# Quality Assurance Project Plan

**Mapping and Classification of Wetlands in New Mexico**
CWA Section 104(b)(3) Wetlands Program Development Grants with CD# 01F109-0l-0B, 0IF109-0l-0E, 01F39501-0, 01F39701-0, 01F671-0l-l, 01F672-0l-0, 02F04201, and 02F12401

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Revision 03

Submitted by:
New Mexico Environment Department
Surface Water Quality Bureau

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**ACRONYMS**

| | |
|---|---|
| ACOE | Army Corps of Engineers |
| ASB | Application Services Bureau |
| CWA | Clean Water Act |
| dd | decimal degrees |
| DEM | Digital Elevation Model |
| DOQQs | Digital Orthophoto Quarter |
| Quads DRG | Digital Raster Graphics |
| DVD | Digital Versatile Disk |
| EPA | United States Environmental Protection Agency |
| FGDC | Federal Geographic Data Committee |
| FTP | file transfer protocol |
| GIS | Geographic Information Systems |
| GPS | Global Positioning System |
| GSD | Ground Sample Distance |
| GSS | Saint Mary's University of Minnesota, Geospatial Services |
| HARN | High Accuracy Reference Network |
| HGM | Hydrogeomorphic |
| HUC | Hydrologic Unit Codes |
| JPEG | Joint Photographic Experts Group |
| LiDAR | Light Detection and Ranging |
| LLWW | Landscape Position-Landform-Water Flow Path-Water Body Type |

| | |
|---|---|
| NAD | North American Datum |
| NAIP | National Agriculture Imagery Program |
| NHD | National Hydrography Dataset |
| NMED | New Mexico Environment Department |
| NMRAM | New Mexico Rapid Assessment Method |
| NDOP | National Digital Orthophoto Program |
| NRCS | National Resources Conservation Service |
| NSDI | National Spatial Data Infrastructure |
| NWI | National Wetlands Inventory |
| ONRW | Outstanding Natural Resource Water |
| PA | Producer's Accuracy |
| QAPP | Quality Assurance Project Plan |
| QA | Quality Assurance |
| QC | Quality Control |
| QAPP | Quality Assurance Project Plan |
| RA | Rapid Assessment |
| RGB | Red Green Blue |
| RGIS | Resource Geographic Information System |
| SDE | Spatial Database Engine |
| SOP | Standard Operating Procedures |
| SQL | Structured Query Language |
| SSURGO | Soil Survey Geographic Database |
| SWQB | New Mexico Environment Department Surface Water Quality Bureau |
| TMU | Target Mapping Unit |
| U | Uplands or Unwanted NWI codes |

| | |
|---|---|
| UA | User's Accuracy |
| US EPA | United States Environmental Protection Agency |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| WPC | Wetlands Program Coordinator |
| WPO | Wetlands Project Officer |
| WPS | Watershed Protection Section |
| WQPD | Water Quality Protection Division |

## 1.0 PROJECT MANAGEMENT

### 1.1 Distribution List

The Wetlands Program Project Officer will distribute copies of this approved QAPP and any subsequent revisions to the project personnel listed below.

**New Mexico Environment Department Surface Water Quality Bureau**

Wetlands Program Project Officer: Dustin Nelson (505) 469-6186
Wetlands Program Project Officer: Tiffany Anders (505) 470-4774
Wetlands Program Coordinator: Maryann McGraw (505) 819-9832
Program Manager: Vacant
QA Officer: Miguel Montoya (505) 819-9882
GIS Coordinator: Zachary Stauber (505) 372-8476
GIS Analyst: Andrea Goodbar (505) 372-8475
GIS Analyst: Phil Polzer (505) 372-8474

**Saint Mary's University of Minnesota, Geospatial Services**

Director: Andrew Robertson (507) 457-8706
GIS Analyst: Jeff Knopf (507) 457-8721
Wetland Image Analyst: David Rokus (507) 457-8752
Senior GIS Analyst: Kevin Stark (507) 457-8750
Senior GIS Analyst: Michael Knudson (507) 457-7268
GIS Programmer: Roger Meyer (507) 457-8747
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GIS Technician: Joshua Balsiger (507) 457-7276

**U.S. Environmental Protection Agency Region 6**

Chief: Nelly Smith, State and Tribal Programs Section, (214) 665-7109
Project Officer: Kyla Chandler Water Quality Protection Division, (214) 665-2166

**U.S. Fish and Wildlife Service Southwest Region 2**

Regional Wetlands Coordinator: Gary Hunt (505) 248-6776

### 1.2 Project Organization

This section lists the roles and responsibilities of persons that will collect and/or use the information gathered using geospatial techniques and image interpretation processes to remotely map and classify wetlands and riparian areas in New Mexico. A project organizational chart on page 11 displays hierarchy of the project. The Project Officers will ensure that any staff responsible for conducting work in accordance with this QAPP will be provided a copy to read and acknowledge the QAPP requirements by signing **Appendix III. Mapping and Classification of Wetlands in New Mexico QAPP Acknowledgement Form.** The Wetlands Program Project Officers will maintain the acknowledgement forms with the project files, as applicable to each project area.

**Table 1. Project Roles and Responsibilities**

| Name | Organization | Role | Responsibilities | Contact Information |
|---|---|---|---|---|
| Dustin Nelson | SWQB | Wetlands Program Project Officer (for Eastern Plains and Northern NM projects) | Manage progress of project, QAPP distribution, file management for the project, assist in ground-truthing site selection, data transfer and distribution activities, prepare semi-annual and final project reports | (505) 469-6186 dustin.nelson@env.nm.gov |
| Tiffany Anders | SWQB | Wetlands Program Project Officer (for Bootheel/ Permian Basin and NM Wilderness projects) | Manage progress of project, QAPP distribution, file management for the project, assist in ground-truthing site selection, data transfer and distribution activities, prepare semi-annual and final project reports. | (505) 470-4774 tiffany.anders@env.nm.gov |

| | | | | |
|---|---|---|---|---|
| Maryann McGraw | SWQB | Wetlands Program Coordinator | Review and approve QAPP, ensure consistency among wetlands projects, participate in planning meetings, review and submit reports to EPA | (505) 819-9832 maryann.mcgraw@env.nm.gov |
| Miguel Montoya | SWQB | Acting QA Officer | Review QAPP, approval of QAPP, and periodic audits | (505) 819-9882 miguel.montoya@env.nm.gov |
| Zachary Stauber | ASB | GIS Coordinator | Ensure compatibility of products with NMED GIS | (505) 827-2933 zachary.stauber@env.nm.gov |
| Andrea Goodbar | ASB | GIS Developer | Review project products and ensure compatibility of products with NMED GIS | (505) 222-9527 andrea.goodbar@env.nm.gov |
| Andrew Robertson | Saint Mary's University of Minnesota, Geospatial Services | Contractor / Director | Assist in site selection, responsible for acquisition of remotely sensed data, data handling, data analysis, data validation, accuracy check | (507) 457-8746 aroberts@smumn.edu |
| Jeff Knopf | Saint Mary's University of Minnesota, Geospatial Services | Contractor/ GIS Analyst | Assist in site selection and classification, preparation of hardcopy mapping, quality assurance of geodatabases | (507) 457-8721 jcknop01@smumn.edu |

