2020 RESIDENCY DOCUMENT

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NOVEMBER 1, 2020

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Residency Acknowledgements

First, I would like to thank my advisor, Dr. Christopher Brown, for his continued support through this process, for whom without this would not be possible. His guidance, knowledge, and continued patience in my pursuit of a Master of Applied Geography was greatly appreciated by all, especially my wife. I could not have envisioned a greater mentor and advisor in my pursuit of higher education. Second, I would like to thank my two committee members, Dr. Daniel P. Dugas and Dr. Brian Hurd, for their feedback and support in these trying times.

The SpARC lab at NMSU provided me a place in which to pursue my residency work. In addition to providing me a lab in which to work, I was also provided server storage for my sensitive installation data, along with the technical expertise of the lab's director. I would also like to thank the NMSU Department of Geography faculty for providing me the technical skillset to perform my work.

I will be forever grateful to all that assisted me with this project, including the WSMR staff of Joel Giblin, Carol Placchi, and Kristen Hestir. I enjoyed making lifelong relationships with the AGEISS staff of Garrett Smith and Matthew Taylor, as I'm incredibly appreciative of their guidance and support. The ability to work on a DoD Mentor-Protégé Program provided invaluable technical expertise and funding for my work.

Finally, to my understanding wife Whitney Blickem, for whom none of this would have become a reality. I can't forget to mention my 6-month old son, Liam, who provided me the final push to complete my work.

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Mentor Protégé Program Background

The Mentor Protégé Program (MPP), created by former U.S. Senator Sam Nunn and implemented by former Secretary of Defense William Perry, was enacted on November 5, 1990, as a vehicle for the development of Proteges. The program was created in response to concerns raised by prime DoD contractors, in their inability to meet Small Disadvantaged Business (SBB)

subcontracting goals (DoD, 2020).[1] The program was created to assist small businesses, Woman-Owned Small Businesses, Service-Disabled Veteran-Owned Small Businesses, and Historically Underutilized Business Zone small businesses in transitioning from modest attainments to more successful contributions to the defense of our nation. The MPP initiative encourages and incentivizes prime government contractors to develop the technical capabilities of small businesses.

Technology Transfer

New Mexico State University (NMSU) engaged in the MPP in Las Cruces by partnering with two private-sector firms, AGEISS, the mentor firm, and IDEALS, the protégé firm. The AGEISS/IDEALS relationship came about in 2013 with AGEISS providing corporate infrastructure and business development support under the SBA's 8(a) Small Business Development program. NMSU's participation came about through a Request for Proposal (RFP) from AGEISS, sent to NMSU's College of Engineering on 15 June 2014. AGEISS, an environmental consulting firm, was interested in pursuing submitted proposals to develop a Multi-Criteria Decision Analysis Model (MCDA) that would be executed at a pilot installation. The execution of the model would be through on the job training for an NMSU intern to support the creation of the MCDA.

The NMSU intern gained expertise in analysis modeling, through on the job training and practical exercises to support the creation of the MCDA. This was done by utilizing data

[1] https://www.defense.gov/Newsroom/Releases/Release/Article/2184321/department-of-defense-announces-winners-of-the-fiscal-year-19-nunn-perry-award/

analytics and geospatial integration of Army and community datasets, and by conducting interviews with installation decision-makers.

With NMSU's College of Engineering being awarded the contract, the need arose to establish a partnership between WSMR and the Departments of Geography and Civil Engineering at NMSU. A Memorandum of Understanding was signed in September of 2016, defining and delineating the responsibilities of both parties to conduct research on developing Geographical Information Systems (GIS) tools that would assist WSMR Army compatible Use Buffer (ACUB) Program.

It was later proposed to transfer a DoD targeted environmental planning service and the associated technology under the DoD MPP. The DoD Mentor Protégé Agreement was initiated in 2015. This agreement led to the creation of a decision-analysis tool called the Comprehensive Long-Range Encroachment Analysis Resource (CLEAR). The CLEAR tool improves military warfighter capabilities by assisting Installation Management Command (IMCOM), it's installations, and other DoD customers in overcoming specific constraints caused by encroachment.

The MPP Relationship

The MPP relationship is focused on aiding the military mission and creating a new and sustainable revenue stream. AGEISS is helping IDEALS create a unique technical capability and technology that will be immediately useful to DoD installations nationwide. Details of this relationship are noted below:

- AGEISS provided IDEALS with technical assistance and training in technical areas of encroachment, military land-use training and management, installation planning, and a multi-component decision-based criteria analysis tool.
- To aid in IDEALS success, AGEISS and IDEALS partnered with New Mexico State University (NMSU), who provided an NMSU student as a STEM intern. Through this arrangement, the project offered a valuable on-the-job technical development opportunity, and the STEM intern, Ryan Blickem, would later secure employment with IDEALS in encroachment management. AGEISS, IDEALS, and NMSU piloted with White Sands Missile Range (WSMR), which is in Las Cruces, near the IDEALS office and NMSU.
- The encroachment support and technology demonstration pilot provided IDEALS and the NMSU student on the job training and provided IDEALS the technical capability in the growing training support industry.
- The technical assistance provided to IDEALS allowed them to compete for opportunities that will improve the operational capabilities of Army installations, where warfighters train, fight and win.

Creation of the CLEAR Tool

The CLEAR tool began as an Excel spreadsheet that was constructed using a cascading, multi-tiered questionnaire that was filled out by installation decision-makers, using general questions that helped to identify and predict any risks due to relevant encroachment conditions near DoD installations or training areas. Once these relevant conditions were identified, the factors and sub-factors that apply to those relevant conditions were weighted. This process and its outcomes aided the encroachment mitigation process by prioritizing efforts to ensure mission friendly and sustainable land uses that are compatible with DoD training operations.

Encroachment Questionnaire

Services within the DoD have identified specific challenge areas that have the potential to negatively impact testing and training operations on or near military installations. By

exploring these specific challenge areas, decision-makers and stakeholders can use the CLEAR tool to identify the challenge areas that are currently impacting training and testing operations.

Using a binary approach in the questionnaire-based decision tool, where there are only two options offered (*Yes or No*), the tool allows the users to easily determine whether a challenge area is present or not and also highlights the encroachment conditions that are relevant and present to their respective installation or range. The output of the questionnaire was then used to generate a report and a visual GIS representation for WSMR that offers a snapshot of the applicable encroachment challenge areas. The report generated contains a summary of current encroachment conditions and potential mitigation strategies. The visual GIS representation identifies where those encroachment conditions are occurring. These products can be integrated into future planning, management, and/or mitigation strategies, that will provide mission sustainability as well as guide future discussions with local defense communities.

Each encroachment challenge area included in the questionnaire allows for the installation to select the cumulative mission impact from the applicable encroachment conditions (Low, Medium Low, Medium High, and High) that occur within that challenge area. Below are the challenge areas that have been identified by the DoD:

- Air
    - Air quality and opacity standards.
- Airborne and Ground Noise
    - Creates community complaints from nearby developed areas regarding aircraft or blast noise (including sonic booms),
    - Testing and training work that avoids community complaints (operational changes to testing hours, locations, routes, etc.).

- Frequency Spectrum Encroachment (avoid and resolve radio frequency related issues that impact testing and training missions)
    - Spectrum availability,
    - Civilian telecommunication uses conflicting with military operations/communications,
    - Renewable energy interference (wind, high tension power lines, substations),
    - Primary and tenant unit operational EM interference on DoD facilities,
    - Line of sight obstruction (smoke, steam, dust, structures, power lines).
- Unexploded Ordnance and Munitions
    - Required remediation of unexploded ordnance sites,
    - Risk associated with trespassing by the general public onto installations/ranges.
- Urban Growth (Driver for most other challenge areas)
    - Development of land outside installation/range with new uses,
    - Population growth and increased densities,
    - Current land uses -Residential, Agricultural, Commercial, Industrial,
    - Economics (tax base, diversity of industry),
    - Land use authority of local governments.
- Water
    - Availability,
    - Wastewater Treatment/Disposal
    - Quality,
    - Sourcing,
    - Delivery Infrastructure,
    - Contamination,
    - Drought,
    - Floodplains,
    - Stormwater and flooding,
    - Water Rights.
- Airspace and Land Restrictions
    - Land development and associated activities on and off an installation that affects training and testing capabilities,
    - Tall buildings and structures,
    - Conflicts with civilian aviation,
    - Drones (unmanned aircraft systems),
    - BASH (Bird/Animal Strike Hazard).
- Cultural Resources
    - Compliance with multiple Federal and/or State regulations,
    - Historic designations of lands and/or structures,
    - Archeological sites (Native American burial sites, petroglyphs, etc.).
- Endangered Species and Critical Habitat
    - Threatened or endangered plants and animals,
    - Sensitive habitat.
- Energy Compatibility and Availability

    - Federal requirements,
    - Government subsidies and incentives,
    - Impacts of proposed energy generation or transmission facilities,
    - Radar interference.
- Marine Resources (this was left out for the pilot installation)
    - Competition over water, airspace, and surfaces (DoD training, recreation, energy development),
    - Restrictions associated with threatened/endangered species.
- Natural Factors and Climate Effects
    - Earthquakes, tornadoes, flooding,
    - Extreme variations in temperature, rainfall, etc.,
    - Drought (of special relevance on the WSMR installation),
    - Increase in sea level.
- Security and Safety
    - Lack of stand-off distance (Anti-Terrorism concerns, Quantity Distance Safety Arcs, lines-of-sight, vantage points, unrestricted access onto installations/ranges, and the SunZia Southwest Transmission Project located in the Northern Call-up Area of WSMR).

The questionnaire was completed by the installation, which can be done at fixed intervals or at random, to track the status of current encroachment conditions or to identify emerging conditions. Each iteration of the questionnaire, report, and visual representation can be saved, creating a legacy of how encroachment conditions were tracked, addressed, and mitigated against.

The purpose of the questionnaire was to generate a report that would provide a snapshot of current encroachment conditions that have the potential to impact mission sustainment, operational readiness, and mission capabilities at WSMR. The report included the following:

- A summary and ranking of WSMR's Encroachment Assessment Questionnaire output that are relevant to existing encroachment challenges and conditions,
- Encroachment factors associated with two priority areas that have been identified in WSMR's 2016 ACUB proposal, and

- Encroachment mitigation strategy recommendations.

Below are examples of the questionnaire and the summary report provided to WSMR.

