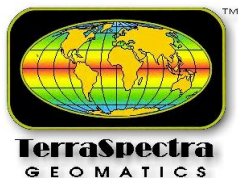


IMPROVED PROCESSING, ANALYSIS AND USE OF HISTORICAL PHOTOGRAPHY

Larry Tinney
Elaine Ezra
TerraSpectra Geomatics

Environment, Energy Security & Sustainability (E2S2) Symposium
Denver, Colorado



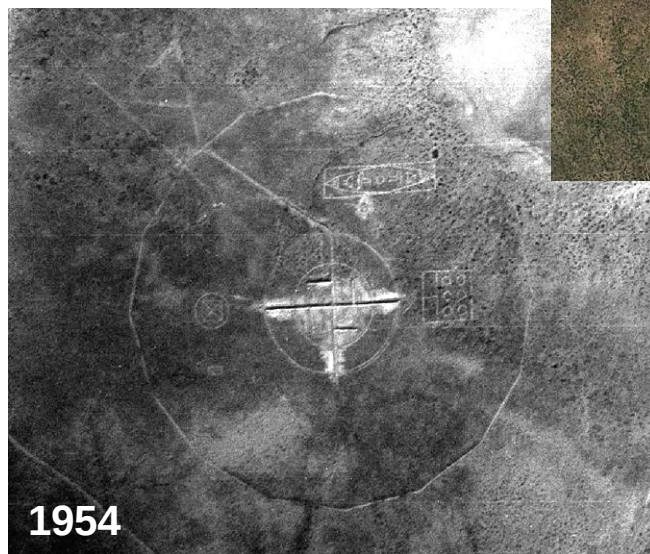
17 June 2010

Report Documentation Page				Form Approved OMB No. 0704-0188	
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Overview

- **Problem Statement**
 - ◆ Accuracy of Range/Feature Locations (FUDS MMRP)
- **Technical Objectives**
 - ◆ Comparison of 3 Methods
- **Goals and Results**
 - ◆ 8 Test Sites
 - ◆ Validation Efforts
- **Key Observations**
 - ◆ Methods
 - ◆ Scan Resolutions
 - ◆ Photo Searches
- **Summary**



**Aerial Photos of New
Mexico WWII-era
Precision Bombing Range
(PBR)**

(Unknown Site)



Historical Versus Recent

Features at some sites are distinct on historical photos
but extremely faint or not visible on recent imagery



2005 Color Orthophoto

K06NM0333 - Former Guadalupe Bombing and Gunnery Range



Historical Versus Recent

Features at some sites are distinct on historical photos
but extremely faint or not visible on recent imagery



1950 BW Photograph

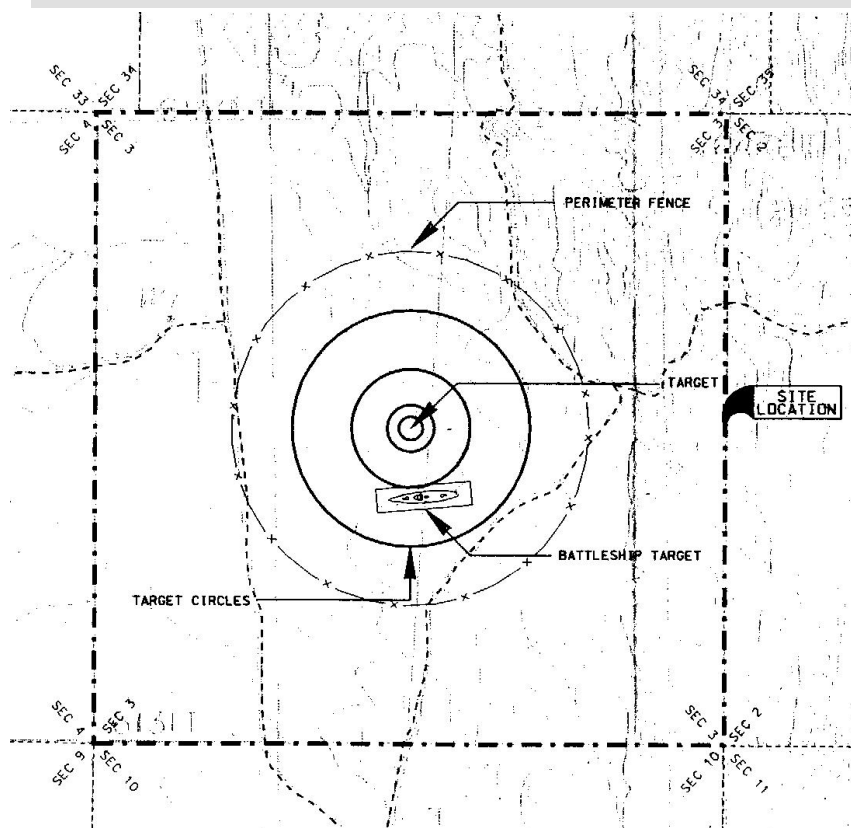
K06NM0333 - Former Guadalupe Bombing and Gunnery Range



Archive Search Reports (ASR)

NOTE: AREAS DEPICTED ARE BASED ON BEST AVAILABLE DATA

Primary Source for FUDS Property and Range Feature Data.

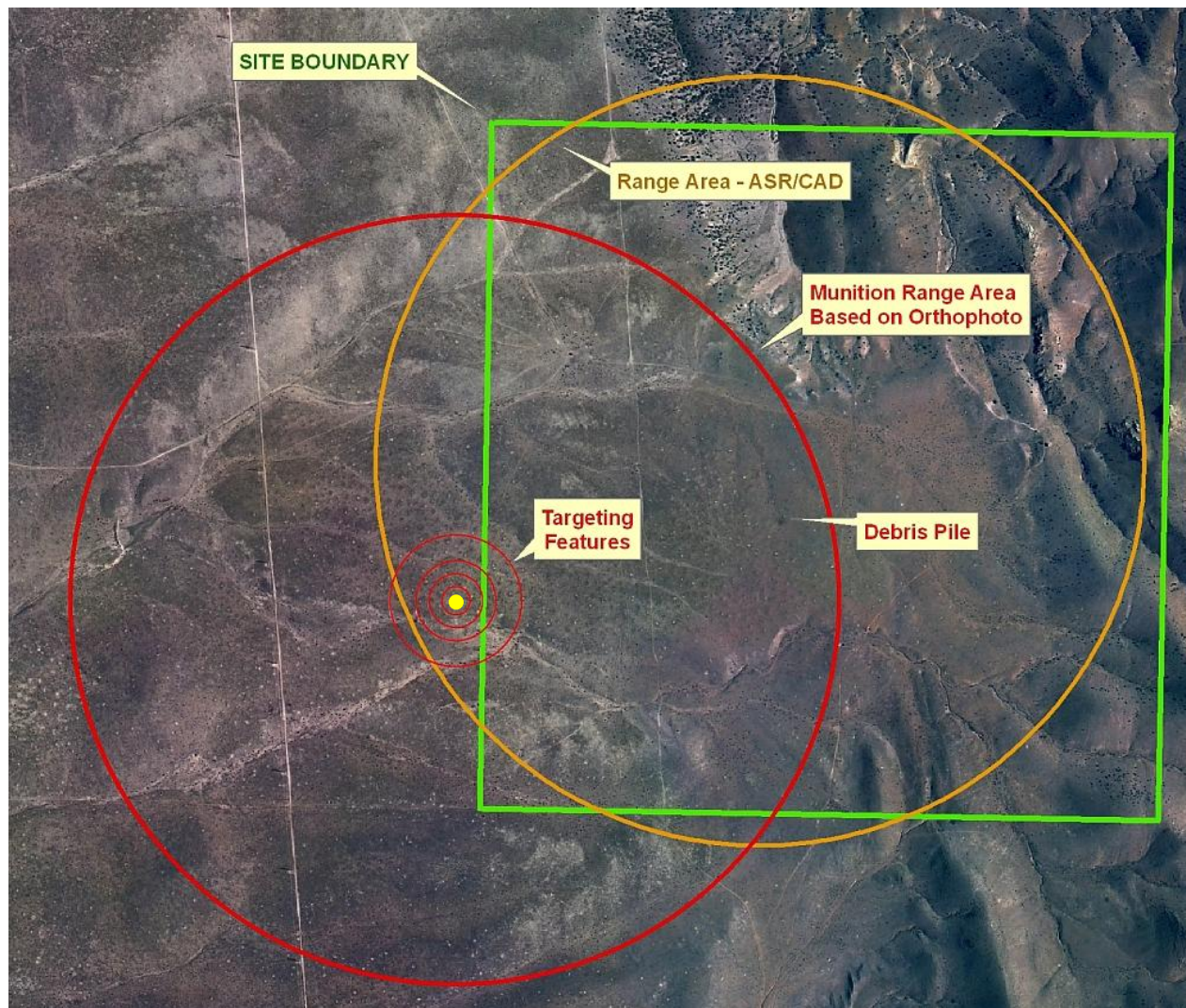


J11 Residue pile located at target center

Assumed "Target Center" based on 1952 photo prints and pocket stereoscope viewing



