NATIONAL HYDROGRAPHY DATASET (NHD) UPDATE PROJECT

FOR US FOREST SERVICE REGION 3

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Executive Summary

This project focused on completing a spatial data update to the National Hydrography Dataset (NHD) within all of the forests under the jurisdiction of the US Forest Service (USFS), Region 3. The Center for Geospatial Science and Technology (CGST) at California State University Northridge (CSUN) was contracted to update feature attributes and geometry within the NHD, which is a comprehensive spatial dataset of surface water. This project was divided into three phases: Phase one included Coronado, Tonto, Coconino, Carson, and Kaibab National Forests. Phase two included Prescott, Apache-Sitgreaves, and Cibola National Forests including National Grasslands. Phase three included Lincoln and Santa Fe National forests. CGST used the applications of geographic information systems (GIS) to update the hydrographic features such as streams, lakes, washes, ponds, canals, and ditches. Phase 1 was previously completed with Phase 2 and 3 underway in 2018. This project was essential for improving the NHD, which is a critical decision-making resource for the USFS.

Project Objectives

The objective of this project was to improve NHD features through realigning geometry, updating seasonality and other attributes, and adding new features. The hydrographic features that were updated in the NHD included points, lines, flowlines, areas, and waterbodies. The NHD features were edited at a scale of 1:12,000 - 1:10,000 in order to be accurate at a high resolution scale of 1:24,000. The stream types (ephemeral, intermittent, and perennial) were used to represent the most accurate seasonality of flowlines. Provisional names were given to hydrographic features, such as points, streams, and water bodies. In order to accomplish comprehensive updates, a variety of reference data was utilized, such as aerial imagery interpretation, US topographic maps, Google Earth/Maps, local forest data, and specific mapping business rules. The NHD updates were completed by using custom USGS editing tools within the GIS software application, ArcGIS, which allowed spatial data to be captured, manipulated, and analyzed. The NHD updates I helped to carry out will be reviewed by the local USFS hydrologists and GIS managers, before being submitted to the USGS National Database and made public. The National Forests from phase one of the project were completed in 2017. I worked on phase two and three of the project.

The National Forests I was assigned to work on in phase 2 were Prescott and Apache-Sitgreaves. The landcover type in both National Forests were semi mountainous to mountainous areas. The terrain in Apache-Sitgreaves Nation Forest was not dry and arid because it mostly had moderate vegetation. Prescott National Forest had semi mountainous areas along with some areas of semi urbanization. Prescott National Forest also had moderate vegetation.

I am currently pursuing a Master's degree in Geographical Information Science (GIS) at California State University, Northridge. I chose GIS because it is an environment where I can continuously learn new skills that can be applied to numerous fields outside of GIS. My long term career goal is to work as a GIS Crime Analysist for one of the government branches. This internship has provided me a great opportunity to learn new skills and apply those skills to real life situations.

Project Approach

Data Preparation

The dataset that was checked out from USGS's NHD system needed to be checked for any errors before implementing any NHD edits. A pre-initial quality control (QC) check was preformed to recognize any errors such as small segment check, pseudo-nodes, invalid geometry, and flow directions. Once QC review was complete, the NHD job was ready for NHD editing to begin.

NHD Editing

The National Forests in phase two were broken down into watershed boundaries known as Hydrologic Unit Codes (HUC) or watersheds. The NHD editing took place at the HUC12 boundary level, which are the smallest watershed units. A "Tracker" layer was created for my NHD job, in order for me to keep track of my editing progress within the HUC12 boundaries.

The main documents that guided editors on this project were the mapping business rules and workflow documents provided by CGST. The business rules were used to keep the NHD jobs and decision making consistent. The other main supporting documents and data that helped in the process of NHD editing were USGS support pages, USFS Region 3 resource photography, Arizona Department of Water Resources data, and current NAIP aerial imagery. Additional secondary datasets were used to produce accurate NHD edits such as Google Earth/Maps, Bing Maps, USFS Region Three data (stream line and water point data), and Arizona Spring Institute data.