ENCROACHMENT ASSESSMENT QUESTIONNAIRE

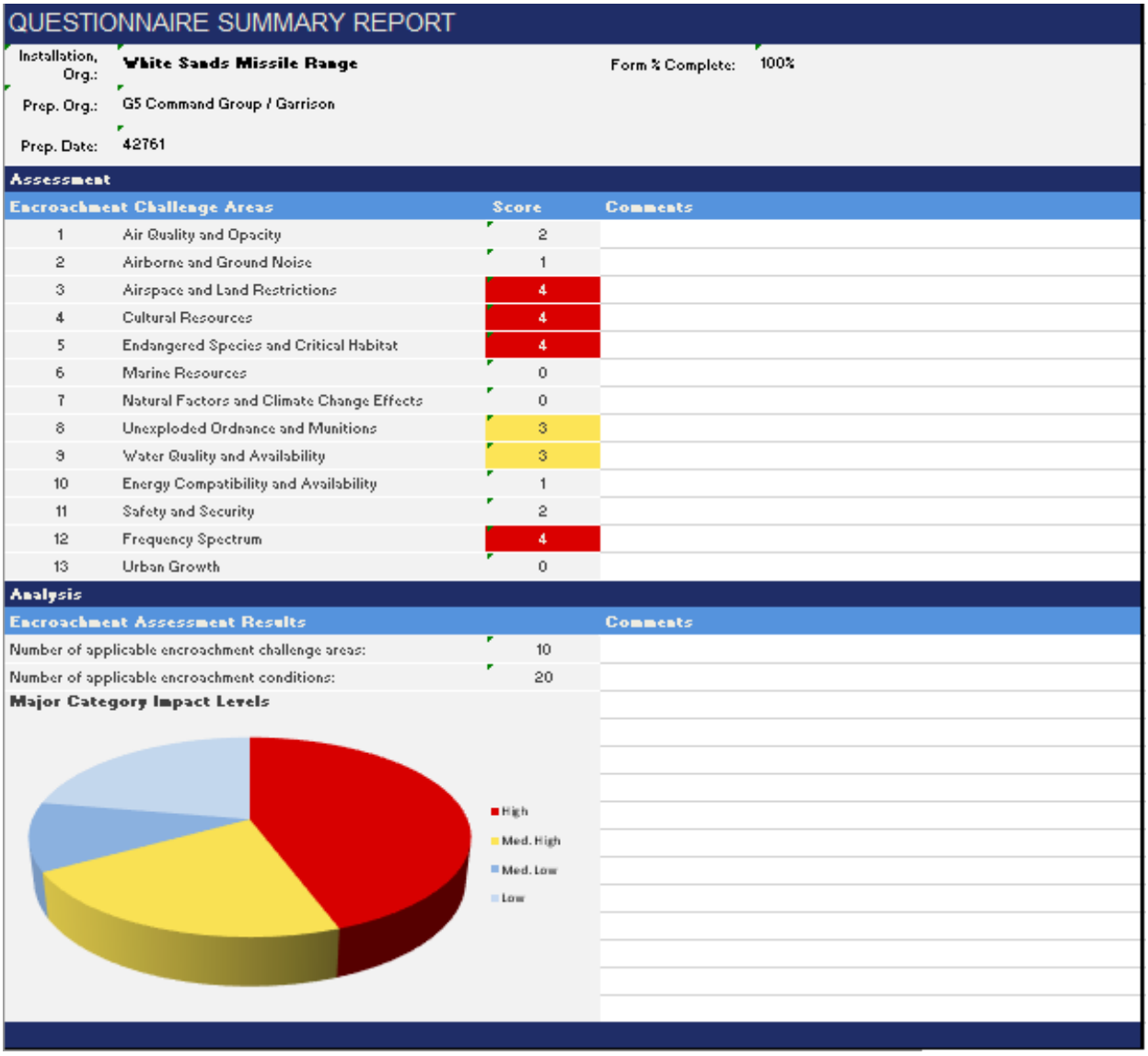
Installation, Org.:	White Sands Missile Range	Form % Complete:	100%
Prep. Org.:	G5 Command Group / Garrison		
Prep. Date:	26-Jan-17		

Question Number	Question	Example	Enter Response
1	**Air Quality and Opacity** Do existing air quality or visibility conditions or restrictions (mandatory or self-imposed) affect operational readiness by requiring changes to the execution of mission testing or training operations?	*Example: Some residents view smoke and/or fumes created by military training as a nuisance and potential health hazard, contributing to Federal or State imposed mandatory emission reductions. The installation considers options that will reduce smoke and fumes created by current training activities.*	Y
a	Mission changes implemented due to mandatory compliance with air quality or visibility laws such as the *Clean Air Act* or requirements associated with a Title V Air Quality Permit. The surrounding community may or may not be in nonattainment status as determined by the Environmental Protection Agency.		Y
b	Mission changes implemented due to activities in the surrounding community that create air opacity issues such as dust, smoke, steam, or glare.		N
c	Mission changes implemented due to community complaints about training activities that create air quality or opacity issues such as dust, smoke, steam, or fumes.		Y
d	Which Impact Level best describes current mission impacts due to Air Quality and Opacity related encroachment conditions?		2
2	**Airborne and Ground Noise** Do existing airborne or ground noise conditions or restrictions (mandatory or self-imposed) affect operational readiness by requiring changes to the execution of mission testing or training operations?	*Example: Community individuals complain to the installation, elected representatives, and local media about noise generated by mission operations. In response, the installation alters times and reduces durations of operations during early evening hours to reduce the noise exposure experienced by residents living near the installation.*	Y

Figure 1: Encroachment Assessment Questionnaire Example 1

Question Number	Question	Example	Enter Response
c	Mission changes implemented because portions of the installation boundary are not secure due to inadequate security staffing and/or security infrastructure such as perimeter fencing and surveillance.		N
d	Which Impact Level best describes current mission impacts due to Safety and Security related encroachment conditions?		2
12	**Frequency Spectrum** Do existing frequency spectrum interference conditions or restrictions (mandatory or self-imposed) affect operational readiness by requiring changes to the execution of mission testing or training operations?	*Example: Several communications towers are under construction throughout the surrounding community. One tower is constructed near a flight corridor used to test remotely piloted vehicles and the installation cannot sustain safe testing operations due to radio frequency interference.*	Y
a	Mission changes implemented due to affected communication capabilities caused by sources of spectrum interference within the installation or in the surrounding community.		Y
b	Mission changes implemented due to affected warfare systems testing capabilities caused by sources of spectrum interference within the installation or in the surrounding community.		Y
c	Mission changes implemented due to spectrum or radar interference caused by renewable energy development in the surrounding community such as wind farms, solar arrays, or transmission lines.		Y
d	The sale of spectrum frequency by the Federal Communications Commission to non-DoD entities requires the installation to transition to different frequencies for		Y

Figure 2: Encroachment Assessment Questionnaire Example 2



QUESTIONNAIRE SUMMARY REPORT

Installation, Org.:	White Sands Missile Range	Form % Complete:	100%
Prep. Org.:	G5 Command Group / Garrison		
Prep. Date:	42761		

Assessment

	Encroachment Challenge Areas	Score	Comments
1	Air Quality and Opacity	2	
2	Airborne and Ground Noise	1	
3	Airspace and Land Restrictions	4	
4	Cultural Resources	4	
5	Endangered Species and Critical Habitat	4	
6	Marine Resources	0	
7	Natural Factors and Climate Change Effects	0	
8	Unexploded Ordnance and Munitions	3	
9	Water Quality and Availability	3	
10	Energy Compatibility and Availability	1	
11	Safety and Security	2	
12	Frequency Spectrum	4	
13	Urban Growth	0	

Analysis

Encroachment Assessment Results		Comments
Number of applicable encroachment challenge areas:	10	
Number of applicable encroachment conditions:	20	

Major Category Impact Levels

Figure 3: Questionnaire Summary Report

WSMR completed the project questionnaire in January 2017, and the survey results indicated that 10 of 13 encroachment challenge areas and 20 encroachment conditions in the questionnaire are applicable to WSMR. For greater prioritization of the 10 applicable encroachment challenge areas, a mission impact perspective factor was utilized to better rank these areas.

Each encroachment challenge area was viewed by WSMR staff from 4 basic mission impact perspectives, listed in order of importance:

1. Resource Competition – Incompatible Uses or Activities in the Surrounding Community
   Encroachment conditions are occurring or may occur in the surrounding community that reduce or restrict testing or training operations taking place on the installation or within military operating areas beyond the installation boundaries. Mitigation of resource competition constraints are typically the most difficult to resolve, as mitigation efforts may require significant property acquisition or conservation financial resources and/or multiple partnerships with governmental or non-governmental entities.

2. Quality of Life – Mission Impacts on the Surrounding Community
   Encroachment conditions created by military testing or training operations are occurring or may occur on the installation or within military operating areas that cause health, safety, welfare, quality of life, or property rights concerns in the surrounding community. Voluntary attempts on the part of an installation to mitigate quality of life impacts on the community caused by testing and training activities are effectively self-imposed, where the installation reduces or restricts testing or training operations to assuage community concerns.

3. Natural Events – Weather, Climate, and Geology
   Encroachment conditions are occurring or may occur on the installation or within military operating areas due to natural occurring events not directly involving military testing or training operations or development activities in the surrounding community. Extreme weather events (tornadoes, hurricanes), sustained changes to historic weather patterns (increased or decreased temperature, precipitation), or geologic events (earthquakes, landslides) can create significant mission impacts. Though natural events may be prepared for, reductions or restrictions in testing or training operations caused by natural events cannot be remedied by simply executing compatible use strategies or satisfying mandatory requirements.

4. Regulatory Compliance – Laws, Policies, Orders, or Agreements
   Encroachment conditions are occurring or may occur on the installation or within military operating areas that reduce or restrict testing or training operations due to mandatory compliance issues with federal, state, or local laws, policies, executive orders, agreements, or other regulatory controls. Mitigation of regulatory compliance constraints

typically requires outright compliance with the controlling federal or DoD law, policy, or order in the absence of a waiver or other form of regulatory relief where compliance is conditional. As this type of encroachment condition is driven by federal or DoD requirements, mission constraints are effectively self-imposed, and mitigation of regulatory compliance constraints does not involve the surrounding community.

Many of the applicable encroachment conditions at WSMR were largely a result of regulatory compliance issues with specific mandatory requirements. These regulatory compliance issues do not require the cumbersome and complicated compatible use partnerships normally associated with physical encroachment conditions.

Based on the questionnaire results and mission impact perspectives, WSMR's applicable challenge areas are ranked in Table 1 (created by author and project partner Matthew Taylor), with color-coding indicating the severity of encroachment risk.

