

**Secret Canyon Ranch
GIS and Reservoir Analysis
GISWR2014
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Introduction

Secret Canyon Ranch (SCR) is located just north of Malad, ID. The ranch spreads over 2400 acres with a mix of wheat, alfalfa and areas in the Conservation Reserve Program (CRP). In addition to crops, SCR has also installed four wildlife ponds and is looking to improve natural habitat in sections of land. Currently the map used to plan planting and management consists of a 3x4ft NRCS map highlighted to designate parcels. No formal hydrological data is known or mapped besides water share times. The current planning, management, and use of land could be greatly enhanced with GIS mapping and data analysis.

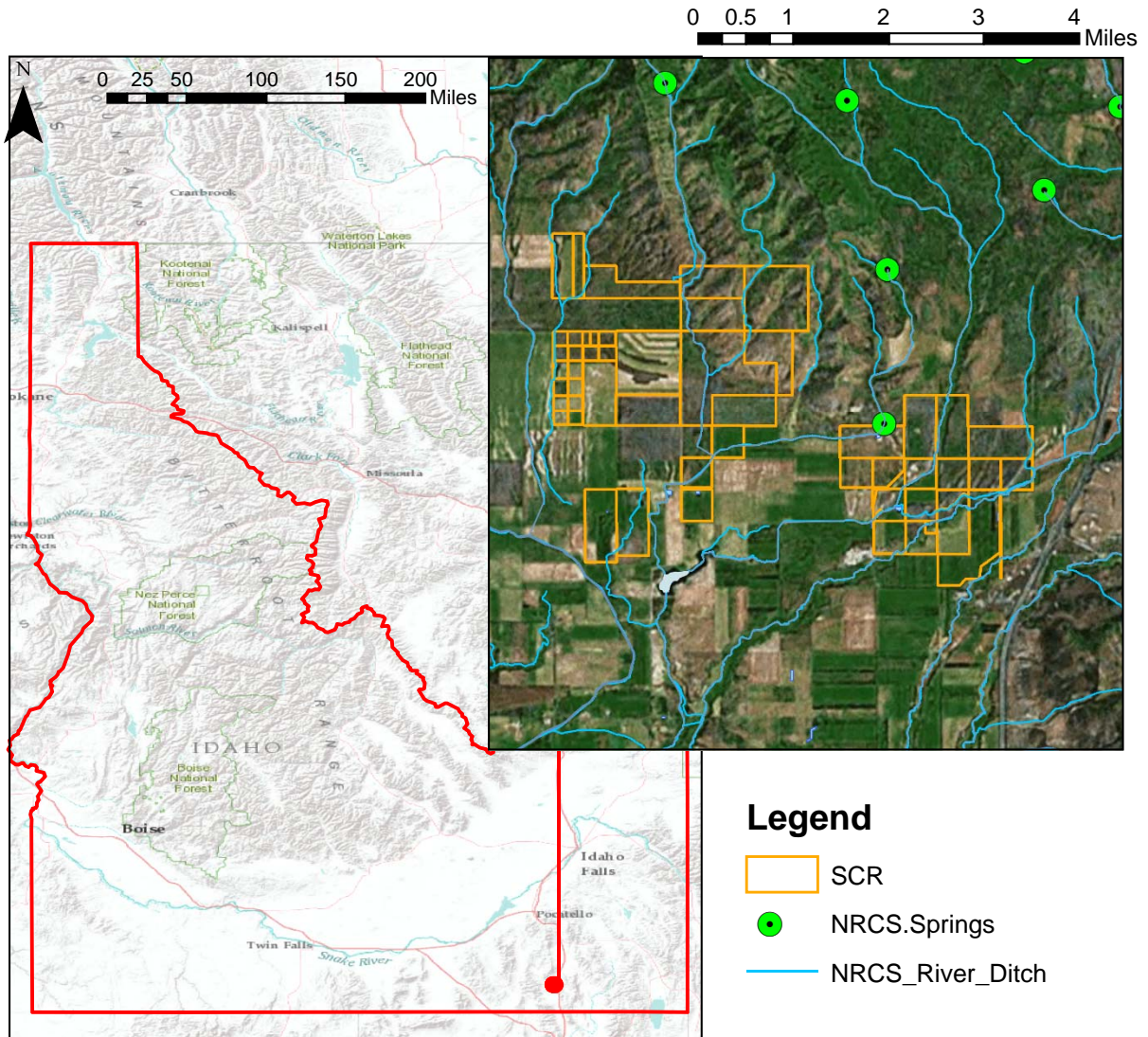


Figure 1 SCR Location and Extent

Problem Statement:

The purpose of this project is to collect and present all pertinent GIS data for use by SCR in planning and maintaining ranch operations, current ponds, and planning future development. The goal is to combine national datasets with local official land records and data for comprehensive and accurate mapping of SCR and the surrounding area.

Goals and End Products:

The goal of this project is to produce two products: (1) A set of usable reference maps outlining ranch extent and correlating property lines, crop/land usage with pertinent metadata for each field available as fields in each features attribute table. (2) An interactive map and dataset will be built for storing all datasets and GIS data found. This data will be exported to ArcGIS online, Google Earth or other open source software for continued use by SCR.

As data collection began another goal of modeling potential reservoir sites was proposed. This in turn led to the creating of an ArcMap tool for calculating volume and surface area for potential pond locations.

Methods and Results:

Work on this project will be discussed in three sections: data collection, map development, and reservoir modeling. The initial goals were achieved in each of these areas. However as this project applies to personal use, each section also identifies future work that can be done for continual use of this project in coming years.

Data Collection

Local Sources

