WRPI Watershed Management Internship Program

San Bernardino National Forest & Sand to Snow National Monument

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Table of Contents

1. Acknowledgements.....3

2. Executive Summary.....3

3. Project Objectives.....4

4. Project Approach.....6

5. Project Outcomes.....7

6. Conclusions.....8

7. Additional Projects.....9

7.1. FRVC & Watershed Monitoring Projects.....9

7.2. Feral Cattle Remediation Project.....10

8. Appendices.....12

1. Acknowledgements

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Additionally, I would like to acknowledge the support and assistance received from staff and volunteers at the San Bernardino National Forest Supervisor Office and South Coast Bureau of Land Management Field Office. In particular, my supervisor Jihadda Govan, who arranged for numerous interesting activities on a range of projects during my appointment; BLM geologist Jeffery Johnston, who took me along to visit several sites and provided me with a central project; William Wells FS Hydrologist, who I accompanied on several field days; the FS GIS staff Chris Chandler and Tracy Tennant, who generously answered questions and assisted with mapping projects.

2. Executive Summary

My internship with the San Bernardino Forest Service covered a number of projects, the primary of which was to develop a map database intended for use by the Bureau of Land Management Geologist. An organized map database for use with handheld GPS devices was required to accurately locate oneself, determine mineral claim boundaries, and surface management responsibilities in the field. Developing the best possible map for this purpose required outlining key goals, compiling data, and efficiently organizing information. Additionally, I accompanied experts to assist on other field projects; however, I will only be discussing hydrologic monitoring and cattle remediation ground survey. Although these projects are still ongoing, my participation has provided me with a wealth of additional field skills.

3. Project Objectives

The Bureau of Land Management (BLM), a branch of the Department of the Interior, is responsible for the management of public lands predominantly, in the western United States. This includes the conservation of fragile ecosystems, issuing and monitoring grazing leases, the organization of a variety of recreational pursuits on public lands, supervision of mineral rights and permits as well as a managing a variety of permitted renewable energy projects. Of primary interest to me as a geology student is the 2.8 million km^2 subsurface mineral estate that the BLM administers; lone prospectors and mining corporations are both capable of leasing or claiming sites within BLM land to extract minerals or material of value. Depending on the type of material and the potential value of it, as determined by an examiner, these claims fall into different categories and the owners are allowed to extract various amounts and compensate the Federal government through the BLM.

Jeff Johnston is the BLM Geologist for the South Coast Field Office, and within his area of coverage are numerous small claims and established quarries that require monitoring. To aid Mr. Johnston in this monitoring process a map project was planned, the objective of which was to develop a map suitable for use on a handheld GPS Trimble unit. The map will be used to not only locate smaller claims in remote field locations, but to determine if the larger quarries are adhering to their extraction limits. To accomplish this, the map must meet the following criteria:

- Accurate enough to determine position in the field or proximity to boundaries within 1-3 meters.
- Include the location of the target quarries and claims, as well as any additional contact information available about the claim holder.
- Include a Public Lands Survey System and Surface Management overlay.

- Be packaged efficiently so that it will operate effectively on the handheld unit.
- Demark as many permanent structures or specific regions of use.

The first goal is a priority for any map project to a certain degree, but with this project as much precision as possible was desired. Since accurate spatial information is needed to determine appropriate cost for extracted materials, the precision should ideally be at the maximum allowed by the technology available. The second goal is designed to assist in organization of the various data layers and provide easy access to information in the field or office. The Public Lands Survey System (PLSS) mentioned by the third goal is a surveying system still widely used in the United States that divides land into a series of smaller grids. While it is an archaic system, it is still widely used to locate roads and property lines. The Surface Management overlay is required so that the map user can determine if a location is on land owned by the state, BLM, Department of Defense, Forest Service, or various other agencies or private entities. At times a quarry might be located on both public and private land, and to determine if material removed needs to be paid for or not, the boundary of ownership must be clear. Handheld GPS units, like the Trimble Juno used in this project, do not always include the most powerful hardware and as such a map developed for use on a desktop computer might not be effective in the field. The inclusion of more data than is necessary for field operation is taxing and undesirable, so every possible effort should be made to trim the map package to a reasonable size.

