

**IMPROVEMENT OF THE NATIONAL HYDROGRAPHY DATASET FOR PARTS OF  
THE LOWER COLORADO RIVER REGION AND ADDITIONAL AREAS OF  
IMPORTANCE TO THE DESERT LANDSCAPE CONSERVATION COOPERATIVE**

Project Technical Memorandum

Center for Geographical Studies  
United States Geological Survey  
United States Fish and Wildlife Service  
Desert Landscape Conservation Cooperative  
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## I. Overview

This project represented a partnership between US Geological Survey (USGS) National Geospatial Program, the US Fish and Wildlife Service (on behalf of the Desert Landscape Conservation Cooperative (DLCC)), and the Center for Geographical Studies (CGS) at California State University, Northridge (CSUN). The project focused on updates and improvements to the high resolution National Hydrography Dataset (NHD) through the addition and/or improvement of NHD polygon, line, and point features in effort to fully realize a more robust and accurate NHD for priority areas within the DLCC geography. The work performed was designed to support the science objectives for the DLCC and its partners through the use of an updated NHD. The work will provide an important framework basis for the development of hydrologic models required to address effects of climate change. Additionally, several other DLCC objectives and needs will be supported by this work, which include: biological modeling, storm impacts on flow, and conservation planning. This effort also directly supported and advanced the USGS' efforts related to the improvement of the NHD and its delivery to the public via The National Map. Finally, it also facilitated an additional agreement with the US Forest Service (USFS) for continued NHD improvement work in Arizona and beyond.

## II. Objectives and Work Performed

Specific objectives were slated in order to meet the overarching goal of bringing improvements to the NHD within critical DLCC priority areas. These objectives were separated out into 3 different tasks: 1) bringing comprehensive NHD updates to the Lower Colorado River Region, 2) improving NHD springs in critical DLCC geographies, and 3) bringing NHD updates to watersheds within the Madrean Boundary in Arizona.

### *Methodology Overview:*

All NHD editing and improvement work was done under the USGS' NHD stewardship system, a controlled mechanism for data acquisition, manipulation, editing, and posting. NHD was checked out and edited using the NHD Update Tools versions 6.2.0 and 6.2.1.23 for ArcGIS (ESRI) version 10.2.2. As the project progressed into the latter part of 2016, a portion of the spring improvement work (Task 2) was done using NHD Update Tool version 6.3.0 on ArcGIS 10.3.1.

For all of the work completed, the accuracy scale matched that of the high resolution NHD: 1:24,000. This is the scale at which the data should be assessed and used. A standard workflow and set of mapping and interpretation business rules were developed and used during the update process in order to standardize the end product. In order to improve the NHD and have it reflect recent conditions, the latest NAIP aerial imagery was used as a primary source when adding new features or updating existing features' geometry or attribution. Work done in California utilized the 2014 NAIP aerial imagery and work done in Arizona utilized the 2015 NAIP aerial imagery. Additional reference sources were used to aid mapping decision making when helpful and time saving. The data went through a rigorous quality control/quality assurance (QC/QA) process in order to ensure it met NHD and project specific standards.

### Workflow Summary:

- 1) NHD Jobs Check-Out and Pre-Processing
- 2) Pre-Initial QC Tasks Initial QC
- 3) NHD Editing/Updating
- 4) Quality Control
  - a) Internal Quality Control

- b) NHD Utility Quality Control
- 5) Job Check-in

Primary Reference Datasets Used:

- 1) NAIP Aerial Photos (2015 in AZ, 2014 in CA)
- 2) Springs Stewardship Institute Springs Dataset
- 3) Google Maps
- 4) US Topographic Maps (ESRI Basemap)
- 5) Arizona DWR Hydro Data
- 6) National Wetlands Inventory Dataset

**Task 1: Bringing Comprehensive NHD Updates to the Lower Colorado River Area (Imperial Reservoir Watershed)**  
This task covered the extent of HUC8: 15030104, which is split between California and Arizona. The Lower Colorado River flows through the center of the unit, leading to the Imperial Reservoir and Dam. The watershed covers approximately 3,700 square miles. This area contains a mixture of agricultural and wetland areas along the banks of the Colorado River, while more traditional arid areas cover the majority of the watershed east and west of the river. The Colorado River and its associated hydrologic complexes were updated to current conditions. Many NHD “swamp/marsh” features were added or modified along the banks and updated to current conditions as depicted on the NAIP aerial photos. The areas within close proximity to the Colorado also contained ponds, lakes, and other wetter features. Lastly, some agriculturally dominated areas were present along the banks of the Colorado in the mid and northern sections of the watershed and as such, the hydrography within them (mostly canal/ditch features) was modeled following the project mapping business rules.