The first data collection came from site visits to local sources in Malad, ID. Both the Oneida County office and the Natural Resources Conservation Service (NCRS) office have local ArcGIS experts that keep each agency's maps up to date. A shape file for all CRP records particular to SCR was obtained from the Natural Resources Conservation Service (NCRS) office. The County Assessor's office was very helpful in giving shape files for each SCR property. Malad Valley Irrigation (MVI) was contacted to obtain any hydrological data available for area. MVI provided the water-turn and share data (flow units in miner's inches). They also discussed potential locations for irrigation storage reservoir. The location used for modeling was identified as a canyon upstream from an existing irrigation reservoir. This was chosen with the idea that MVI already has permits to dam the creek for storage. Thus placement along this water source would be easiest because of existing permits and natural geography. Lastly, SCR was sectioned by hand into zonal fields for future organization.

Online Data Sources

Esri web services were accessed to find national datasets including the 30 meter Digital Elevation Model (DEM) and the National Hydrography Dataset (NHDplus). Further data including local county datasets for lakes, ponds, ditches, and springs were obtained from the NCRS webpage. Previous to this class, the only GPS data were obtained by marking GPS waypoints while flying, driving or walking to each site.



Figure 2 Early data collection efforts

Map Development

Reference Maps

After the data collected above was imported into ArcGIS, layouts were prepared for printing. These printed maps remain very simple as the majority of the metadata and visualizations are more beneficial in a digital format.

Interactive Map

Watershed delineation was performed to identify the HUC 8, 10, 12 watershed catchments that SCR is located within (see in Figure 3). Various layouts were prepared to highlight different attributes of the geography and hydrology. These maps were then converted to .kmz files for use by Google Earth. Converting the data to this format allows SCR to continue to benefit from the GIS mapping and data collection without the necessity of purchasing ArcGIS software licenses. Google Earth does not provide the sophisticated analysis that ArcMap offers but the free and simple-to-use aspects of the software provide a good platform for SCR's use.

Further Work

The metadata available for each legal parcel is contained in a large attribute table for each layer. This attribute table could be trimmed down or organized for easier access to key info. SCR will remain in contact with the mapping experts at both NRCS and County Assessor offices for updates to maps. While sorting through the attributes of the legal records it was found that SCR is listed under varying names for different parcels. This legal paperwork will be consolidated for easier reference for both SCR and the County Assessor.