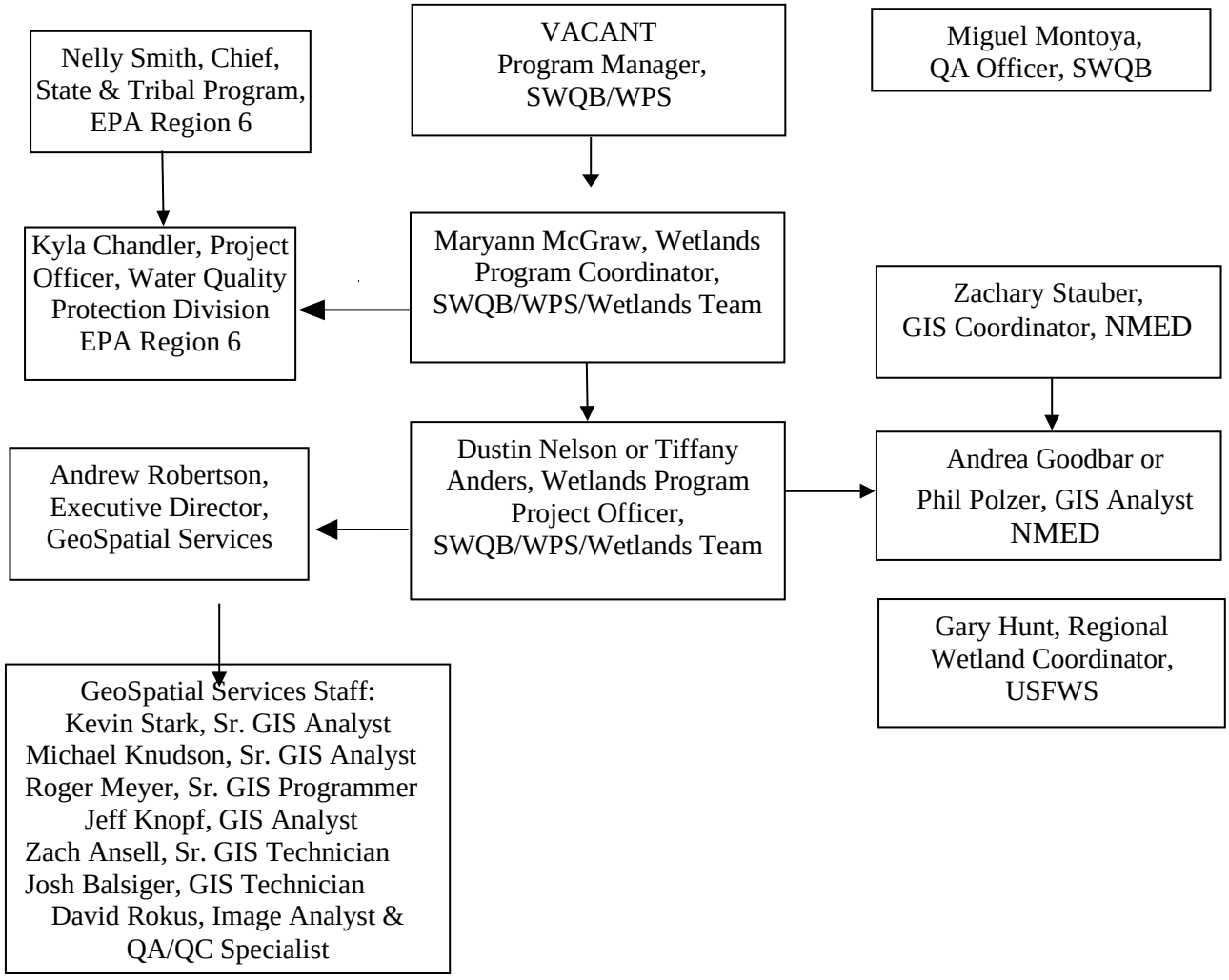
| | | | | |
|---|---|---|---|---|
| David Rokus | Saint Mary's University of Minnesota, Geospatial Services | Contractor/ Wetland Image Analyst and QA/QC Specialist | Compilation of GIS layers for site selection, assist in site selection and image classification, quality assurance and quality control, GIS management | (507) 457-8752 ddroku04@smumn.edu |
| Kevin Stark | Saint Mary's University of Minnesota, Geospatial Services | Contractor / Senior GIS Analyst | Database design, development of quality control scripts and SQL query tools required to assign ecosystem functions to wetland polygons | (507) 457-8750 kjstar06@smumn.edu |
| Michael Knudson | Saint Mary's University of Minnesota, Geospatial Services | Contractor / Senior GIS Analyst | Database design, development of quality control scripts and SQL query tools required to assign ecosystem functions to wetland polygons | (507) 457-7268 mknudson@smumn.edu |
| Roger Meyer | Saint Mary's University of Minnesota, Geospatial Services | Contractor/ Senior GIS Programmer | ArcGIS administration, Python programming, automation and script development | (507) 457-8747 rmeyer@smumn.edu |
| Zach Ansell | Saint Mary's University of Minnesota, Geospatial Services | Contractor / GIS Analyst | Wetland digitizing and quality control | (507) 457-8743 zansell@smumn.edu |
| Josh Balsiger | Saint Mary's University of Minnesota, Geospatial Services | Contractor / GIS Technician | Wetland digitizing and quality control | 507-457-7276 jbalsige@smumn.edu |
| Gary Hunt | USFWS Southwest Region 2 | Regional Wetlands Coordinator | Acceptance and Quality Assurance/Quality Control for | (505) 248-6660 gary_hunt@fws.gov |

| | | | | |
|---|---|---|---|---|
| | | | National Wetlands Inventory | |
| Kyla Chandler | U.S. EPA | EPA Project Officer | QAPP review and approval | (214) 665-2166 chandler.kyla@epa.gov |
| Nelly Smith | U.S. EPA | EPA Management | QAPP review and approval | (214) 665-7109 smith.nelly@epa.gov |

### 1.3 Line of Authority Description

The SWQB Quality Management Plan (NMED/SWQB 2023) documents the independence of the QA Officer from this project The organizational structure for this project is presented in Figure 1.

**Figure 1. Project Organizational Chart**



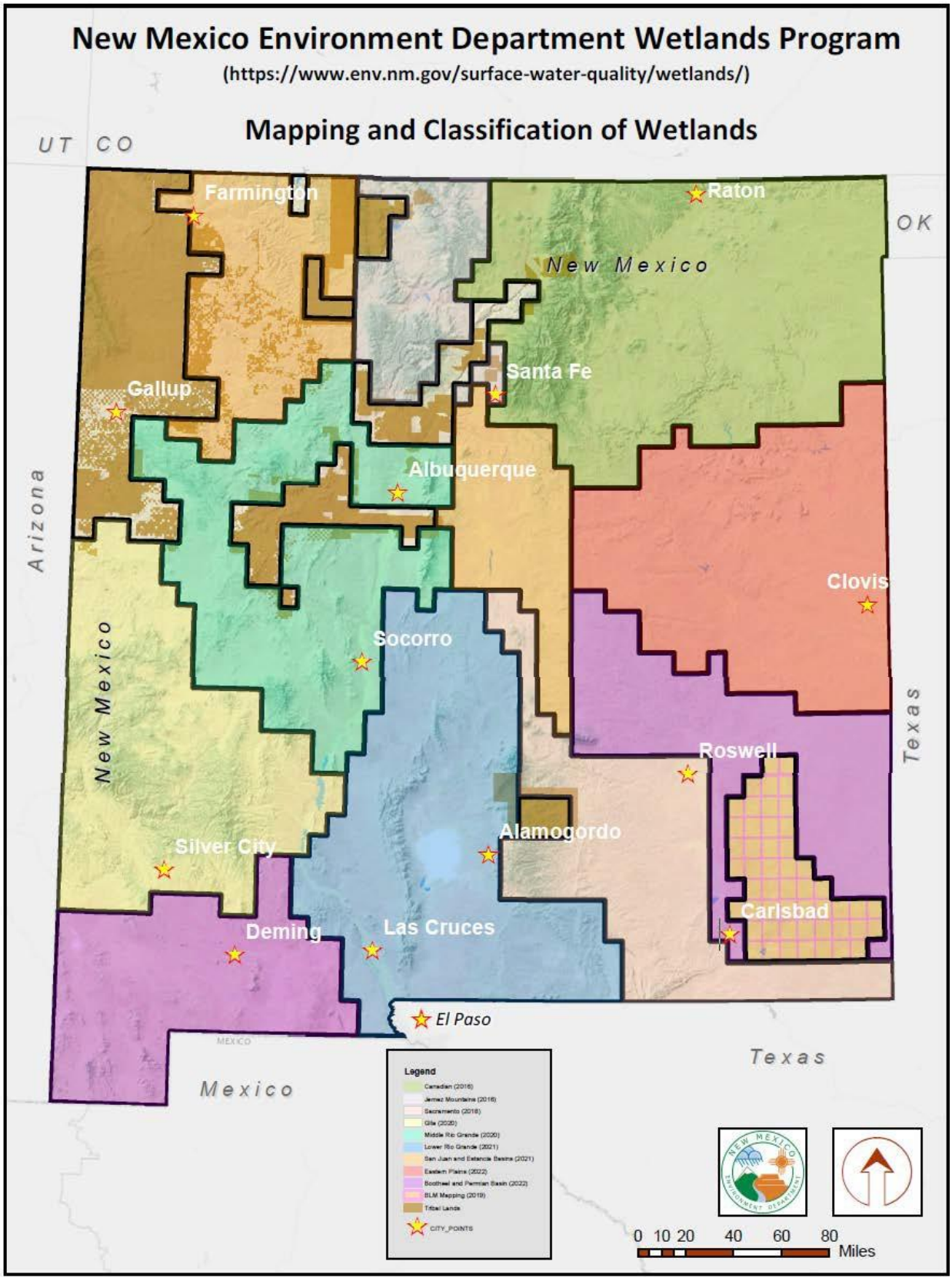
### 1.4 Problem Definition/Background

The SWQB Wetlands Program is updating the wetlands inventory for New Mexico. The purpose of wetlands mapping and classification projects is to map and classify linear and polygonal wetlands, deepwater and riparian features throughout New Mexico as part of a Landscape Level 1 wetlands assessment strategy.

This Quality Assurance Project Plan (QAPP) covers wetland mapping and classification projects conducted by the SWQB Wetlands Program for the Middle Rio Grande, Southwestern NM, San Juan and Estancia Basins, Lower Rio Grande, Bootheel and Permian Basin, Eastern Plains and Wilderness ONRW and Northern New Mexico (Figures 2. & 3 Wetlands Mapping and Classification Project Areas). Each project area is defined by 7.5 Minute USGS Quadrangle Maps. Wetlands will be mapped and classified using: the National Wetlands Inventory (NWI) classification system (Cowardin et al., 1992); the System for Mapping Riparian Areas in the Western United States (USFWS 2009a); the Landscape Position-Landform- Water Flow Path-Water Body Type (LLWW) classification (Tiner, 2011); and the Hydrogeomorphic (HGM) classification (Brinson, 1993). A functional assessment will be performed for landscape level assessment tailored to arid region wetlands.

As the Wetlands Program continues to develop, the need for wetland mapping and classification of wetlands becomes more and more of a necessity. As opportunities to restore and protect wetlands are hindered or lost by the lack of comprehensive mapping, preliminary assessment and appropriate classification of wetlands is required to meet the State's needs. There are many human activities that could have potentially irreversible effects on wetland resources if the State is not prepared to protect them. All states in the southwest are lacking adequate mapping/assessment of wetlands and need an arid-land landscape wetlands model. Currently, NWI digital vector data is available for the project areas, however, these data were created circa 1979 from small scale aerial imagery using analog geo-referencing and orthorectification processes. As a result, wetland features are under-represented and spatially displaced from their true geographic location. The New Mexico Resource Geographic Information System (RGIS) has digital orthophoto quarter quads (DOQQs) from the National Agricultural Imagery Program (NAIP) in color infrared emulsion. For the San Juan and Estancia Basins, and Lower Rio Grande project areas, the most recent imagery was acquired in 2016 and is available at one-meter resolution. In addition, one-meter resolution NAIP natural color imagery from earlier years (e.g. 2011, 2013, and 2014) will be consulted for decision support and wetland classification. For the Bootheel/Permian Basin and Eastern Plains projects, the SWQB Wetlands Program and Saint Mary's University of Minnesota, GeoSpatial Services will evaluate the most recent imagery (2019) to determine whether it is representative of wetland conditions. New Mexico experienced extreme drought in 2018, thus it is unlikely that 2018 NAIP imagery will be used as the primary source imagery. NAIP imagery from 2020 and future dates as appropriate will be used.

