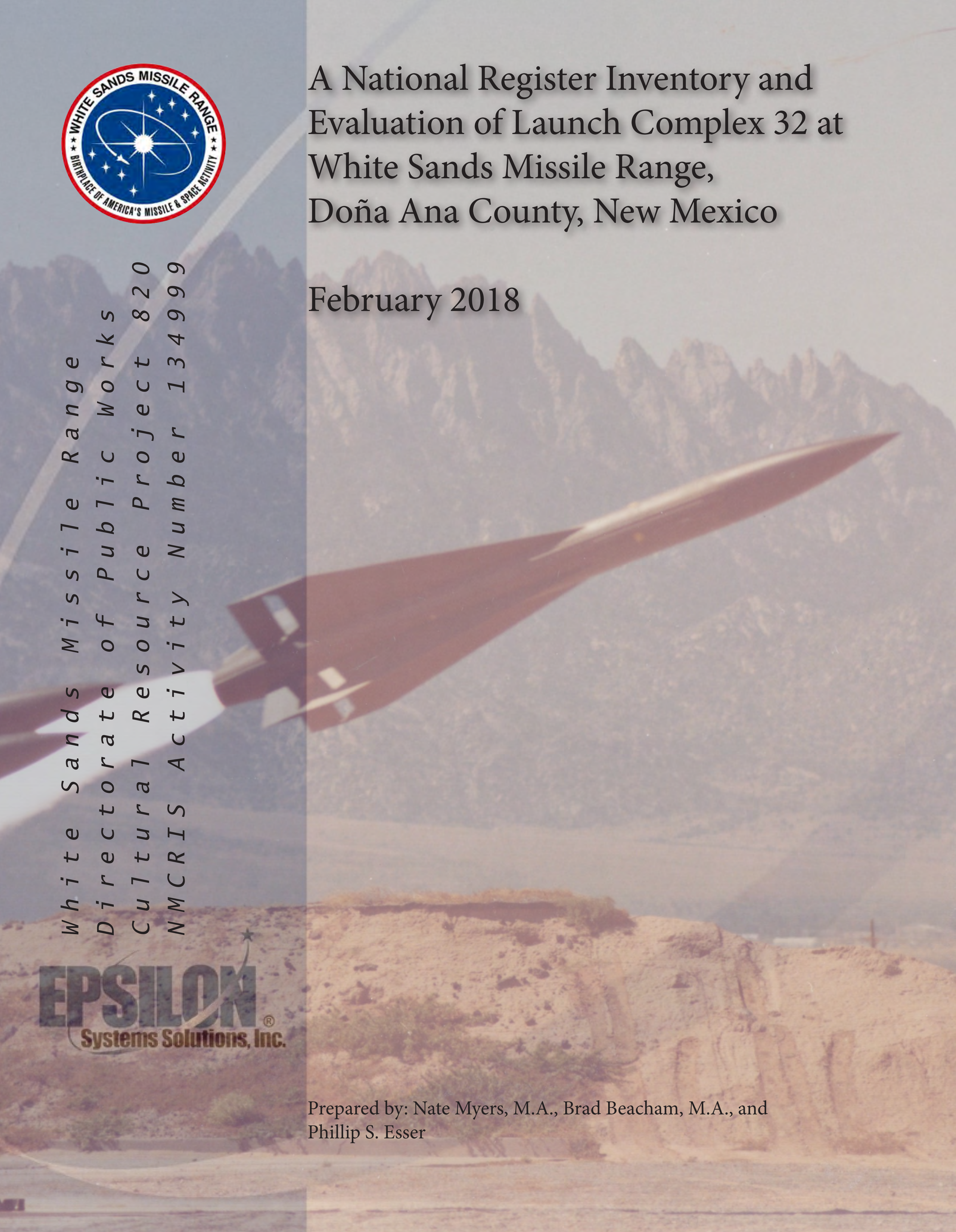

A National Register Inventory and Evaluation of Launch Complex 32 at White Sands Missile Range, Doña Ana County, New Mexico

February 2018

White Sands Missile Range
Directorate of Public Works
Cultural Resource Project 820
NMCRIS Activity Number 134999

EPSILON Systems Solutions, Inc.

Prepared by: Nate Myers, M.A., Brad Beacham, M.A., and Phillip S. Esser

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14. ABSTRACT
The United States (US) missile and space programs are pivotal themes in our nation's historic identity and White Sands Missile Range (WSMR) was a central staging area for this historic narrative. The Army's Launch Complex 32 (LC-32) served as one of the major launch complexes at WSMR through the entire Cold War. It was built to support two major programs; the Hawk anti-aircraft missile and the Sergeant tactical missile. LC-32 also played an important role in the development of the Hawk missile system, which was arguably one of the most successful missile systems developed during the Cold War. The complex was active throughout the 1990s as well, supporting launches of the Hera Target Missile and the Patriot Missile. The new millennium saw the introduction of the Orion Launch Abort System (LAS) test facilities at the complex, furthering the rich history of LC-32.

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March 23, 2018

James Bowman
Cultural Resource Manager
Department of the Army
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ATTN: Environmental Division (Building 163 / DPW)
White Sands Missile Range, NM 88002-5000

Dear Mr. Bowman,

The New Mexico Historic Preservation Division (State Historic Preservation Office) has reviewed the report: "A National Register Inventory and Evaluation of Launch Complex 32 at White Sands Missile Range, Doña Ana County, New Mexico," prepared by Nate Myers, Brad Beacham, and Phil Esser of Epsilon Systems Solutions, Inc., in February 2018. The report reflects the installation's continued efforts to record and evaluate launch complex under Section 110 of the National Historic Preservation Act.

We concur with the findings in the report that modifications to the design and alterations throughout LC-32 have diminished its historic integrity so that it is no longer eligible for listing in the National Register. The properties surveyed on HCPI forms in Appendix C are, therefore, not eligible because they do not contribute to a historic district and they are not individually eligible for listing in the National Register.

We also concur that the one exception is Property 21759, which individually eligible under Criterion A in the area of military because it was the primary facility where the Raytheon Hawk missile was developed from 1959 through the 1970s, when the program shifted to the SAM-D (Patriot) missile.

If you have any questions, please contact me at 505-476-0444 or steven.moffson@state.nm.us.

Best regards,

Steven Moffson
State and National Register Coordinator

HPD Log #107486; NMCRIS Activity #134999

A National Register Inventory and Evaluation of Launch Complex 32 at White Sands Missile Range, Doña Ana County, New Mexico

Prepared for:
White Sands Missile Range in a
Cooperative and Joint Venture Agreement with
New Mexico State University

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We are especially indebted to William Godby, Archaeologist at White Sands Missile Range (WSMR), who provided direction, access and key contacts as well as documents, photographs, and files necessary for the success of this project. Special gratitude is extended to Doyle Piland and Gene Dirk with the WSMR Historical Foundation for providing access to the extensive materials in the WSMR Museum Archives. Thanks also go to Carol Placchi for providing historical and current mapping, and Carl Krause for providing access to the realty data on file with the WSMR Public Works Department.

Figure 1. Doyle Piland receives a performance award from Colonel Alan Jones, 1990.

Figure 2. Bill Jones (*left*) and Glenn Moore (*right*) at the WSMR Missile Park, 2000.

The authors would also like to thank Glenn Moore and Bill Jones, former Hawk technicians and current WSMR Museum Archives volunteers, for sharing their memories of LC-32 and taking the time to tour the complex with us. Gratitude is also extended to Raytheon manager Stephen Lowery for providing information about the history of the complex.