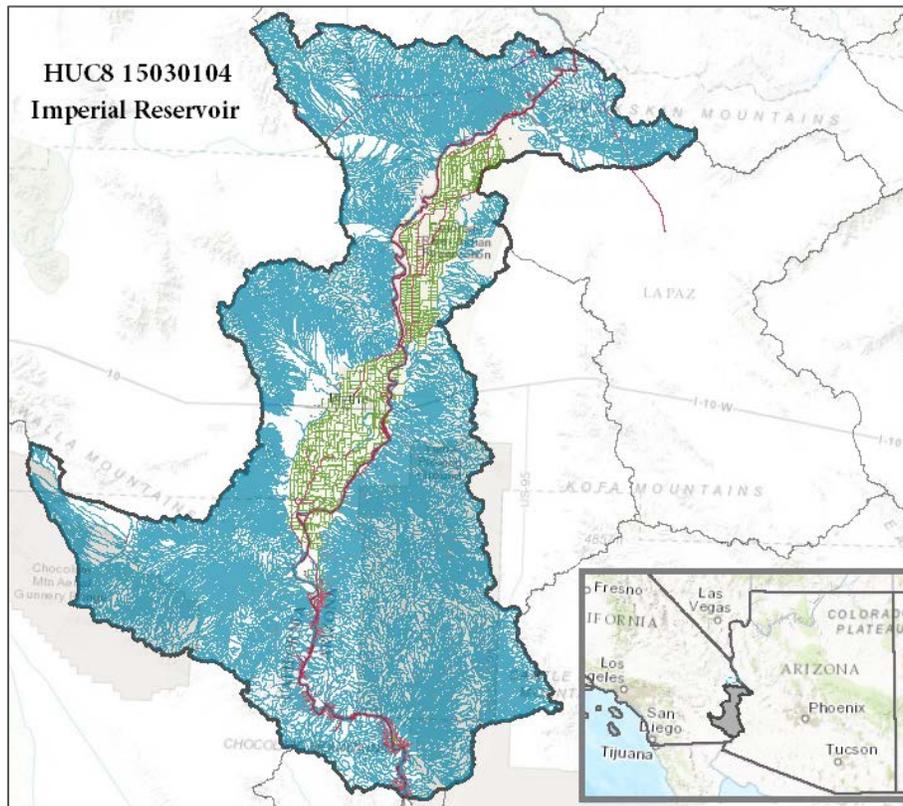


Figure 1: Imperial Reservoir Watershed Reference Map

As mentioned above, the majority of the watershed is covered in arid land and thus, many drier drainage systems were modeled, mostly contained ephemeral channels and washes. NHD flowline densification was a primary objective in this watershed resulting in many new flowlines and drainages being representing in the NHD that previously were not accounted for. In this specific watershed, a threshold of 1,500 meters was implemented for the addition of new ephemeral channels. That is, ephemeral channels less than 1,500 meters long were not added due to very large channel densities within the various desert basins of the watershed. Mapping the NHD in this area also facilitated the development of new business rules that apply specifically to hydrography within arid areas and were then implemented in this watershed and later on, the watersheds covered by Task 3.