Refinement of Range Centroid Locations via Orthophotos



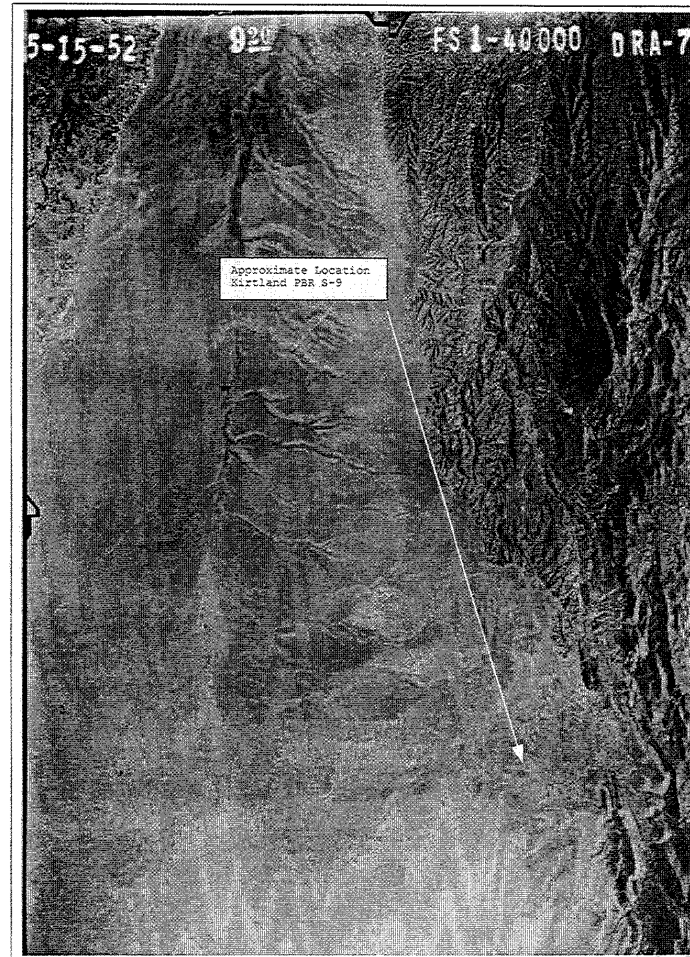
- Over 65% of NM FUDS MMRP Range centroids showed apparent offsets >25 meters
- Offsets as much as 1 mile found
- Detailed range feature mapping, however, was not always possible using 2005 orthos
- Some ranges were not apparent on recent photos
- Better standard and new practices are available

ASR Historical Photos



- Available Archive Search Report (ASR) photos of limited use due to coarse Portable Document Format (PDF) image compression.

- Analysis was conducted on print copies rather than diapositives with better resolving characteristics.



K-4



ESTCP Project Technical Objectives

- Define and demonstrate an improved set of image interpretation and geospatial analysis procedures for the more effective use of historical aerial photos
 - ◆ Emphasis upon detection and mapping of former range locations over large areas (Wide Area Assessments)
 - ◆ Secondary focus is improved site specific assessments, such as identification of target features, especially demolition bomb craters (or crater fields)



Primary Goal: Comparison of 3 Methods

1. Existing Archive Search Reports (ASR)*

Based on aerial photo prints and pocket stereoscopes



Pocket Stereoscope

2. Recent/Current Standard Best Practice

Based on diapositives (film) and stereo zoom scopes



Mirror Stereoscope



Stereo Zoom Stereoscope

3. Digital Image Processing

Based on blur removal, enhancements, and stereo viewing

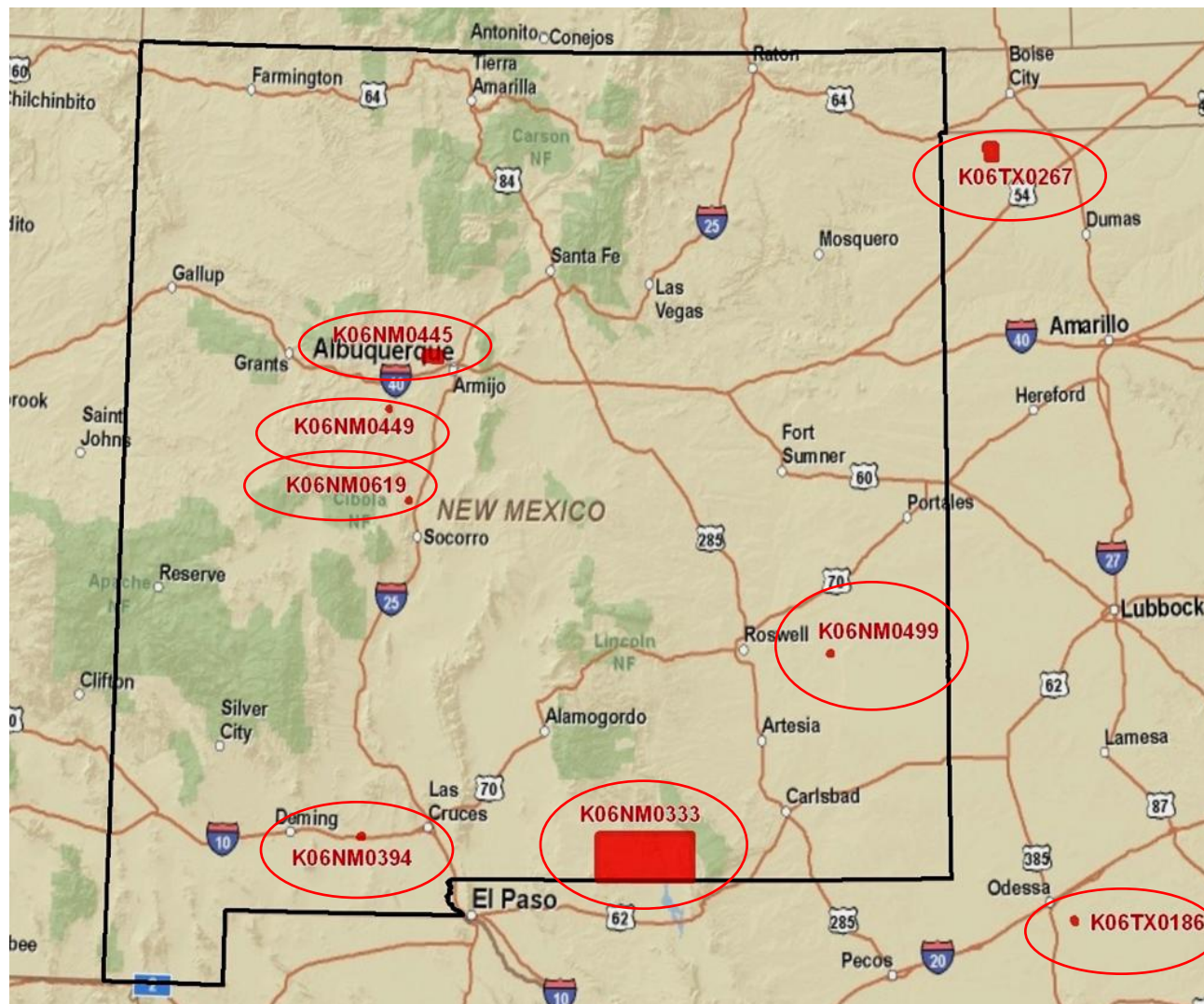


Digital 3-D

* Two Preliminary Assessments (PA) and one Site Investigation (SI) reports were used in place of ASR documents where ASR documents were not available or did not include photo analyses.



6 New Mexico and 2 Texas Sites



NEW MEXICO SITES

K06NM0333 – Guadalupe Bombing and Gunnery Range 495,053 acres

K06NM0445 – Kirtland AFB PBR N1, N3, and New Demolition 15,246 acres

K06NM0394 – Deming AFB PBR #10 960 acres

K06NM0449 – Kirtland AFB PBR #S-12 640 acres

K06NM0499 – Walker AFB Demolition Bombing Range #35 1,000 acres

K06NM0619 – Kirtland AFB PBR #18 Target S-5 640 acres

Range map not available at start of the project for blue sites

TEXAS SITES

K06TX0186 – Midland AAF Target Range #14 1,646 acres

K06TX0267 – Dalhart PBR #3 and #4 16,581 acres



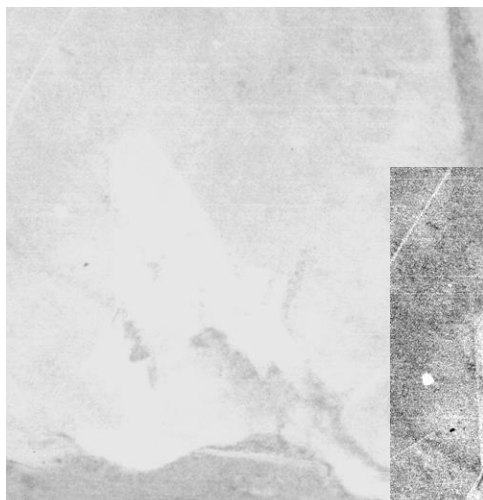
Comparison of Results

	<u>Ranges (29)</u>	<u>Features (79)</u>
• Original ASR Photo Print Interpretations ◆ Missed and/or incorrectly located several ranges ◆ Found fewer target and navigation features	72%	42%
• Photo Interpreters Using Diapositives with Zoom Stereoscopes ◆ Consistently found all but 1 ranges ◆ Usually found more target and navigation features	97%	75%
• Image Analysts Using Digital Processing ◆ Consistently found all ranges ◆ Similar or slightly better results than diapositive film analyses.	100%	84%



Examples of Enhancements

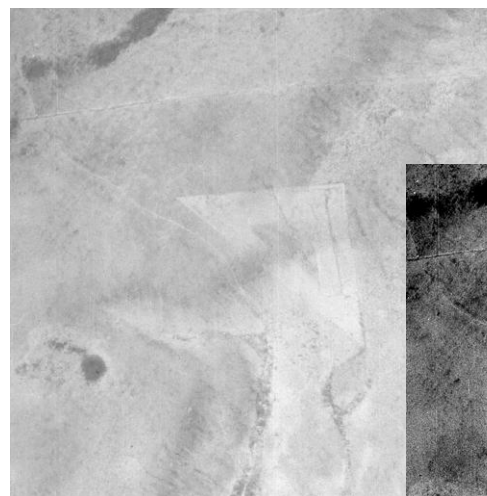
Standard image sharpening, brightness, and contrast enhancements proved effective.