Phillip Esser served as the project manager and Nate Myers and Brad Beacham conducted the site survey work and field recordation for the project. Nate Myers was the principal author of the report, with valuable contributions and reviews from co-authors Phillip Esser and Brad Beacham. Justin Pooley created the maps for the report and managed the project spatial data.

List of Acronyms and Abbreviations

A&E	Architect and Engineering
AADS-70s	Army Air Defense System for the 1970s
ABM	Anti-Ballistic Missile
ABRES	Advanced Ballistic Re-Entry Systems
AFMTC	Air Force Missile Test Center (Cape Canaveral)
ALA	Army Launch Area
ARCAS	All Purpose Rocket for Collecting Atmospheric Soundings
ARGMA	Army Rocket and Guided Missile Agency
ARMS	Archaeological Resource Management System (New Mexico)
ARMTE	Army Materiel Test and Evaluation
APL	Applied Physics Laboratory
ASL	(White Sands) Atmospheric Sciences Laboratory
ASP	Annual Service Practice
ATACMS	Army Tactical Missile System
ATBM	Anti-Tactical Ballistic Missile
BBV	Black Brant V
BCC	Battery Control Center
BMD	Ballistic Missile Defense
BMDO	Ballistic Missile Defense Office
BOMARC	Boeing and Michigan Aeronautical Research Center (missile)
Caltech	California Institute of Technology
CMU	Concrete Masonry Unit
CWAR	Continuous Wave Acquisition Radar (Hawk)
CW	Continuous Wave
DFCS	Drone Formation Control System

DMA	Defense Mapping Agency
DOD	Department of Defense
DOVAP	Doppler Velocity And Position
DR	Discrimination Radar (Nike Zeus)
ECCM	Electronic Counter-Countermeasures
EDT	Engineering Design Test
ESS	Epsilon Systems Solutions
FAAD	Forward Area Air Defense
FDL	Flight Determination Laboratory
FIX	Firing In Extension
FVP	Feasibility Validation Program
GALCIT	Guggenheim Aeronautical Laboratory (Caltech)
GAPA	Ground to Air Pilotless Aircraft
GE	General Electric
GIS	Geographical Information System
GPS	Global Positioning System
GRTS	Green River Test Site (Utah)
GTV	Guidance Test Vehicle
HAFB	Holloman Air Force Base
HARP	High Altitude Research Project
HAWK	Homing All the Way Killer (missile)
HBIF	Historic Building Inventory Form
HCPI	Historic Cultural Property Inventory (New Mexico)
HELSTF	High Energy Laser System Test Facility
HIP	Hawk Improvement Plan
HPD	Historic Preservation Division (New Mexico)
HPI	High-Power Illuminator Radar (Hawk)

HSR	Human Systems Research
HVAC	Heating, Ventilating, and Air Conditioning
ICBM	Intercontinental Ballistic Missile
IFC	Integrated Fire Control
IGOR	Intercept Ground Optical Recorder
I-Hawk	Improved Hawk (missile)
IPT	Initial Production Testing
IRBM	Intermediate Range Ballistic Missile
IRIG	Inter-Range Instrumentation Group
KEM	Kinetic Energy Missile
KW	Kilowatt
JATO	Jet Assisted Take Off
JPL	Jet Propulsion Laboratory
LAS	Launch Abort System
LC	Launch Complex
LES	Launch Escape System (Apollo)
LOSAT	Line-of-Sight Anti-Tank (missile)
LP	Liquid Propane
LSS	Land Locked Ship
LTV	Launch Test Vehicle
MAB	Missile Assembly Building
MAD	Mutually Assured Destruction
MAR	Multi-functioning Array Radar
MICOM	Missile Command (Army)
MIRACL	Mid-Infra-Red Advanced Chemical Laser
MLRS	Multiple Launch Rocket System
MPCV	Multi-Purpose Crew Vehicle

MRBM	Medium Range Ballistic Missile
MTLC	Multiple Target Launch Complex
NASA	National Aeronautics and Space Administration
NATIV	North American Test Instrument Vehicle
NATO	North Atlantic Treaty Organization
NAWS	Naval Air Weapons Station (China Lake)
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMCRIS	New Mexico Cultural Inventory System
NMSU	New Mexico State University
NORAD	North American Aerospace Defense Command
NOTS	Naval Ordnance Test Station China Lake, California
NPS	National Park Service
NRHP	National Register of Historic Places
NRL	Naval Research Laboratory
NVA	North Vietnamese Army
OPSEC	Operational Security
ORDCIT	Ordnance and California Institute of Technology
OST	Operations Support Trailer
RAM	Rolling Airframe Missile (Navy missile)
RAM	Radar Advanced Measurement (radar)
RAMPART	Radar Advanced Measurement for Analysis of Re-Entry Techniques
RCA	Radio Corporation of America
R&D	Research and Development
RDT&E	Research, Development, Test, and Evaluation
ROR	Range Only Radar (Hawk)
ROTI	Recording Optical Tracking Instrument

PAC	Patriot Advanced Capability
PAR	Pulse Acquisition Radar (Hawk)
PEO STRI	Program Executive Office for Simulation, Training, and Instrumentation (Army)
PIP	Product Improvement Plan
PM-ITTS	Project Manager Instrumentation, Targets, and Threat Simulators
PSDF	Propulsion Systems Development Facility
PSL	Physical Science Laboratory
SAC	Strategic Air Command
SAGE	Semi-Automatic Ground Environment
SALT	Strategic Arms Limitation Talks
SAM	Surface to Air Missile
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Office
SHORAD	Short Range Air Defense
SHPO	State Historic Preservation Officer
SLS	Space Launch System
SMR	Small Missile Range (WSMR)
SP-Hawk	Self Propelled Hawk
TACMS	Tactical Missile System
TBM	Tactical Ballistic Missile
TDRSS	(NASA) Tracking and Data Relay Satellite System
TDU	Talos Defense Unit
T&E	Testing and Evaluation
THAAD	Theater High Altitude Area Defense
THEL	Tactical High Energy Laser
TMD	Theater Missile Defense
TMDE	Test, Measurement and Diagnostic Support (WSMR)

TMO	Targets Management Office
TOW	Tube-Launched Optically-tracked Wire-guided (missile)
TVM	Track Via Missile
USAF	United States Air Force
USSR	Union of Soviet Socialist Republics
US	United States
V-1	Vengeance 1 (rocket)
V-2	Vengeance 2 (missile)
VAL	Vulnerability Assessment Laboratory (WSMR)
VLS	Vertical Launch System
VSTT	Variable Speed Training Target
WAC	Without Altitude Control
WRCC	Western Regional Climate Center
WSMR	White Sands Missile Range
WSPG	White Sands Proving Ground
WSTF	White Sands Test Facility
WWII	World War II
ZURF	Zeus Up Range Facility

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Appendices*

**The Appendices for this study are found on a CD attached to the back cover of the report. Additionally, a large fold-out map calling out the district boundaries, properties and features is also found in the back of the report*

List of Figures

List of Tables

1. Management Summary

The U.S. Army Garrison White Sands Missile Range (WSMR), with the assistance of the U.S. Army Engineering and Support Center Huntsville Facilities Reduction Program (FRP), is actively developing lists of properties that may be candidates for demolition. In accordance with Sections 106 and 110 of the National Historic Preservation Act (NHPA) the WSMR Environmental Stewardship Program is actively evaluating all candidate buildings, structures, and objects for their National Register of Historic Places (NRHP) eligibility in addition to acquiring existing historic documentation on each.