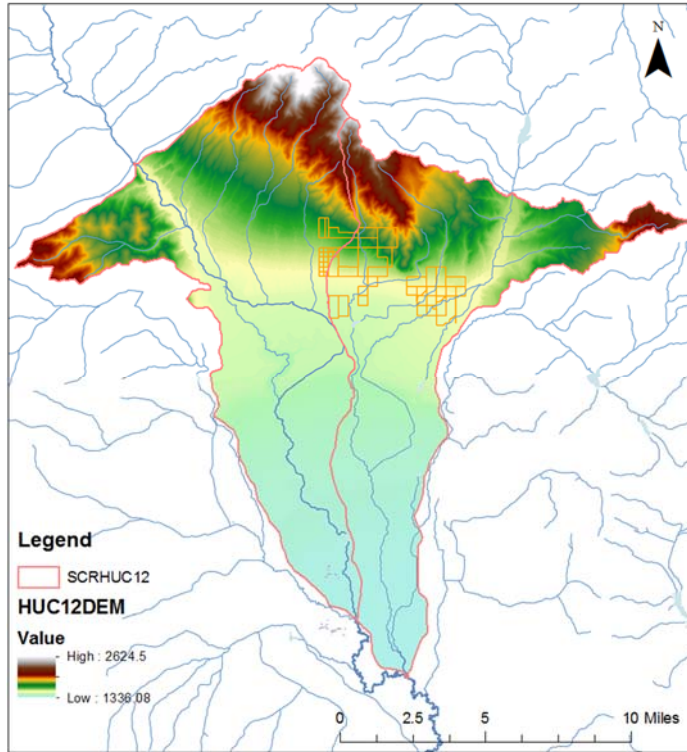


Figure 3 SCR Watershed Delineation

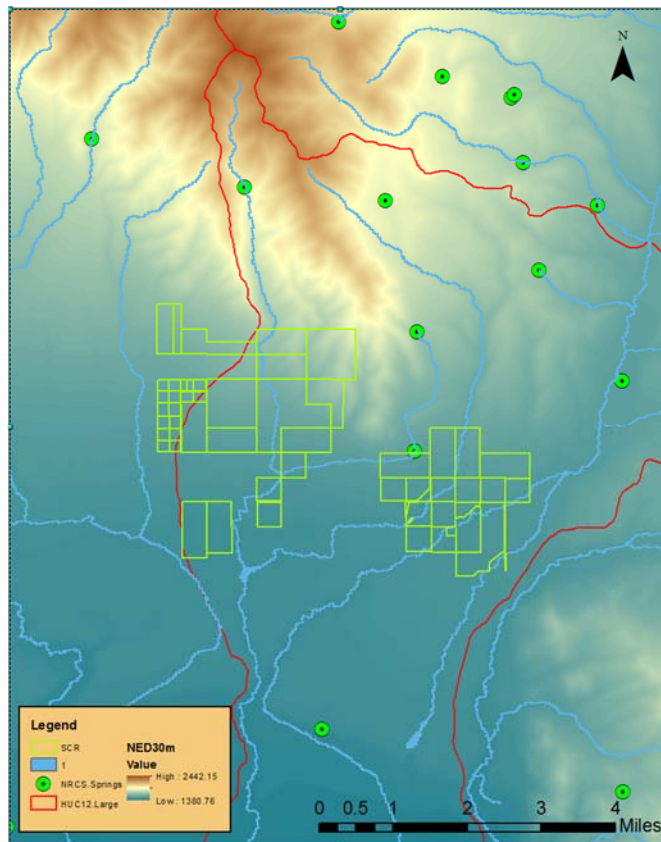


Figure 4 SCR Extent Elevation Map

Reservoir Analysis

Location

SCR has previously developed small scale wildlife ponds. Because of the size of these projects, each was planned with limited calculation and construction could be carried out by a small Kubota tractor. The reservoir modeling tool developed for this project gives preliminary volume calculations for slightly larger scale reservoirs. This larger reservoir would also serve as storage location for irrigation of surrounding fields.