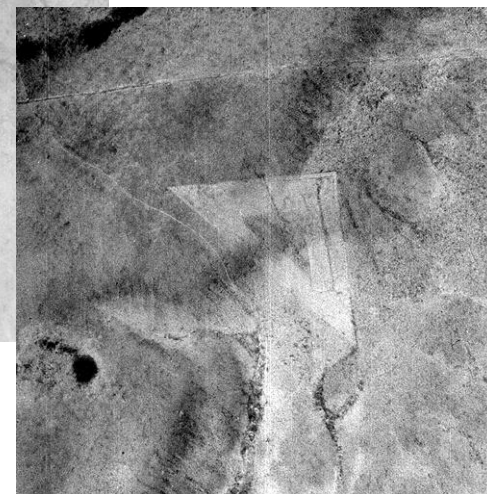
Original Photo Scan



Digitally Enhanced



Original Photo Scan



Digitally Enhanced

Features match location and appearance of ATAGR navigation features on 1944 map included in 2008 ASR Supplement.

1951 Photo – Enlarged Area Outlined

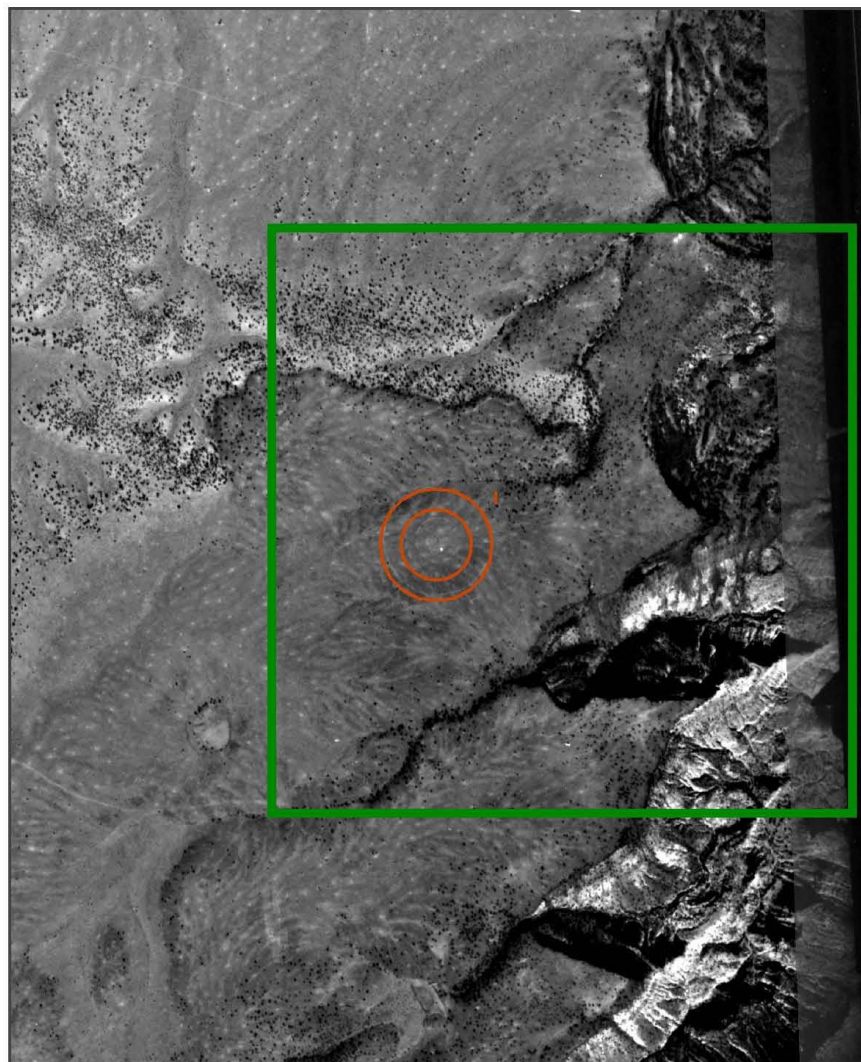


Original Photo Scale
1:28,400 (about 4 by
4 mile scene)

NOTE: Film prints
or diapositive copies
are no longer
available from
USGS-EDC

Digital scans are
now their standard
means for all photo
products

2005 ASR Mapping – 1951 Photo



KEY TO FEATURES:

FEATURE NUMBER	FEATURE DESCRIPTION
1	CONCENTRIC RING BULLS-EYE TARGET VISIBLE AT: N 34°50'28" W 107°07'37"

LEGEND

- SITE LOCATION
- FEATURE LOCATION

0 1000 2000
APPROXIMATE SCALE IN FEET

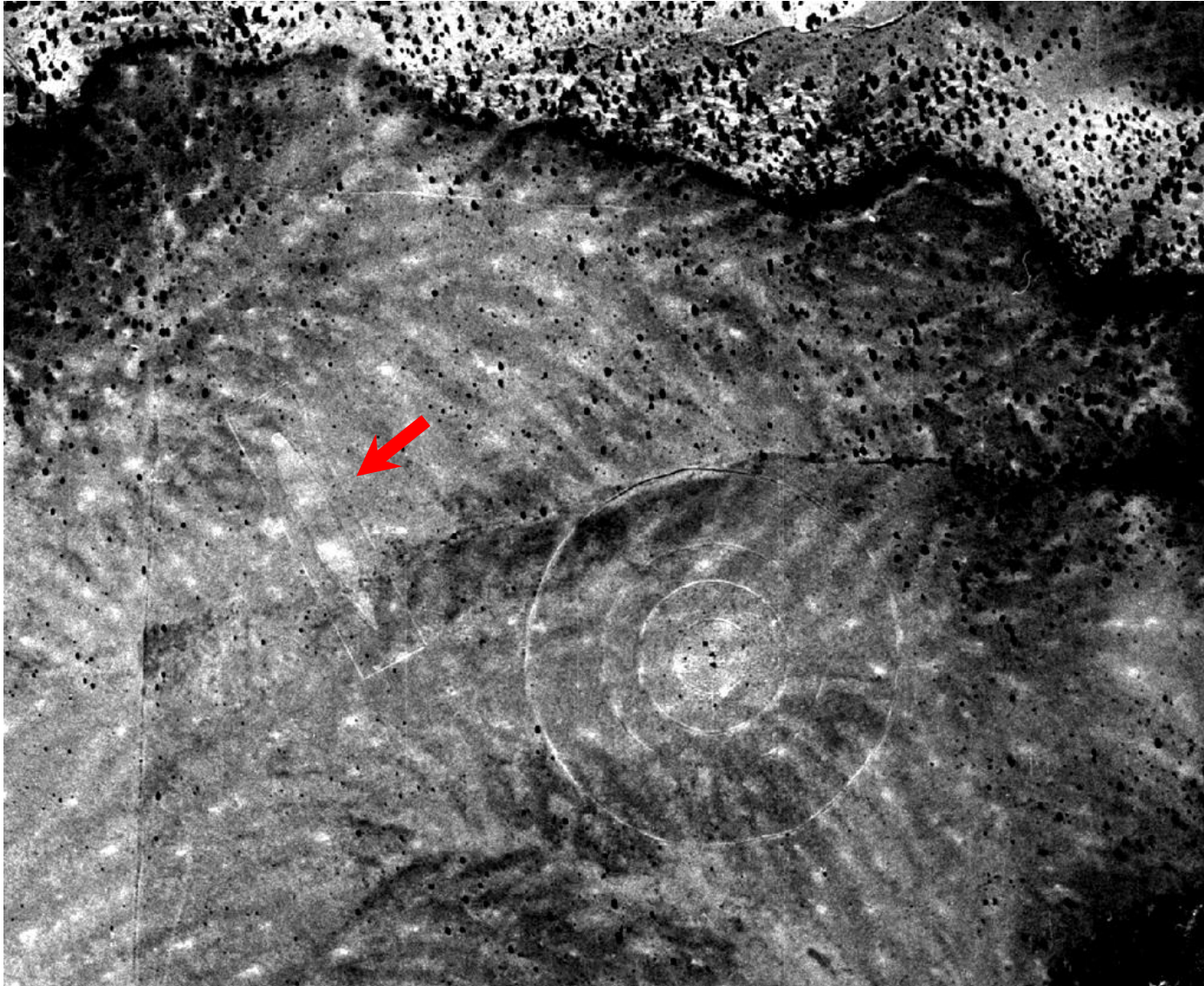


U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

KIRTLAND PBR NO. S-12
FUDS PROJECT NO. K06NM044901
SOUTH GARCIA, NEW MEXICO
VALENCIA COUNTY
1951 AERIAL PHOTO

PROJ. DATE: 19-JAN-2005 1505	DATE OF 3D YEAR 5-12-1951 1951	PLATE NO. 4
---------------------------------	-----------------------------------	----------------

Digital Enhancement of Site Area



All methods noted the target circle, but the battleship target was identified only on the digitally enhanced imagery.