In April 2015, Epsilon Systems Solutions, Inc. (ESS) was contracted by the WSMR Environmental Stewardship Program to conduct an inventory and evaluation of properties scheduled for future demolition at Launch Complex 32 (LC-32). The scope of the inventory area was determined in consultation with William Godby, archaeologist at WSMR. In order to adequately meet the requirements set forth in Section 106 of the NHPA and NRHP guidelines, the inventory was inclusive of all LC-32 properties rather than just those that are scheduled for future removal.

During the current inventory, multi-disciplinary team of archaeologists and architectural historians conducted an on-site inventory in June to July 2015 and recorded a total of 75 buildings, structures, and objects as well as 336 features at LC-32. All the recorded resources related specifically to Research, Development, Testing, and Evaluation (RDT&E) activities in the Cold War era (1953 to 1966) and immediate post-Cold War years; no prehistoric features were recorded or evaluated. The current inventory was logged as New Mexico Cultural Resource Inventory System (NMCRIS) number 134999 with the New Mexico Archaeological Resource Management System (ARMS).

Nineteen properties at LC-32 have been previously recorded, which are summarized in Table 11. The majority of these properties (17) were submitted for concurrence of eligibility by the New Mexico SHPO (SHPO). All of these resources were updated during the current inventory, the only exceptions being Properties 20539 and 20552, which were demolished. Most of these properties received a formal concurrence from the SHPO via two response letters, one dated June 28, 2000 (HPD Log No. 059829) and another dated September 23, 2002 (HPD Log No. 65537). A final response letter dated October 15, 2002 did not supply a formal concurrence, as requested by WSMR. Of the 17 properties, only five were recommended as eligible, and of these only one (Property 21759) received concurrence of eligibility by SHPO. The majority of the submitted properties were recommended ineligible by SHPO either due to lack of significance or their recent age as of the submittal date. Per NRHP guidance, properties less than 50 years old must be of exceptional importance to be considered for eligibility to the NRHP (NPS 1996).

As part of the current effort, all of the recorded resources, including the 17 previously consulted upon, were evaluated for their NRHP eligibility. Only one resource, the 1959 Hawk Missile Assembly Building (Property 21759), was recommended for individual eligibility to the NRHP under Criterion A. Due to lack of significance, lack of integrity, or both, the other resources recorded during the current inventory were not recommended for individual eligibil-

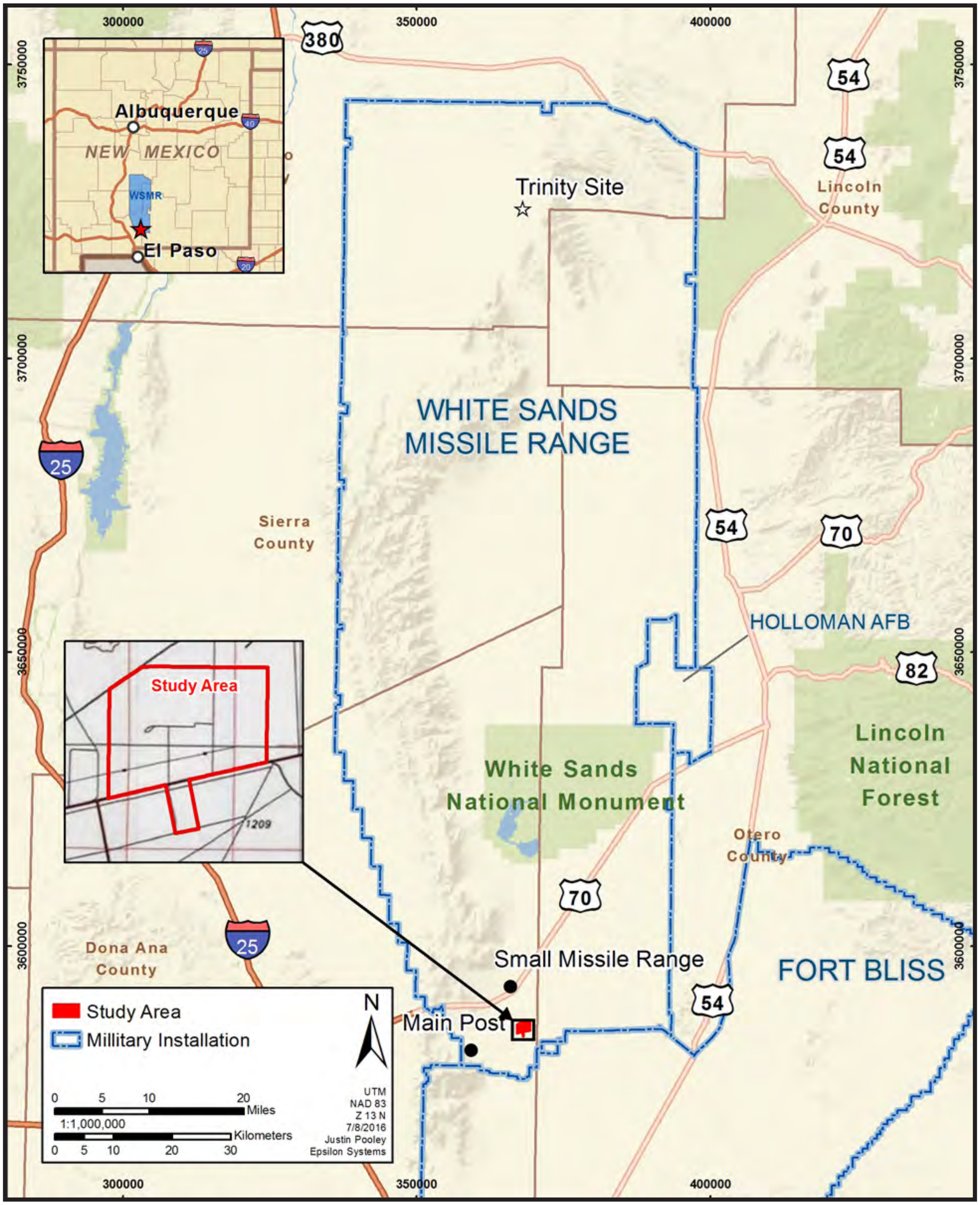

Figure 3. Map of the current inventory location within WSMR.

ity to the NRHP.

Due to the above identified issues of alterations and recent additions to LC-32, and the diminished integrity of many of the individual resources, a district encompassing the LC-32 properties cannot be recommended. Additionally, although the LC-32 properties represent a definable concentration of resources, many of which date to the identified period of significance (1958 to 1966), the complex has accrued a substantial number of recent additions and modifications. As a result, LC-32 has transitioned from a relatively discrete entity to more of a palimpsest accumulation of properties, many of which post-date the end of the Cold War and are unrelated to the programs the complex was established to support. The two core areas of LC-32, the Hawk area and the Sergeant area, have both undergone recent additions and reuse within the last 20 years. Therefore, the diminished integrity from the period of significance precludes the recommendation of the collective LC-32 resources as a possible historic district.

The NRHP eligible Property 21759 should be managed so as to avoid any impacts to the elements that contribute to its eligibility. Any proposed undertakings that would adversely impact the property should include consultation with SHPO beginning early in the planning stages. Mitigation measures for adverse effects should also be developed in consultation with the SHPO.