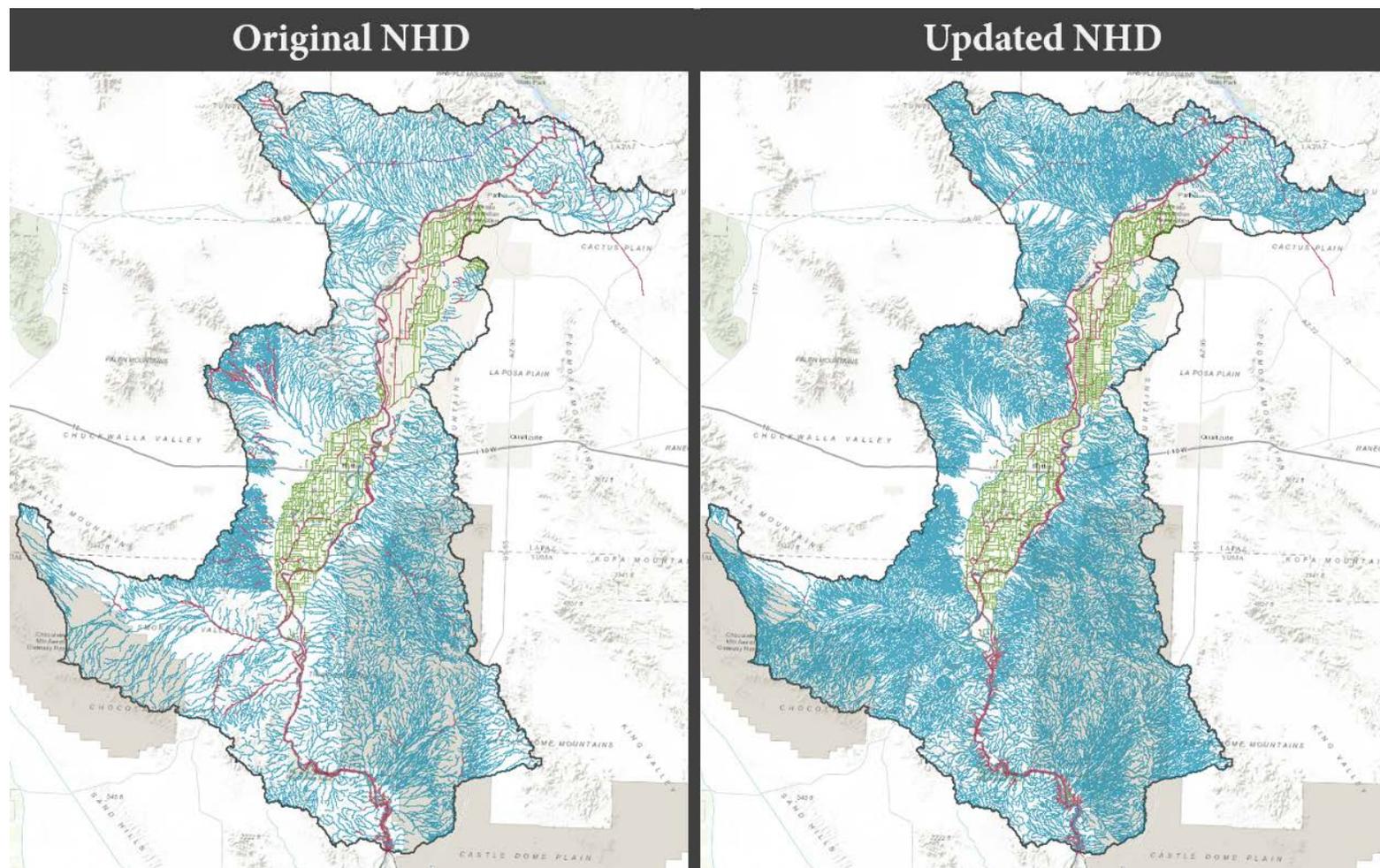


Figure 2: Densification of the Imperial Reservoir Watershed

### **Task 2: NHD Spring Improvements within the DLCC’s Madrean Boundary**

Springs are features that contribute to surface water and thus, are very important features in arid environments. This task allowed for the improvement of NHD springs and covered the DLCC’s Madrean Boundary within the US. The Madrean Zone is a study area that covers arid parts of the US and Mexico. It was identified by the DLCC group as a key area that would benefit from having a springs improvement carried out. This area contained some of the watersheds that received comprehensive updates from Task 3. Thus, this task allowed for springs to be improved within areas that also received updates to the NHD linework and polygons, realizing a more robust hydro model.

Initially, the Sky Island Springs Dataset was considered as a priority dataset to be used for the basis for the springs improvement. This dataset originally contained an estimated 520 springs. After research was conducted on this task and relevant partners provided additional details and information about the available springs data within Arizona, it was decided that the Springs Stewardship Institute’s (SSI) spring database was a more robust and validated source of ground truthed spring locations and attribute information. Additionally, it contained the springs originally found within the Sky Islands Springs Dataset plus many others. Thus, it was decided that the SSI data would be used for this task over the Sky Island Spring data.

