Geographic Information Systems Conceptual Site Model for Ordnance and Explosives Remediation at the Formerly Used Defense Site Camp Beale

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The Formerly Used Defense Site Camp Beale Conceptual Site Model is a document that evolves throughout a project lifespan to show a profile status at a specific time. This profile status presents what is currently known or suspected at a site about sources, pathways, and potential receptors of Ordnance and Explosives (OE). Important topics to be covered are: the Facility Profile, Physical Feature Profile, Hazard Release Profile, Land-Use and Exposure Profile, and the Ecological Profile.

The bulk of the paper will show the pivotal role the Former Camp Beale GIS plays describing these profiles and the relationship between them over time.

Brief History, Location, and Mission

The Formerly Used Defense Site (FUDS) Camp Beale was once used as a military training area by the Department of Defense (DoD). “DoD purchased the property in 1942, buying 87,000 acres from 150 families, and used it for a "full service" combat training facility, utilizing many types of ordnance. The training facility included bombing, rifle, mortar, demolition, and machine gun ranges.

Between 1959 and 1964, DoD sold 64,000 acres back to the public, retaining 23,000 acres for Beale Air Force Base. While DoD performed surface clearances of the ranges prior to selling the 64,000 acres, the possibility exists that unexploded ordnance may remain in some of the former training areas.” (Reference: www.campbeale.org)

“The former Camp Beale site encompasses approximately 64,000 acres located in northern California immediately east of Beale Air Force Base, straddling both Yuba and Nevada counties. The site is located approximately 45 miles north of Sacramento and 20 miles east of Marysville, CA.” (Reference: www.campbeale.org)

The overall mission of the Camp Beale project team is to reduce the risk of unexploded ordnance (UXO) contact with the public, which includes over 1,500 private landowners, and detect and remove all residual Ordnance and Explosive (OE) materials. In order to accomplish that, the Camp Beale project currently employs a combination of geophysical, Global Positioning Systems (GPS), and Geographic

Information Systems (GIS) technologies. The geophysical instruments include digital and analog magnetometers to output and record measurements and are typically used jointly in various ways with GPS to capture location data in the field.

The Camp Beale Conceptual Site Model

Part of the overall mission includes creating and maintaining a Conceptual Site Model (CSM). The CSM is used by the program and project mangers, the project stakeholders, and other team members and enables the establishment of a current status of project progress. In turn, the CSM document becomes a "snapshot" of the project for a particular timeframe. Because of the many changes over time to many of the contents of the CSM profiles, another CSM document is issued at either regular intervals or after significant changes to one or more of the project profiles. Since the Camp Beale project is estimated to take many years to complete, the CSM will be versioned many times. Due to the versioned nature of the CSM, this creates a "living", continually updated document. The current CSM version profiles Camp Beale before the OE removal process.

The CSM can also be dissected into various themed profiles: the Facility Profile, Physical Feature Profile, Hazard Release Profile, Land-Use and Exposure Profile, and the Ecological Profile. The Camp Beale GIS plays a key role in identifying the geographic features of these profiles and showing the relationship between each other and between these profiles, sources, pathways, and potential receptors of OE.

Stepping through these profiles will allow better descriptions of these specific relationships.

The Facility Profile

The Facility Profile is important in order to show where structures are, for two reasons. One reason is to display where our ground geophysical instruments cannot be used to detect subterranean OE and therefore cannot be encountered by potential OE receptors such as humans; typically ground would need to be exposed allowing detection, digging, and removal of any OE items. In fact, we can use GIS layers with features such as buildings, paved areas, above ground or underground tanks, and pools to initially eliminate the areas where detection cannot occur. This concept has been commonly referred to as "footprint reduction".

Additionally, there are yet other features such as underground utility lines, electrical lines, metal fences, and hard-packed roads that are used a different way. These features represent areas that may cause detection difficulties for our commonly used digital magnetometer geophysical instruments through possible interference due to ferrous rock or metal and, of course, electricity. For OE detection and removal purposes, these areas are assigned a common attribute of possible difficulty in OE detection and, in turn, we can make sure we take appropriate action upon planning and commencement of OE detection and removal field operations. Various actions taken might include temporarily removing metal fences, using different instruments or instrument detection parameters in the higher ferrous areas or in

the higher electrical interference areas.