2. Introduction and Project Background

White Sands Proving Ground (WSPG) grew rapidly during the 1950s as a result of increased defense funding in the wake of the Korean War, and a number of new testing facilities were established by the end of the decade. The establishment of LC-32 was part of this general expansion at WSPG, with architectural plans for the complex drawn up in early 1957 with revised as-built dates added in April of 1958. The plans clearly show that the new complex was built to support two major programs; the Hawk anti-aircraft missile and the Sergeant tactical missile. An existing timing and distribution station at Uncle Site was located to the southeast of the Hawk area at LC-32 East.

The LC-32 facilities were substantially expanded in 1959 with the construction of several additional areas at the complex. The Hawk Fixed Battery, the Hawk Assembly Area at LC-32 South, and the Hawk Annex on the eastern edge of complex were all established during 1959. LC-32 played an important role in the development of the Hawk missile system, which was arguably one of the most successful missile systems developed during the Cold War. Aerial drone target launch complexes, a critical component of testing anti-aircraft missiles like the Hawk, were constructed along the eastern margin of LC-32 during the 1970s. LC-32 also hosted testing of the Roland anti-aircraft missile in the 1970s and early 1980s. The complex was active throughout the 1990s as well, supporting launches of the Hera Target Missile and the Patriot Missile. The new millennium saw the introduction of the Orion Launch Abort System (LAS) test facilities at the complex, furthering the rich history of LC-32.

In April 2015, ESS was retained by WSMR Environmental Stewardship to conduct an inventory and evaluation of the area for its NRHP eligibility. This task relied upon the current boundaries of LC-32 as indicated in WSMR Geographic Information System (GIS) layers to guide the inventory, but the inventory area was also influenced by the distribution of the built environment resources of the complex. In order to accommodate spent boosters and other launch debris, the WSMR designated LC-32 boundary extends far north beyond Range Road 202. This is far beyond the actual limit of the LC-32 built environment and the current inventory stayed south of Range Road 202. Conversely, some areas located outside the current WSMR LC-32 boundary were included in the inventory due to the historic association with the complex. The Hawk Assembly Area south of Nike Avenue was referred to as LC-32 South in period realty records and photos, and served as a significant support area for the launches conducted at LC-32.

During the course of the project, comparison of the LC-32 boundaries as depicted on historic maps versus that displayed in the WSMR GIS files showed a discrepancy of several hundred meters along the north and east margins. This was significant to the current project as the actual east boundary of LC-32 was found to be several hundred meters further east than that shown in the GIS layer. The WSMR GIS files were subsequently corrected using geo-referenced archival maps, and additional pedestrian inventory was completed by Epsilon Systems staff along the eastern margin of the complex to fully inventory the buildings, structures, objects, and features within this portion of the complex. Due to the discrepancy of the launch complex boundaries, pedestrian inventory along the west and east margins of the complex was extended slightly beyond the limits of LC-32 to ensure adequate inventory coverage of these transitional

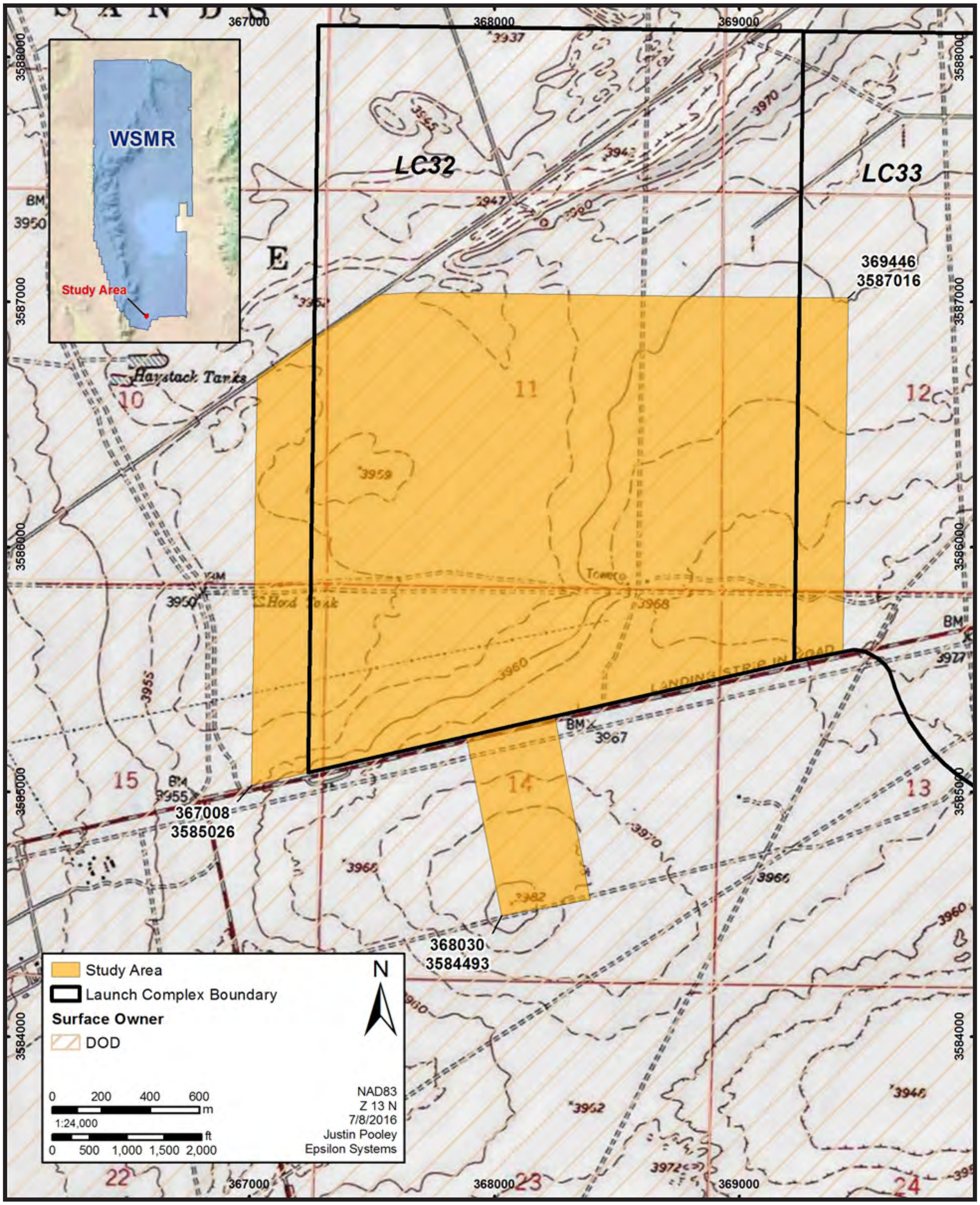

Figure 4. The current inventory location along Nike Avenue.

areas of the complex. This was of particular relevance to the eastern boundary of the project as properties related to the Multiple Target Launch Complex (MTLC) extend slightly beyond the eastern limit of the corrected boundary. Due to the lack of identified boundaries for the LC-32 South area, which lies south of Nike Avenue, pedestrian inventory was not conducted in this portion of the complex. Only resources within the fenced portions of LC-32 South were recorded.

The documented resource types at LC-32 include Launch Control Facilities, Missile Launch Facilities, Assembly and Maintenance Facilities, Instrumentation Facilities, Blast Barriers, Magazines, and Miscellaneous Facilities. The inventory also recorded isolated historic resources that were not identifiable as buildings, structures, or objects as features. No prehistoric archaeological resources were recorded as part of the inventory. In addition to the detailed recordation of the identified resources, each was evaluated for its eligibility to the NRHP. Additionally, the inventoried resources were evaluated as possible contributing elements to a larger military landscape or historic district.