Table 1. Encroachment Challenge Area Rankings

Ranking	Encroachment Challenge Area	Mission Impact Level	Key Encroachment Conditions	Primary Encroachment Condition
1	Airspace and Land Restrictions	High	○ Memorandum of Understanding under development with Spaceport NM to avoid future conflicts ○ Proposed energy projects such as wind farms and transmission lines ○ Testing requires occasional vehicular/aircraft restrictions in northern and western call up areas	Resource Competition
2	Frequency Spectrum	High	○ Spectrum interference due to energy projects involving transmission lines or wind turbines ○ Transition of spectrum frequency due to Federal Communications Commission (FCC) sale to non-DoD entities	Resource Competition
3	Cultural Resources	High	○ Mandatory compliance with historic and preservation or protection laws ○ White Sands National Monument is located within testing range ○ San Andres National Wildlife Refuge is located along WSMR western boundary	Regulatory Compliance

			○ Coordination with agencies such as State Historic Preservation Office, National Park Service ○ Required submittal and compliance with Environmental Impact Statements, Environmental Assessments, and Recognized Environmental Conditions	
4	Endangered Species and Critical Habitat	High	○ Presence of protected species such as Bald and Golden Eagles, White Sands Pupfish	Regulatory Compliance
5	Water Quality and Availability	Medium High	○ Limited supply of potable water in Hazardous Test Areas due to contamination ○ Potential for water restrictions or rationing depending on mission requirements	Regulatory Compliance
6	Unexploded Ordinance and Munitions	Medium High	○ Presence of unexploded ordinance, primarily sub-munitions, within the installation	Regulatory Compliance
7	Air Quality and Opacity	Medium Low	○ Missions occasionally impacted by high winds blowing dust ○ Mission impacts from high winds blowing gypsum from White Sands National Monument	Regulatory Compliance
8	Safety and Security	Medium Low	○ Security of installation fence line is a chronic issue	Regulatory Compliance
9	Energy Compatibility and Availability	Low	○ Energy projects involving transmission lines or wind turbines are always of concern	Resource Competition
10	Airborne and Ground Noise	Low	○ Noise issues (sonic booms and blast noise) associated more with Holloman Air Force Base and Fort Bliss than White Sands Missile Range	Quality of Life
Marine Resources, Natural Factors and Climate Change Effects, and Urban Growth challenge areas identified as "Not Applicable" in the completed questionnaire.				

Encroachment Factors

Out of the encroachment assessment questionnaire and WSMR's 2016 Army Compatible Use Buffer (ACUB) proposal, Priority Areas 1A and 1B were selected for specific comparative analysis. The criteria used to select these priority areas were location, ownership, and potential or existing encroachment conditions.

The encroachment factors relevant to Priority Area 1A and 1B are located in Table 2.

Table 2. ACUB Priority Area Encroachment Factors		
	Priority Area 1A	Priority Area 1B
Location	West of and Adjacent to WSMR Southwestern Boundary	WSMR Northern Call-Up Area
Local Government	Doña Ana County NM	Socorro County NM
Ownership	Private (Cox Ranch)	Private and Public
Acreage	2,669.72	29,469.02 (Private) 20,570.78 (BLM) 21,268.79 (State)
Land Use Regulations	T2 (Rural) Zoning – Two-acre minimum lot size; agricultural and residential uses permitted; commercial and industrial uses allowed with approved Special Use Permit	Building health and safety codes; minimal regulations that dictate specific uses of private or public lands
Encroachment Challenge Areas	○ Safety/Security ○ Urban Growth* ○ Water Quality/Availability	○ Airspace/Land Restrictions ○ Energy Compatibility/Availability ○ Frequency Spectrum
Encroachment Conditions	○ Adjacent to installation boundary with unobstructed views of operational testing areas ○ Current Doña Ana County zoning allows a variety of land uses* ○ Located within Rio Grande Aquifer System boundary*	○ Renewable energy developments may create physical obstructions or cause electromagnetic interference* ○ Proposed Sun Zia Southwest Transmission line
*Encroachment challenge areas and conditions not identified in the completed questionnaire.		

Encroachment Mitigation

Based on the encroachment questionnaire and data layers provided by WSMR, basic mitigation strategies were formulated that supported encroachment strategy utilization of the ACUB Program and are contained in Table 3 (also created by author and project partner Matthew Taylor).

Table 3: Encroachment Mitigation Strategies	
Community Engagement	○ Develop and maintain a proactive approach to encroachment management by building stakeholder relationships and promoting WSMR's status as a unique and valuable contributor to the community. ○ Maximize public outreach opportunities via traditional/social media.

	○ Coordinate with Army IMCOM, installation command, Public Affairs, and Judge Advocate to craft consistent mission sustainability messaging to guide discussions with the local defense community, including local and state government agencies, elected officials, and advocacy groups. ○ Monitor state legislative proposals and coordinate with DoD Regional Environmental Coordinators (REC) when proposals have the potential to impact current or future testing and training operations. ○ Ensure notification provisions adopted by local communities advising the installation of potentially incompatible development are met.
SNMEP JLUS Implementation	○ Continue engagement with the JLUS Implementation Committee ○ Maintain regular, interactive relationships with JLUS partners ○ Monitor JLUS recommendation implementation efforts taken by local and state governments
Leverage Compatible Use Partnerships	***Readiness and Environmental Protection Integration (REPI)*** REPI is a cost-sharing DoD program where installations may enter into land conservation agreements with willing governmental or non-profit, non-governmental agencies to reduce or avoid incompatible uses near military installations. REPI is administered through the Office of the Secretary of Defense (OSD) annually. Evaluation factors for awarding funds include strategic benefit, cost sharing ratio, likelihood of execution, and project innovation. WSMR's potential compatible use partners include, but are not limited to, the following: Governmental Partners ○ Bureau of Land Management ○ U.S. Department of Agriculture – Natural Resources Conservation Service ○ U.S. Fish and Wildlife Service ○ U.S. Forest Service ○ State of New Mexico ○ Doña Ana, Lincoln, Otero, Sierra, Socorro Counties NM Non-Governmental Partners ○ Compatible Lands Foundation ○ New Mexico Land Conservancy ○ Nature Conservancy ○ Sierra Club ○ Socorro Agricultural Land Trust Additional REPI information can be found at http://www.repi.mil/ ***Sentinel Landscapes Partnership*** Sentinel Landscapes is a joint effort by the U.S. Departments of Agriculture, Defense, and Interior to preserve farm, ranch, and forest lands as well as critical habitat and natural resources in the interest of both preservation and DoD mission sustainability. Sentinel landscape designation proposals may be submitted via the Sentinel Landscapes website, https://sentinellandscapes.org/apply-now/

Support and Resources	○ Army Installation Management Command https://www.imcom.army.mil/ ○ NM Military Base Planning Commission http://www.governor.state.nm.us/Military_Base.asp ○ DoD Siting Clearinghouse (*Coordinates review of energy project compatibility with military testing or training operations*) http://www.acq.osd.mil/dodsc/ ○ Western Regional Partnership (*Compatible use through community engagement and partnerships*) https://wrpinfo.org/

GIS Representation of the CLEAR Tool

Overview

The GIS component of the CLEAR tool consists of an integrated encroachment constraints layer that assists installations in the identification and potential mitigation of existing encroachment conditions. The data for the constraints layer were acquired from WSMR and publicly available datasets (local, state, and federal), and these data contain ownership and land boundary information of all lands within WSMR's established priority areas. The NMSU GIS project team provided WSMR with a visual representation of geographical areas near the installation that contribute to current encroachment conditions as well as data that assisted the installation in developing prioritized mitigation strategies.

Integration Process

The data provided by WSMR were integrated with the acquired public datasets to create a richer and more valuable constraints layer for WSMR. Plans such as the Southern New Mexico El Paso Joint Land Use Plan (SNMEP JLUS) were consulted to clarify the geographical locations of encroachment conditions by priority areas and individual parcels (SNMEP JLUS,

2015).[2] The SNMEP JLUS is a cooperative effort between WSMR and the jurisdictions surrounding the installation that carries out strategies for promoting compatible civilian development. The SNMEP JLUS acts as a comprehensive strategic plan that utilizes specific implementation actions to address and prevent any incompatible civilian development that may impair the operational mission of an installation or impact resources, such as air, land, water, and electromagnetic spectrum. Doña Ana County was awarded a grant to undertake the JLUS with participating jurisdictions offering a match. The JLUS is only advisory, but it does offer multiple tools and processes to partner entities (SMJLUS,2015, p. 10). These entities, including WSMR, cities, counties, and state and federal agencies, have the discretion to adopt recommendations provided by the JLUS. As part of the JLUS process, project partners entered into a Memorandum of Agreement (MOA) that established a Regional Planning Organization (RPO) to direct the effort (SMJLUS,2015, p. 12). A range of partners joined the study process:

- Doña Ana County,
- El Paso County,
- Lincoln County,
- Otero County,
- Sierra County,
- Socorro County,
- The City of Alamogordo,
- The City of El Paso,
- The City of Las Cruces,
- Fort Bliss,
- Holloman Air Force Base,
- White Sands Missile Range,
- New Mexico State Land Office,
- New Mexico Office of Military Base Planning and Support,
- Military Base Planning Commission,

[2] https://snmepjointlanduse.org/

- New Mexico Spaceport Authority,
- Bureau of Land Management.

The JLUS also engaged residents, landowners, state and local governments, and others that were not explicitly mentioned in the list of formal MOA participants (SMJLUS,2015, p. 12).

Once the acquired parcel data were collected and clipped within each of the priority areas, data were parsed using an ArcGIS query expression to identify specific parcels of interest. An Excel spreadsheet with small text tags was created and joined to the parcel data, so that map users may see a callout showing the associated text. The deliverable consisted of an ArcGIS geodatabase that included the pertinent constraints as well as maps with linked callout text. Hard copies were also delivered as a summary of the data callouts, along with maps of each priority area as a visual reference.

Processing Steps

- Integrated Encroachment Questionnaire output was cross-referenced with WSMR's Army Compatible Use Buffer (ACUB) priority areas to help steer GIS data acquisition,
- Acquired WSMR databases,
- Acquired open-source data through publicly available GIS sources,
- Purchased parcel data from surrounding counties, including Doña Ana and Socorro,
- Uploaded all GIS data to an internal server for use in ArcGIS,
- Cross-referenced all pertinent WSMR and public data pertinent to specific ACUB priority areas with the SNMEP JLUS and the WSMR 2046 Strategic Plan. Relevant output data were extracted and clipped for map creation,
- Created an Excel spreadsheet describing specific challenge areas at the parcel level for the associated ACUB priority area,
- Merged the Excel spreadsheet with the parcel data in ArcGIS so that the data are represented using callout texts.