The location of interest was chosen primarily based on the canyon topography that would provide a natural boundary. The site was also suggested upstream of the existing St John's Reservoir as it was assumed that because the permits to dam this water body already existed, they may ease the process of approving this new location. St John's Reservoir can be seen in figure 5 with the location chosen for analysis highlighted in green to the north east.

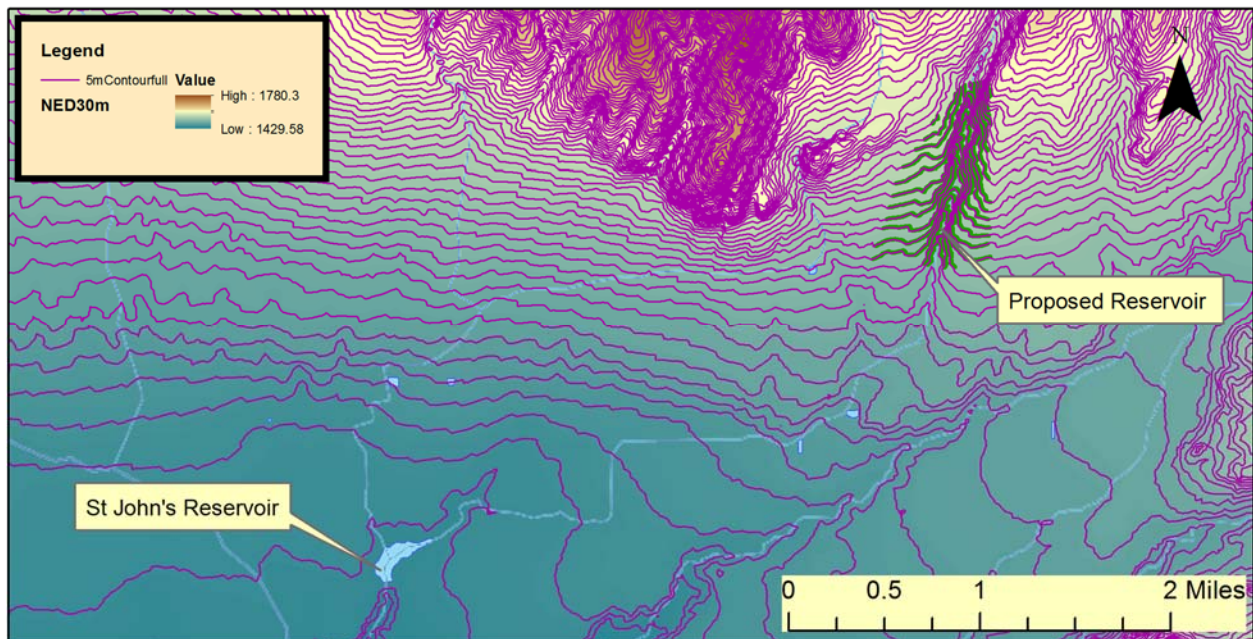


Figure 5 Existing and Proposed Reservoir locations

Tool Design

The preliminary analysis needed for the site location was to optimize achieving maximum volume with minimum construction costs. This was done using a tool developed to calculate the volume of reservoirs created by differing dam heights. Locations were then compared to find the site with the least height (construction cost) and greatest volume.

An ArcMap provided tool called Surface Volume in the 3D Analyst extension was used with additional features added using Model Builder. The workflow in Figure 6 demonstrates the tool logic: take a user defined polygon, clip the DEM outlined by that polygon and then run the Surface Volume tool at 18 elevations with 5 foot increments.