The results of the inventory effort and NRHP evaluation are provided herein. Cultural resource specialists Nathaniel Myers and Brad Beacham with ESS conducted the survey work and authored the report. Phillip Esser acted as project coordinator and report co-author. William Godby, archaeologist with WSMR Environmental Stewardship, provided support and guidance throughout the process.

3. Purpose of the Project

The purpose of the project is to inventory and evaluate the LC-32 properties for NRHP eligibility. The project is in support of the WSMR FRP efforts and will ensure the US Army's compliance with the NHPA. The buildings to be inventoried are primarily along Nike Avenue corridor (including LC-32) and in downrange areas of WSMR.

Historic resource inventories and evaluations have been undertaken at military installations since the passage of the NHPA in 1966 and issuance of Executive Order 11593 in 1971. Section 106 of the NHPA requires federal agencies to "take into account" the impact of their undertakings on historic properties, whereas Section 110 directs federal agencies to inventory historic properties under their care and management, beyond considerations related to specific projects. Historic properties are buildings, structures, sites, districts, and objects that meet the criteria for listing in the NRHP (36 Code of Federal Regulations [CFR] 60). Executive Order 11593 requires agency heads to locate, inventory, and nominate all eligible cultural resources to the National Register and to exercise caution until these inventories and evaluations are complete to ensure that no eligible federally owned property is transferred, sold, demolished, or substantially altered. The Order outlines procedures for meeting the inventory requirements of NHPA and the National Environmental Policy Act (NEPA) and establishes the principle of "interim protection," which means that until a resource has been evaluated, it must be treated as if it were eligible for listing in the National Register.

This report will assist WSMR in compliance with Section 106 and Section 110 of the NHPA. This document serves as a comprehensive inventory and NRHP evaluation of the LC-32 resources from the initial use of the location in support of Hawk and Sergeant Missile testing through its later expansion and evolution to support a wide variety of programs, including the Mauler prototype, aerial target drones, the Roland anti-aircraft missile, Hera Target Missile, Patriot Missile, and finally the Orion LAS tests in 2010.

4. Research and Field Methodology

Launch complexes are one of the most historically significant facility types encountered at WSMR. In recognition of this, the historic core LC-33 was listed as a National Historic Landmark in 1985. Other launch complexes at WSMR that were active during the Cold War (and later) include LC-32, LC-34, LC-35, LC-36, LC-37, LC-38, and LC-50 (Eckles 2013:7-9). The focus of the current inventory is LC-32, the westernmost of the WSMR launch complexes located along Nike Avenue.

Generally, a launch complex can be defined as a staging and launch area for missile RDT&E, and can include a wide variety of built environment resources, including launch pads, gantry cranes, blast barricades, magazine cells, radar installations, blockhouses, and assembly buildings. The intent behind the methodology outlined herein is to provide a comprehensive treatment and evaluation of the built environment resources found at LC-32.

Traditionally, built environment is conceived of as the net result of human activity resulting in the accumulation of physical modifications, materials, and facilities present within a defined area of the natural environment. Buildings, structures and objects serve as the most prominent exemplars of the built environment and typically serve as the focal point of inventory efforts while minor elements of supporting infrastructure are often overlooked. For the purpose of the inventory of the launch complexes at WSMR, these elements were captured as associated features to provide a more comprehensive understanding of the launch complex built environment.

The methodology for recording launch complex facilities at WSMR was based on the four components of research and fieldwork: revisiting and updating previous evaluations; on-site recordation; contextual historic research; and research into the evolution of the construction and function of individual buildings, structures, and objects. Each of these components informs upon the other, and together can provide an in-depth understanding of the history and activities carried out at a given launch complex. Each of these components is described in greater detail, beginning with the incorporation and enhancement of previous recording efforts.

4.1 Revisiting and Updating Previous Evaluations

Prior to the initiation of fieldwork, the listing of previous inventory and evaluation efforts housed at the WSMR Environmental Stewardship Program were consulted in order to identify the previously documented properties located within a given project area. The previous recording forms and files are housed at the Environmental Stewardship office. Additionally, Department of Public Works (DPW) Real Property files were consulted and scanned, as needed, to facilitate future referral. These previous recordings were updated with current photography and any observed changes in the property's condition or physical characteristics were also noted. In many cases, the previous recordings were completed on the now obsolete New Mexico Historic Building Inventory Form (HBIF), and for these recordings a current WSMR specific version of the New Mexico Historic Cultural Properties Inventory (HCPI) form was prepared. The previous recording was referenced in the property's descriptive narrative, recommendations, and HCPI form.

In many cases, previous recording efforts were conducted in a piecemeal fashion, which prevented a comprehensive perspective on the entire launch complex facility. The current methodology expands upon the previous inventories, and all of the resources at LC-32 were inventoried and evaluated both individually and as elements of a possible historic district. The current approach seeks to remedy the lack of comprehensive evaluation by taking a holistic approach which considers the macro view (i.e., historic military landscape and historic district potential) in addition to evaluating each resource individually.

4.2 On-Site Recordation

In order to achieve a comprehensive inventory of LC-32, on-site fieldwork included all areas with built environment located within the boundaries of the launch complex, as defined in the WSMR Master Plan (WSMR 1982). This included several sub-areas, such as the Sergeant area, Hawk area, LC-32 Helipad, Hawk Annex, Lara Site, and Uncle Site (WSMR 1982). The survey relied upon the WSMR GIS layer of the LC-32 boundary displayed on handheld Trimble GPS units to guide the on-site survey.

During the course of the project, comparison of the LC-32 boundaries as depicted on historic maps versus that displayed in the WSMR GIS files showed a discrepancy of several hundred meters along the north and east margins. This was significant to the current project as the actual east boundary of LC-32 was found to be several hundred meters further east than that shown in the GIS layer. The WSMR GIS files were subsequently corrected using geo-referenced archival maps, and additional pedestrian inventory was completed by Epsilon Systems staff along the eastern margin of the complex to fully inventory the buildings, structures, objects, and features within this portion of the complex. Due to the discrepancy of the launch complex boundaries, pedestrian inventory along the west and east margins of the complex was extended slightly beyond the limits of LC-32 to ensure adequate inventory coverage of these transitional areas of the complex. This was of particular relevance to the eastern boundary of the project as properties related to the MTLC extend slightly beyond the eastern limit of the corrected boundary. Due to the lack of identified boundaries for the LC-32 South area, pedestrian inventory was not conducted in this portion of the complex. Only resources within the fenced portions of LC-32 South were recorded.

The primary resources that compose the built environment of LC-32 are buildings, structures, and objects, although associated features are also present across the complex, which is discussed in further detail below. However, some additional discussion regarding the recordation of the prominent components of the launch complex environs is required.