Validation Efforts

- Most of the additional ranges and range features were confidently identified.
- For “probable” and “possible” feature interpretations, additional historical photos were acquired to assist the validation of interpretation results – ongoing Site Investigations (SI) also provided some feedback.
- Substantially more dates of older historical photography were identified than used in the original ASR’s.
- Additional range features were noted at several sites.



Photo Search Results – Oldest Dates

Site	Photo	Site Active	Validation Photos
◆ K06NM0333	1950	1943-1956	1943, 1946, 1949, 1958
◆ K06NM0394	1974*	1943-1947	1942, 1951, 1953, 1956
◆ K06NM0445	1967*	1941-1947	1935, 1945, 1951
◆ K06NM0449	1951	1942-1946	not considered necessary
◆ K06NM0499	1971*	1944-1945	1946, 1954
◆ K06NM0619	1946	1943-1946	not considered necessary
◆ K06TX0186	1946	1942-1953	not considered necessary
◆ K06TX0267	1954	1943-1945	1941, 1952, 1953

***Dates significantly later than period of activity**

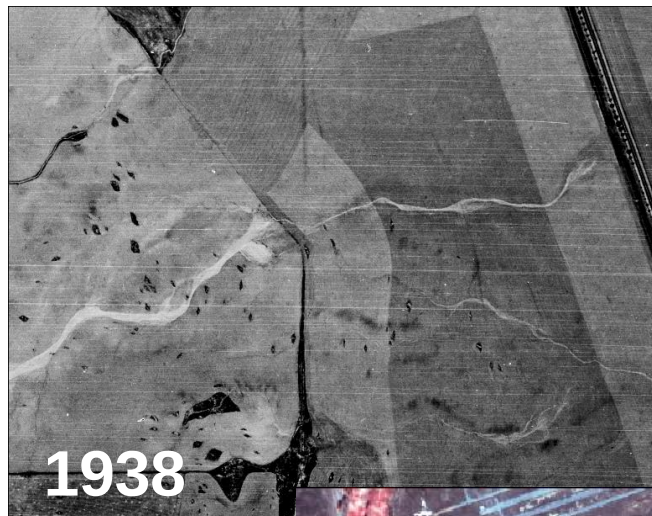
Site review document dates ranged from 1994 to 2009



Example Photo Search Results

Former Camp Haan, Riverside, CA – J09CA0279

1938	1971	1988
1941*	1973	1989
1947	1974	1990
1949	1975	1991
1953	1976	1992
1958	1977	1994
1961	1978	1996
1963	1979	2003
1966	1980	2004
1967	1984	2005
1967	1985	2006
1970	1986	2008



Primary Sources:

- NARA
- USGS-EDC
- USDA-APF0
- Univ. Libraries
- Private Firms
- State/Local Gov't
- Museums

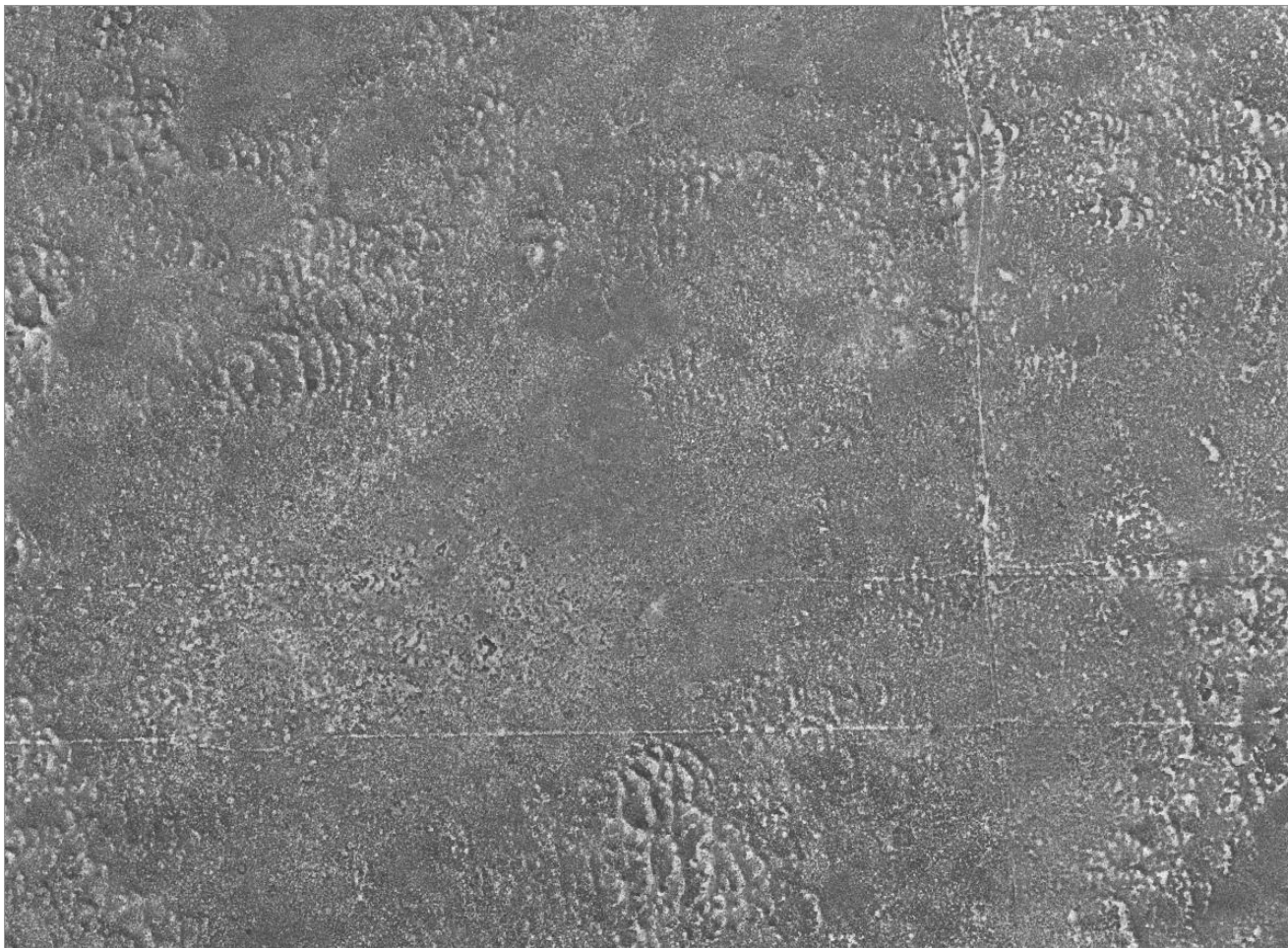


* Pending DoD acquisition



Walker Demolition Range #35 - 1971

(Original Photo Scale 1:24,000)





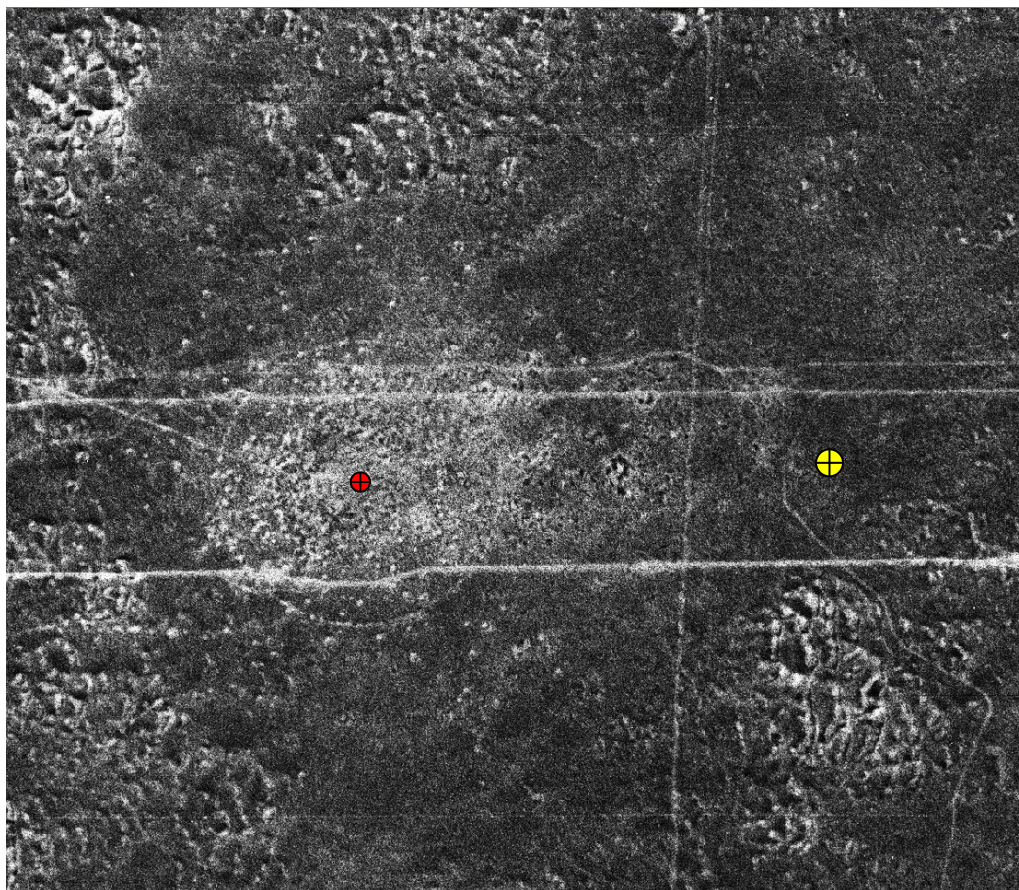
Walker Demolition Range #35 - 1954

(Original Photo Scale 1:63,000)





Walker Demolition Range #35



Actual Target Center (●)
Appears Nearly 1,600
Feet West of the Field
GPS Mapped Location
identified as “Target
Center” (⊕)

1954 Enhanced 1:63,000 Scale Photo

K06NM0499

1994 ASR Field Photo



Wide Area Assessments

- Historical photos should be routinely used as a cost-effective baseline component of Wide Area Assessments (WAA).
- Kirtland site (K06NM0445) had only partial photo interpretation assessment for 1994 ASR using 1967-1970 photography.