Contract Deliverable

The contract deliverable consisted of an ArcGIS-based integrated encroachment constraints layer, contained in a geodatabase, that was delivered to WSMR along with printed maps that accompany the encroachment assessment report. The constraints layer integrates publicly sourced data into WSMR's own constraints layer, creating a new constraints layer to focus on WSMR's specific encroachment conditions and locations where these conditions are occurring. Priority Areas 1A and 1B were called out specifically and include pertinent data for individual parcels within the priority areas, including why the particular parcels are of interest.

The encroachment questionnaire and integrated encroachment constraints layer were combined to support the development of ACUB proposals and ACUB Program implementation on WSMR, by identifying encroachment conditions where they are occurring. In addition, the encroachment questionnaire and encroachment constraints layer can function as dual platforms for storing all encroachment-related data needed to track encroachment conditions and mitigation efforts. The installation ACUB Program Manager can use both resources to list encroachment conditions that may or may not be of long-term concern.

The maps identify select installation priority and call-up areas and include basic map details. The map report offers an immediate and intuitive visual representation of the encroachment assessment report's contents. All exported data created for the integrated constraints layer meet Federal Geographic Data Committee (FGDC) data standards. See Figures 4,5, and 6 for priority area maps, which were generated from and include data contained in the integrated constraints layer.