4.2.1 Building, Structure, and Object Recordation

The National Park Service (NPS) guidance for identifying NRHP-eligible properties recognizes buildings, structures, and objects, as well as two additional types of resources that may include multiple resources; sites and districts. The NRHP is by necessity oriented towards recognizing “physically concrete properties that are relatively fixed in location” (NPS 1995:4). The selection of categories should be dictated by “common sense and reason” (NPS 1995:4) and the NPS Bulletin 15 provides definitions for building, structure, and object as follows:

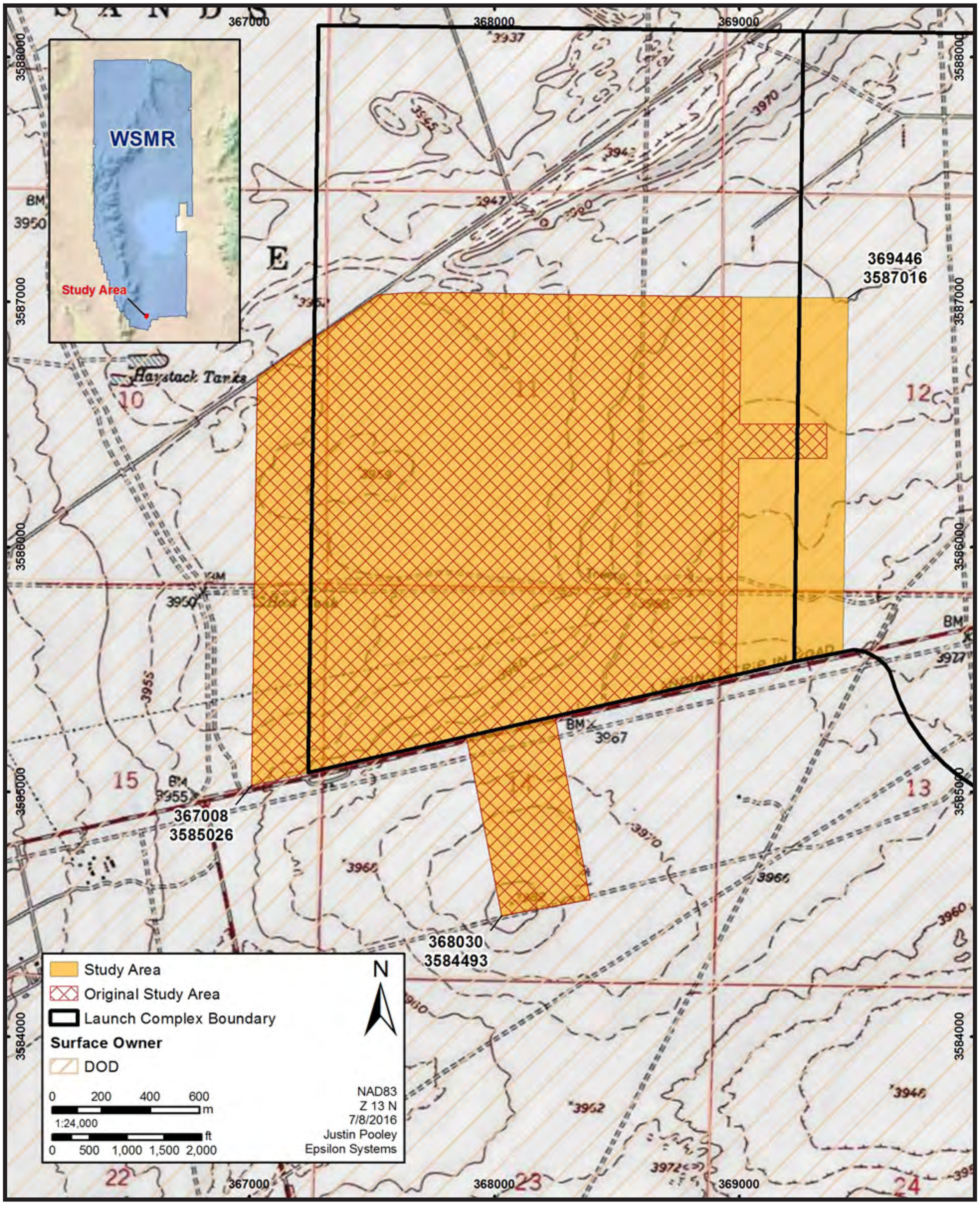

Figure 5. Comparison of the original study area and the final expanded study area.

> A building, such as a house, barn, church, hotel, or similar construction, is created principally to shelter any form of human activity. "Building" may also refer to a historically and functionally related unit, such as courthouse and jail or a house and barn [NPS 1995:4].

In the case of LC-32 and other WSMR launch complexes, buildings are more specialized and serve specific functions related to launch control and support. Examples of such buildings include blockhouses, assembly buildings, and instrument shelters.

> The term "structure" is used to distinguish from building those functional constructions made usually for purposes other than creating human shelter [NPS 1995:4].

At LC-32 and other WSMR launch complexes, specialized structures are required to prepare and physically support missiles for launches, as well as to isolate surrounding areas from potentially hazardous refueling and launch sequences. These specialized structures include launch pads, gantry cranes, magazines, and blast barricades.

> The term "object" is used to distinguish from buildings and structures those constructions that are primarily artistic in nature or are relatively small in scale and simply constructed. Although it may be, by nature or design, movable, an object is associated with a specific setting or environment [NPS 1995:5].

Assorted objects at LC-32 are not artistic in nature, but otherwise fit the definition by being of a portable nature, small in scale, and simply constructed. Examples include modular towers, and portable buildings.

Additionally, the NPS defines sites and districts as:

> A site is the location of a significant event, a prehistoric or historic occupation or activity, or a building or structure, whether standing, ruined, or vanished, where the location itself possesses historic, cultural, or archaeological value regardless of the value of any existing structure [NPS 1995:5].
>
> A district possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development [NPS 1995:5].

The resources present at LC-32 primarily consist of buildings, structures, and objects, which were distinguished using the stated NPS definitions. It is likely that these collective resources may also qualify as a historic district, as the guidance states that "properties with large acreage or a number of resources are usually considered districts" (NPS 1995:4). However, the recommendation of LC-32 as a district can only be made after a comprehensive recordation of its affiliated properties, followed by a careful consideration of these properties and their relative integrity within the framework of an appropriate historic context. The potential of LC-32 as a historic district is discussed in detail in Chapter 8.

The purpose of the on-site inventory was to document previously unrecorded buildings, structures, and objects and update the recordings of those that were previously evaluated, both at the individual level and as contributing elements to a potential historic district. Additionally, built environment resources recognized as associated features were recorded via a simplified documentation process as discussed in the following section. In order to record the LC-32 properties, the survey team prepared field forms and took representative photographs of each building, structure, and object. In addition to inclusion within the body of the inventory report, the in-field recording data and information from archival research were incorporated into a WSMR-specific version of the HCPI form. The WSMR-specific version of the HCPI form eliminates many fields of the standard HCPI form that are not applicable to the properties encountered at the range, and substitutes these with fields and descriptive options that are more useful for describing WSMR properties. When accessible, building interiors were also photographed and alterations noted. The condition of the building interior was considered when assessing the overall integrity of the property. Interior photography of some LC-32 properties was not possible as some locations were locked or otherwise inaccessible. Some facilities were still actively being used for current programs and in these cases photographs were not taken for Operational Security (OPSEC) reasons.

4.2.2 Associated Feature Recording

The NPS guidance does not recognize minor elements that are less substantial than buildings, structures, and objects. However, many isolated remnants of the range infrastructure are scattered across launch complexes, either in association with more substantial properties or in isolated locations. These isolated remnants can be both architectural and archaeological in nature. Although spatially and functionally associated with the launch complexes, these elements are not readily identifiable as a building, structure, or object. Nor can they always be treated as associated elements of a building or structure, as they are often located in discrete locations away from more substantial construction. As such, they were recorded as features.