**Figure 2. Wetlands Mapping and Classification Project Areas.**



This QAPP covers the Middle Rio Grande (in turquoise), Southwestern NM (Gila) (in yellow), San Juan and Estancia Basins (in orange), Lower Rio Grande (in blue), Bootheel and Permian Basin (in purple) and Eastern Plains (in pink) project areas. Tribal lands are excluded from the project areas and will not be mapped.

**Figure 3. Integrating Linear Features and Mapping and Classification Data Gaps in Northern New Mexico Project Area.**

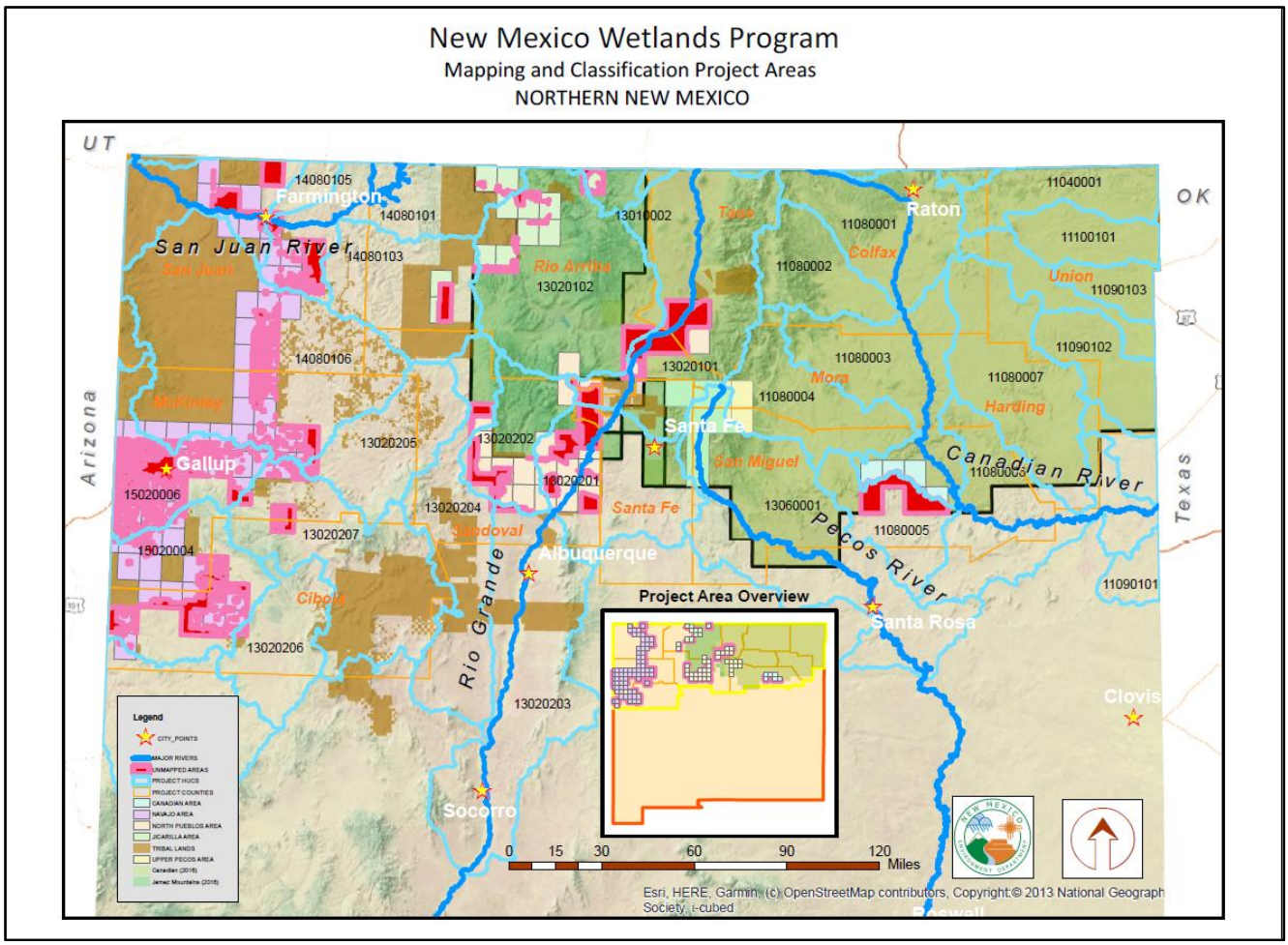
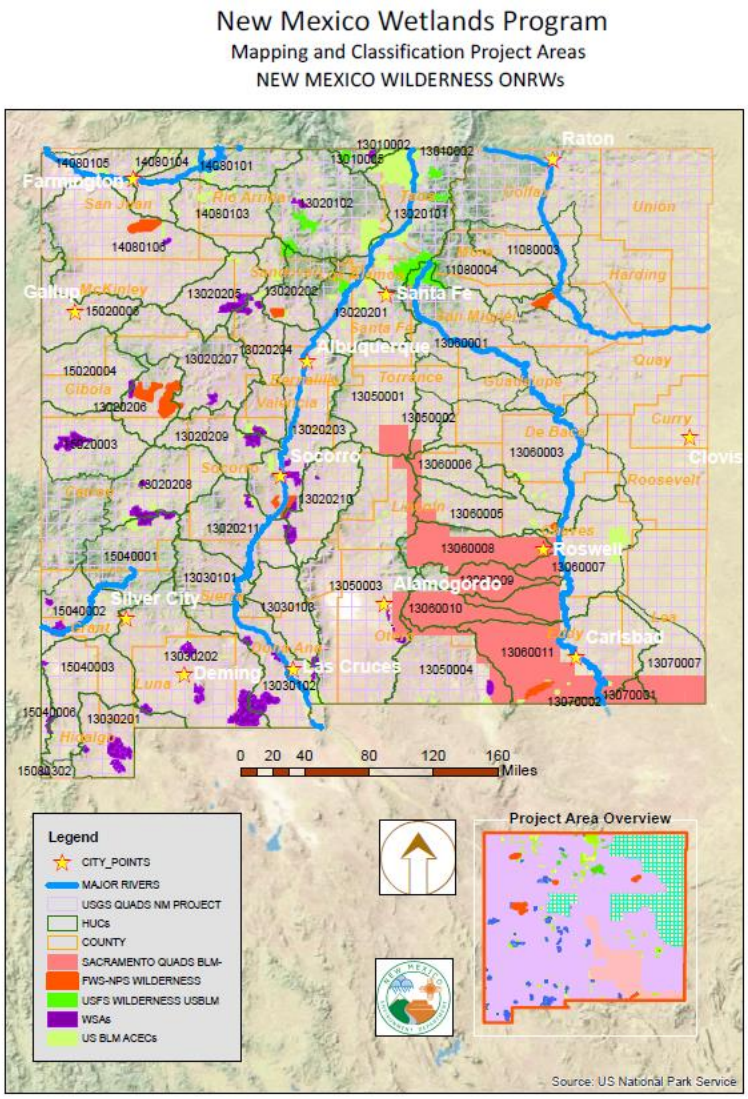


**Figure 4. Integrating Linear Features and Mapping and Classification Data Gaps in New Mexico Wilderness ONRWs Project Area.**




## 1.5 Project/Task Description

The scope of this project is to map and classify wetlands and riparian areas in New Mexico for the Middle Rio Grande, Southwestern NM, San Juan and Estancia Basins, Lower Rio Grande, Bootheel and Permian Basin, and Eastern Plains (Figure 2); Figures 3 and 4 show the new project areas that include additional areas that require updated mapping, Northern New Mexico and New Mexico Wilderness ONRWs Mapping and Classification Project Areas. Edge mapping all of the project areas and reviewing the entire state wetlands mapping database for consistency is the final outcome of this effort as part of a Landscape Level 1 wetlands assessment strategy. The SWQB Wetlands Program will use the LLWW mapping classification and descriptors for landscape level assessment tailored to arid region wetlands and assign HGM subclasses to prepare for future NMRAM development. This project will support future on-the- ground NMRAM data collection and other monitoring efforts, help

build our set of reference wetland sites, help design and distribute assessment units for water quality standards development, contribute to the selection of restoration sites, inform our CWA Section 401 Certification conditions, and provide the demonstration of significant tools for understanding wetlands resources in Southeastern New Mexico.

Project tasks include acquiring NAIP imagery, LiDAR data and assembling a geodatabase, pre- and post- mapping field reviews, performing the wetland mapping, assigning NWI, LLWW and HGM classifications, and assigning functional descriptors to the LLWW classified units for the project area.

In addition, a task for the Wilderness ONRWs grant will be developed to utilize mapping products created by this project and previous mapping to select potential reference standard wetlands that may be reviewed for possible Outstanding National Resource Water nominations and other options for protection.

Project timelines, including completion dates for each task, are specified in EPA-approved project workplans and will be completed in the order listed in Table 2 of this QAPP. Workplan timelines will be adhered to for each of the four projects. Semi-annual progress reports from NMED to EPA for each project will be used track progress.