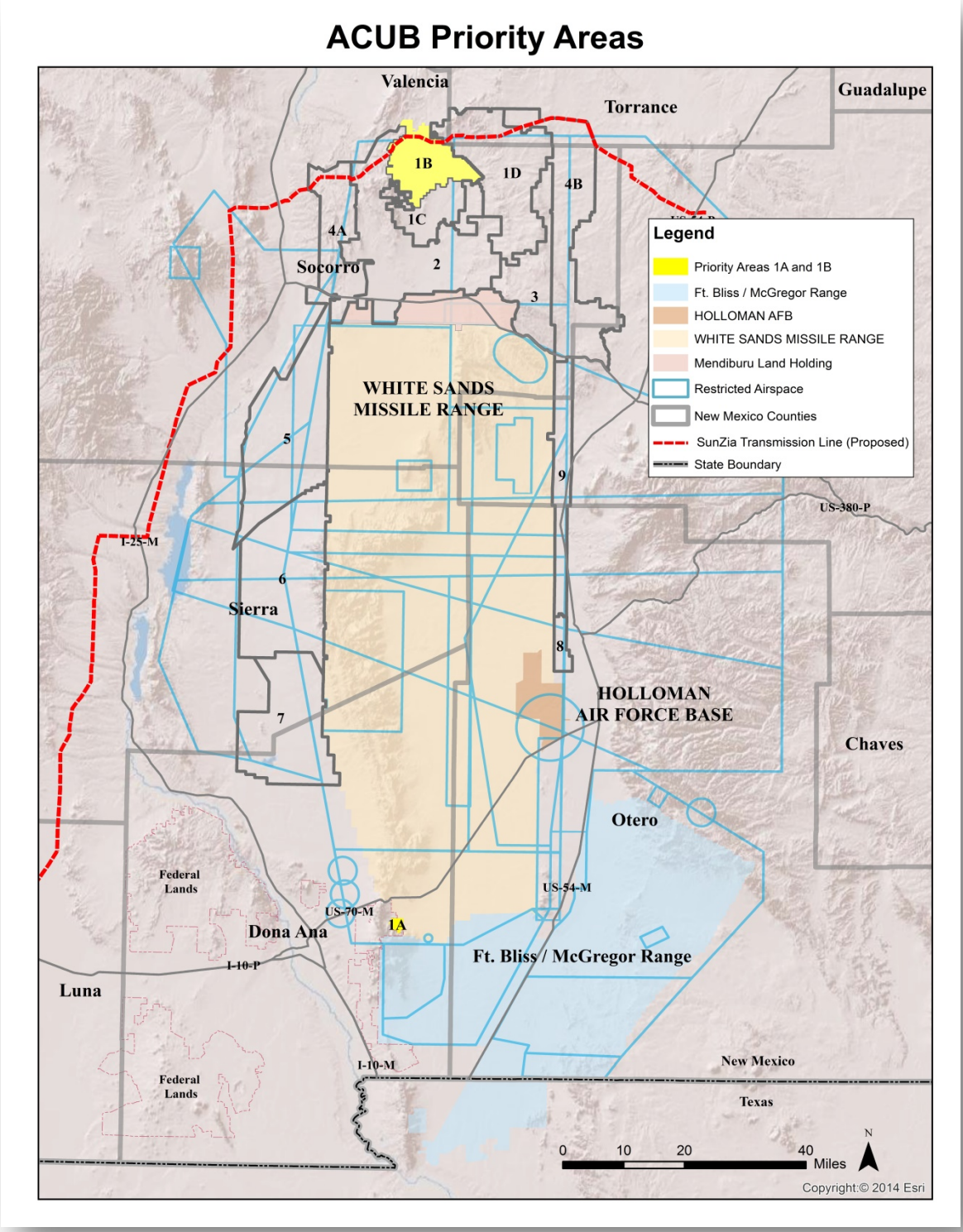


Figure 4: ACUB Priority Areas

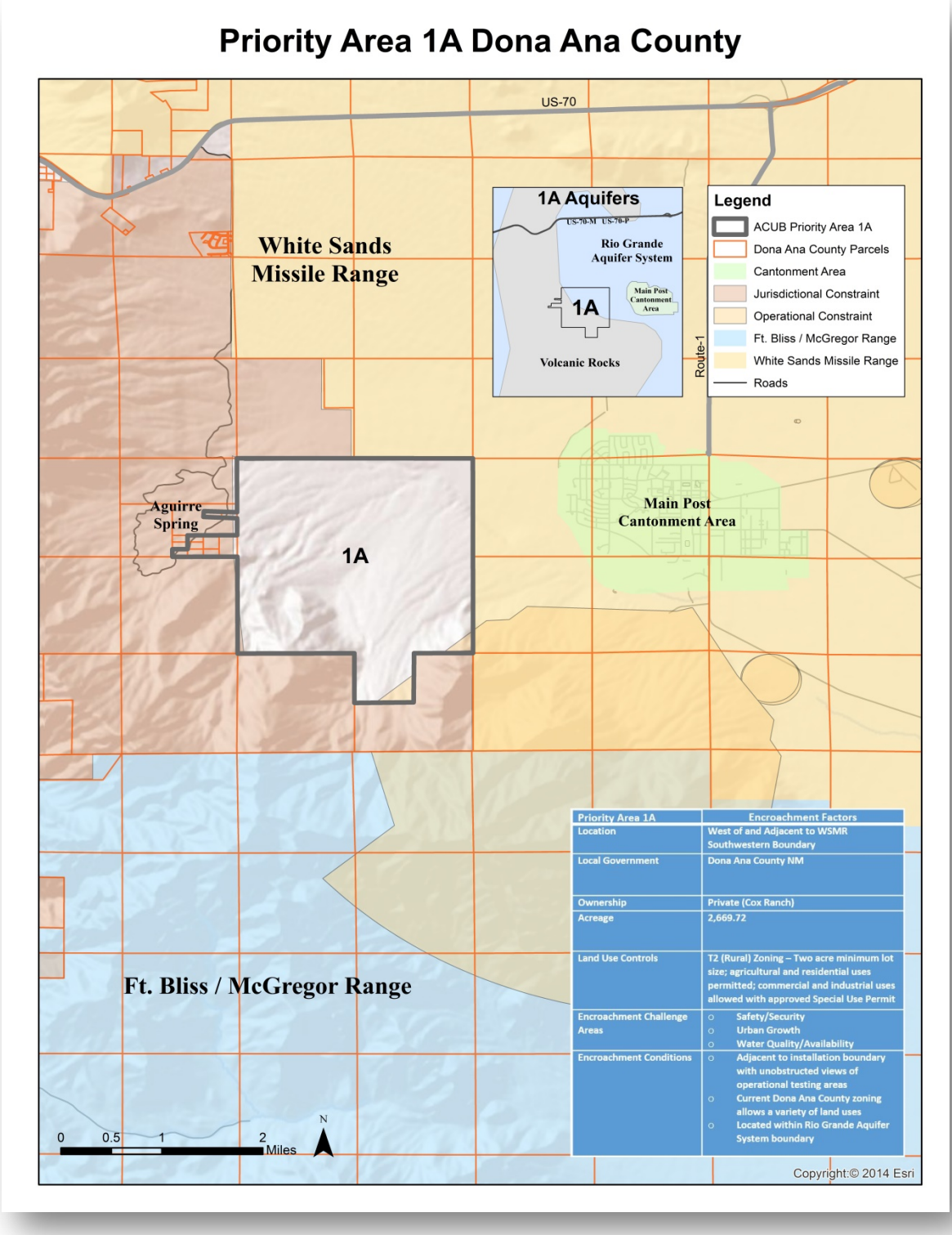


Figure 5: Priority Area 1A

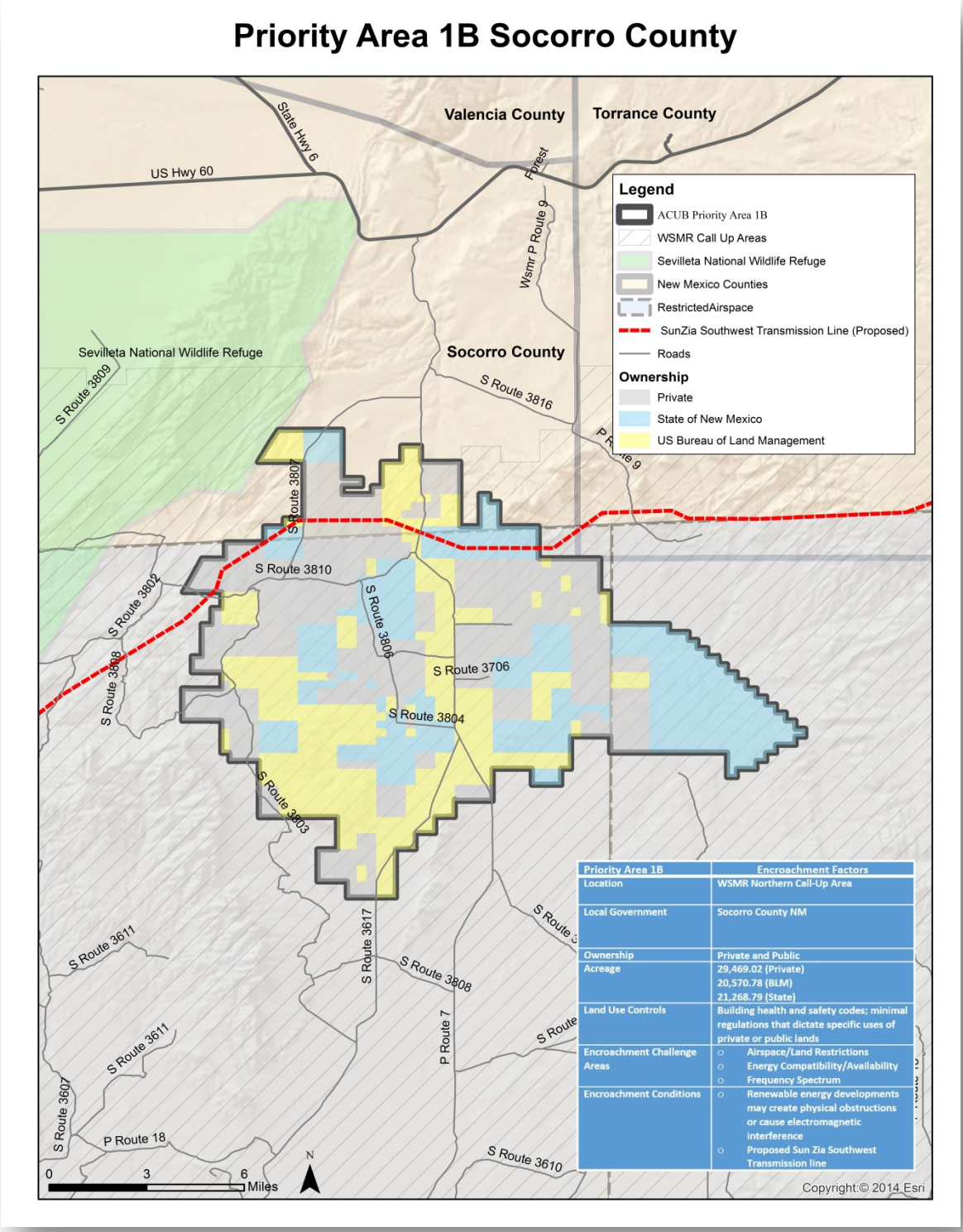


Figure 6: Priority Area 1B

IDEALS, inc Proposal

Once the final contract deliverables were provided to WSMR, IDEALS, inc continued to work on the CLEAR tool through:

- Initial and continual priority area land/ownership data collection and monitoring are required,
- Visual representations of data are the best way to identify current land status as it relates to ACUB success metrics,
- Continued data collection should be initiated to support ACUB approaches outlined for each priority area,
- Continued mapping and visual representation of priority areas data should be continued to support ACUB approaches outlined for each priority area,
- Because no active link to ownership data exists, monitoring of data should be continued to maintain an accurate and dynamic model,
- Develop a schedule for data collection/visualization, and
- Develop a schedule for data monitoring.

The continued work performed by IDEALS, inc led to the creation of a fee estimate to perform services in support of WSMR's ACUB program which was submitted to G-5 Strategic Planning/Command group at WSMR.

Once I had completed the final project deliverable and submitted it to WSMR, my work transitioned to the data conversion and Civil Engineering/Construction Tool component of my residency with IDEALS, inc. This work took place at the IDEALS office, as I needed access to CAD files specific to current engineering projects taking place and work with engineering staff to assist in the creation of the tool.

AutoCAD to GIS Data Conversion

Background and Overview

Geographic analysis and engineering design are highly valued capabilities that engineering/construction firms utilize. These different technologies provide answers that other platforms just can't answer. Most engineering firms recognize the increasing demand for CAD and GIS software that are easily integrated into the firm's projects. The data integration process helps staff exchange information and collaborate more effectively throughout the lifecycle of a project.

Engineering staff are constantly analyzing, mapping, and designing infrastructure that usually consists of roads and utilities, and also land use and land ownership. In today's modern firms, a collaborative need exists between engineering, GIS, and surveying departments, so that the sharing of design and geographic data flows without interruption.

Engineers and architects rely on the capabilities of computer-aided design/drafting (CAD), which emphasizes highly precise two-dimensional graphics and sketches.[3] Geographic Information Systems (GIS) emphasize mapping, data management, and spatial geoprocessing. CAD uses highly precise mathematical models that generate forms, including circles, arcs, and

[3] Akin, O. (2009). CAD/GIS integration: rationale and challenges. In *CAD and GIS integration* (pp. 63-84). Auerbach Publications.

parallel lines.[4] GIS was initially developed around arc-node topology, which is used to represent linear features and polygons and was used for analyzing spatial data.

Both systems benefit an engineering firm by allowing staff to make qualified decisions for engineering tasks and design. CAD data can be enhanced with spatial information and attributes when converted to GIS datasets, providing staff with georeferenced drawings and all pertinent data.

The two sets of tools, CAD and GIS, have been developed independently of one another over many years, leading to data integration issues. One of the issues facing GIS/CAD users is the loss of annotations and symbology that are not supported in most GIS products. CAD representations rely heavily on annotations to make sense of the blueprint. Data interoperability is one potential solution to overcome the data integration issue and presents a unique challenge for users of both software platforms. One-way ArcGIS overcomes the issue of data interoperability is through the use of AutoCAD plug-in, which allows AutoCAD users to integrate GIS directly into their CAD environment. With increasing data interoperability, a need arose to better facilitate standards, making the transition work more smoothly between the two programs. Existing format tools allow auto-conversion and allow the user to preserve the needed data while removing unneeded data. This allows objects from one platform to be more easily utilized in another program, negating the need for manual editing.[5]

[4] Chau, K. W. (2007). An ontology-based knowledge management system for flow and water quality modeling. *Advances in Engineering Software*, *38*(3), 172-181

[5] Karimi, Hassan A., and Burcu Akinci, eds. 2010. *CAD and GIS Integration*. Boca Raton: CRC Press, pg. 205.

Details of CAD

CAD (Computer-Aided Design/Drafting) utilizes computers for the creation and editing of drawings, used primarily by civil engineers and surveyors. Before the creation of CAD, most drawings were created using paper and ink, which is incredibly expensive, time-consuming, and very cumbersome to edit. Then in the early '80s, Autodesk introduced AutoCAD software, which was accessible on a PC platform. Many of the first CAD applications centered around the manufacturing, architectural, and mapping disciplines.[6]

Initial CAD drawings were organized in layers and were file-based, which in turn were organized by attributes such as color, line type, and feature types. This was initially an easy way to organize the data but required a high level of quality control to maintain data consistency. CAD was initially developed to represent real-world objects, usually consisting of buildings, roads, and other structures. These geometric objects were represented with a high degree of precision, where tolerances of a fraction of a centimeter are important.[7]

Details of GIS

Geographic Information Systems (GIS) are systems developed for the storage, retrieval, manipulation, analysis, and display of geographically referenced data.[8] GIS software didn't take off till the mid 80's when GIS went commercial with the introduction of ARC/INFO produced by

[6] Amirebrahimi, S., Rajabifard, A., Mendis, P., & Ngo, T. (2015). A data model for integrating GIS and BIM for assessment and 3D visualization of flood damage to buildings. *Locate*, *15*(2015), 10-12.

[7] Solutions, A. I. CAD and GIS-Critical Tools, Critical Links.

[8]Solutions, Autodesk Infrastructure. "CAD and GIS-Critical Tools, Critical Links."

ESRI, which allowed the user to perform spatial analysis and planning to make informed decisions. Initial GIS tools were targeted at general cartography and land use analysis, rather than a precision design like CAD. GIS data can be used to represent road projects but lack the precision that many engineers demand in their projects.

With GIS shapefiles being built on points, lines, and polygons, they have difficulty storing other more precise geometric objects that would traditionally be used in a CAD platform.

Data Conversion Selection

Data that were converted in this residency project consisted primarily of military installation data and data used by the United States International Boundary and Water Commission (USIBWC) to assist the engineering department in the creation of maps and figures. This data conversion exercise arose because the engineering department required CAD data to be presented in a more digestible format for clients and stakeholders.

The first task for the conversion of CAD data to GIS data was figuring out what data needed to be converted. This was done through several meetings with the engineering staff to prioritize data conversion. Staff determined that the greatest value would be in converting installation infrastructure data from Cannon Air Force Base (CAFB), Holloman Air Force Base (HAFB), and Kirtland Air Force Base (KAFB), which would be used in future works and representations.

USIBWC data that were transformed were examined as part of a riparian restoration project at multiple sites located in the Lower Rio Grande Valley that the firm was contracted to

perform. Data that were converted consisted of site locations, current salt cedar stands, planting locations, wells, and contour elevations.

Data Conversion

All CAD data that were converted needed to follow a common workflow for easy integration into a GIS environment. I used the following task sequence provided by ESRI Online, to convert CAD data into ArcGIS: define a spatial reference, add data to map, georeference the dataset, and set up the display properties.

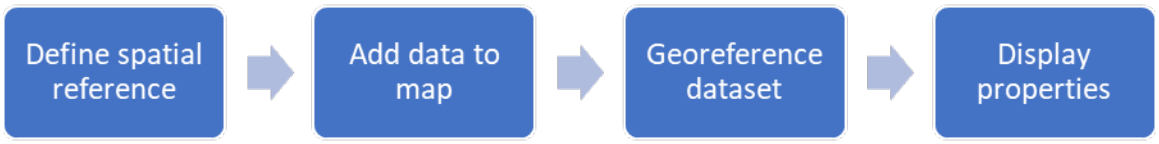


Figure 7: ESRI CAD Data Conversion Workflow (Source: ESRI Online)

Processing Steps

Spatial Referencing

Defining a spatial reference for CAD data being imported into ArcGIS is a paramount step in allowing the user to measure distances and areas. You can drag CAD data into a map without being spatially referenced, but the data will not project correctly, and the user will not be able to make measurements with the data (ESRI, 2020).[9] Geoprocessing tools that require linear units to perform calculations, will automatically default to meters if the dataset has not been spatially referenced. When choosing a spatial reference, you must decide what kind of

[9] https://developers.arcgis.com/documentation/core-concepts/spatial-references/

distortion you want to minimize, such as shape and area. These issues arise when you are projecting a three-dimensional surface on a two-dimensional plane.