The term “feature” was used as it is commonly recognized within the New Mexico Cultural Resources Information System (NMCRIS) archaeological guidelines. The features were captured, per NMCRIS guidance, on Laboratory of Anthropology (LA) forms. Although not formally defined within the New Mexico Historic Preservation Division (HPD) guidelines, features generally “include, but are not limited to, structures (i.e., something made up of a number of parts that are held or put together in a particular way), facilities (i.e., something created to serve a particular function), and other cultural remains such as middens, deposits, stains, pits, rock alignments, etc…” (NMCRIS 1993:10). Examples at LC-32 are obviously historic in nature and consisted largely of small components of the built environment that fell outside the definitions of buildings, structures, and objects.

4.2.3 Pedestrian Inventory

In order to properly capture the full range of associated feature locations at LC-32, a pedestrian inventory of the complex interior was conducted. The limits of the pedestrian inventory were defined by the WSMR GIS boundary of the complex, which was loaded into the Trimble Global Positioning System (GPS) units carried during the inventory. This intensive pedestrian survey was based upon the standard New Mexico HPD guidelines for cultural resource surveys which call for 15 meter transects established via GPS guidance. Pedestrian survey is not usually a component of built environment inventory as it is implicit that standing building, structures, and objects are readily visible and obvious. However, features are often more subtle and can be masked by vegetation growth or otherwise blend into the landscape. The use of pedestrian survey was borrowed from archaeological inventory methods and allowed for a more systematic and comprehensive method of encountering and recording associated features, which in turn facilitated a more complete understanding of the full range of activities and built environment at LC-32.

Due to the above noted discrepancy of the launch complex boundaries discovered during the project, pedestrian inventory along the west and east margins of the complex was extended slightly to ensure adequate inventory coverage of these transitional areas of LC-32. This provided additional information on the MTLC properties that extend slightly beyond the eastern limit of the corrected boundary. Due to the lack of identified boundaries for the LC-32 South area, pedestrian inventory was not conducted in this portion of the complex. Only resources within the fenced portions of LC-32 South were recorded.

4.2.4 Associated Feature Recordation

For the purpose of the LC-32 inventory, seven general feature types were encountered. These types were defined based primarily on functional characteristics and were largely constructed in support of operations at the launch complex. The feature types were influenced by previous inventory experience at WSMR and consisted of:

- Electrical Infrastructure: Provided electricity in support of the facilities associated with LC-32.

  Subtypes:

  - Pull boxes
  - Electrical cabling
  - Electrical panels
  - Electrical boxes and terminals

- Water and Wastewater Infrastructure: Water and wastewater systems constructed in support of the LC-32 facilities.

  Subtypes:

  - Septic tanks
  - Water lines and valves
  - Fire hydrants
  - Drain fields

- Instrumentation Support: Supported instrumentation systems in use at LC-32.

  Subtypes:

  - Calibration targets and poles
  - Instrument pedestals
  - Instrument mount foundations
  - Portable pedestals

- Launch Support: Elements constructed in support of launch activities at LC-32.

  Subtypes:

  - Concrete platforms
  - Earthen platforms
  - Fire control plumbing
  - Earthen blast berm
  - Stand-alone lighting fixtures
  - Anchor rails and hardware

- Liquid Propane tanks: Supplied LC-32 facilities with liquid propane gas.

  Subtypes:

  - LP tanks with concrete supports
  - LP tanks with steel supports

- Refuse Dumps: Discrete deposits of historic trash, including formal and informal dumps with either individual or multiple episodes of deposition.

  Subtypes:

  - Structural
  - Domestic
  - Commercial
  - Industrial

- Shipping/packaging
- Launch debris
- Mixed debris

- Miscellaneous: Features whose functional associations were ambiguous or unknown, and therefore cannot be assigned to a more specific category.

Most of the features encountered were highly redundant and consisted largely of minor, standardized infrastructural components. The term “infrastructure” as used here refers to the basic power, communications, and water systems that were constructed in support of LC-32. By design, the basic components of these systems are highly standardized to minimize cost and facilitate simple installation and operation. As a result, these associated features have little to relate regarding the story of the launch complex, and lack the interpretative power of actual buildings, structures, or objects.

Most associated features encountered during launch complex inventories were captured via a streamlined recording process that is incorporated into the handheld Trimble GPS units. The Trimble units were used to take a Universal Transverse Mercator (UTM) position on the feature for inclusion in the project mapping. Within the project data dictionary in the GPS unit, drop down menus were utilized based on the types and sub-types presented above to quickly describe the feature type and subtype. No additional description or photography was necessary for the typical features encountered at WSMR launch complexes. However, if a given feature was particularly complex or notable, yet still not classifiable as a building, structure, or object, a photograph and additional notes were taken in the field. The recorded features are presented in a tabular presentation in Appendix A and displayed graphically on the maps included in Appendix B. Unlike Buildings, Structures and Objects, associated features were not documented on HCPI forms; however, a summary of the feature results is included in Chapter 7 of this report.

4.3 Contextual Historic Research

The purpose of a historic context is to allow the significance of a historic property to be judged and explained within the larger patterns of history. NPS Bulletin 15 provides the following definition:

> Historic contexts are those patterns or trends in history by which a specific occurrence, property, or site is understood and its meaning (and ultimately its significance) within history or prehistory is made clear. Historians, architectural historians, folklorists, archaeologists, and anthropologists use different words to describe this phenomena such as trend, pattern, theme, or cultural affiliation, but ultimately the concept is the same [NPS 1995:7].

Coincident with field recording of the launch complex properties, a comprehensive historic context for the given launch complex will be prepared that considers not only the history and activities of the launch complex itself, but also the larger historical framework of WSMR and the Cold War, and how the launch complex and its programs were intertwined with larger national and international trends. Sources for this context include a number of DOD-sponsored guidance and contextual documents, as well as several historical overviews of Cold War activities at WSMR. Specific program summaries are also often available for in-depth coverage of the various missile programs that were tested at launch complexes.

The recent completion of a searchable electronic archive of the WSMR base newspaper, Wind and Sands and later The Missile Ranger, is also a publicly available resource for the local history of WSMR and its numerous Cold War programs and activities. Additionally, the WSMR Museum Archives contains a large number of historic photographs, documents, and videos that offer invaluable information into the WSMR launch complexes and the myriad programs they supported.

4.4 Property Evolution and Function

Fieldwork will be followed by research into the recorded buildings, structures, objects, and associated features. This research will include review of original construction information and alterations, historic images, and a variety of other manuscript materials collected over the decades by Public Works, WSMR Museum Archives, and WSMR Environmental Stewardship. This information will be checked against the station's extensive architectural drawings collection of original as-built and project drawings. Although limited information is available for most features, in some cases they can be identified as the remains of a more substantial property through the use of historic maps, photography, and architectural drawings further adding to the story of the launch complex's change and evolution through time.

Property evolution and function can often be established through individual property records including the disposition forms and real property forms available from the WSMR Public Works Department. The WSMR Museum Archives, in addition to information about the larger launch complex facilities and programs, also often include period photos of individual properties and locations. Original architectural drawings and plans are accessible via WSMR and are one of the best resources for changes in building design and use, but are not always available for all properties. The changes at the individual building level can be tied back to the overall historic context, and the larger Cold War programs and initiatives that drove the re-use and adaptation of the built environment at WSMR.