The NHD edits consisted of attribution modification, realignment, and adding new hydrologic features, like streams, lakes, washes, ponds, canals, and ditches. Editors had a 500 meter flowline densification threshold in both mountainous and semi-mountainous areas within USFS boundaries, which meant that no new flowlines under 500 meters could be added to the data. The seasonality of the streams were modified to match the appropriate stream type (ephemeral, intermittent, and perennial) and to have the same consistency throughout the HUC12s. Riparian Map (RMap) datasets provided by USFS Reg3 personnel were used in order to determine the seasonality of the streams. Other editors added provisional names to water bodies, streams, and points.

Job Submission

Once the NHD edits were completed by the first editor, a second editor would run an internal quality control (QC) check and review the edits previously made. Each NHD job had a second editor review the work previously done to insure accuracy and a feedback loop where the original editor would receive comments on their editing work. Internal QC assessed spring integration, seasonality checks, GNIS Name Continuity, and flow direction/ properties checks. A final QC check was performed to verify all errors were fixed, which included NHD's standardized topology, feature to feature, database integrity, and other integral rules. Finally, the updated NHD was sent for review to the USFS Local Forest hydrologists and GIS managers. This provided them an opportunity to review the data and provide feedback based of their needs and expertise. After CGST editors received their feedback and made the final modifications to

the updated NHD jobs, the NHD jobs were submitted back to the USGS National Database for check-in.

Project Outcomes

Phase two and three work, which I contributed to, is currently underway at CGST. For the duration of this internship, phase two, covering Prescott, Apache-Sitgreaves, and Cibola National Forests, was where most of my NHD edits took place. The results from this project established that the NHD updates were necessary within National Forest jurisdictions for USFS Region 3 in order for the hydrography features to be accurate. Many of the improvements included realigning existing streams and water bodies to match the aerial imagery. New features such as streams were added as long as they were above the 500 meter threshold in specific areas. The outcome of the NHD edits indicated that many of the streams that were added or modified were ephemeral, which meant that the waterway only contained water during or immediately after a rainstorm, flooding event, or heavy snowmelt (Figure 3 and 4). Any stream that fell within or overlapped any riparian vegetation polygon from the RMap reference dataset was considered intermittent (Figure 5). Intermittent streams were defined as channels that contained water in the cool months of the year and contained no water in the dry months of the year. Most of the water bodies were classified as intermittent with high water elevation, which indicated that water was present, but not up to its highest capacity level. A reference map of the National Forests for all three phases and a legend that demonstrates some of the common features that were updated during NHD editing are provided below (Figure 1 and 2).

Figure 1: This map displays the study area for each phase of work in the National Forests.