**Table 2. Mapping Tasks and Products**

| Task | Products |
|---|---|
| Preliminary meeting and image acquisition | Meeting completed, quads designated, images acquired |
| Complete QAPP | Complete Project Quality Assurance Project Plan ensuring measures are in place to collect quality data |
| Assemble geodatabase | Confirmation of geodatabase assembly |
| Pre-mapping field review and mapping classification | Pre-mapping field review report including image interpretation and mapping conventions |
| Mapping and wetlands interpretation | Preliminary and final GIS mapping |
| Landscape level assessment | Preliminary and final classification systems |
| Post-mapping field review (Ground-truthing) | Post-mapping field review report |
| Quarterly reports and final version of map, report on methodology | Quarterly reports and final report from Contractor to NMED. Semi-annual reports and final report from NMED to EPA. |

Project products include classified wetland and riparian maps covering the project areas specified in the project workplan: Middle Rio Grande, Southwestern NM, San Juan and Estancia Basins, Lower Rio Grande, Bootheel and Permian Basin, Eastern Plains and Northern and Wilderness ONRWs project areas. The wetland geodatabase will also include LLWW information for all features as well as attributes describing the functional value of each wetland and riparian area. Additional products will include the preparation of reference materials, base maps, and an assemblage of information. The projects will use geospatial techniques and image interpretation processes to remotely map and classify wetlands and riparian areas including features captured as line segments in addition to polygons. These techniques and procedures are outlined in Section 2 (Data Generation and Acquisition) and **Appendix II. Data Integrity Procedures for GeoSpatial Services NM Wetland Mapping and Classification Projects.**

Tasks that will be completed for each project area include:

1.5.1 NWI mapping using the Cowardin System (USFWS, 1992) for classifying wetlands and the System for Mapping Riparian Areas in the Western United States (USFWS 2009a)

1.5.2 classification of wetlands using the LLWW functional assessment classification which considers landscape position, landform, water flow path and water body types (Tiner, 2011)

1.5.3 development of wetland classes and subclasses according to hydrogeomorphic characteristics (Brinson, 1993);

1.5.4 image analysis from a variety of input image and collateral data sources; and field verification.

All mapping will be completed with at least 1:12,000 resolution with a Target Mapping Unit (TMU) of 0.5 acres or better and will comply with the National Wetlands Mapping Standard of the Federal Geographic Data Committee (FGDC). The final product to NMED will be compatible with our schema, Geographic dd NAD83 (HARN).

### 1.6 Quality Objectives and Acceptance and Performance Criteria

The purpose of this section is to specify the level of quality needed to make a decision regarding the success of the project and to document the acceptance and performance criteria used to generate New Mexico wetland maps and classifications.

**Type of data needed to support intended uses**

Wetland mapping and classification relies on the subjective interpretation of wetland boundaries and wetland classification characteristics from a primary aerial image source supported by consultation with collateral spatial data. The primary image source from which all wetland boundaries will be derived is the most current NAIP imagery from the U.S. Department of Agriculture for New Mexico. However, if mapping is conducted during a period of extreme drought, the project partners may decide to use earlier NAIP imagery as the primary image source, and use current imagery as collateral data. All mapping and classification of wetland boundaries that are collected for the intention of populating the wetlands spatial data layer of the National Spatial Data Infrastructure (NSDI) are governed by the specifications of the FGDC Wetlands Mapping Standard (FGDC, 2009). The objective of the FGDC Wetlands Mapping Standard is to support the accurate mapping and classification of wetlands while ensuring mechanisms for their revision and update as directed under Office of Management and Budget Circular A-16 (Revised). If Federal funding is used in support of wetlands inventory mapping activities, then use of this standard is mandatory. The minimum standard for the completeness of the wetland classification is: ecological system, subsystem (with the exception of Palustrine), class, subclass (only required for forested, scrub-shrub, and emergent classes), water regime, and special modifiers (only required where applicable). The minimum standard for deepwater habitat classification is: system, subsystem, class, and water regime.

The application of the LLWW classification is a demonstration of its use on western wetland types. The LLWW classification is intended to bridge the gap between HGM and the NWI Cowardin et al. Classification systems. The use of the LLWW Classification System for this project is the continuation of a pilot study in New Mexico for wetlands in arid western states. The use of a dichotomous key along with mapped data and ground-truthing will be tested for accuracy and applicability for wetlands and riparian areas of the West.

**Conditions under which the data will be collected**

Pre- and post- mapping field review will provide the image analyst an opportunity to become familiar with wetland communities and land use patterns. Pre- and post-mapping ground-truthing check sites will be identified in the project area based on typical and atypical signatures for verification of mapping units. A minimum of 100 check sites will be identified and visited for each field review in each project area. Data that will be collected at all pre- and post-mapping check sites will include GPS location and photographs. Additional data (i.e. soil descriptions, hydrologic condition descriptions, weather, vegetation, wildlife, and current land use practices) will be collected if the field review team determines, based on professional judgement, verification of imagery is needed. Data will be entered

on field data forms provided in **Appendix I. National Wetlands Inventory Field Data Form (NWI Field Data Form).** Pre-mapping and post-mapping ground-truthing will take place during a month that is advantageous for observing wet conditions on the landscape.

**Specify tolerable limits**

Data quality indicators for wetlands mapping and classification are described in Table 3. Accuracy is a measure of both errors of omission and commission. For this wetland mapping project, accuracy may depend upon several factors affecting identification including:

- Scale of imagery
- Mapping scale or base map scale
- Quality of imagery
- Season of imagery (leaf-off or leaf-on)
- Type of imagery or emulsion of imagery
- Environmental conditions when imagery was captured
- Difficulty of identifying particular types of wetlands
- Availability and quality of ancillary or collateral data sources

Accuracy is also a function of data quality and technology as well as proper training of the image interpreter. Classification accuracy of the final map product should be measured by the Target Mapping Unit (TMU) (0.5 acres or better) and Producer's Accuracy (PA) (98%) metrics. The FGDC Wetlands Mapping Standard presents no requirement for User's Accuracy (UA).

Wetlands data that meet or exceed the minimum TMU and PA requirements will be accepted for submission to the NSDI. Ninety-eight percent of all wetlands visible on an image, at the size of the TMU or larger shall be mapped regardless of the origin (natural, farmed, or artificial). Features that are at least 0.5 acres will be mapped with a demonstrated PA of 98% for feature accuracy and 85% for attribute accuracy, or higher, across each project map (or the project area if the project area is smaller than an individual map), as documented through external quality assessment of samples. Habitat changes that have occurred between the date of the base imagery and the date of field observation or ground-truthing are not considered errors because the wetland was correctly classified on the base imagery. The actual TMU and PA for the project area shall be documented in the metadata, along with an associated justification and description of the quality assurance process used.

The quality of the information used for this assessment will be ensured by the following data quality indicator requirements described below in Table 3. Additionally, data integrity procedures for St. Mary's University of Minnesota, Geospatial Services are outlined in **Appendix II. Data Integrity Procedures for GeoSpatial Services NM Wetland Mapping and Classification Projects.** These procedures are used as a checklist to insure project data integrity.

**Table 3. Data Quality Indicators**

| Data Quality Indicator | Description | Data Acquisition |
|---|---|---|
| Precision | The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves | The basis for determining precision will be the comparison of photo-interpreted wetlands against a set of reference wetlands distributed across the project study area. Characteristics of reference wetlands will be collected through field data collection during the project ground-truthing exercise as well as through the expert assessments of members of the SWQB project team. |
| Accuracy | Degree of agreement between an observed value and accepted reference value | The basis for determining accuracy will be the comparison of image analyzed wetlands against a set of reference wetlands distributed across the project study area. Characteristics of reference wetlands will be collected through field data collection during the project ground-truthing exercise as well as through the expert assessments of members of the SWQB project team. |
| Bias | The systematic or persistent distortion of a measurement process that causes errors in one direction | Bias will be reduced by using professional and experienced staff to collect and analyze data |
| Representativeness | The degree to which data accurately and precisely represents a characteristic of an environmental condition | Sites selected as part of the reference data set will be field-verified. Sample selection is representative of the entire sample unit. |
| Comparability | The measure of confidence that one data set can be compared to another | This project will collect new data where no data is available for comparison. However, methods for data collection are standardized and reproducible. |
| Completeness | A measure of the amount of valid data needed for project | All representative sites based on typical signatures and atypical signatures within the mapping area will be identified for ground-truthing and represent wetlands and riparian areas of the entire mapping area. Parameters identified in the NWI Field Data Form for each check site will be completed sufficiently to verify imagery data. |
| Sensitivity | The capability of a method to discriminate between measurement responses representing different levels of the variable of interest | All wetlands and riparian areas within TMU will be mapped. The actual TMU and PA for the project area shall be declared in the metadata, along with an associated justification and description of the quality assurance process used which is compliant with the "National Wetland Mapping Standard" of the Federal Geospatial Data Committee (FGDC) |

**1.7 Special Training/Certification**

SWQB has qualified and experienced scientific and GIS staff that have applicable skills and scientific background to help carry out and administer this project.

In addition, the Wetlands Program will use qualified and experienced contractors to concurrently carry out this project. Contractors must be skilled image analysts in wetland delineation and classification across various landscapes in the United States, including the arid and semi-arid areas of the West and Southwest regions. Contractor qualifications are documented through resume and professional references.

The qualifications of key personnel are described below.

The Contractor/Director is Andrew Robertson. Mr. Robertson has over 25 years of experience in the implementation of a wide range of wetland mapping, spatial data development and natural resource management projects. He is responsible for supervision and development of technical staff including Wetland Biologists and GIS Analysts. Mr. Robertson specializes in the implementation of appropriate GIS applications and other information technologies, such as GPS; image analysis, and field computing, to facilitate information gathering and analysis for decision support. He is a Registered Professional Forest Technologist in Alberta, Canada and a member of the Canadian Institute of Forestry and the Society of American Foresters.

David Rokus is the Contractor/Quality Assurance and Quality Control (QA/QC) specialist for this project is David Rokus. Mr. Rokus is responsible for the management of project resources and GIS analysts for a wide range of spatial data development and natural resources projects. Focused mainly on-air image analysis, wetland delineation, and landuse/landcover mapping, his responsibilities range from project estimation, establishing mapping standards and conventions, developing and implementing QA/QC techniques, providing technical assistance to peers, and writing documentation reports and metadata.