Georeferenced Dataset

Georeferencing the dataset is an ESRI function, best done using the ESRI Georeferencing toolbar, located within ArcGIS Desktop 10.6. This toolbar allows you to rubbersheet the dataset into its correct space. You can also choose to use control points to specific geographic coordinates to help align your dataset. Georeferencing is the process of adjusting a CAD drawing spatially, without having to change the original data source. Using control points in the CAD drawing that will be registered to known geographic coordinates allows the user to reference the CAD dataset.

Display Properties

Since CAD features can be difficult to represent clearly in ArcGIS due to the aggregation of geometry contained in the original CAD dataset, users need to filter out unneeded data. I performed additional filtering with a definition query, within the Definition Query textbox, as seen in Figure 8 below, to narrow the number of features on the selected drawing layer, of a particular color or line type, or containing other properties. Using the definition query allowed me to then display the selected data for use in my map projects. This process also creates a level of consistency across users of the represented data, for use in other CAD or ArcGIS projects.

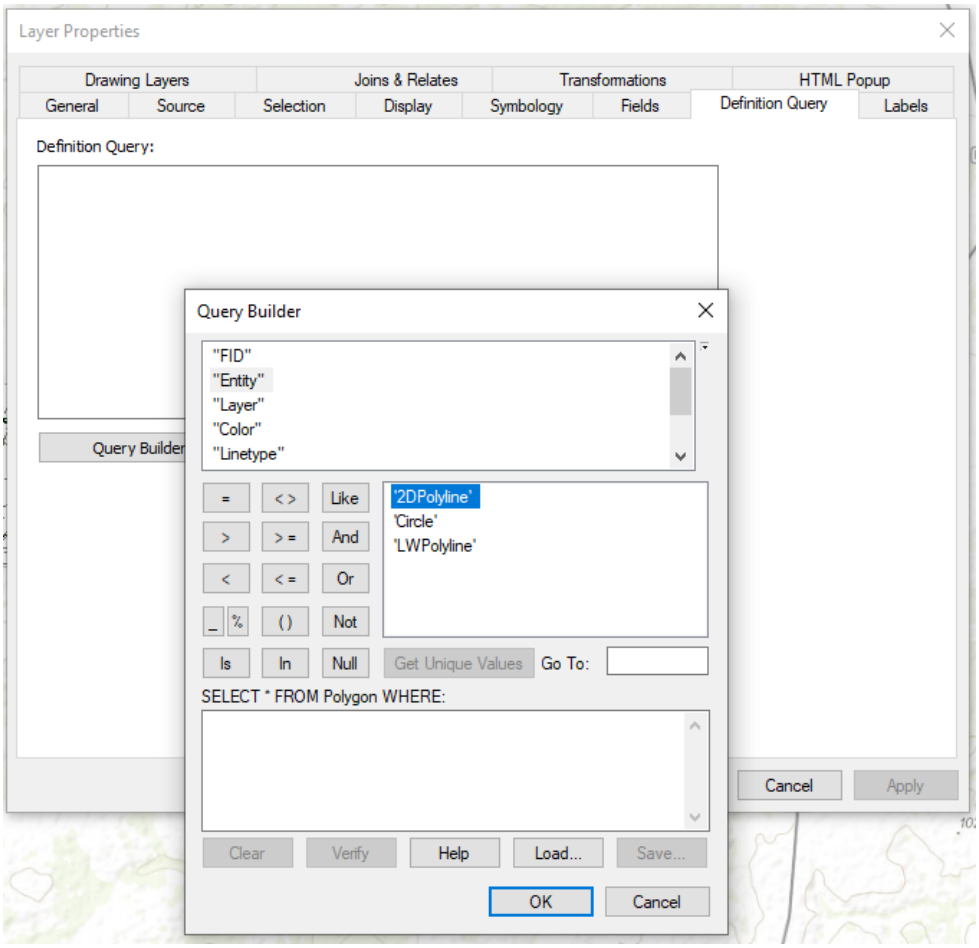


Figure 8: Definition query performed

ACAD Datasets Connection

In ArcGIS, you can connect to CAD files through the ArcCatalog toolset, and the drawing will be instantly translated and organized in ArcGIS. The GIS features that are represented in ArcCatalog contain the geometry and annotation, along with metadata, where the data structures are now similar to GIS data structures. As you can see below in Figure 9, the CAD data have already been converted into a usable format in ArcGIS and are ready for insertion into maps or figures. The data may not line up with your existing drawing, and this is where you will need to spatially reference the CAD dataset.

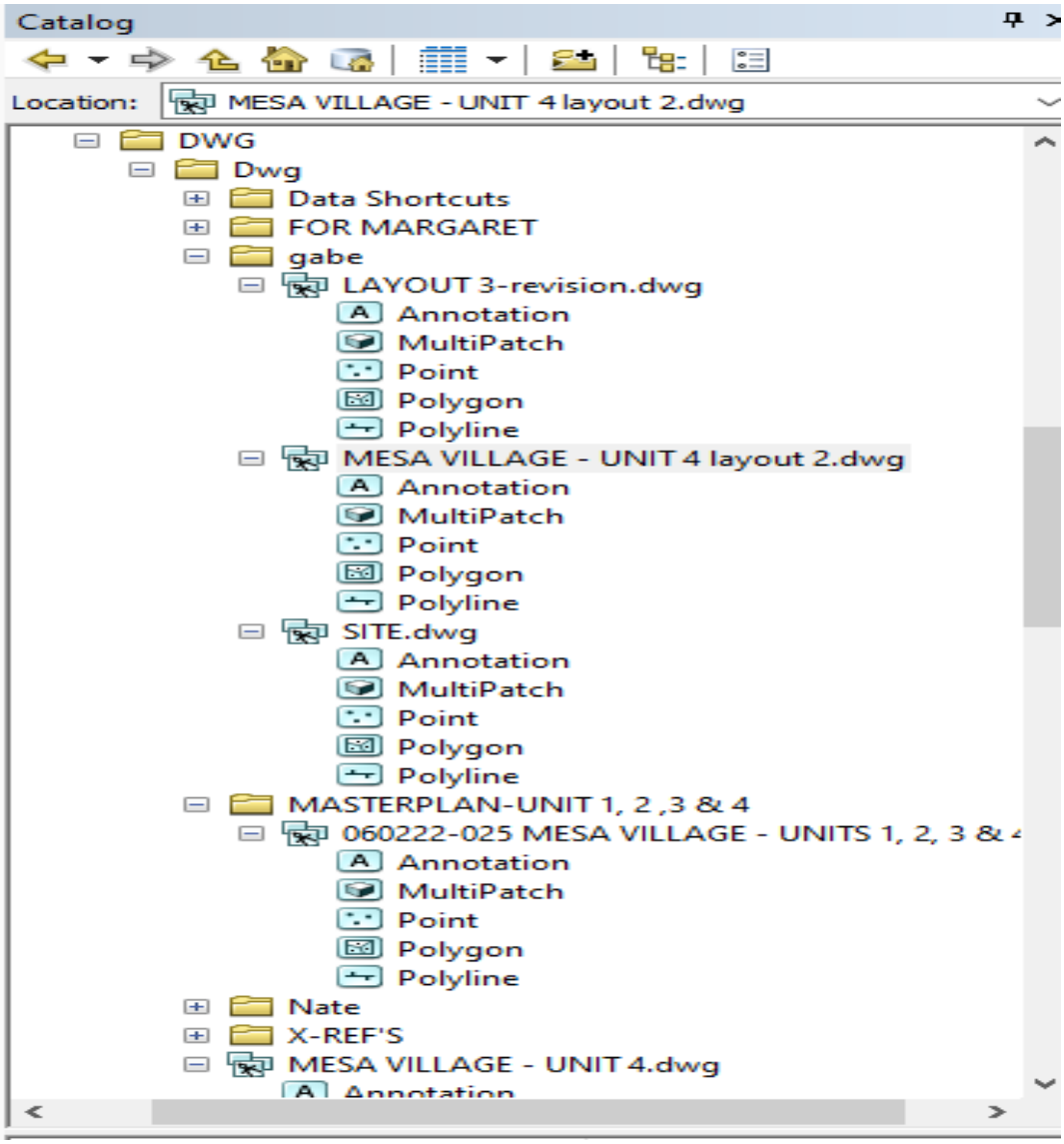
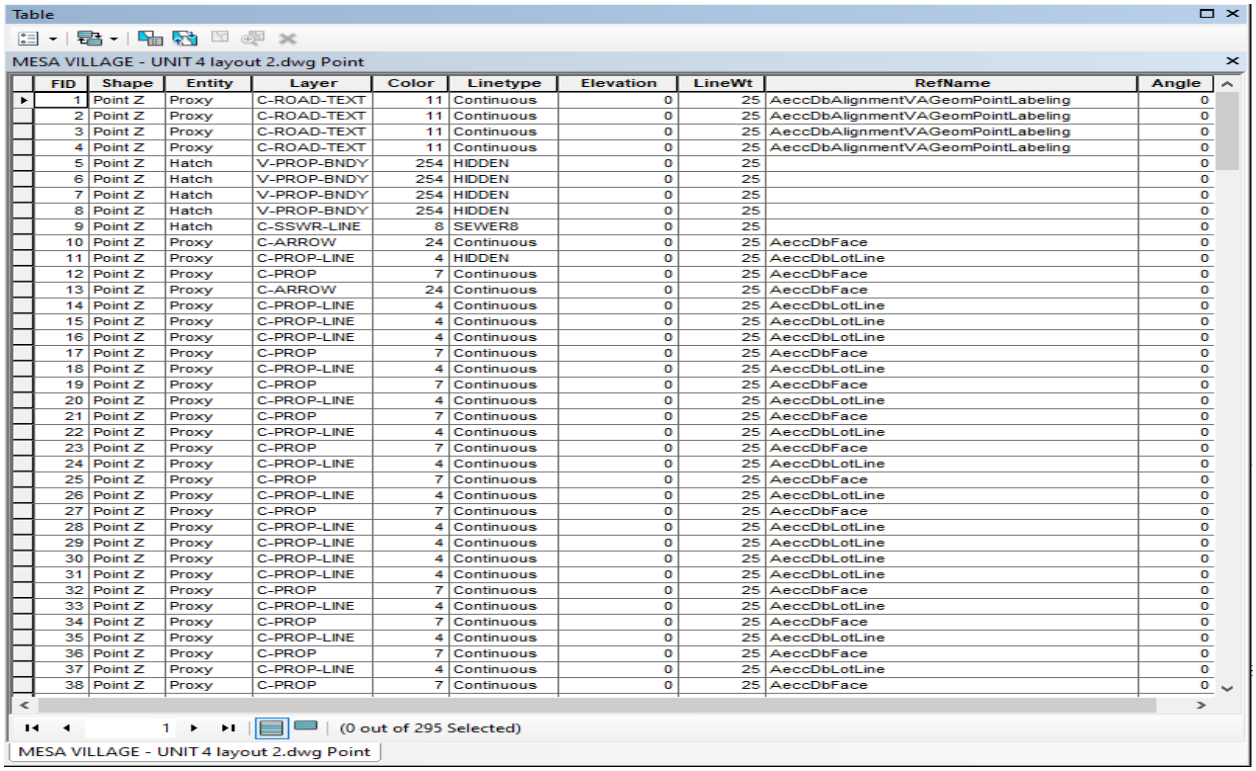


Figure 9: Arc Catalogue ACAD data structure

Adding CAD data

Adding CAD data to a map document was a straightforward process as I was able to drag data from the catalog window and place it into the map. When the data are imported in ArcGIS, a virtual attribute table is created as seen below in Figure 10. This is a read-only table as the data properties cannot be manipulated. I then exported the data as a shapefile or feature class, which makes it more usable in a GIS setting.