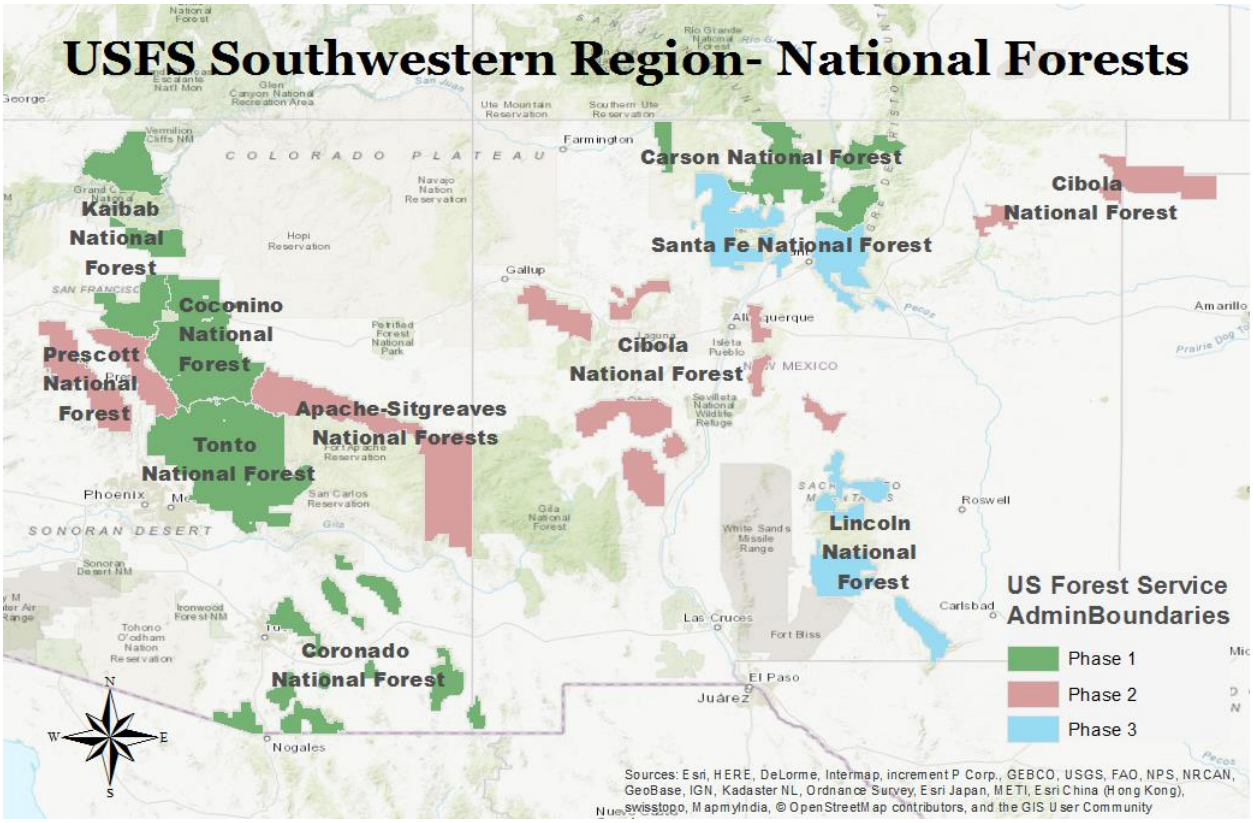


Figure 2: A legend of NHD features present in figures 3-5. These are the primary features that receive NHD Edits, not including Riparian Vegetation, which is a reference dataset.

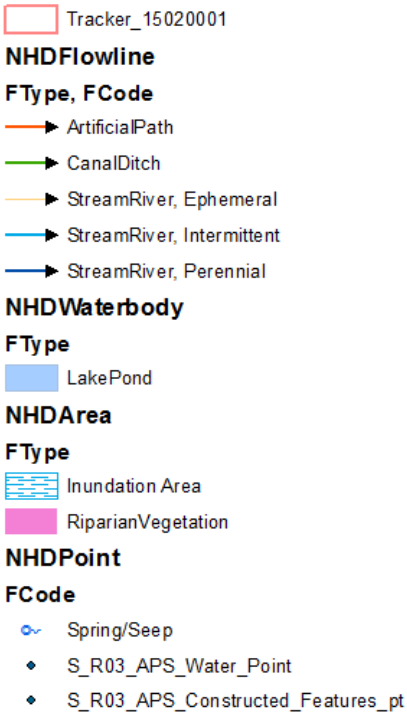


Figure 3: Before NHD Updates in Apache-Sitgreaves National Forest - Little Colorado Headwaters Watershed.