Kevin Stark is the Contractor/Senior GIS Analyst for this project. Mr. Stark is responsible for database design, development of quality control scripts and SQL query tools required to assign ecosystem functions to wetland polygons.

Jeff Knopf is the Contractor/Senior GIS Analyst for this project. Mr. Knopf is responsible for the development and supervision of a variety of GIS and image analysis related projects for a wide array of customers ranging from private industry, university researchers, and local and federal government agencies. In addition, Mr. Knopf oversees employees and their training and the development of project methodologies. Mr. Knopf has many years of experience with processing raster datasets and specializes in projects where image analysis techniques are utilized.

Roger Meyer is the Contractor/GIS Programmer for this project. Mr. Meyer is responsible for automation tasks and software maintenance including: incorporating software updates, developing new approaches to wetland classification, preparing models and scripts for data development, and

story map design and creation. Mr. Meyer has over a decade of experience working with spatial data and software management for ArcGIS.

Michael Knudson is the Contractor/Senior GIS Analyst for this project. Mr. Knudson is responsible for data modelling particularly related to wetland hydrogeomorphic classification and wetland functional assessment.

Zack Ansell is the Contractor/GIS Analyst for this project. Mr. Ansell is responsible for wetland data creation, fieldwork planning and QA/QC of all GIS and Student Technicians. Mr. Ansell has an MSc in GIS and over 5 years' experience in wetland data production using the FGDC National Wetland Classification Standard.

Josh Balsiger is the Contractor/GIS Technician for this project. Zack is responsible for providing oversight for other technicians, interacting with project partners in the field, preparing materials for fieldwork, training new technicians and providing quality control.

Dustin Nelson, M.S. Environmental Science and Policy, serves as a Wetlands Program Project Officer for this project. He is responsible for data quality assurance and monitoring. While attending San Francisco State University, he worked at a research technician, collecting data for and aiding in the implementing wetland restoration projects across the San Francisco Bay Area. After completing his B.S. in Biology in 2015, he worked as a crew lead for the vegetation crew at both Point Reyes National Seashore and Rocky Mountain National Park, treating invasive species and implementing restoration projects across a variety of habitats. He earned his M.S. at University of Wisconsin – Green Bay in 2020. Mr. Nelson's research in Wisconsin required soil, plant tissue, and plot-based sampling to assess the changes in soil and plant phosphorus and other characteristics over time with the implementation of a warm-season grassland restoration in highly degraded agricultural soils. Mr. Nelson has been trained in wetland ecology, plant identification, and delineation, as well as GIS systems and water quality sampling.

Tiffany Anders is a Wetlands Program Project Officer with the Surface Water Quality Bureau. Ms. Anders received a Master of Applied Geography, Resources and Environmental Studies from Texas State University-San Marcos. When assigned as Project Officer of a wetlands mapping and classification project, Ms. Anders will manage the progress of the project, distribute the QAPP, assist in ground-truthing site selection, data transfer, distribution activities, and preparation of final project report to EPA. Ms. Anders is also a Professional Wetland Scientist with experience in wetland delineation and wetland functional assessment.

Maryann McGraw is the Wetlands Program Coordinator (WPC) and has ACOE Wetlands Delineation Training and has been performing routine wetlands delineations, and wetlands hydrology, soils and plant identification since 1994. Ms. McGraw will ensure consistency of this project with other wetlands mapping and classification projects, participate in planning meetings and field verification of mapping signatures, and review and submit reports to EPA.

Gary Hunt is the Regional Wetlands Coordinator for the SW District of the USFWS and is responsible for

all NWI mapping in Texas, Arizona and New Mexico. Gary has extensive wetland mapping and classification experience in the southwest and will be responsible for the quality assurance, quality control, and acceptance criteria for mapping products incorporation into the National Wetlands Inventory Database.

**1.8 Documents and Records**

Copies of this QAPP and any subsequent revisions will be provided to all individuals included on the distribution list by the SWQB Wetlands Program Project Officers. The Wetlands Program Project Officers and the Contractor/Director will also distribute all applicable protocol documents and subsequent revisions used throughout the project to the appropriate personnel. The QAPP, protocol documents and monitoring reports will be maintained in the central project file at SWQB. These documents will also be submitted to EPA Region 6 Wetlands Program files as specified in the project work plans.

All data collected and project information generated by the Contractor will be maintained using both hardcopy and digital filing systems. Hardcopy documents are stored in locked filing cabinets in a secure location that is protected from natural and manmade hazards. Digital records are stored on isolated computer servers which are backed up to redundant data locations on a nightly basis. Distribution of digital project documents is completed via corporate email. Read receipts are requested by the Contractor/Director for all critical path documentation (e.g. the QAPP) to ensure that project staff are always informed of the latest version of key documents. All project documentation and data is retained for a minimum of 3 years from the contract termination date. Digital data including files, emails, spatial geodatabases, scans and photographs will be archived on a portable, external hard drive for long term storage.

Final digital spatial data (i.e. wetland delineation and classification and all collateral data) will be delivered to SWQB in ArcGIS rev. 10.6 file geodatabase format (or the latest version compatible with SWQB software). The delivery version will be specified by SWQB prior to the contract termination date. Quality assurance reports resulting from final examination of the digital spatial data will also be included in the project geodatabase. These reports will include the spatial location of wetlands that have been examined; the results of runs of the USFWS NWI verification tool against the project geodatabase; summaries of internal testing performed by Saint Mary's University of Minnesota, GeoSpatial Services error checking routines; and, a cross reference table that documents NWI wetland classification codes by LLWW code. Data will be copied to a portable external hard drive for delivery, or will be transferred through the Contractor's or NMED's file transfer protocol (FTP) website.

The pre-mapping field review and post-mapping ground-truthing exercises will result in data being collected from a series of field validation points. A hardcopy of the NWI Field Data Form (Appendix I) following the format prescribed by U.S. Fish and Wildlife Service documentation on data collection requirements for wetland mapping under the NWI (USFWS, 2009b) will be prepared for each site where field data area collected. In addition, a GPS coordinate will be recorded to document the spatial location of each sample point and one or more photographs will be taken to document site conditions.

GPS data will be delivered as part of the final spatial geodatabase (see above); field sheets will be scanned by the Contractor into digital PDF format for transfer to SWQB; and, site photographs will be delivered in digital format along with other project documents. If SWQB collects data independently of the Contractor, then data will be shared with the Contractor electronically and stored on the Wetlands Program Project Officer's computer and in the Wetlands Program central project files.

## 2.0 DATA GENERATION AND ACQUISITION

### 2.1 Sampling Process Design

For wetland mapping and classification projects at the landscape level, field reviews are used to address questions regarding image interpretation, land use practices, classification of wetland type and verification of functional metrics such as landscape position, landform, water body type, and hydrologic flow path. Pre- and post- mapping field reviews will be conducted as quality control measures to ensure that map information is correct.

The procedures for pre-and post- mapping field reviews are the same although they occur at different times during the project. Pre- mapping field reviews provide an opportunity for image analysts to become familiar with wetland communities and land use patterns, whereas post-mapping field review ground-truthing ensures accurate and consistent interpretation of imagery. Information gained from field reviews in combination with the analyst's skills and experience in image interpretation and the use of ancillary data will contribute to successful wetland mapping and classification.

Accurate and consistent interpretations of imagery will be ensured by conducting a pre- and post-mapping field review for each project area to correlate image signatures with observed wetland and upland types. Viewing digital data on a laptop computer or other portable device will facilitate the review of wetlands map data in the field. Field reviews will include identification of hydric soils or hydric soil characteristics (using standard practices for Munsell soil color chart), information about common regional wetland plants and their distribution, dominant land use, drainage practices, agricultural crops and some preliminary image analysis of sites to be reviewed. Participants in the field reviews will include: Wetlands Program Coordinator, Wetlands Project Officer, Contractor/Director, and Contractor/Senior Wetland Image Analyst. In addition, the USFWS Regional Wetlands Coordinator will be invited to participate.

Field reviews will involve visits to a cross section of wetland types as well as to sites that may be mapped using different image types, scales, and dates. Check sites for field reviews in each project area will be chosen based on commonly occurring image signatures or habitats characterizing an area; unusual but important imagery signatures (some which may be difficult to identify); borderline signatures (those features that might be wetland or upland) and; specific signature problems based on the date of imagery (recent burning, extreme high or low water conditions). All sites will be accessible via road. Analysts will select field sites near roads or public lands if access is limited.

After each field review, a field trip report will be prepared by the Contractor following published guidance from the NWI Program (FGDC, 2009) and subject to requirements established by the NWI Regional Wetland Coordinator. Field trip reports will discuss the details of the field review efforts (including participants, dates, and location), ancillary data sources and uses, general descriptions of wetlands and uplands in the area, description of water conditions, details about the quality and interpretation of the imagery, identifiable metrics of wetland function and any special problems, findings or conventions.

During the field reviews, participants will complete NWI Field Data Forms (Appendix I) at a variety of different check sites which are well distributed throughout the trip area. The exact number of check sites will be determined by the participants, per defined project specifications, weather conditions, access to sites, and trip objectives. Good quality digital photographs will be provided for field sites for which a NWI Field Data Form is completed.

**2.2 Sampling and Image Acquisition Methods**

The primary image source from which all wetland boundaries will be derived is the most recent NAIP from the U.S. Department of Agriculture for New Mexico. The specifications for this imagery are documented on the internet at the following location: https://catalog.data.gov/dataset/the-national-agriculture-imagery-program-naip-information-sheet. Collateral data used to derive wetland boundaries include data such as USGS DRG, NHD streams, and historical aerial imagery.