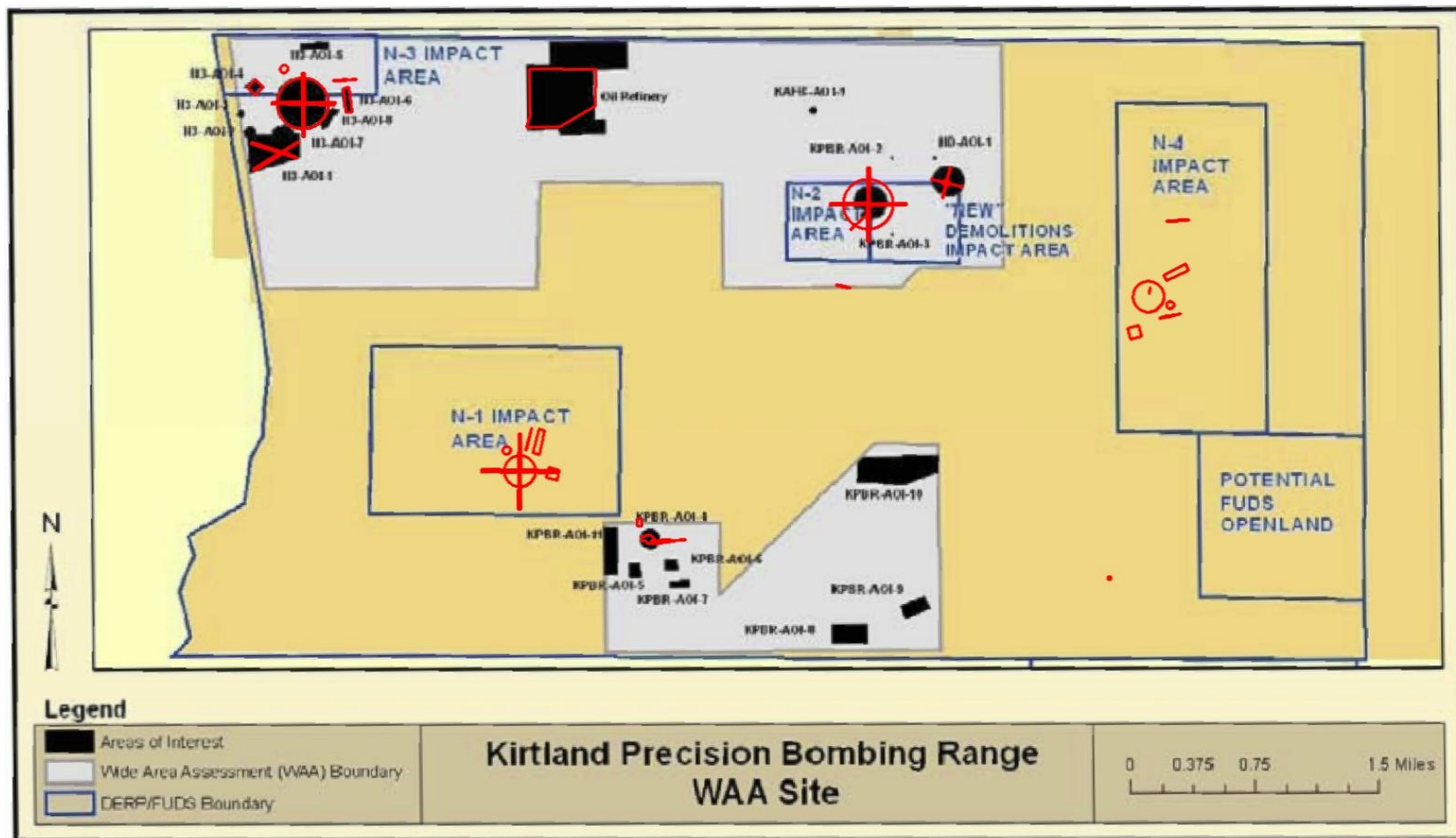


2006 Engineering Evaluation and Cost Analysis





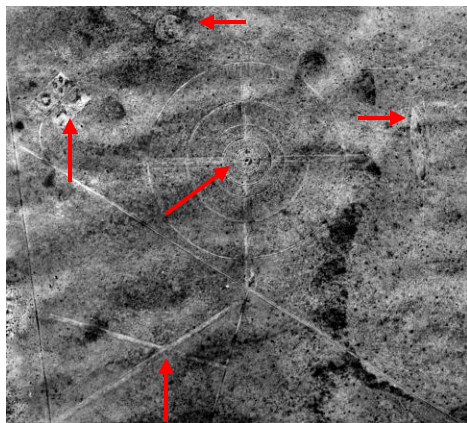
2008 WAA and Ongoing RI/FS Study



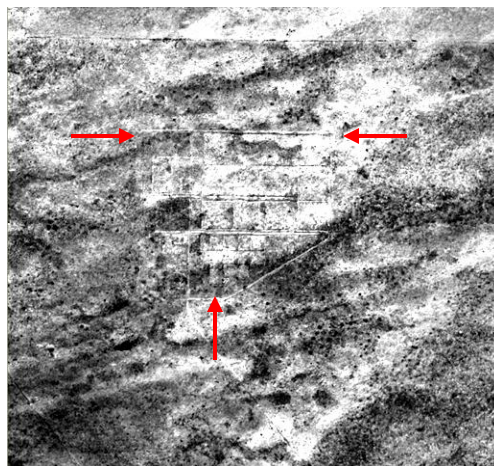
ESTCP Range Features Mapped from 1945 and 1951 Photos