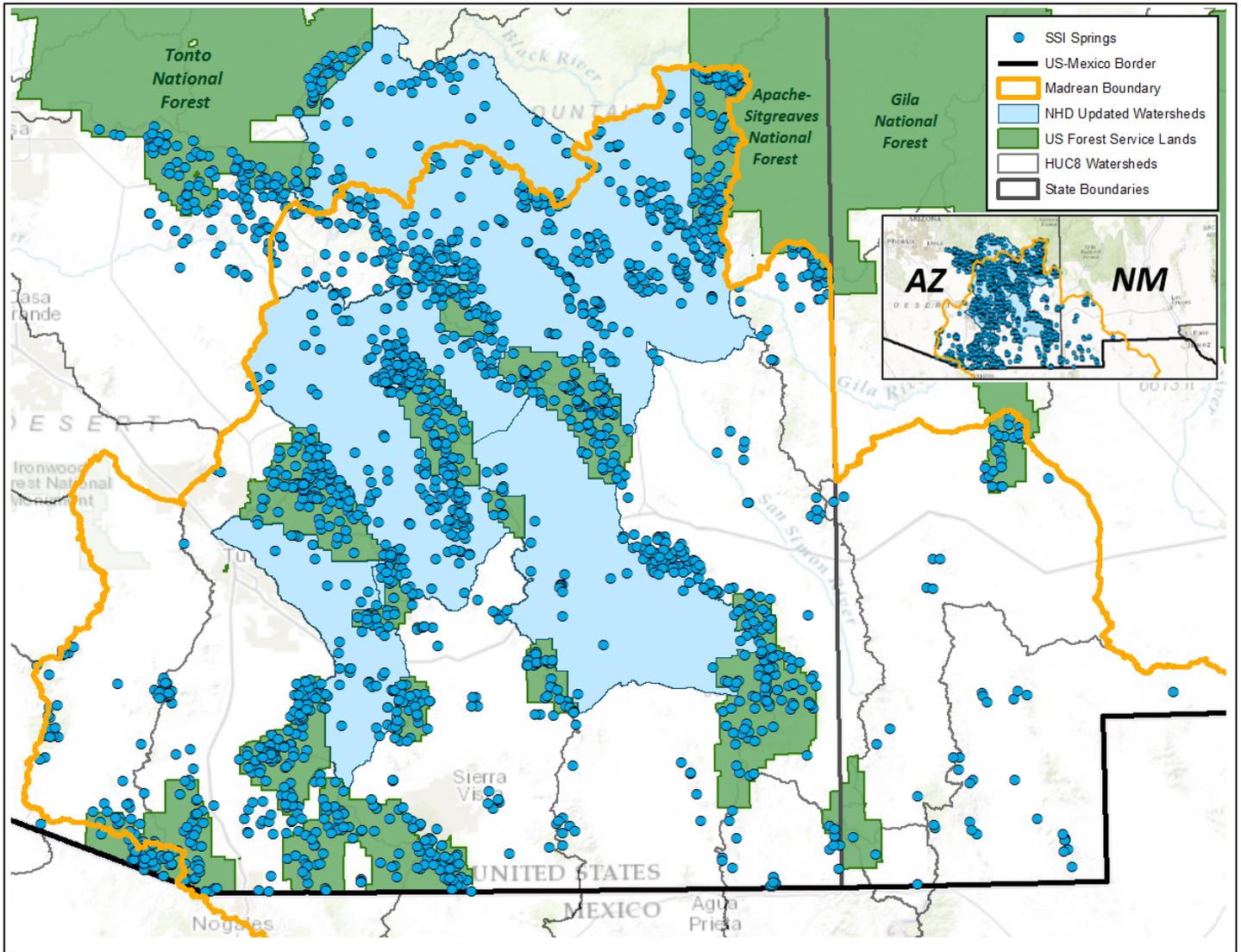


Figure 3: Task 2 Spring Distribution Reference Map

Testing was carried out to establish a workflow that covered the assessment of the SSI springs against the NHD for new spring integration and existing NHD spring updates. A decision tree workflow was created that ended in one of three possible tasks after assessment of each spring within the SSI data was carried out: integration of new springs into the NHD, updating the location of existing corresponding NHD springs features, or no action (in the event the NHD matched the SSI data). An assessment scale of 1:5,000 was used during the assessment. Additionally, the amount of SSI springs and the area extent to be assessed under this task was determined given this task’s specific

budget. The area covered by this improvement task included the entire Madrean area within the US, with three additional smaller areas:

1. The portion of the Rio De La Concepcion Watershed (HUC8: 15080200) within the US just north of the US/Mexico border and just outside of the Madrean Boundary (mostly within Coronado National Forest).
2. The San Carlos Watershed (HUC8: 15040007) just north of the Madrean Boundary. This watershed also received comprehensive updates in Task 3 (see below).
3. The portion of the Middle Gila Watershed (HUC8: HUC8: 15050100) outside of the Madrean Boundary.

These areas combined covered a total of 17 HUC8 watersheds. SSI springs data was acquired directly from the SSI on-line site. Only springs available to public were acquired and participated in this integration work. No springs that were deemed to be sensitive were included. These may include springs that harbor critically endangered species and are actively being validated/researched, springs that are located on certain Native American Reservations, or have been tagged as such for other political or scientific reasons. The total number of SSI springs that were assessed in this task was 2,329.

*Table 1: Summary of Task 2 Watersheds*

HUC8 Name	HUC8 Code	Improvement Area Specification	Improvement Area State Intersection	Number of SSI Springs Assessed
Animas Valley	15040003	Full Watershed	AZ, NM	36
Brawley Wash	15050304	Full Watershed	AZ	59
Cloverdale	15080303	Within US	NM	3
Lower San Pedro	15050203	Full Watershed	AZ	430
Middle Gila	15050100	Full Watershed	AZ	192
Playas Lake	13030201	Within US	NM	26
Rillito	15050302	Full Watershed	AZ	149
Rio De La Concepcion	15080200	Within US	AZ	40
San Bernardino Valley	15080302	Within US	AZ, NM	23
San Carlos	15040007	Full Watershed	AZ	96
San Simon	15040006	Full Watershed	AZ, NM	165
Upper Gila-Mangas	15040002	Within Madrean Area	AZ	48
Upper Gila-San Carlos Reservoir	15040005	Full Watershed	AZ	518
Upper San Pedro	15050202	Within US	AZ	151
Upper Santa Cruz	15050301	Within US	AZ	247
Whitewater Draw	15080301	Within US	AZ	32
Willcox Playa	15050201	Full Watershed	AZ	114
			<b>TOTAL:</b>	<b>2,329</b>

**Task 3: Bringing Comprehensive NHD Updates to Additional DLCC Priority Areas**

This task served as an extension of Task 1. As discussed above, the DLCC’s Madrean Study Area within Arizona was identified as a high priority area that would benefit from comprehensive NHD updates. A total of five watersheds were selected for this task. Four of the five watersheds selected under this task were located within the Madrean Boundary and were adjacent to the Coronado National Forest (NF). The fifth watershed was located immediately north of the boundary and overlaps the Tonto National Forest. Although the work excluded US Forest Service (USFS) lands, the overlap of these watersheds with USFS lands was a critical component that would tie into a future separate partnership with USFS. See table in the next section for full watershed listings and related information.

Similar to the Task 1 work, comprehensive updates were carried out to the watersheds slated under this task. The areas covered contained similar landcover types and hydro features. Arid area composition lead to the development and implementation of hydro mapping rules in Task 1, so that work was leveraged for this task. Moreover, these areas also provided the opportunity to develop additional general as well as arid area-specific mapping rules. A majority of the time spent on the NHD improvement in these areas went specifically to updating the current NHD, which was clearly very outdated. Another significant task was the adding new features that were not previously represented in the NHD. An abundance of flowlines were added, enhancing the various drainages present in the five watersheds. This work resulted in a more uniform dataset useable at the high resolution, 1:24,000 scale.