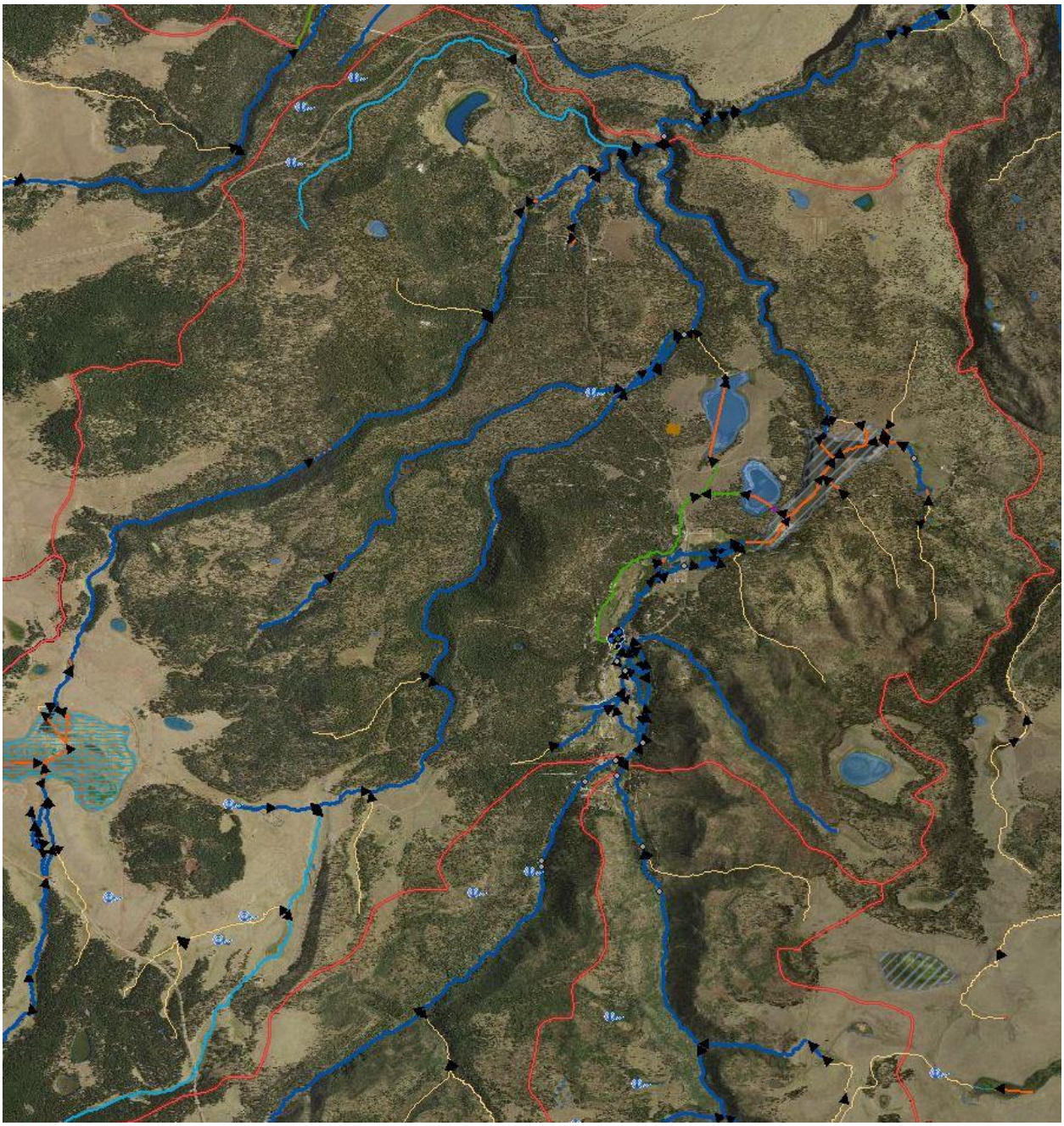


Figure 4: After NHD Updates in Apache-Sitgreaves National Forest - Little Colorado Headwaters.