FID	Shape	Entity	Layer	Color	Linetype	Elevation	LineWt	RefName	Angle
1	Point Z	Proxy	C-ROAD-TEXT	11	Continuous	0	25	AeccDbAlignmentVAGeomPointLabeling	0
2	Point Z	Proxy	C-ROAD-TEXT	11	Continuous	0	25	AeccDbAlignmentVAGeomPointLabeling	0
3	Point Z	Proxy	C-ROAD-TEXT	11	Continuous	0	25	AeccDbAlignmentVAGeomPointLabeling	0
4	Point Z	Proxy	C-ROAD-TEXT	11	Continuous	0	25	AeccDbAlignmentVAGeomPointLabeling	0
5	Point Z	Hatch	V-PROP-BNDY	254	HIDDEN	0	25		0
6	Point Z	Hatch	V-PROP-BNDY	254	HIDDEN	0	25		0
7	Point Z	Hatch	V-PROP-BNDY	254	HIDDEN	0	25		0
8	Point Z	Hatch	V-PROP-BNDY	254	HIDDEN	0	25		0
9	Point Z	Hatch	C-SSWR-LINE	8	SEWER8	0	25		0
10	Point Z	Proxy	C-ARROW	24	Continuous	0	25	AeccDbFace	0
11	Point Z	Proxy	C-PROP-LINE	4	HIDDEN	0	25	AeccDbLotLine	0
12	Point Z	Proxy	C-PROP	7	Continuous	0	25	AeccDbFace	0
13	Point Z	Proxy	C-ARROW	24	Continuous	0	25	AeccDbFace	0
14	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
15	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
16	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
17	Point Z	Proxy	C-PROP	7	Continuous	0	25	AeccDbFace	0
18	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
19	Point Z	Proxy	C-PROP	7	Continuous	0	25	AeccDbFace	0
20	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
21	Point Z	Proxy	C-PROP	7	Continuous	0	25	AeccDbFace	0
22	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
23	Point Z	Proxy	C-PROP	7	Continuous	0	25	AeccDbFace	0
24	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
25	Point Z	Proxy	C-PROP	7	Continuous	0	25	AeccDbFace	0
26	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
27	Point Z	Proxy	C-PROP	7	Continuous	0	25	AeccDbFace	0
28	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
29	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
30	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
31	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
32	Point Z	Proxy	C-PROP	7	Continuous	0	25	AeccDbFace	0
33	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
34	Point Z	Proxy	C-PROP	7	Continuous	0	25	AeccDbFace	0
35	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
36	Point Z	Proxy	C-PROP	7	Continuous	0	25	AeccDbFace	0
37	Point Z	Proxy	C-PROP-LINE	4	Continuous	0	25	AeccDbLotLine	0
38	Point Z	Proxy	C-PROP	7	Continuous	0	25	AeccDbFace	0

Figure 10: Read-only table

Georeferencing

As noted previously, georeferencing is the process of manually adjusting the CAD dataset, without changing the source data. I did this by registering arbitrary points in the CAD drawing to known points in your GIS drawing. Once the data have been georeferenced, ArcMap automatically transforms the dataset while maintaining the source data.

As you can see below in Figure 11, I used the Georeferencing toolbar, which I normally have pinned to my taskbar. The toolbar contains all the tools necessary to “place” the CAD dataset to its desired location within the map session. These interactive tools include a nudge, rotate, and a scale function which allows the user to spatially adjust the drawing to the location it represents in real-time.

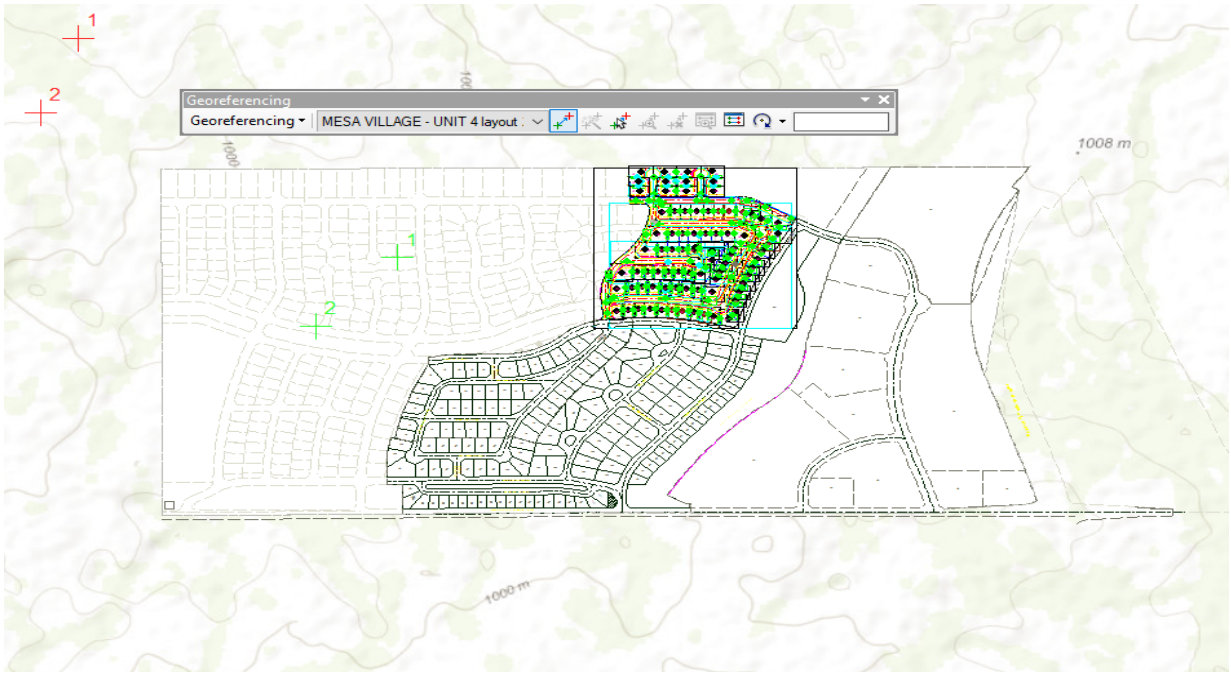


Figure 11: Georeferencing ACAD dataset

Exporting Data

Once I cleaned up the CAD dataset by running a definition query to extract the pertinent data, I exported the data as a shapefile or feature class. This allows the user greater flexibility in displaying and manipulating the data while making it easier to store in a file or personal geodatabase. An added benefit to exporting the data as shapefiles is the creation of one layer containing all converted data as seen in Figure 12.

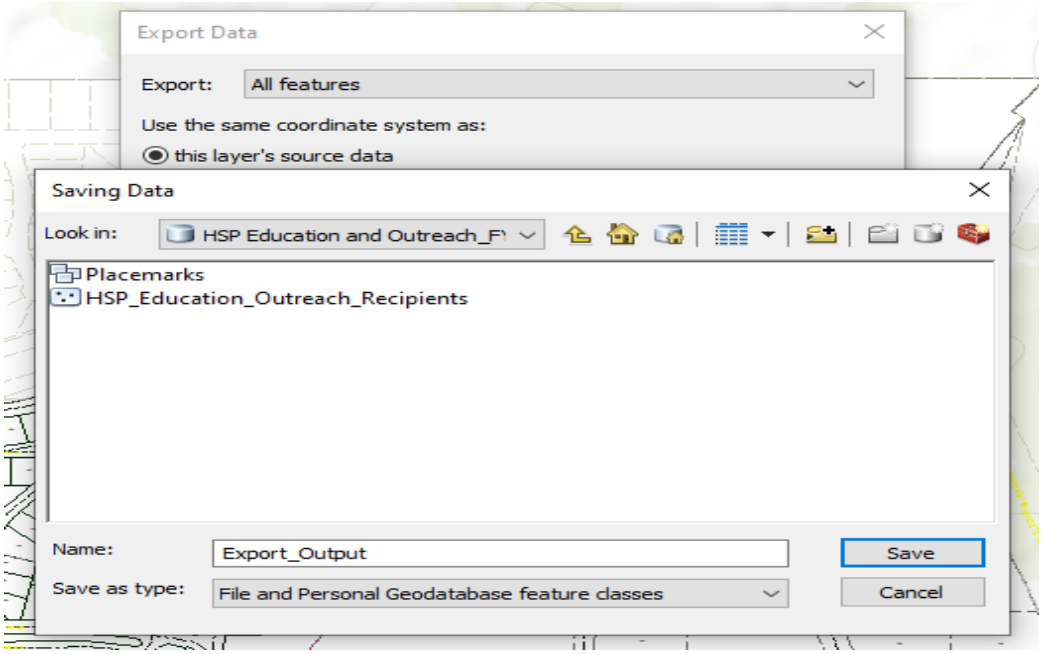


Figure 12: Data Exportation

Lessons Learned in Data Conversions

Collaboration is one of the most important aspects in data creation and conversions. All staff needs to recognize the need for early and consistent collaboration. Collaboration between me and the engineering staff allowed both sides to express what their needs and expectations would be, increasing the improved functionality of future data products.

When I met with engineering staff on ACAD/GIS data interoperability, we understood that it was best to create a long-term understanding of expectations for both sides of the data issue. One of the reasons for this long-term understanding was to make sure that we were able to address the firm's future data needs and representations.