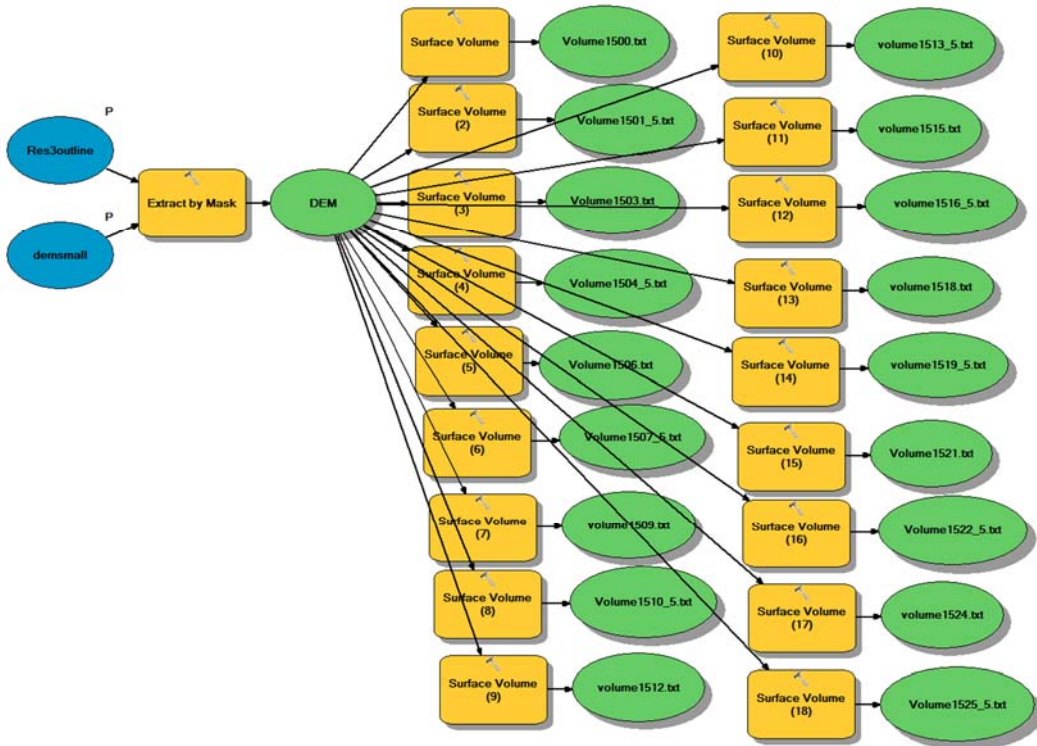


Figure 6 Model Builder Workflow

For this application, the south end of the input polygon loaded into the tool simulates the dam location by ending the DEM along the lined defined. Clipping the DEM to a more exact location was needed to ensure the tool provided correct volume calculations. The tool operates by calculating the volume in-between the DEM and a specified elevation plane. This means that if a small enough DEM is not selected, the tool will find the volume of every part of the valley that is lower than the proposed dam as seen in Figure 7. To clip the DEMs in Figure 7-8 the national 30 meter DEM (NED30) was used along with the location specific polygons in Figure 9.