The final project goal is the most crucial, the map is intended to be used to locate claims and boundaries in the field so that any changes can be quantified. Small mine claims and large quarries both have to maintain certain boundaries when extracting material, and when out in the field determining these exact boundaries can be difficult. This map project aims to include these

crucial boundaries and claim limits so that the user can easily determine if any violations have been made. Additionally, monitoring and updating the map with information on quarried regions will help to determine the volume of extracted material over time and thereby enable officials to properly bill for that material. A final element is that the nature of resource extraction requires a wide range of equipment and materials, which in turn requires the construction of stockpiles, filtering ponds, sorting platforms, diesel tanks, pumps, water tanks, wildlife fences, security gates, office buildings, processing areas, "boneyards" where broken equipment is stored, and various other semi-permanent features. These features need to be marked and monitored when they are present on public land since it all needs to be removed when extraction is finished and the site closed.

4. Project Approach

The first step to developing the map was to investigate the limits of the handheld equipment and determine how much data could be included, while expecting reasonable field performance. Within the BLM database I located and extracted out a Surface Management layer and PLSS overlay, but they covered the entire state, so to avoid overwhelming the device I found it necessary to trim them to the extent of the South Coast BLM district. The next steps were a series of site inspections with Mr. Johnston, we visited four quarries operating on BLM land, and several small mine claims (Figure 1). The quarries were producing concrete aggregate, specialized sands, and decorative gravels, while the small claims were attempting to locate gold deposits. During these visits I collected a series of data points with the handheld GPS to both begin the process of mapping out key features, as well as determining the accuracy capable in the field areas. Next, I began to transfer location and supplemental informative data into the map

project, in which many points were exported directly from the GPS unit and into ArcGIS, but additional features were located in GoogleEarth and exported into the Arc map project. Taking data from a range of sources requires close attention to which map projection is used, exported data does not all share the same projection and unit system so conversions must be made to "reproject" data. I chose to use Universal Transverse Mercator North American Datum 1983 (NAD83), it is a projection widely used in the scientific community and will be recognizable by anyone who uses the finished map. Once all available data was added to the map project, I worked to make the database organized and intuitive by selecting and maintaining a universal symbology, in which different surface management agencies should be easily identifiable and features of a certain type should all appear with the same symbol. For example, BLM and Forest Service land should be labeled as such and assigned the colors or patterns used on all Forest Service maps.

5. Project Outcomes

The final map project is both accurate and simplified for use in the field. It will allow the user to determine with sufficient accuracy where they are located, who manages the land at that location, what township and section is that location within, what quarries or claims are nearby, any contact information available for those sites, and the location of any permanent or semi-permanent features. This should greatly reduce the amount of time needed in the field searching for locations or data, and will better enable the user to track changes in the field as quarries and claims expand or close.

Before starting this project I had a very limited understanding of the process by which the BLM and other agencies handles resource extraction permits, but I now have a foundational knowledge of the elements involved. The limits of what can be extracted, how different

resources are valued, the bonds required by larger operations, and the monitoring of sites done by agency geologists are things that I had never covered in class work and I am grateful I had the opportunity to learn about those elements from experts in the field.

If anything could have been done differently, it would have been having additional time to gather data for the project. Large quarries hire engineering firms to survey their sites, and it is those surveys that determine the location and boundaries of the various claims. Many claims were made before the advent of digital record keeping and a robust survey of their location was not required, an issue arises where these old claims are still active and subject to different fee structures but their location is unclear. To gather the location of these various claims, engineering firms must be contacted so you can request access to their survey data; however, waiting to get a response, approval by the permit holder, and final follow-up took up more time than I had available during this internship.

6. Conclusions

Overall my map projected developed along the path I expected, the objectives were largely met, and the only setback was an inability to acquire all the desired data due to time limitations. If someone was to continue on the project I would hope that what has already been developed will easily work as a foundation to simply add more current data to, the disturbed area of mining claims are in constant flux and any return inspection can make adjustments to the map project to account for and monitor those changes. Additionally, as quarries hire new engineering firms to perform updated surveys changes to the map will likely be required, it can be a time consuming process, but contacting firms to obtain revised location data will increase the value of the map project.

The final product is not a map designed for printing and display, and since those are the types of project I have worked on previously, making something designed to be a field tool was an interesting challenge and experience. It requires a unique approach to collecting data and benefits from a different design structure. I am grateful I was able to gain knowledge and develop skills I had no way of being exposed to through traditional course work. I am certain that this experience will prove useful when I graduate, as I now have an appreciation for the variety of options available to me at the USDA and similar agencies, and look forward to exploring my career options in that direction.