Initially, I was met with some trepidation by engineering staff; they quickly understood that collaboration between ACAD and GIS staff would yield better results and make workflows for both sides easier.

Civil Engineering/Construction Tool

The creation of a CE/CON tool would consist primarily of a research project that would be used to assess and track the IDEALS engineering team's needs, for improved efficiency and monitoring, from initial inception to project close-out. This component of the project never gained much traction within IDEALS, as time and interest were limited. The identification of what would be needed to implement such a tool was done through a basic literature review. After reviewing several articles on the topic, I found that the following components would be used to assess and track the firm's needs:

- Tracking components using GPS data that would be exported to .kml files for easy representation and review by IDEALS Project Manager, which then would be compared with timesheets to track employee's worksite progress,
- Working version of the projects to visualize within a 3D model contained in ArcSCENE to monitor building and jobsite progress,
- Inventory protocol that would be implemented for tracking equipment and materials,
- All high dollar inventory would be placed into both Excel and PDF formats for tracking and inventory purposes, and
- Sign-in and sign-out for all equipment, which was stored in a locked room with minimal access.

The expectation of using a GIS platform was to develop a spatial representation of all aspects of construction progress graphically and then synchronizing it with the construction schedule. All spatial aspects would be depicted by a 3D model that would be initially developed within an AutoCAD platform and the construction schedule would be generated as a Gantt charted in Microsoft Excel. Scheduling and spatial information would be linked together in a GIS environment, for greater understanding and monitoring by project managers.

Inventory Management

One area that I identified that would increase efficiency and monitoring was through the implementation of an inventory control protocol. This was done on all high dollar items, as shown in the following figure. The inventory that was compiled was then barcoded to monitor the check-out and check-out phase. The generated Excel spreadsheet would be used for tracking and monitoring purposes by IDEALS staff for specific jobs. Out of the inventory arose the creation of a sign-in/sign-out document and limited access to equipment, which would reduce equipment loss, increasing profits. I expected to take the tabular inventory (as seen in Figure 13) data and integrate it into a GIS platform that would assist in creating a complete picture of all job site activities.

Inventory ID	Name	Description	Unit Price	Model Number	Serial Number	Accessories	Photo
0001	Trimble GPS Unit	Trimble GPS Unit in Yellow w/batteries and 2 cables	N/A	TSCe 45185-20	00043893	Power Cord, Ethernet Cable, HDMI, Batteries	1
0002	Trimble GPS Receiver Unit	Trimble GPS Unit Yellow and Black with White Receiver	N/A	5800	53618-46	Coaxial Cable, Power Unit, Receiver, Control Unit, and Battery Packs	2
0003	Trimble 5700	Trimble GPS Model 5700 with Receiver	N/A	5700 P/N: 40405-00	0220315816	Coaxial Cable, Glass Eye, Balancer, Control Unit, Receiver Disk	3
0004	Trimble Radio Receiver	Trimble Trimmark 3 46000-46 GPS Radio Receiver	N/A	P/N: 46000-46	4325123419	Battery Connections (for car Batteries -2), power cables, coaxial cable	4
0005	TopCon Total Station	Topcon GTS-233W Total Station 3" Sec Gun Dual Display GTS	N/A	GTS-233W	260478	Battery Pack and Plumb bob	5
0006	Rotary Hammer	Bosch GBH2-28L 1-1/8" SDS-plus Bulldog Xtreme Max Rotary Hammer	N/A	GBH2-28L	3611B68510	Core Bit and Chipping Bit	6
0007	Makita Sawzall	Makita JR3050T 11 Amp Reciprocating Saw	N/A	JR3050T	962367	1 –5 pack of thin Milwaukee 6" blades, 1 –6" Makita wood blade, 1 –6" Metal blade	7
0008	Milwaukee Angle Grinder	11 Amp Corded 4-1/2 in. Small Angle Grinder with Lock-On Paddle Switch	N/A	6142-30	H40BD1727 01057	8—4.5" Diablo Metal Cutoff 0.04" thick wheels, 1—Zirconium Flab Disc—60 Grit, 1—Safety guard, 1—rubber handle, 1—wrench tool	8
0009	Worx Circular Handsaw	4-1/2" WORXSAW COMPACT CIRCULAR SAW	N/A	WX429L	201432019607	QTY 2—4.5" Carbide HP circular Blades	9
0010	Lufkin Measuring Wheel	12" Professional SAE Measuring Wheel	N/A	PSMW48N	N/A		10
0011	DeWalt Impact Drill	20V MAX* LITHIUM ION 1/4" IMPACT DRIVER	N/A	DCF885	Scratched Out	Qty 2—Battery Pack, Charging Module	11
0012	Bosch Blue Tripod	Bosch Aluminum Contractor Tripod BT 152	N/A	BT 152	412 (?) 0		12

Figure 13: IDEALS inventory monitoring

Vehicle GPS Tracking

Vehicle tracking was another area that was identified where IDEALS could increase job project monitoring. Vehicle GPS tracking units were installed on all work trucks to track the movements of on-site workers. The data that was imported into ArcMap was then outputted as .kml files for use in Google Earth by project managers. The output of the tracking units was then compared to employee timesheets to make sure their timesheets matched their actual on-site movements. Any discrepancies would be brought to the attention of the project manager for later corrective action.

Closing Comments

CLEAR

The development of the CLEAR tool was initially created to act as a legacy resource that would support the sustainment of DoD research and development, testing, and training missions through encroachment management. We proposed that this would be done by supporting existing DoD encroachment management programs, such as the ACUB and Air Force Encroachment Management, in a low cost, easily maintained resource for DoD installations. The work performed at WSMR would support continued testing and training activities that are currently conducted by the U.S. Army, Air Force, and Navy as well as other governmental and non-governmental agencies. WSMR is currently faced with the task of monitoring and addressing encroachment factors that have the potential to create additional constraints affecting mission sustainability. With testing operations at WSMR expected to expand in the future as discussed in WSMR's 2046 Strategic Plan, it is paramount that current and future missions be supported by mitigation of existing encroachment conditions and preventing emerging encroachment conditions.

The CLEAR resource was expected to be integrated into planning, management, and mitigation strategies to inform mission sustainability and guide future encroachment discussions with local defense communities. It would be used as a visual representation of current land status as it relates to ACUB success metrics being continually updated with new data, as there is currently no active link to land ownership status. My expectation through the technology transfer component of the MPP was to submit a proposal to WSMR, for continued

land/ownership data acquisition and monitoring contained in a geodatabase. This unfortunately did not come to fruition as new staff at WSMR decided to go another way with their encroachment mitigation strategies.

CLEAR Future

A resource that would benefit the CLEAR tool in the future would be the creation and inclusion of a Sonics Constraint Layer. With training and testing missions originating out of HAFB involving supersonic military aircraft has become a source of noise pollution for the communities near supersonic flight corridors, and the Air Force being required to deal with damage claims, it would be prudent to model and then represent the data within the CLEAR tool. The creation of a Sonics Constraint Layer would allow installation staff the ability to predict future impacts, and how to mitigate against them, saving money and manpower.

Additionally, the inclusion of soils data into the CLEAR resource would allow installation decision-makers the ability to mitigate against the effects of fugitive dust created by training and testing missions. With increasing drought frequency leading to higher temperature and increased dust, there is an even greater need to mitigate against fugitive dust. Increased dust will affect an installation's ability to perform off-road vehicle maneuvers, affecting an installation's ability to perform future training and testing missions.

The soils data would also be pertinent for areas adjacent to an installation. With increased construction development disturbing soils leading to an increase in fugitive dust that affects sensitive measuring devices utilized by the DoD’s training and testing missions.

The inclusion of soils data and the creation of a Sonic Constraints Layer would be of great benefit to the continued development of the CLEAR resource, providing installation decision-makers a valuable visual representation of current encroachment conditions.

AutoCad to GIS Data Conversion

The most valuable output of the data conversion component of my residency was performed on USIBWC data created by IDEALS engineering staff, using AutoCAD, for use by field staff. These data were converted into GIS shapefiles for submission in progress reports, that were submitted to USIBWC project managers. The data were also exported in the form of a geodatabase for use by USIBWC staff to monitor on-site progress for riparian restoration work being done by IDEALS.

The data conversion was a straightforward process, as the data interoperability extension makes quick work of converting CAD data in ArcGIS. This was not always the case if the CAD data creator did not spatially reference their work, as the data would show up not where expected. If this happened, I would need to spatially reference the data myself or possibly rubbersheet it, if it would not project in the correct location on the earth's surface.

This was a useful exercise not just in the data conversion, but it also allowed me to work more directly with the engineering staff, which created a greater level of collaboration and understanding between IDEALS employees.

Future AutoCad Conversions

If were to perform future ACAD conversions, I could see the process benefiting from the creation of a script using Python scripts to automate the conversion process. The improved

process could be done directly through the creation of a python script using the ArcPy geoprocessing framework within ArcGIS, to load CAD data directly into a geodatabase. This process would require further identification and understanding, as I am currently not proficient in this process.

Civil Engineering/Construction Tool

Unfortunately, I did not have more time at IDEALS, as I would have liked to have seen an integration of AutoCAD project data, inventory data, tracking data, and construction scheduling into a GIS platform. Such an integrated system would allow IDEALS staff to move beyond traditional approaches for progress monitoring, such as bar charts, tabular data, and Critical Path Method (CPM).

Even though this was primarily a theoretical exercise, a few tangible things did come about. This included vehicle monitoring and inventory components, which I viewed as the initial steps in creating complete project integration into a GIS platform. These components did provide invaluable at times when "issues" with staff would arise. Being able to reference the vehicle tracking data and inventory provided IDEALS staff with a more complete picture of on-site work being completed.

Civil Engineering/Construction Tool Future

The future of this tool would be where all project-specific data would be integrated into a GIS environment (ArcSCENE), for real-time schedule monitoring and construction process. I could see the benefit of increased visualization in scheduling and monitoring, as

current/traditional methods are not sufficient in painting a complete picture of project monitoring activities.

Final Thoughts

The greatest beneficiary of this project, was me, as I was able to reap the benefits of the MPP Agreement and subsequent employment at IDEALS. The technical expertise gathered through working on such a valuable product has provided me the skills needed for my current position as a Policy Analyst for the New Mexico Department of Agriculture. The icing on the cake was winning the prestigious Nunn-Perry Award our first year on this project. This is a prime example of the value this work brought to WSMR and potentially other DoD installations.