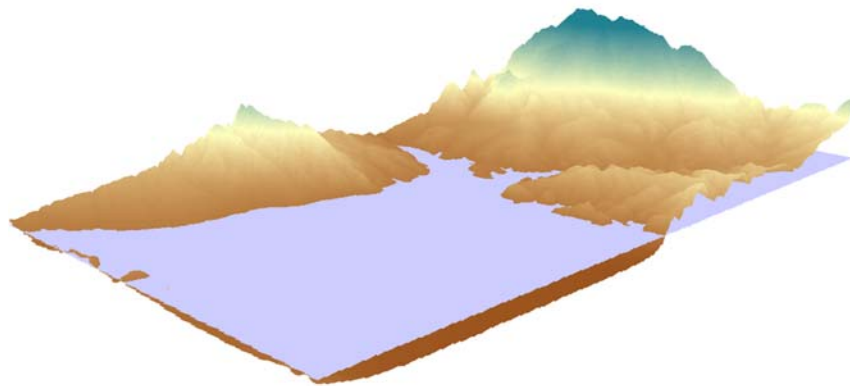


Figure 7 Volume tool run with large DEM

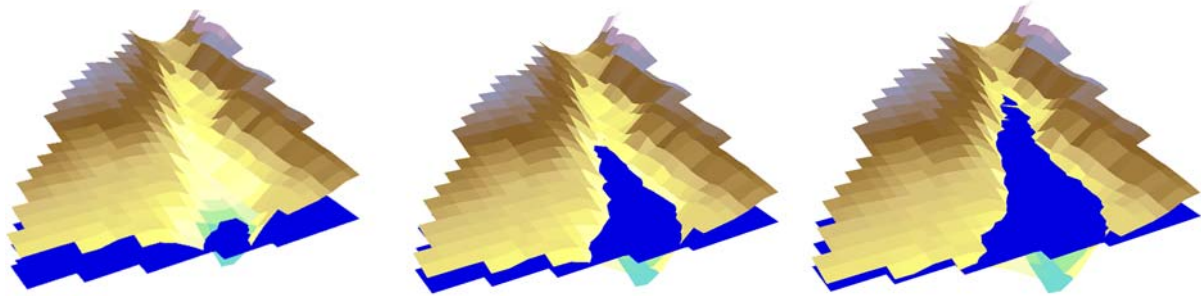


Figure 8 Volume tool run with small DEM

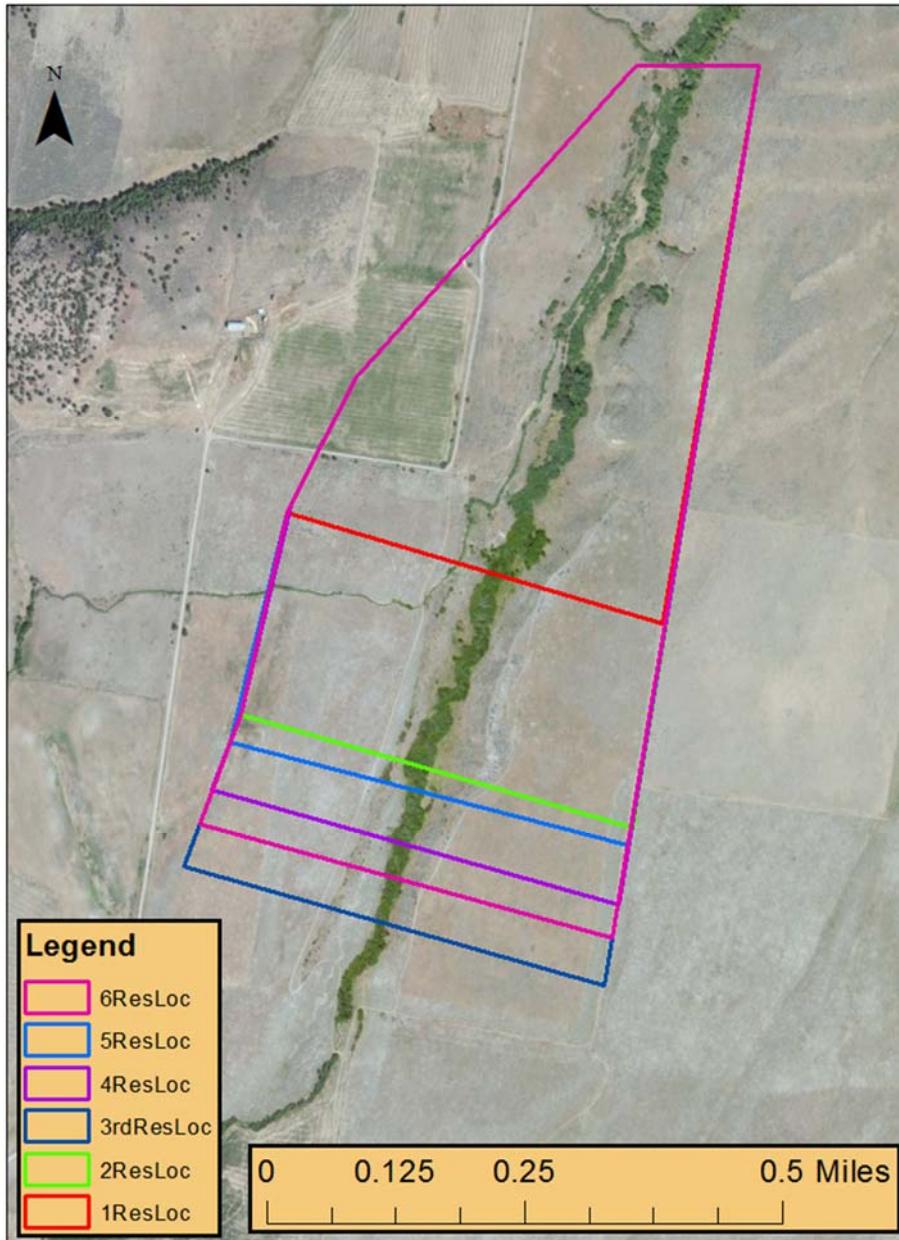


Figure 9 Input Polygons with Dam location on South Border

Results

Volume per dam height continued to increase the further south (down the canyon) the reservoir was located. Location 3 and 6 gave the greatest volume per given dam height. However this brought up another variable that had previously been simplified out of the calculations: the span of the dam is also a factor in the total cost of the dam. The preliminary calculations considered minimizing dam height as the greatest variable to be optimized. The volume increase benefit suggests choosing a site further down the canyon but the width of the canyon also increases in this direction complicating the optimization problem.