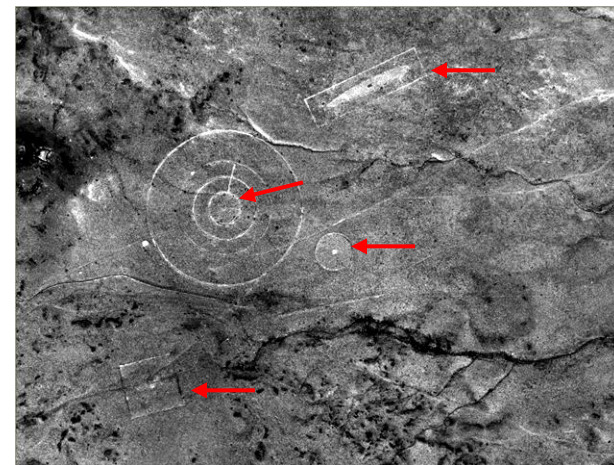
Kirtland PBR's – 1951 Photography



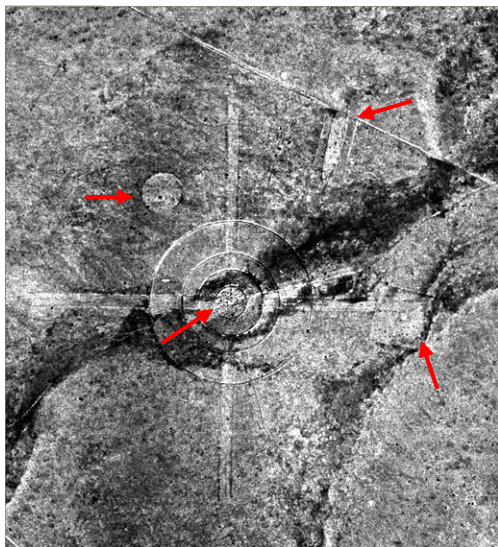
N-3



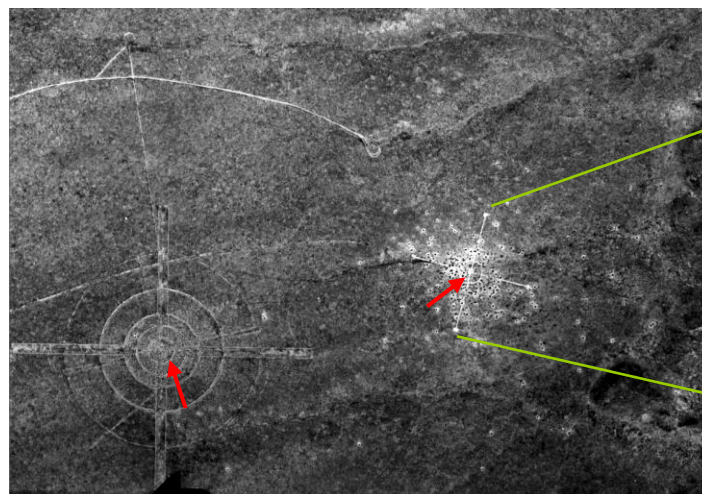
Simulated Oil Refinery Target



N-4

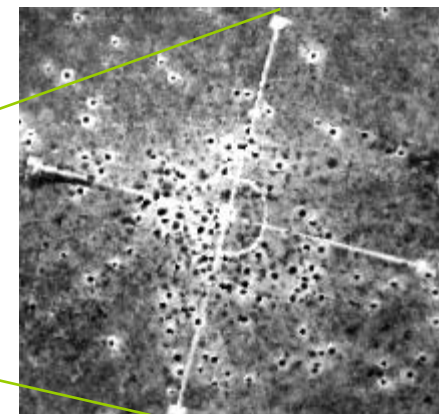


N-1



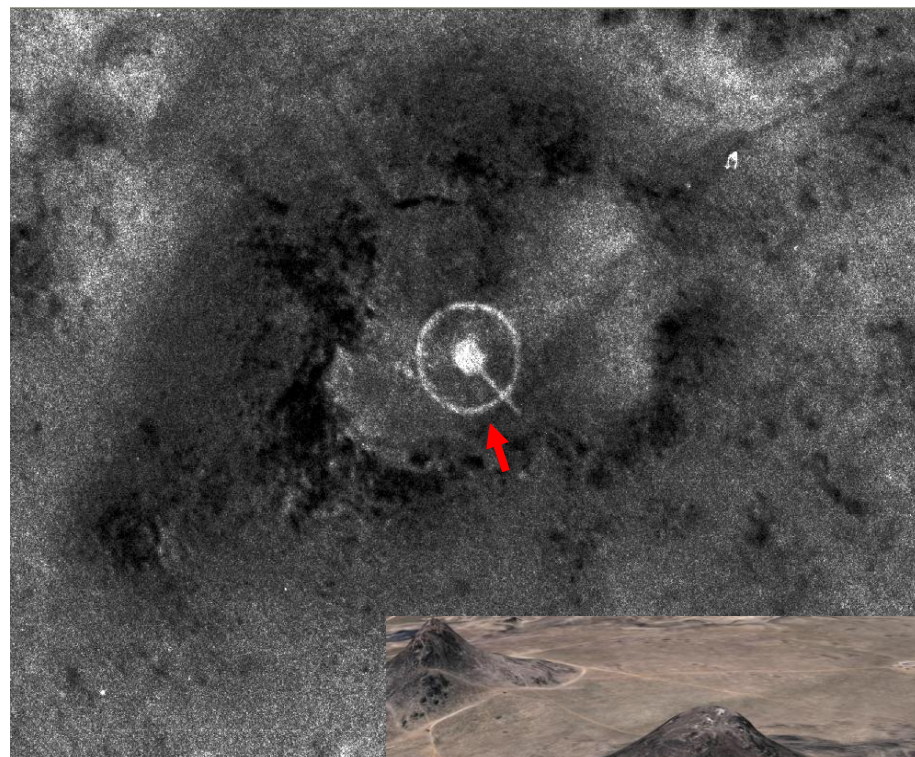
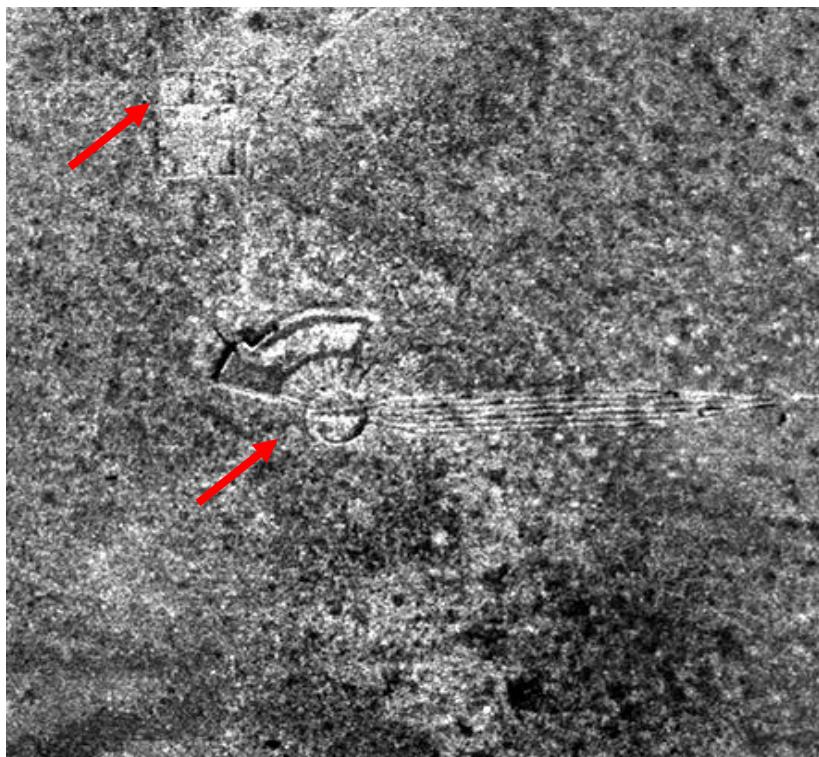
N-2

"New Demolition"





Kirtland – 1951 Photography



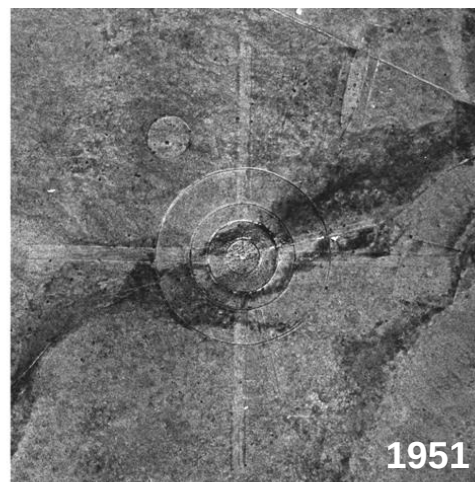
Plus Newly Identified Range Features





Range Features Through Time

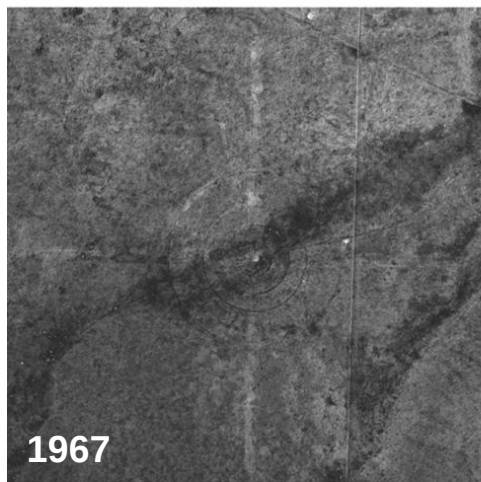
Operational
Period for
Site Use as
Bombing
Range