Both of these GIS ideas in the Facility Profile are used in the overall project management plan. It allows for quick calculation of acreage of the “footprint reduction” area and the areas where we might have to use different instruments or procedures that impact the field operations task scope, cost, or time to complete.

The Physical Feature Profile

This profile uses GIS features such as lakes, streams, rivers, trees, and other vegetation, as well as terrain attributes such as slope and geologic classification. Typically, lakes, streams, and rivers are areas that fall under the Physical Feature Profile but yet can be used in the above “footprint reduction” idea since we are typically not going to conduct subterranean detection field operations in those areas.

The features representing trees and other vegetation are very useful to the OE project since it can pose problems for geophysical field operations. Trees are not only obstacles in the path of a geophysical instrument, but also can reduce or eliminate satellite reception of a GPS under canopy. Other vegetation, such as chaparral, can make certain field operations problematic. A cart-pulled geophysical instrument that is a mere 1-3 feet above ground level will not be able to be used nor can the instrument be bumped by the vegetation causing the cart to tip to too extreme of inclinations relative to the ground for proper measurements. However, successful detection can occur one of two ways. The vegetation can be removed by a number of methods to allow a cart-pulled instrument in or a digital or analog hand-held instrument may be used without vegetation removal, depending on the density and type of vegetation. Before we could make any assessments of the vegetation over 100 square miles of area, we needed to capture the vegetation features in the GIS at high enough detail to make it useful for our purposes.

Using a 1 foot per pixel resolution on a color digital orthophoto of the site, and through a phased process, the GIS was able to discern the trees and chaparral of the springtime image. This process was conducted through the use of ESRI format Grid layers and then converted into polygon shapefiles. The result was a very detailed polygon layer of general vegetation. To make this layer useful to the project, this layer was then spatially queried against a pre-established, site-wide grid system. This grid system consists of, at it’s smallest level, uniquely named 100 foot by 100 foot grid cells based on the California State Plane Coordinate System. The static and constant, site-wide grid system was generated for the express purpose of keeping track, via a database, of where detection, removal, and other field operations has occurred and where it has not occurred. It also limits the search area and breaks it down to a more manageable level when conducting total area geophysical surveys.

The spatial query established the square foot area of vegetation per grid cell and passed that value as an attribute to each respective grid cell. This allowed the display of grid cells by overall vegetation density and allowed us to start to see more specifically what and where geophysical instruments might be able to be used by grid cell features.

To better characterize these grids relative to geophysical instruments, slope must also be taken into consideration. A given geophysical instrument has a slope parameter range that it can successfully operate within. In order to establish slope by grid, a Triangulated Irregular Network (TIN) was created of the terrain through the input of spot elevations. This allowed an ESRI format Grid layer to be created by slope degree and then converted to an ESRI shapefile polygon layer with slope degree attributes populated. From this point we can query the slope layer against the site-wide grid system and further characterize grid cells suitability for particular geophysical instruments. Because there can be varying slope degrees throughout a given grid cell, varying instruments must be assigned to accommodate the specific types of terrain.

In addition, the various geologic areas of Camp Beale must also be considered when creating the Physical Feature Profile. Geophysical instruments might also have certain parameters for certain geologic areas. Therefore, another spatial query can be conducted to assign the geologic classification to each grid cell.

Once each grid cell has square footage of “footprint reduction” areas, vegetation, degrees of slope, and geologic classifications attributed, then each grid can be assigned the appropriate instruments and square footage anticipated for each instrument to be used. One more query reveals the total acreage by instrument and can be directly related to project management and planning concepts such as field operations task scope, cost, or time to complete.

Another GIS part of this profile might display any erosion since the time period the OE was first used in the area. This might help point at any potential OE that might have moved and/or exposed the OE source to receptors due to natural processes. In addition, other earth or water movements, if it is present in the site for the same time period, may need to be displayed.

The Hazard Release Profile

This profile displays the extent of any suspected OE areas in the Former Camp Beale. These GIS features include all known and suspected ranges, targets, firing points, demolition areas, and other former military activity areas. These areas were spatially captured in the GIS mostly from historic military map sources. In addition, through historic data research, these features may have specific types of munitions associated with each of the features. This can isolate the more unstable and dangerous munitions and impact the prioritization of field operations for OE detection and removal. The profile also includes GIS features representing OE related items found by various people over time outside of a formal OE detection process; these items are commonly called “incidental OE finds”. These finds sometimes provide excellent physical clues as to where impact or target areas are and therefore where other OE might be. Additionally, areas with disturbed or scarred ground were identified on historic aerial photos and spatially captured as GIS shapefile polygon layers. These disturbed ground areas may or may not be due to OE activity but are treated as such until they are eliminated through solid evidence.