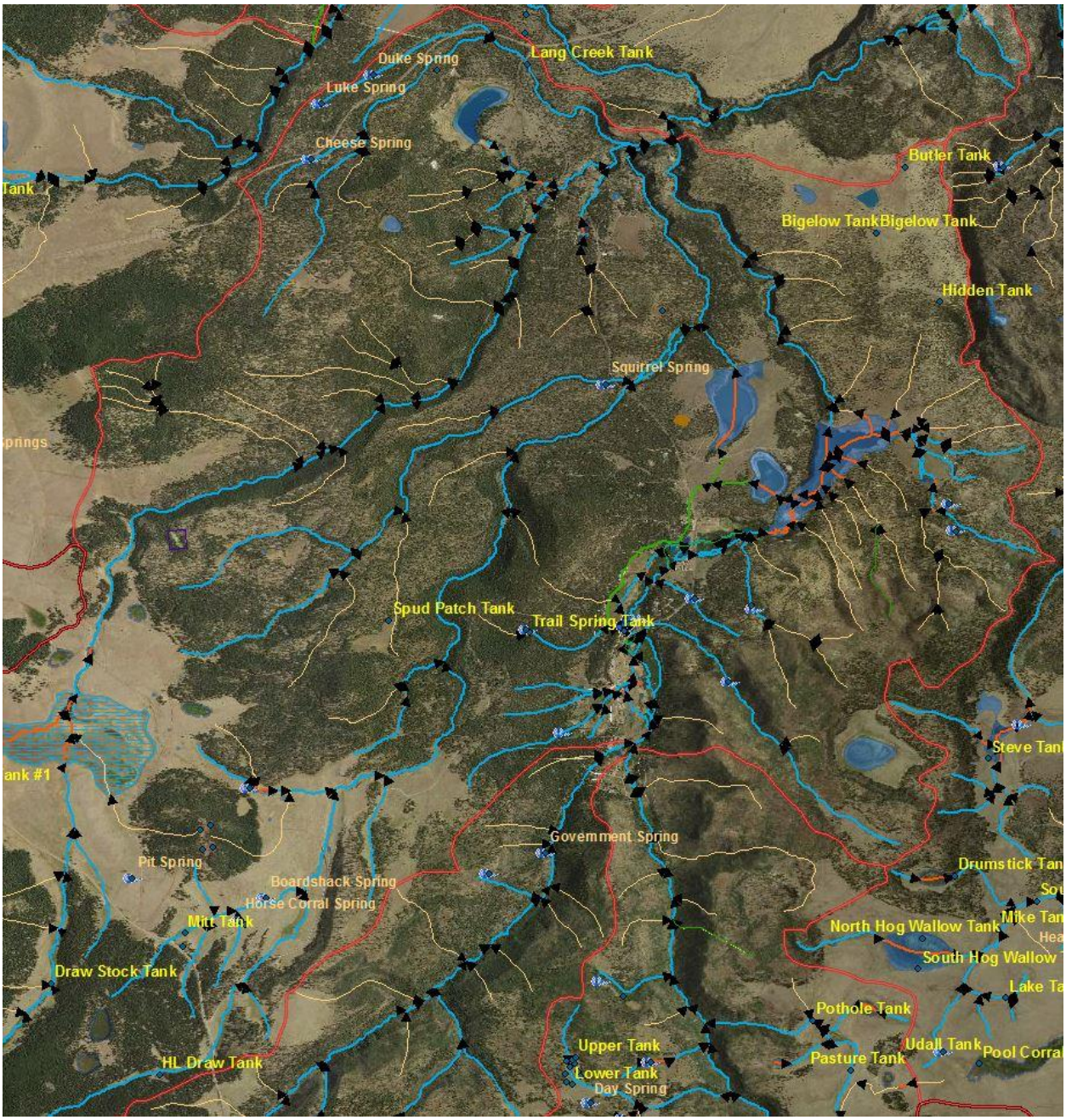
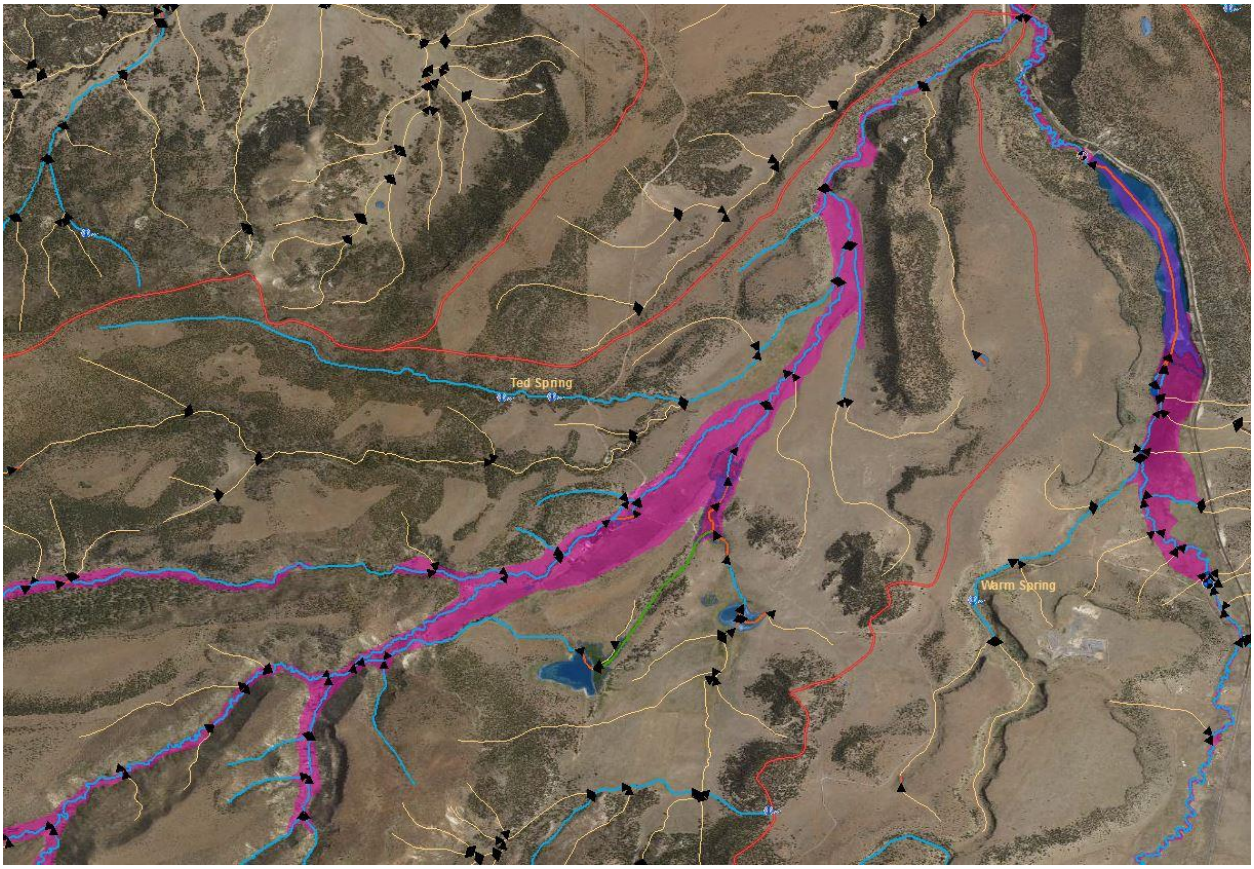


Figure 5: Riparian Vegetation reference dataset.



Conclusions

This project provided NHD enhancements that would be integral to the USFS program, research, spatial planning, reporting, and other projects. When all three phases are complete, CGST will deliver to the USFS a more precise surface water dataset to support land management choices and decision-making. Furthermore, this project gave me the chance to build up my geospatial skills, such as hydrography interpretation, GIS editing, quality checks, and following a structured workflow. This WRPI Internship has helped me understand how USGS and USFS work together on important projects to benefit the future utility of natural resources. The internship also allowed me to grow professionally and expand my technical skills in both GIS and project documentation.