6 Years Later
Most – but not
all - Features
Still Evident

0 500 1,000 Feet

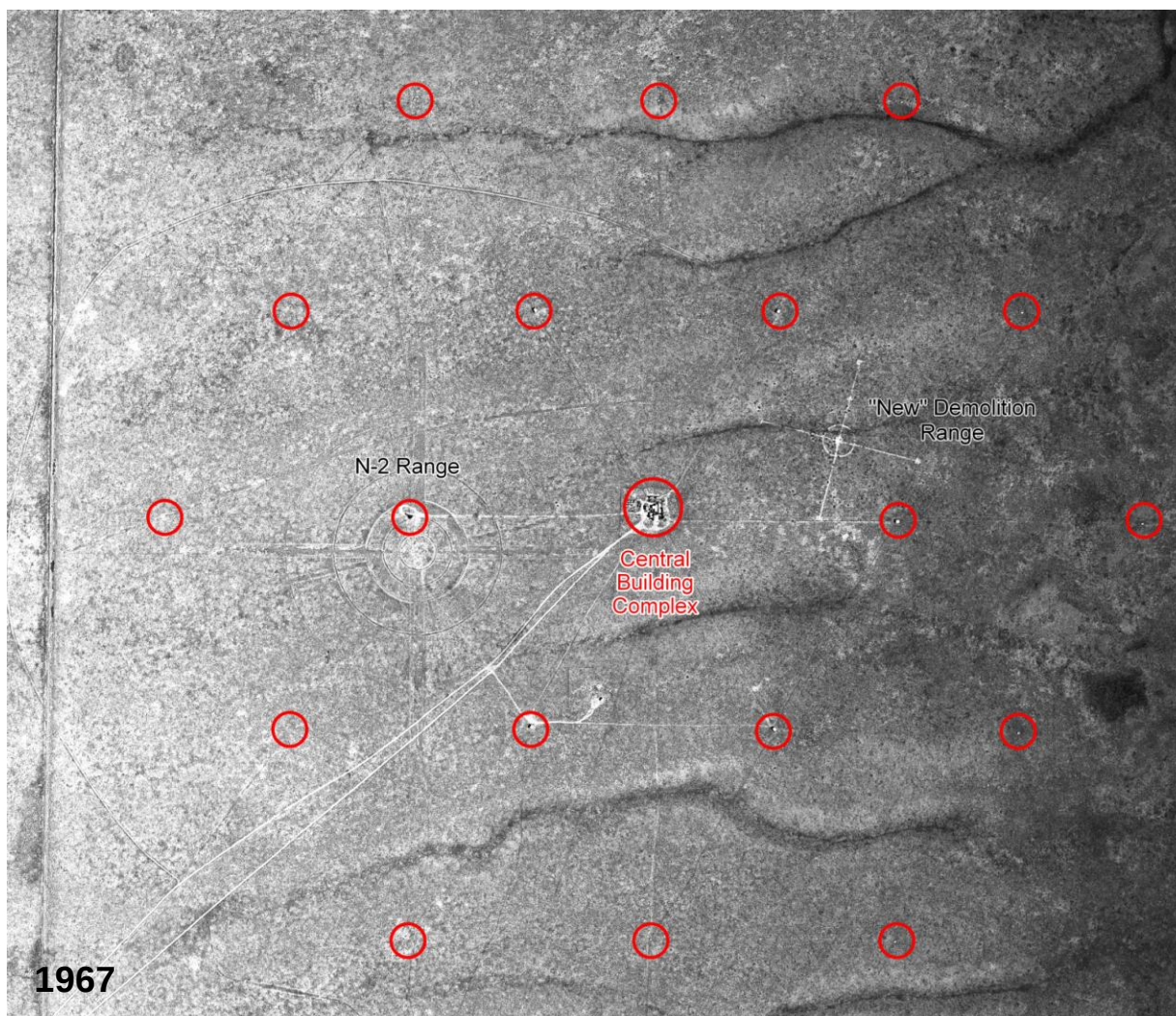
Timeframe
of Photos
Cited in
ASR



Some Features
Remain Marginally
Apparent



Later “False Alarm” Features



Use of later dates of photos can resolve some interpretation “false alarms”.

The hexagon pattern layout shown is for a facility developed over the N-2 practice and New Demolition bombing ranges.

Original Photo 1:26,000



Photo Archives Going Digital

- Film shelf life varies by type and environment
 - Early cellulose nitrate was highly flammable
(replaced with cellulose acetate “safety film”)
 - “Vinegar Syndrome” deterioration remains a major archive concern
- Conversion to digital allows use of simple to advanced image processing techniques
 - Simple brightness/contrast and sharpening is very effective
 - Stereo-viewing requires more complex equipment and software but is rapidly advancing
 - Geo-referencing (registration or ortho-correction) improves utility
- Conversion to digital involves scanning quality issues
 - Photogrammetric versus Graphics versus Consumer quality
 - Scanning Resolution: recommend ~ 1800dpi for film, ~1200dpi for print

Summary



- Use of historical film diapositives and digital analysis techniques can result in improved range and target feature interpretations.
- Historical photo searches often need to be more extensive and periodically updated – photo search results are not static!
- Image registration or full ortho-correction provides a useful basis for analysis and use of historical photos in Geographic Information Systems.
- Comprehensive historical photo analyses provide a cost-effective baseline component for any Wide Area Assessment (WAA) of World War II era Bombing Ranges.



US Army
Corps of
Engineers



BACKUP MATERIAL

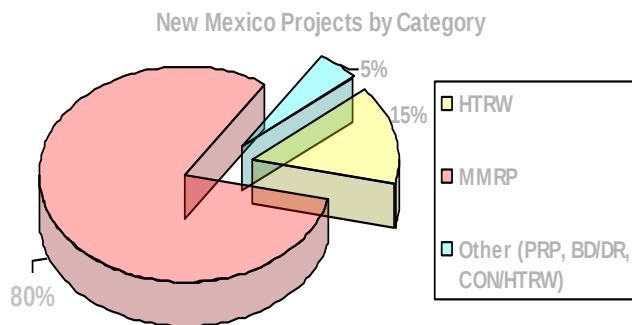




Background

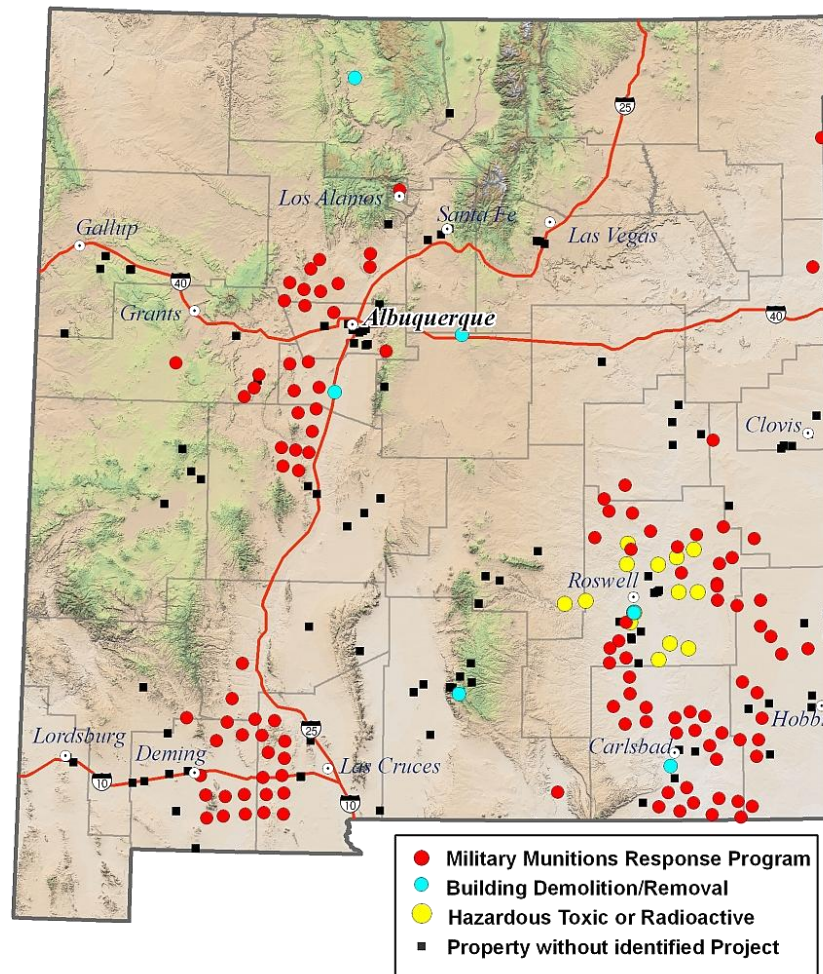
- Army Corps of Engineers Albuquerque District FUDS Program GIS Support:

255 New Mexico FUDS Properties*
147 NM FUDS Projects



- 118 Military Munitions Response Program (MMRP) sites
- Primarily WWII Practice Bombing Ranges

NEW MEXICO

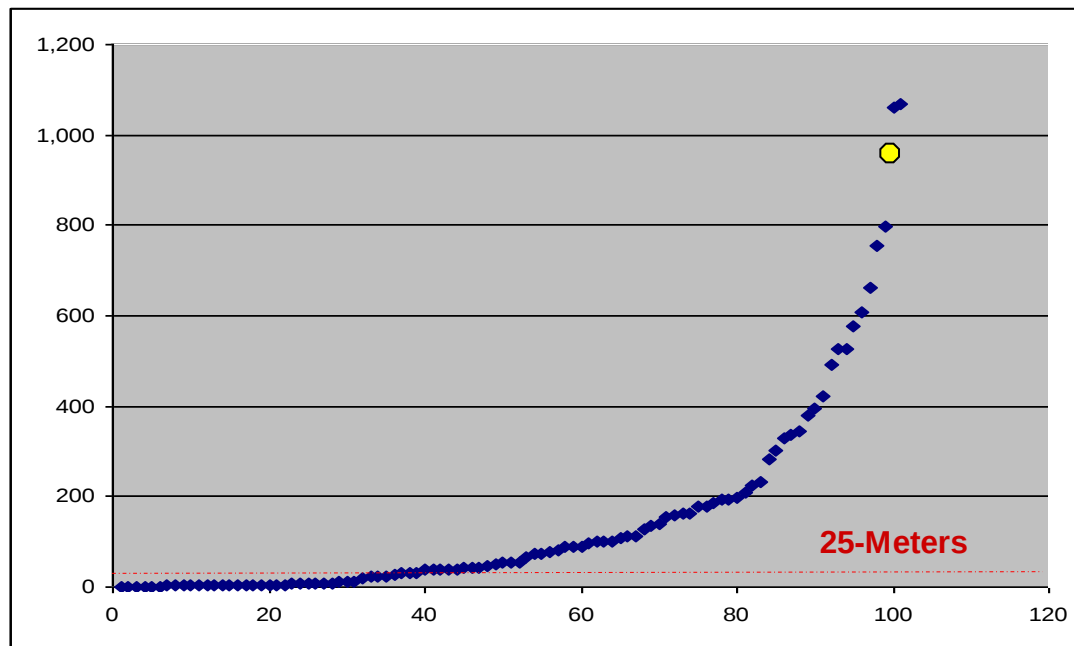


Orthophoto Adjustments



EPA Locational Data Policy used 25 meters as standard for environmental data accuracy.