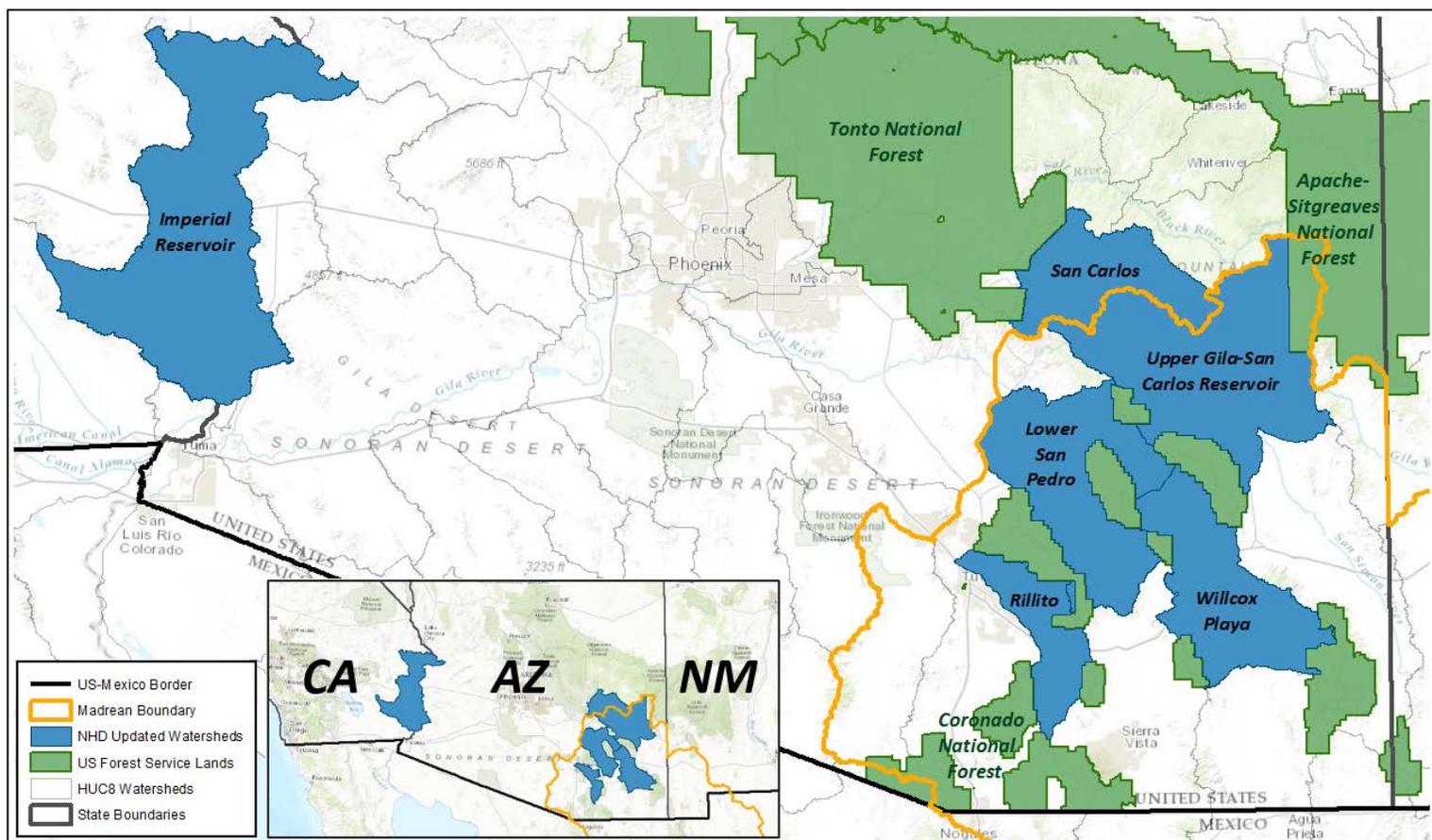


Figure 4: Reference Map of Watersheds That Received Comprehensive NHD Updates Under Task 1 and 3

At the time this task initiated, US Forest Service Region 3 was contacted as they had previously shown interest in bringing updates to the NHD within their forests, Coronado NF and Tonto NF being two of them. They were informed of the work being done under this DLCC agreement and how the work done therein could be leveraged via a separate effort to bring NHD updates to the forests they were interested in. A separate agreement was drafted between the Center for Geographical Studies and USFS Region 3 that would continue the NHD improvement work immediately upon the conclusion of the DLCC agreement. The USFS improvement work will cover five forests within Region 3, two of which overlap the work done in Task 3 and two others within Arizona just north of the DLCC Madrean Area. The value of this timing and the overlap in the similarity in area and scope standards will lead to a cost efficient update effort that will result in a more uniform and expansive NHD within Arizona that can be used by various end-users.