While in the field, photographs of land use and wetland characteristics will be obtained for reference purposes. NWI Field Data Forms will be completed for selected sites. The exact location of the site locations referred to in notes and other information will be captured digitally through GPS. Any handwritten field notes on maps regarding changes observed will be clear and understandable. Examples of notations are: 'extend or add this wetland;' 'delete wetland:' or 'refine delineation.'

To realize maximum results, it may be necessary to reassess pre-mapping check sites during the post-mapping field review. based on work already completed versus time, access to sites and priorities. Image interpreters will conduct field verification exercises to ensure accurate and consistent interpretation of imagery. Field trip reports and NWI Field Data Forms will provide documentation of the field verification efforts including, general descriptions of wetlands and uplands in an area, descriptions of surface water conditions both on the imagery and at the time of field work, and details about the quality of the source materials used.

**2.3 LIDAR**

Lidar, which stands for *Light Detection and Ranging,* is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth. These light pulses—combined with other data recorded by the airborne system — generate precise, three-dimensional information about the shape of the Earth and its surface characteristics.

A lidar instrument principally consists of a laser, a scanner, and a specialized GPS receiver. Airplanes and helicopters are the most commonly used platforms for acquiring lidar data over broad areas. Two types of lidar are topographic and bathymetric. Topographic lidar typically uses a near-infrared laser to map the land, while bathymetric lidar uses water-penetrating green light to also measure seafloor and riverbed elevations.

Lidar systems allow scientists and mapping professionals to examine both natural and manmade environments with accuracy, precision, and flexibility. NOAA scientists are using lidar to produce

more accurate shoreline maps, make digital elevation models for use in geographic information systems, to assist in emergency response operations, and in many other applications.

A Hillshade layer, rendered from bare earth DEM (Digital Elevation Model) is a LiDAR product that is used in multiple aspects of the wetland data mapping process from the initial stages of data creation to the final steps of quality control exercises. Hill shade derived from LiDAR data provided by the University of New Mexico Earth Data Analysis Center, is used to identify potential wetland features and to visualize finite changes in topography. Hill shade layers are scanned by both editors and analysts to identify depression shaped basins, channels, and areas of human influence. During the data creation stages editors use the LiDAR products as a collateral data source to identify wetlands with diminished signatures, floodplain boundaries, and to verify historic wetland mapping data. During a quality control session, analysts will often use LiDAR as a primary data source to detect errors in wetland signature identification. By scanning with LiDAR layers errors such as, missed features, incorrect flow representations, and inaccurate modifications are rectified before final delivery. The use of LiDAR is a critical piece of information to ensure a quality final dataset.

**2.4 Sampling Handling and Custody**

GPS data and digital photography collected during field reviews will be stored on a portable laptop. During the field review, these digital data will be backed-up on a portable hard drive nightly for safe storage. After the field review, upon arrival at the Contractor's office, GPS data and digital photography will be transferred to corporate servers for permanent storage in project files. Corporate servers are backed up on a nightly basis. The Contractor/Director will retain custody of all data NWI Field Data Forms, GPS data, digital photography, and draft hard copy, maps during the field reviews. These data will later be submitted to the Wetlands Project Officer as project deliverables in accordance with the project workplans.

**2.5 Analytical Methods**

The delineation of wetlands, deepwater habitats and riparian features through image analysis forms the foundation for deriving all subsequent products and data results. Consequently, a great deal of emphasis is placed on the quality of the image interpretation. Standard image analysis methodology will be used for landscape level wetland assessment and habitat characterization.

Wetland delineation will be conducted on-screen in ArcGIS on a digital image backdrop composed of color infrared true color, summer aerial photography from the National Resources Conservation Service (NRCS) NAIP imagery. This program collects aerial imagery during the agricultural growing seasons in the continental U.S. The default spectral resolution is natural color (Red, Green and Blue, or RGB) but beginning in 2005, some states were delivered with four bands of data: RGB and Near Infrared. NAIP imagery is acquired at a one-meter ground sample distance (GSD) with a horizontal accuracy that matches within five meters of photo-identifiable ground control points, which are used during image inspection. This is compliant with the "National Wetland Mapping Standard" of the FGDC.

Wetland mapping and classification in New Mexico relies on the subjective interpretation of wetland boundaries and wetland classification characteristics from a primary aerial image source supported by consultation with collateral spatial data. The image analyst will make use of the following “basic elements” to make decisions about ecological habitat boundaries, wetland types and visible functional characteristics. These same elements are used in the quality control review of delineated information to check for accuracy and completeness.

Tone (also called Hue or Color) -- Tone refers to the relative brightness or color of elements on an image. It is, perhaps, the most basic of the interpretive elements because without tonal differences none of the other elements could be discerned.

Size -- The size of objects must be considered in the context of the scale of an image. The scale will help you determine if an object is a stock pond or large lake or reservoir.

Shape -- Refers to the general outline of objects. Regular geometric shapes are usually indicators of human presence and use.

Texture -- The impression of "smoothness" or "roughness" of image features is caused by the frequency of change of tone in images. It is produced by a set of features too small to identify individually. Grass, cement, and water generally appear "smooth," while a forest canopy may appear "rough".

Pattern (spatial arrangement) -- The patterns formed by objects in an image can be diagnostic. Consider the difference between (1) the random pattern formed by a natural grove of trees and (2) the evenly spaced rows formed by an orchard or planted forest.

Shadow -- Shadows may aid interpreters in determining the height of objects on aerial imagery. However, they can also obscure objects within them.

Geographic Location -- This characteristic of imagery is especially important in identifying vegetation types and landforms. For example, large oval depressions in the ground are readily identified as Carolina Bays in the coastal regions of southeast.

Association -- Some objects are always found in association with other objects. The context of an object can provide insight into what it is. For instance, a nuclear power plant is not (generally) going to be found in the midst of single-family housing.

The on-screen method is the most feasible for identifying and delineating wetlands using digital imagery and supporting tools. The on-screen method involves viewing digital map data that overlays digital imagery on a personal computer screen (monitor). Changes to the map data to make it current

with the digital imagery can be made on-screen and the digital data file checked and saved or exported.

The Contractor/Image Analyst using the on-screen method will be experienced in the identification and classification of wetlands. Using the on-screen method, image analysts will ensure the ecological integrity of the mapping process as well as most of the cartographic accuracy. The identification, delineation and attribution of features will be completed within the digital data files.

An ArcMap geodatabase will be the format for viewing, editing and storing map data. This greatly improves the administration, access, management and integration of spatial data. The ArcMap system also provides access to a suite of editing tools available in ArcGIS which creates smaller more efficient files and permits map editors to "drag and drop" polygons which prove to be a very important capability in updating wetland map files. The heads-up method has several distinct advantages:

- Uses digital imagery (DOQs or other digital data)
- Eliminates manual cartographic transfer work
- Provides seamless coverage of work areas
- Easily transportable to ArcSDE or other platforms
- Digital Raster Graphics (DRGs), or other digital data layers (historic imagery, SSURGO, DEM etc.) provide a direct backdrop for image interpretation and validation
- Hydric soils can be imported and viewed as ancillary information
- Linear feature files can be eliminated
- Automated verification routines can incorporate GIS capability

To support a streamlined QA/QC process, customized scripts will be created by the Contractor/GIS Analyst to allow quicker attribution of map features using wetland and deepwater codes as well as other descriptive codes or information. A standardized verification tool is also available from the NWI Program to provide quality control or logic checks of the digital data. This tool can be accessed at: http://www.fws.gov/wetlands/Data/Tools-Forms.html

Editing and updating wetland digital map data using the heads-up process implies the following:

- Digital imagery will be used as the base imagery to update the wetlands information.
- The existing wetland map digital data will overlay and register to a USGS DRG topographic base map or rectified imagery where available.
- ArcGIS software (latest version) will be used in a Windows environment to edit existing digital data
- Customized software tools from the NWI Program will be used to assist the updating, editing and data verification processes

**2.6 Quality Control**

Internal reviews and checking by the Contractor/GIS Analyst and Contractor/Director provide a first and critical step in the quality control process. Quality control of interpreted map products (both

boundary delineation and classification) is typically performed on 100% of the project area by a qualified image analyst other than the person performing the original work. To accomplish this, the review analyst will perform an incremental screen by screen (working west to east or north to south) qualitative review of the project area at no less than 1:12,000 scale. Following completion of row or column on-screen views, edits will be saved in the personal geodatabase.

Internal quality control review of interpreted images will include a comparison of contours, hydrographic symbols, or cultural features from the DRG to wetland delineations and vegetation signatures. There is considerable latitude allowed in conducting qualitative reviews. However, a complete review of the project area with the backdrop of the standardized base visible at a scale not smaller than 1:12,000 must be completed. All work will adhere to published NWI National Standards, quality requirements and data collection methods. In addition, customized editing scripts will be used in this step to: validate topological accuracy; search for null polygons and slivers; identify adjacent polygons with the same classification; and verify coding to national standards.

Customized data verification tools have been constructed to automate (to the extent possible) the quality control functions necessary to ensure the geodatabase is accurate. This suite of functions has been designed to address geo-positional errors, digital anomalies, and some logic checks that make use of the power of the geographic information system. These tools are extensions to ArcMap desktop geographic information system product.

Cartographic accuracy - For digital data to be accepted into the USFWS National Wetland Geodatabase, they must first pass verification. A number of geospatial quality control checks are mandatory for the digital data to pass verification. The pass/fail function on the customized tool will automatically execute those verification tools. Other potential problems identified with the verification tool will provide the image analyst the option of editing or ignoring the feature.

Logic checking - The geodatabase verification process also uses the analytical ability of the Geographic Information System to build in enhancements to the quality control process. Items such as wetland classification accuracy will be checked along with cartographic precision.