**Range
Location
Offsets
(meters)
ASR/CAD
from Recent
Orthophoto**



Sequential Site Number – Sorted by Offset

1:24,000 Scale
Orthophoto
Map Accuracy
Standard is
<10 meters

Edge matching
and survey
checks indicate
1-3m
is typical

Over 65% of NM FUDS MMRP Range centroids checked had apparent offsets >25 meters.

Interactive Deconvolution

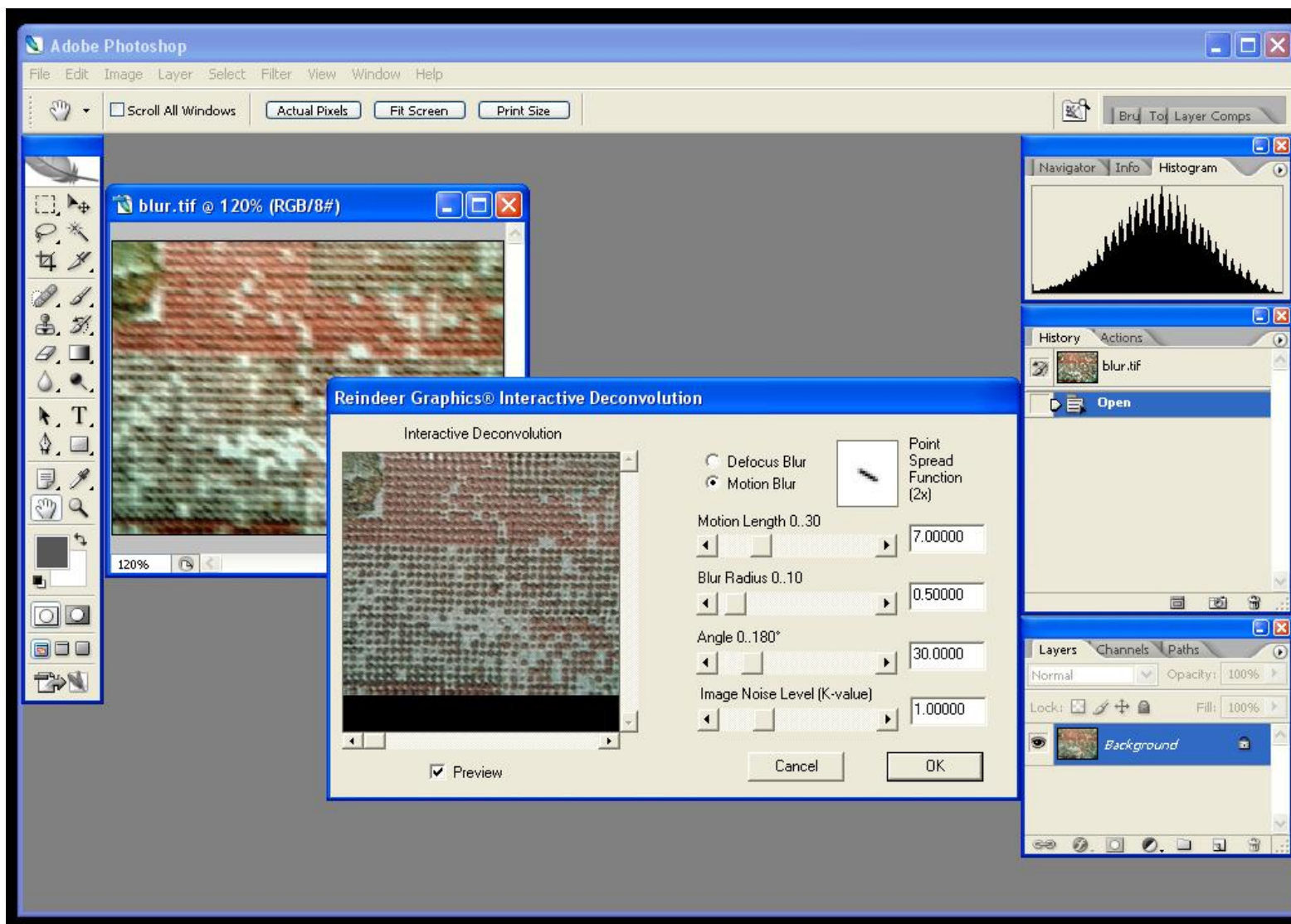


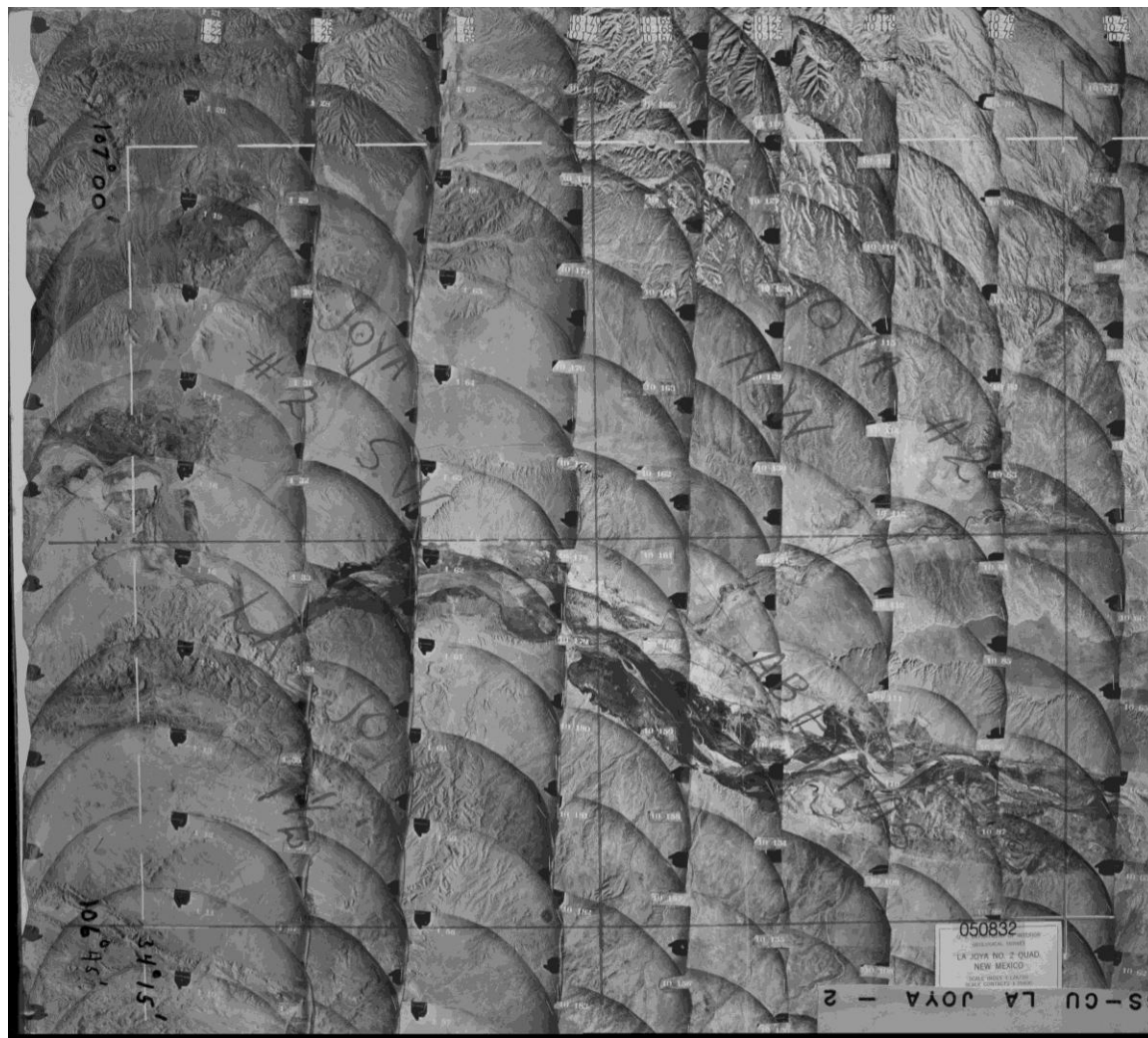


Photo Coverage Availability

Example Photo Index
for Acquisition Series

Not all Photos are
Individually Indexed
for Computer Search
by Coordinates

1946 photo index





Kirtland AFB PBR #18 Target S-5



1946 Photography

Photo Scale 1:34,500

K06NM0619



Kirtland AFB PBR #18 Target S-5



Range Target Circles
and Perimeter Fence
Line are Distinct

Site was originally mis-
located based on Public
Lands Survey System
(PLSS) legal description
and range was not
mapped

Subsequent PA has
used this 1946 photo
and mapped range

K06NM0619



Scanning Resolution



**USGS-EDC
Photogrammetric
Scanner
3629 pixels per inch
(7 microns)**

**1954 Photo for K06TX0267
Photo Scale: 1:64,000
Dalhart PBR #3 & #4**



Scanning Resolution



**USGS-EDC
New Standard 9/1/09
1000 pixels per inch
(25 microns)**

**Imagery will be available
online at no cost**

**1954 Photo for K06TX0267
Photo Scale: 1:64,000
Dalhart PBR #3 & #4**



Walker Demolition Range #35



1971 Photo Used for ASR (1:24,000)



1954 Photo (1:63,000)