This profile becomes very effective when compared with other profiles to show risk of OE exposure.

The Land-Use and Exposure Profile

The land-use features include real estate parcels that have been attributed with county zoning categorization data. This feature data set might be supplemented with land-use data captured from field observations, especially if the land-use plainly differs from the zoning categorization.

Land-use also includes future land developments. For instance, at Camp Beale there is a proposed large housing development that the GIS can compare to the Hazard Release Profile features to reveal the underlying OE exposure risk associated with construction in the development area.

The Exposure Profile is the result of comparing the above profiles through various queries to produce an analysis with regard to the OE sources, pathways, and potential receptors of OE. For instance, we can compare the Hazard Release Profile features to facilities and the population that might inhabit those structures at a given time as potential receptors to the suspected OE in those areas. This identifies areas of higher potential risk for exposure to OE and therefore should be prioritized to conduct detection and removal or other risk reducing action than a lower populated area with few to no identified Hazard Release Profile features.

Another example is to isolate access availability by comparing the Hazard Release Profile features to known pathways and obstacles from the potential human receptor population to the OE source. These pathway features include trails, roads, and bridges while obstacles might include locked gates, fences, and physical barriers such as buildings, valleys, canyons, rivers, and lakes.

The Ecological Profile

For the Camp Beale CSM, this profile includes GIS features such as any cultural related layers, biological related layers, and areas that are intentionally undeveloped such as Camp Beale’s Spenceville Wildlife and Recreation Area.

Cultural features include layers such as areas known to contain Native American artifacts or related areas. These areas are generated from points related to various cultural features as polygons that show the relative extent of those points; this is done to avoid the risk of leading people to the specific sensitive areas. Biological features include layers such as areas known to contain sensitive species and habitats. Both of these layers are used to plan areas of field operations that might need to have precautions established to assure that the project’s progress does not violate any sensitive species, habitat, or Native American related areas.

A public park such as the Spenceville Wildlife and Recreation Area is easily coordinated with the governing agency to conduct our detection and removal process without establishing a Right of Entry as would happen with a private owner. This GIS feature can be seen as an ecological benefit to the speed of the project progression; however, both the cultural and biological layers and the associated precautions

still apply as described above.

The CSM Through the Project's Lifespan

Though the Camp Beale CSM is in it's infancy, the project's future depends greatly on the GIS analysis to be conducted as we begin OE detection and removal field operations and begin to assess data collected. The resulting GIS features will include OE related and UXO items found, areas cleared of OE to depth, and other information to be incorporated progressively into the CSM.

Other ideas for the future of the CSM include Inhabited Building Distance from removal actions, precautionary Minimum Separation Distance from intentional or unintentional OE detonations, and Maximum Fragmentation Distance of detonations based on munitions type, surrounding terrain, and other barriers.

Conclusions

All of the profiles described, when combined and compared to each other via the GIS, reveal a much larger, detailed, and clearer status profile of the entire project site. The end result allows for better informed project decisions and anticipation of potential problems before they arise. The CSM also provides a powerful tool that can be used to identify any missing and necessary information for project success and detailed planning of field operations and their priority. The relations shown between the profiles and their contents can be easily queried through the GIS and, in turn, can reveal any risk involved stemming from the relationship between OE sources and human receptors, via various pathways.

REFERENCES

www.campbeale.org

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ATTENTION

This website can now only be accessed at the 'www.campbeale.org' location.
Please update any bookmarks you may have to this site.

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CAMP BEALE

Ordnance & Explosive Cleanup Project

US Army Corps of Engineers
Sacramento District

The purpose of this web site is to make information about the former Camp Beale available to the public, particularly current property owners of the parcels that comprised the acreage of the U.S. Department of Defense (DoD) installation that known as Camp Beale.

ENTER

- **Restoration Advisory Board Meeting** (DETAILS)
- **Public Meeting** (DETAILS)