Edge matching - Edge-matching of wetland interpretation is required for a seamless wetland database. Two types of edge-matching will be used: 1) internal ties along the borders of source images and 2) external ties to pre-existing wetland data immediately adjacent to the project area. The USFWS requires that in all cases, internal edge-matching be performed.

Wetland mapping units lying along the outer borders of source images within a project area, whenever practical, will be edge-matched with interpretations on all adjacent images within the project area. All polygon features shall be edited to ensure an identical or coincident transition across images in the entire project area. At a minimum, features located on the outer edge of the project area will be closed exactly at the border of the project area. Because some maps have been updated, there may be some temporal differences in the data. Edge matching of data adjacent to the project area will be facilitated by referencing on-line data available from the USFWS.

Attribute table review is the next stage of the quality control process. During this assessment, the

analyst will access the geodatabase attribute table and review it for errors. Sorting various data fields in ascending order can easily isolate null attributes, empty attributes, improper attributes and very small, or "sliver" polygons. Where multiple classification schemes have been sued to characterize wetland features (e.g. Cowardin and LLWW), additional attribute reviews are required to ensure that combinations of codes are logically consistent. This is achieved by developing a series of cross reference tables and having a skilled image analyst visually review the tables for inconsistencies.

The production of draft map products is an optional quality control process. In this step, plots of the new/updated wetlands data may be made to review in the field or to provide visual inspection of mapped features at various smaller scales than is practical to view on-screen. There are no specifications for draft products since they are considered interim work products - not for distribution. However, since the production of draft maps is usually accompanied by a field verification trip, consideration should be given to plotting at a manageable size and scale for field interpretation.

Finally, all NWI wetland mapping and classification projects will be coordinated, to the extent possible, with NWI Regional Wetlands Coordinators and project personnel for data reviews and quality assurance steps prior to submission to the National Wetlands Geodatabase. This ensures that incoming data will be of sufficient quality and integrity for national distribution. It also ensures that project cooperators have access to the latest tools and techniques endorsed by the NWI Program for data collection.

**2.7 Instrument/Equipment Testing, Inspection, and Maintenance**

The equipment used to collect physical measurements for this project will include the following:

- GPS Navigator
- Laptop Computer
- GPS Receiver
- Digital Camera
- Soil Spade
- Munsell Color Chart
- Vegetation Field Guides

All field equipment will be inspected each morning prior to commencing data collection. All instruments and equipment will be tested, inspected and maintained in accordance with the manufacturer's specifications as included in the associated instrument/equipment manual.

The contractor staff will use their own equipment. Results of equipment inspections will be noted in the maintenance log and/or project file. Any deficiencies in equipment will be noted and reported immediately. If condition of equipment is in doubt, it will not be used. In the event of equipment failure, the SWQB Wetlands Program Project Officer will be notified, and the Contractor will correct the problem, rejecting the resultant data or accepting the data with notations.

### 2.8 Instrument Calibration and Frequency

None of the instruments used in this project require calibration.

### 2.9 Inspection/Acceptance for Supplies and Consumables

There are no supplies or consumables that could affect the quality of data related to this project.

### 2.10 Data Acquisition (Non-direct Measurements)

For this project, the primary image source from which all wetland boundaries will be derived is the most recent NAIP imagery from the U.S. Department of Agriculture for New Mexico. The specifications for this imagery are documented on the internet at the following location: https://catalog.data.gov/dataset/the-national-agriculture-imagery-program-naip-information-sheet.

They include:

- imagery is acquired from aircraft using film or digital cameras that meet rigid calibration specifications
- 1-meter ground sample distance (GSD) or resolution
- 3-band natural color, or Red, Green, Blue (RGB) imagery
- match within 5-meters to existing DOQQs
- 95% of well-defined points tested shall fall within 6 meters of true ground location

The following is an excerpt from the 2011 NAIP metadata for New Mexico:

*This data set contains imagery from the National Agriculture Imagery Program (NAIP). The NAIP acquires digital ortho imagery during the agricultural growing seasons in the continental U.S. A primary goal of the NAIP program is to enable availability of ortho imagery within one year of acquisition. The NAIP provides two main products: 1 meter ground sample distance (GSD) ortho imagery rectified to a horizontal accuracy within +/- 5 meters of reference digital ortho quarter quads (DOQQ's) from the National Digital Ortho Program (NDOP) or from the*
*National Agriculture Imagery Program (NAIP); 1 meter GSD ortho imagery rectified within +/- 6 meters to true ground. The tiling format of NAIP imagery is based on a 3.75' x 3.75' quarter quadrangle with a 300 meter buffer on all four sides. The NAIP imagery is formatted to the UTM coordinate system using the North American Datum of 1983 (NAD83). The NAIP imagery may contain as much as 10% cloud cover per tile. This file was generated by compressing NAIP imagery that covers the county extent. Two types of compression may be used for NAIP imagery: MrSID and JPEG 2000. Target value for the compression ratio is (15:1).*

Given that image analyst will be conducting heads-up (on-screen) digitizing of wetland boundaries using this primary image source, they are, by default, incorporating these image specifications in the final products that will be produced for this project. In addition, other collateral data sources (e.g.

USGS DRG, NHD streams, and historical aerial imagery) will only be consulted to support decision making on the primary imagery so their accuracy specifications have no bearing on the final map products.

### 2.11 Data Management

Data obtained for this project are maintained in GIS electronic files and digitized NWI Field Data Forms. All data will be delivered by the Contractor to the Wetlands Program Project Officer as soon as practical following data collection events. Once delivered, these data are maintained on SWQB hard drive and as paper copies in the Wetlands Program files that are maintained by the Wetlands Program Project Officer for the project. Contractors will provide summary reports to the Wetlands Program Project Officer. All data and summary reports will be compiled into the semi-annual and final project report and provided to U.S. EPA.

## 3.0 ASSESSMENT/OVERSIGHT ELEMENTS

### 3.1 Acquisition and Response Actions

The SWQB Wetlands Program Project Officer provides project oversight by reviewing data collection efforts.

Any problems encountered during the course of this project will be immediately reported to the SWQB Wetlands Program Project Officer who will consult with appropriate individuals to determine appropriate action. Should the corrective action impact the project or data quality, the SWQB Wetlands Project Officer will alert the Quality Assurance Officer and Project Officer. All problems will be documented for inclusion in the project file, semi-annual and final report. The SWQB Wetlands Project Officer will assess project progress to ensure the QAPP is being implemented, including periodic audits by the QAO, as needed.

### 3.2 Reports to Management

Semi-Annual Reports are submitted by the Wetlands Program to U.S. EPA and include progress of project implementation and any available data. Status reports or special reports for SWQB or U.S. EPA will be prepared on request. A report detailing the findings will be provided in the final project report. Any deviations from what is specified in the work plan for this project will be documented and reported to the Wetlands Program Project Officer.

## 4.0 DATA VALIDATION AND USABILITY

### 4.1 Data Review, Validation, and Verification

Data review and verification are key steps for ensuring the integrity, suitability and usability of the data. Validation and verification will be conducted during the course of this project.

### 4.2 Validation and Verification Methods

The SWQB Wetlands Program Project Officer and the Contractor will be responsible to ensure that valid and representative wetland data will be delineated and classified for this project.

Wetland delineation will be conducted on-screen in ArcGIS on a digital image backdrop composed of color infrared true color, summer aerial photography from the National Resources Conservation Service (NRCS) NAIP imagery. This program collects aerial imagery during the agricultural growing seasons in the continental U.S. The default spectral resolution is natural color (Red, Green and Blue, or RGB) but beginning in 2005, some states were delivered with four bands of data: RGB and Near Infrared. NAIP imagery is acquired at a one-meter ground sample distance (GSD) with a horizontal accuracy that matches within five meters of photo-identifiable ground control points, which are used during image inspection. This is compliant with the "National Wetland Mapping Standard" of the FGDC.

The "National Wetland Mapping Standard" of the FGDC also specifies that compliant wetland data must meet both a TMU size and a level of PA. The TMU is an estimate of the size class of the smallest wetland that can be consistently mapped and classified at a particular scale of imagery, and that the image-interpreter attempts to map consistently. TMU allows for mapping below a specified threshold, but does not subject that finer detailed mapping to the accuracy requirements of the Standard. The TMU for the mapping and classification projects is 0.5 acres which is consistent with the "National Wetland Mapping Standard."

PA measures the percentage of wetland features that are correctly identified and correctly classified on the imagery. PA is measured by both feature and attribute accuracy. Feature accuracy is the correctness of the identification of wetland vs. non-wetland. Attribute accuracy is the correctness of the classification of the wetlands using the FGDC Wetlands Classification Standard. The PA for this project is 98% for feature accuracy and 85% for classification accuracy which is consistent with the "National Wetland Mapping Standard."

The USFWS NWI Program has primary responsibility for ensuring that any federally funded wetland data that is to be submitted to the Wetlands Spatial Data Layer of the NSDI meets the specifications of the FGDC "National Wetland Mapping Standard." As a result, the SWQB Wetlands Program Project Officer and USFWS Regional Wetland Coordinator for New Mexico will ensure that data from this project is compliant with the standard. Data validation and verification will include: on- going informal reviews of completed wetland delineation and classification throughout the active mapping

portion of this project; a comprehensive field review of mapped wetlands upon completion of the draft delineation and classification (Draft Map Review); Contractor revisions of the wetland data based on feedback from the field review; and, a complete quality assurance review of the final wetland data, including both manual and automated assessment techniques, prior to submission to the NSDI.