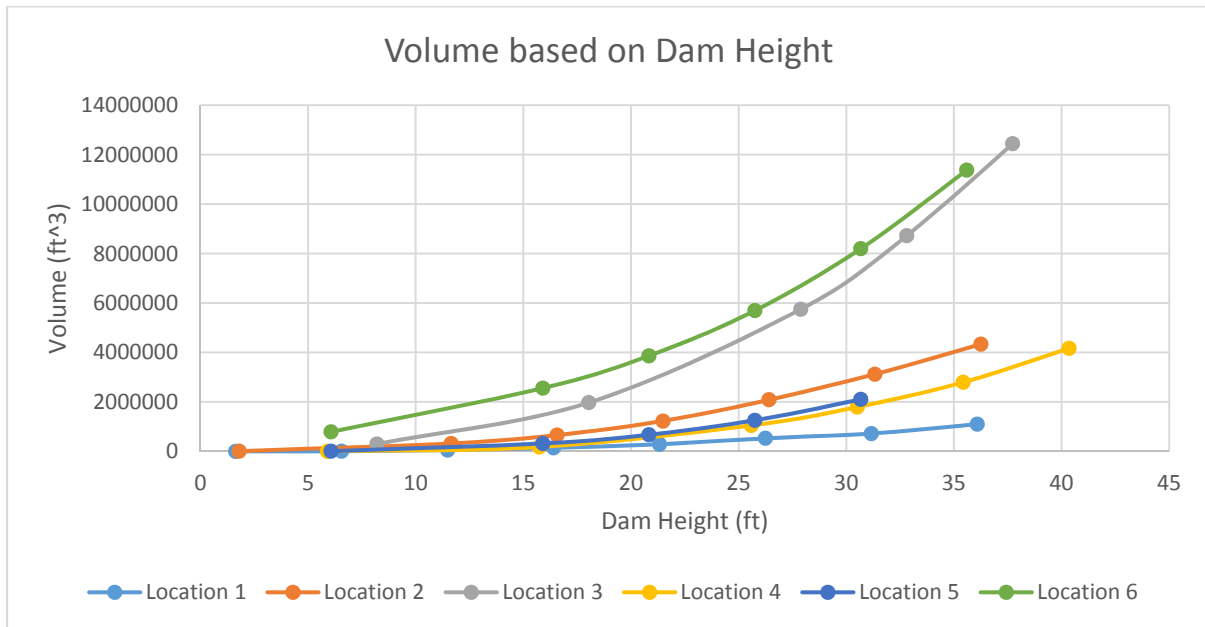


Figure 10 Dam Volume for each site

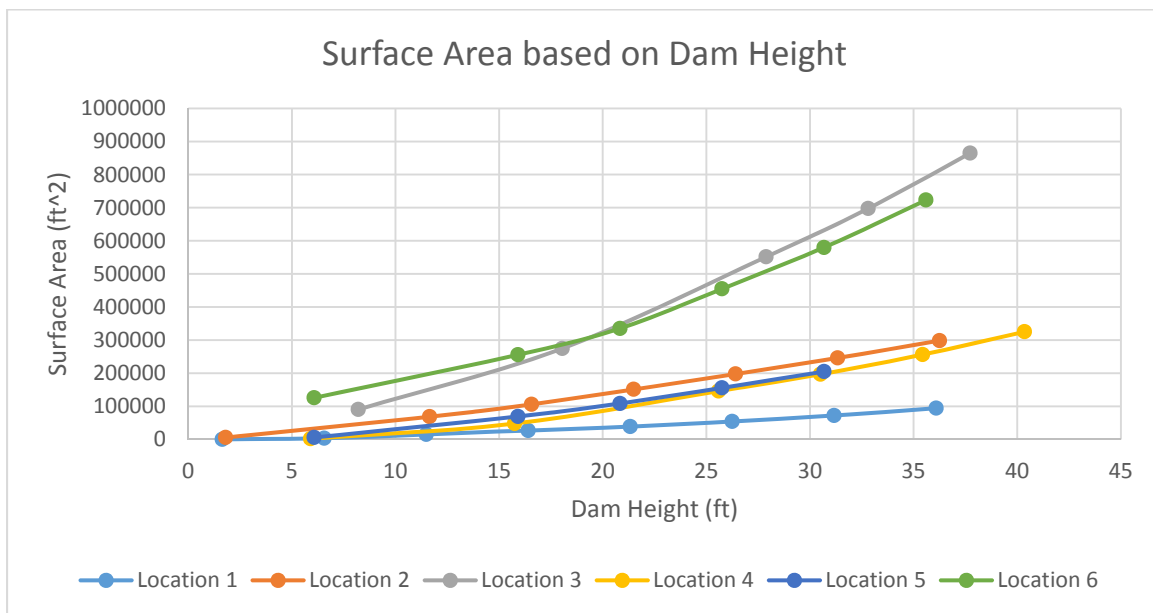


Figure 11 Reservoir Surface Area for each site

Further Work

This tool and the site selection analysis can be enhanced in many ways before the final reservoir site is chosen. Python scripting to enable broader functionality for the tool would be a first step. This would include the ability to automatically find the lowest starting elevation for a potential dam site then run the tool adding designated 5 ft increments from that starting elevation. This would also enable the tool to be more versatile and able to analyze any location within SCR extent. Python enhancement of the existing tool could also provide the optimization ability to model a dam at every location along the entire canyon to better find optimal location.

In addition to tool enhancement, further research into USBR for legal requirements and consulting with the state dam engineer would help find specification and dam classification categories.

Conclusion

Work on this project provided a highly educational and useful means to apply skills and knowledge learned throughout the course. Techniques from each homework exercise were used in map development as well as additional ArcMap functionality such as 3D spatial analysis.

As mentioned above, all of the initial goals were achieved with many ideas for improvement also identified. In addition to this, new features and ideas will come as maps are used by SCR in the coming years.