The completion of Task 3 resulted in about 6,900 square miles of comprehensive NHD updates. It should be noted that in the original scope of work, an estimated 7,100 square miles of update work would be done under this task. When planning was carried out for this task, the DLCC group decided to use the remainder of the funds from this task towards Task 2, allowing for a significantly larger amount of springs to be assessed in the Madrean area.

*Table 2: Summary of Watersheds That Received Comprehensive NHD Updates Under Task 1 and 3:*

HUC8 Name	HUC8 Code	Project Task	Improvement Area Specification	Improvement Area State Intersection	Area (Sq. Km)	Area (Sq. Miles)
Imperial Reservoir	15030104	1	Full Watershed	CA, AZ	8,925.87	3,446.40
Rillito	15050302	3	Excluding Coronado NF	AZ	1,649.77	636.98
Lower San Pedro	15050203	3	Excluding Coronado NF	AZ	4,190.86	1,618.10
Upper Gila-San Carlos Reservoir	15040005	3	Excluding Coronado NF and Apache-Sitgreaves NF	AZ	5,881.22	2,270.75
Willcox Playa	15050201	3	Excluding Coronado NF	AZ	3,582.52	1,383.22
San Carlos	15040007	3	Excluding Tonto NF	AZ	2,530.42	977.00
<b>TOTALS:</b>					<b>26,760.66</b>	<b>10,332.45</b>

### III. Other Outcomes and Milestones

In addition to the data improvements carried out in Tasks 1 through 3, this work allowed for the NHD improvement process to be tested in traditional arid regions. As mentioned above, the areas that were improved provided a unique set of hydrologic composition types in the arid environment. Modeling these systems and features was at times challenging and required assessment of the interpretative approach in order to determine the best way to capture them within the NHD. These situations oftentimes lead to the creation of new mapping business rules and enhancements of previously established rules. DLCC partners and hydrologists reviewed the set of business rules and offered further input for modification and refinement. These rules were implemented throughout the work in order to standardize the product and allow for the data product to offer the best utility for the end user. Furthermore, these mapping business rules can be implemented in future NHD improvement work within the arid Southwest.

Similar to the enhancement of mapping business rules, the NHD workflow was enhanced through this work. Certain workflow phases, especially the internal quality control (QC) and NHD tool's QC was further tested. Additional safety nets such as seasonality checks and name continuity checks were added to the workflow to ensure quality in the resulting product. A better understanding of possible topology errors that are produced within arid regions was also acquired. This was especially critical in areas of high ephemeral flowline densities with frequent braided drainages. As mentioned with the mapping business rules, the workflow enhancements will be used for and will benefit future NHD work.

Possibly the most important milestone to come from this project aside from the direct data deliverables is the establishment of a new agreement with the US Forest Service and the additional work to be done in their Region 3 forests. As described above, this additional work will expand on the deliverables for this DLCC agreement and help increase momentum for potential future work in Arizona and beyond. This is especially important since Arizona currently lacks a state steward for NHD improvements and coordination.

#### **IV. Deliverables Summary**

1. **Task 1 Updates/Data:** *Completed: Data posted to the National Database.*
2. **Task 2 Updates/Data:** *Completed: Data to be posted to the National Database upon completion of USFS Region 3 work.*
3. **Task 3 Updates/Data:** *Completed: Data to be posted to the National Database upon completion of USFS Region 3 work.*
4. **Final Mapping Business Rules Document:** *Completed.*
5. **Project Technical Memorandum:** *Completed.*
6. **Final Performance and Progress Reporting:** *To be completed and submitted before November 30, 2016.*
7. **Final Billing and Invoicing:** *To be completed and submitted before November 30, 2016.*
8. **Final Presentation to USGS NGP Hydrography Advisory Team, DLCC Team, and Other Relevant Parties:** *To be completed before January 31, 2016.*