### 4.3 Reconciliation with Data Quality Objectives

Data quality objectives are agreed upon by the SWQB Wetlands Program Project Officer, Contractor, USFWS Regional Wetland Coordinator and a multi-agency project advisory committee. These groups will work cooperatively throughout the entire project timeframe to answer questions, address issues, review data quality and provide feedback. These reviews will be conducted within the context of federal wetland mapping guidance from three primary documents: the FGDC "Federal Wetland Mapping Standard"; the Classification of Wetlands and Deepwater Habitats of the United States; and the Fish and Wildlife Service National Standards and Quality Components for Wetlands, Deepwater and Related Habitat Mapping. Where variation from data quality objectives is identified by these review processes, the Contractor will make every effort to address issues in a timely and comprehensive manner.

## 5.0 REFERENCES

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## 6.0 APPENDICES

### APPENDIX I

### National Wetlands Inventory Field Data Form

Field Form ID: _____

Site Code: _____

State:_____ County:_____ USGS Quad:_____

TWP/R:_____ Lat/Long (dms):_____Datum: _____

Reported by:_____ Date: _____

(Name and affiliation) (dd/mm/yyyy)

Other Participants: _____

Accessed Via: _____

(Boat /road /helicopter /airboat/etc.)

Wetland type: _____ Cowardin Classification: _____

(Lake, fen, pothole, etc.)

Video:_____ Photograph(s): quantity: _____

(Direction and view angle)

Direction and view angle:_____

**Source Imagery**

Type of Imagery Used: Photograph:_____DOQQ:_____Sat. Image:_____Other: _____

Date of Imagery: _____

Imagery source:_____ Type:_____Scale:

Discussion of Imagery: _____

_____

**Wildlife**

Wildlife Observations: _____

_____

_____

_____

_____

_____

_____

**Hydrology**

Tide Stage: High:____ Low:____ Slack: ____

Water Depth at the time of field visit: _____
(Feet or inches)

**Indicators** Standing water____ Water Marks ____

Buttressed Trunks____ Water Stained Leaves____

Water Carried Debris____ Saturated Soils ____

Floating Mat____ Shallow Roots ____

Bare Areas____ Oxidized Rhizospheres ____

Other Indicators of Hydrology_____

Surrounding Land Use: _____
(Farmland, residential, mining, etc.)

Landscape Position:_____Water Flow Path: _____

Hydrogeomorphic Classification:_____

**Plant Community**

Dominance Type: _____

| | | | |
|---|---|---|---|
| Abundance - | Cover Dense (high) | 70 - 100% | _____ |
| | Common (medium) | 30 - 69% | _____ |
| | Occasional | < 30% | _____ |

Common Plant *Spp.*: _____

_____

Less Common Plant *Spp.*: _____

_____

Rare or Unique Plant *Spp.*: _____

_____

**Soils/Substrate**

Substrate type: Silt_____ Sand_____ Clay_____ Loam_____ Peat _____

Rubble____ Rock_____ Other _____

Soil Map Unit Name: _____

Taxonomy: _____

Drainage Class:_____ Hydric List (National)_____Other_____

Soil Survey Publication Date: _____

Munsell: hue value chroma

_____depth_____(inches)

_____depth_____(inches)

_____depth_____(inches)

_____depth_____(inches)

**Hydric Soil Indicators**

Histosol_____ Concretions_____ Histic Epipedon _____

High Organic Content_____ Sulfuric Odor_____ Organic Streaking_____

Aquic Moisture Regime____Reducing Conditions_____ Gleyed_____

Other Remarks_____

**Disturbance**

Fill ____ Waste ____ Dredging ____ Fire ____

Channels/ditches ___ Farming ____ Industrial ____ Residential___

Commercial ____ Timber Harvesting ____ Roads ____ Drainage ____

Impoundment____ Other _____

**Land Ownership**

Federal ____

State _____

County ____

**APPENDIX II**

**Data Integrity Procedures for**
**GeoSpatial Services NM Wetland Mapping and Classification Projects**

## I. Project Initialization

A. Assemble contact information
   1. Request data checkout from project coordinator
   2. Request names of field experts for fieldwork
   3. Host conference call verifying timelines and processes

B. Data Acquisition
   1. Download collateral data
      a. landscape – topography and soils
      b. imagery – historic and stereo pairs
         i. build pyramids
         ii. calculate statistics
         iii. mosaic individual photos
      c. vector – historic wetlands, soils, land use, etc.
         i. join tabular data
   2. Build project to ensure complete coverage of all data
      a. Establish datum, coordinate system, and projections
   3. Perform sample updates and edits
      a. Submit to partners for primary review
      b. Host conference call to document editing and schedule fieldwork

## II. Initial Fieldwork

A. Pre-fieldwork
   1. Make travel arrangements
      a. Rent car
      b. Book hotel
      c. Contact local experts for input in the field – DNR, USFWS, etc.
   2. Acquire all necessary equipment
      a. Soil probe or spade
      b. Clipboard and field data sheets
      c. GPS with car adapter and batteries
      d. Laptop with removable hard drive and project data
      e. Camera
      f. Field bags
   3. Create field check site file

a. Choose points based on typical signatures
b. Choose additional points based on atypical signatures
c. Points are randomly distributed and accessible by land
d. Upload points to GPS unit

4. Print maps
   a. Several overview maps with streets layer and all points
   b. Large scale navigation and points check list
   c. Individual field site maps with polygons and imagery
5. Upload data to removable hard drive and prepare ArcMap project

B. In the Field
1. Navigate between check sites using GPS and overview maps
2. Check site record data
   a. Soil probe or pit
   b. Record hydrologic conditions
   c. Document vegetation, wildlife, and weather conditions
   d. Take a photograph and record direction facing
   e. Talk with local landowners
   f. Note current land use practices
3. Complete formal field data sheets (NWI, Status and Trends)

C. Post-field Data Dump
1. Compile all GPS points into a single file
   a. Add photo file field
   b. Add mapped attribute field
   c. Add photo direction field
   d. Record mapped attribute and other notable features into field
2. Develop signature conventions
   a. List all prominent and outlying image signatures
      i. cross referenced with appropriate attribute or code
      ii. signature includes: color, tone, texture, etc.

## III. On-screen Digitizing

A. Break data into working units if needed
1. Quadrangles, counties, or sub-watersheds
2. Assign data to interpreters or analysts
3. Maintain file structure

B. Perform updates and edits
1. Perform self QA/QC often
2. Restart computer daily to flush edits
3. Compact database daily to remove bugs

C. Inform QA/QC as units or milestones are completed
1. Discuss problem areas and issues
2. Revisions as needed

## IV. Quality Assurance / Quality Control (QA/QC)

A. Self QA/QC

1. Run daily to weekly by analyst or interpreter
   a. Explode all polygons
   b. Look for Null geometry or polygons below MMU
   c. Find erroneous attributes and fix codes
2. Save a back-up copy to the server

B. Internal QA/QC

1. Data Preparation
   a. Explode all polygons
   b. Select by attribute based on unique value
      i. Remove all erroneous attributes
   c. Review all polygons below the minimum mapping unit
      i. Pan / zoom to each polygon to verify its appearance
      ii. Delete, merge, or accept polygon
   d. Repair geometry and delete Null geometry
2. Signature Matching
   a. Pan through entire dataset at scale of 1:10,000
      i. Scale of interpretation
      ii. Ensures polygons within each complex are categorized accurately and consistently
      iii. Verifies complexes are hydrologically connected throughout drainage systems
      iv. Verifies complexes are disjunctive across roads and other human influences
   b. Select all of one attribute
      i. Pan / zoom to approximately 5% to ensure similar signature conditions
      ii. Repeat for all other abundant attributes
3. Linework Review
   a. Pan through entire dataset at scale of 1:5,000
      i. Scale of delineation
      ii. Ensures polygon structure is appropriately pieced together
   b. Pan through entire dataset at scale of 1:1,000
      i. Look for micro errors that affect polygon smoothness and negatively affect fitting appearance
         - Jags
         - Spikes
         - Intersections
         - Corners
4. Same Adjacent Attributes (SAA) Tool
   a. Identifies multiple polygons with identical attributes in contact with each other

b. Pan / zoom to each of these SAA
c. Merge, delete, or fix polygons

5. Topology
   a. Overlaps
      i. Pan / zoom and fix
   b. Gaps
      i. Pan / zoom and fix
      ii. Large upland gaps are acceptable
      iii. Run Gap Checker Tool to verify acceptable gaps
   c. Must be covered by each other
      i. Mapped features must be contained within study area
      ii. Study area must have mapped features throughout
6. NWI Verification Tool 2.5.1_9.3
   a. Repeats many of the above QA/QC checks
   b. All-inclusive tool that double checks according to NWI specifics
   c. Pan / zoom and fix
7. Repeat steps 1, 4, 5, and 6
8. Database Finalization
   a. Save multiple copies of database
      i. Make changes according to entity – DNR, USFWS, ACOE.
         - Removal of uplands or unwanted codes (DWL in WIDNR) (U in NWI)
         - Project to desired coordinate system or datum
9. External QA/QC
   a. Submit data to client
      i. Allow time for review
      ii. Host conference call for feedback
   b. Make revisions according to review
   c. Re-run internal QA/QC process excluding step 2 and 3

**Field Verification**

A. Repeat Initial Fieldwork
   1. Include field check sites with rare conditions
B. Discuss findings with partners via conference call
   1. Make revisions according to the field verification
   2. Repeat internal QA/QC process excluding step 2 and 3

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**APPENDIX III**

**Acknowledgement Form**

New Mexico Environment Department Surface Water Quality Bureau

## Mapping and Classification of Wetlands in New Mexico

## Quality Assurance Project Plan Cooperator Acknowledgement Statement

This is to acknowledge that I have received a copy of the **Mapping and Classification of Wetlands in New Mexico** *Quality Assurance Project Plan*.

As indicated by my signature below, I understand and acknowledge that it is my responsibility to read, understand, become familiar with, and comply with the information provided in the document to the best of my ability.

_____
Signature

_____
Name (Please Print)

_____
Date