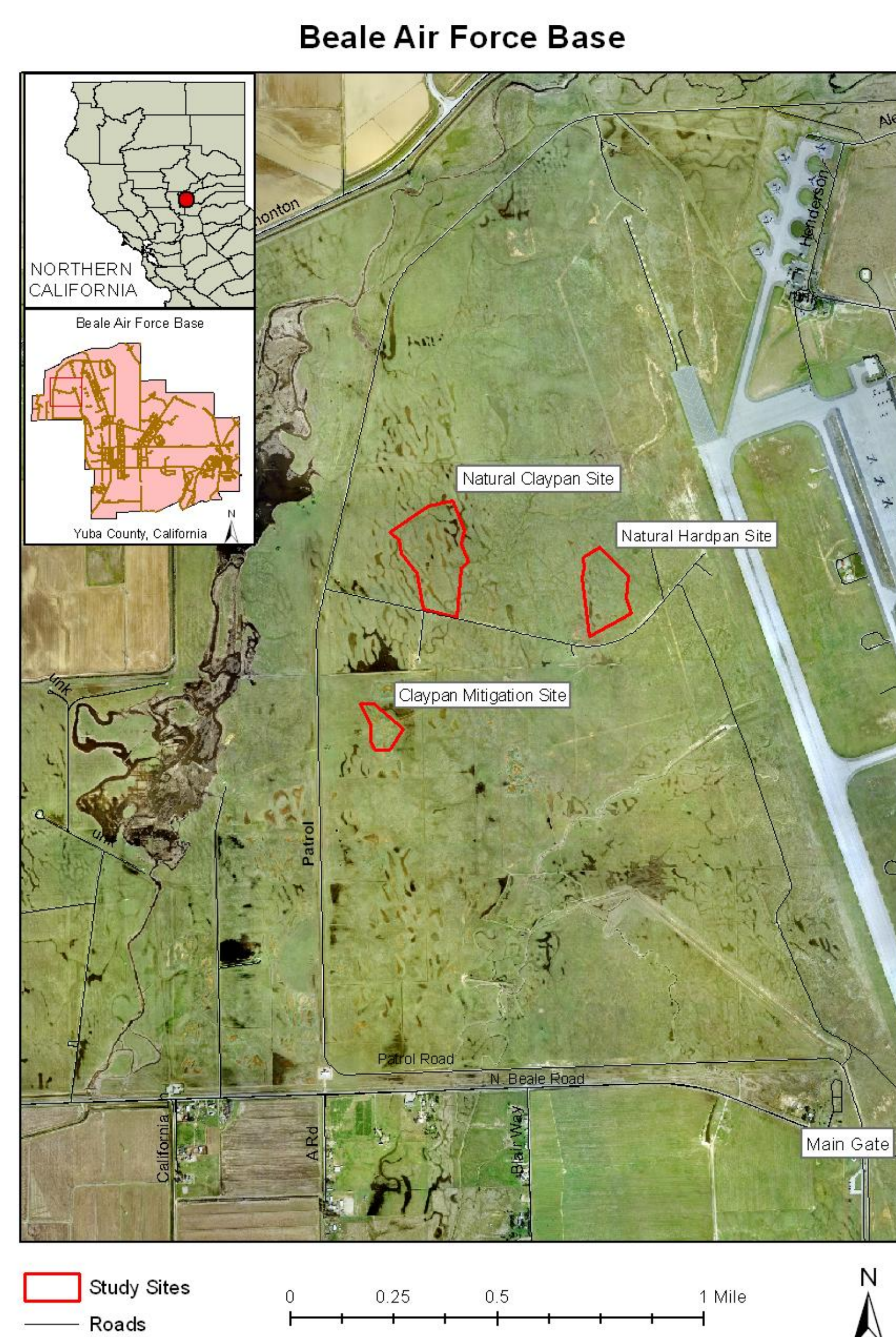


Left: Number of days of surface inundation in five natural pools compared to five created mitigation vernal pools at Beale AFB.

## Conclusions

- The technologies and methods demonstrated in this project are important tools that can assist DoD facilities to understand the extent to which potential projects will impact vernal pools and other wetlands, and provide monitoring tools for habitat management.
- This information can additionally be used to create better mitigation design plans, including identifying sites for pool construction to achieve better functioning and successful vernal pools for mitigation purposes.

## First year demonstration at Beale Air Force Base



Three sets of vernal pools located on Beale Air Force Base, Marysville, CA in north central California, were used in the first year of this demonstration.