7. Additional Projects

7.1. FRVC & Watershed Monitoring Projects

One of the many responsibilities of the Forest Service Hydrologist is the monitoring of springs, drainages, streams, and other hydrological elements within federal land. Springs that produce 10 acre feet per year, or were at one time determined to produce that volume, must be inspected monthly to measure and track the water flow rate. I accompanied William Wells and Arev Markarian on two such field surveys to collect measurements and inspect the surrounding region for any changes (Figure 3A).

I also observed as Mr. Wells met with CalTrans personal to discuss the damage caused by a sizeable mudflow that covered a mountain highway. The mudflow originated in a watershed severely deforested by a past fire, and a sudden thunderstorm triggered a considerable amount of material with enough energy to carry large boulders and cover the highway several miles downslope (Figure 2). Mr. Wells and the CalTrans engineer

devised a plan to excavate the blocked culvert and prepare the area for possible future flow events by constructing a series of terraced flood plains.

Finally I assisted Sheri Craig and Dave Baumgartner, of the Fisheries Resource Volunteer Corps (FRVC), on two data collection trips to Holcomb and Crab Creek. The Clean Water Act includes a list of "impaired" waters and what establishes a maximum amount of pollutant allowed. The San Bernardino Mountains contains several bodies of water on this "303(d)" list, and in the interest of having these streams removed, data must be collected to demonstrate that the level of pollutants has been reduced to accepted levels. The FRVC has volunteered to repeatedly sample the targeted streams, collect on site data, and transport samples to a lab for additional testing. I assisted for two days at Holcomb and Crab Creeks measuring flow rate, alkalinity, pH, conductivity, turbidity, temperature, and collecting water samples for dissolved solids testing. In order to collect the required data I was trained in the use of a Marsh-McBirney flow meter, Hanna Instruments turbidity meter, Lamotte alkalinity kit, and YSI multi-parameter meter (Figure 3B). A preliminary overview of the collected data is encouraging and the FRVC and Mr. Wells are hopeful it will allow the target streams to be removed from the 303(d) list.

7.2. Feral Cattle Remediation Project

The Sand to Snow National Monument covers wide regions that are intended to be kept as unspoiled wilderness, unfortunately many of these regions have been intruded upon by "feral" cattle. Cattle brought into surrounding regions by ranchers sometimes wander into Forest Service lands and become one more form of invasive species to be dealt with. Cattle are well known for causing significant damage in these environments,

in particular they trample native vegetation and destroy fragile riparian zones, to preserve these regions and protect native wildlife action must be taken to remove the cattle and prevent their reentry. Since any effort to remove the currently present feral cattle will be futile without first taking steps to block their entry to Forest Service lands Monument, Manager Jihadda Govan intends to install fencing between federal and private ranching lands. For fencing to be effective the placement location must be carefully determined and cost must be considered in order for the project to proceed. Cattle freely travel up drainages into Forest Service land and trample through low brush, but since they are unlikely to traverse steep rocky regions, “pinch points” where drainages are bound by impassable slopes are ideal (Figure 4). I accompanied Ms. Govan on three trips to assess damage by cattle and locate possible choke points to later install fence. On these trips I used a Trimble GPS unit to collect data at points of interest such as feasible regions for fence installation and signs of cattle intrusion. Before embarking on these field surveys, Ms. Govan and I visited the Morongo Tribe Administration building to obtain permission and directions for passing through their territory and discuss how to best implement the project. Evidence of cattle intrusion was abundant, and the five drainages visited are crucial points to begin remediation efforts, several “pinch points” were identified in those regions and the ground surveying will hopefully enable fencing to be more effectively installed.

8. Appendices

Figure 1: South-East view from the Manzanita claim post within Whitewater quarry, the quarry owner desires to develop the visible road for use transporting material. Mineral claims are often in regions with few landmarks to orient oneself in the field making a detailed GPS map crucial.

Figure 2: Boulders weighing several tons mobilized by a sudden debris flow are blocked by a tree from crossing the highway visible in the background. Mud and rock brought from upslope must be removed and made as stable as possible to mitigate future incidents.

Figure 3: (A) Arev Markarian and William Wells collecting measurements at an unnamed spring near Crestline, CA. (B) Ian Severais measuring a water sample taken from Holcomb Creek to determine alkalinity.

Figure 4: Surveying drainages for locations to place cattle fence it is made clear that not every canyon contains an ideal “pinch point”, but cliffs and talus deposits should discourage intrusion if the more accessible trails are closed off.