5. Environmental Setting

WSMR lies within the Mexican Highland Section of New Mexico's Basin and Range Province. This province is characterized by narrow mountain ranges that separate internally drained structural basins and valleys of major drainages (Hawley 1986). LC-32 is located in the southern portion of WSMR, in the southwest corner of the Tularosa Basin, which is a graben basin bounded by the Organ, San Andres and Oscura Mountains to the west and the Sacramento Mountains to the east. Topographically, LC-32 is located in the basin floor in relatively flat terrain that dips gradually to the west and is dotted with coppice dune formations. LC-32 occupies a low lying area ranging from approximately 3,949 to 3,975 feet above mean sea level. Alkali flats associated with Parker Lake lie to the north, and the Organ and Jarilla Mountains provide a dramatic backdrop to the west and east, respectively.

The built environment associated with LC-32 consists of a series of launch areas and associated facilities located along Nike Avenue that were constructed from the mid-to-late twentieth century. LC-32 is the first significant launch complex east of the main WSMR cantonment. It transitions into LC-33 along its eastern margin and includes a sub-area south of Nike Avenue. The north and western margins of the complex consist of mostly undeveloped desert.

The climate of the LC-32 vicinity is characterized as semiarid (Muldavin et al. 2000b). Climatic data were collected at a weather station located at the White Sands National Monument, New Mexico from January 1, 1939 to January 20, 2015 (Western Regional Climate Center [WRCC] 2015). During this period, mean annual precipitation was 22.89 cm (9.01 inches). Rainfall was heaviest from July through September. Average minimum temperature was 5.2 degrees Celsius (C) (41.4 degrees Fahrenheit [F]), while average maximum temperature was 25.6 degrees C (78.1 degrees F). Average annual snowfall totaled 6.35 cm (2.5 inches). Snowfall was heaviest from December through January (WRCC 2015).

Vegetation typical of the area is Plains Mesa Sand Scrub (Dick-Peddie 1993). Deep-sand areas, such as coppice dunes, throughout New Mexico were historically dominated by grasslands associated with the periphery of old floodplains and playas that have given way to successional communities of expanding Plains Mesa Sand Scrub (Dick-Peddie 1993:128). Plains Mesa Scrub is typically dominated by deep-sand tolerant or deep-sand adapted species that can manifest in various combinations of floral species. White Sands serves as an oft cited example of this successional ecotone (Dick-Peddie 1993:129). The flora within LC-32 were observed to be variable, defined by co-dominance of four-wing saltbush (*Atriplex canescens*) and honey mesquite (*Prosopis glandulosa*) with an understory of forbes and grasses including broom snakeweed (*Gutierrezia sarothrae*), and bush muhly (*Muhlenbergia porteri*). This phenomenon of variable scrubland/shrubland has been documented by comprehensive vegetation mapping at WSMR (Muldavin et al. 2000a; Muldavin et al. 2000b). The floral community observed at LC-32 aligns with the Honey Mesquite-Fourwing Saltbush or Mesa Dropseed Coppice Dune Shrublands Plant Associations defined by Muldavin et al. (2000b) under the Mesquite Shrubland.

6. Historic Context

A historic context is fundamental for understanding the significance of any given property, as physical resources do not occur in historical vacuum but are rather by-products of larger trends and patterns (NPS 1995). These patterns occur at the local, regional, and national levels, and even at the global scale. Often, these tiered patterns are intertwined, and the significance permeates from the local level to the national and beyond.

The built environment of WSMR is largely an outgrowth of the Cold War that is generally attributed to the period between 1946 and 1989. Most of the historic properties at the range were constructed during this period, and were the result of the competitive arms race between the US and the Soviet Union. However, many programs at WSMR that were initiated during the Cold War only reached maturation in the years following the end of that era, so the historic context is often required to reach into the post-1989 years to fully account for the operational life and use of many resources.

Per NPS guidance, only resources that are 50 years of age or older are to be considered "historic" as a half-century is generally considered the minimum amount of time required to assess whether events or trends are significant to the wider patterns of history. However, the NPS guidance also allows for the inclusion of recent properties if they are of "exceptional importance." As of this writing, properties that were constructed after 1965 would be considered for eligibility to the NRHP only if they meet the standards of exceptional importance as outlined in *NPS Bulletin 22*.

In order to provide a complete historical perspective for WSMR, a brief summary of the area prior to the establishment of WSMR is presented. The following section provides a brief overview of the Cold War and how historical events of the period influenced the programs under development at WSMR. The thematic focus then narrows to the topic of launch complexes at WSMR, providing a brief overview of the major launch areas at the range and the programs they supported. With this context established, the history of LC-32 and its various programs is then presented. Typical of many WSMR launch complexes, LC-32 underwent an extensive cycle of re-use and modification; the context summarizes the programs tested at LC-32 and how they modified the built environment of the launch complex.

6.1 The Tularosa Basin before WSMR

The US history of the Tularosa Basin begins with the incorporation of the region into the US by the Treaty of Guadalupe Hidalgo in 1848. Although known by the Spanish and Mexican colonial powers, the Tularosa Basin remained a remote and sparsely settled area that was considered largely uninhabitable due to the constant threat posed by the Apache. Fort Stanton was established along the Rio Bonito in 1855 in order to provide settlers with protection against the Mescalero Apache, but even so, settlement away from the fort in the Tularosa Basin remained a risky affair and the population in southern New Mexico remained focused in the Mesilla Valley of the Rio Grande.

By the 1860s however, several factors conspired to change the uninhabited nature of the Tularosa Basin. The onset of the Civil War made New Mexico a subject of military interest among both the Union and Confederate armies, and several engagements were fought for control of the Territory. These conflicts eventually saw the Union victorious, and the military presence across the area continued following the end of the war. The establishment of a series of military outposts across the region somewhat ameliorated the Apache threat, and the perceived security encouraged settlers to move into the area between the Sacramento and San Andres Mountains.

Figure 6. Colonel Albert Fountain, who disappeared in 1896 within what would later become WSMR (*public domain image)*.

The earliest Territorial settlement in the Basin began even before the end of the Civil War. In the fall of 1862 Hispanic settlers fled the destruction wrought by the flooding of the Rio Grande in the Mesilla Valley and established a community at the mouth of Tularosa Creek at the western base of the Sacramento Mountains. This community, known as Tularosa, was carefully cultivated by its settlers and became a permanent oasis of civilization in the basin. By the early 1870s the Apache were largely contained on reservations which mostly ended the threat of further raids from that quarter (Sonnichsen 1960:15). By the early-1880s, Anglo ranchers, mostly Texans, had discovered the Tularosa Basin, which at the time was especially verdant after several years of higher-than-average precipitation. The Texas cattle growers found in New Mexico a continuation of the open range grazing that was under assault by waves of post-war settlers and farmers in their native state, and these roving cattlemen rapidly established cattle ranching as an industry in the Tularosa Basin (Sonnichsen 1960).

Figure 7. Albert Bacon Fall during his tenure as senator (*public domain image)*.

The rise of cattle ranching in the late 19th century eventually led to "range-war" type conflicts that were experienced in New Mexico and elsewhere across the west. In the Tularosa Basin, this saga culminated in the disappearance of Albert Fountain and his son Henry on February 1, 1896. The site of the disappearance is located within WSMR, at a low ridge known as Chalk Hill that Highway 70 now bisects near the Doña Ana/Otero County line (Eckles 2013:57). Although political rival Albert Bacon Fall and his associates, including prominent area rancher Oliver Lee, were suspected in the case, no convincing evidence tying them to the crime was ever found (Sonnichsen 1960). The Fountain case was a polarizing incident that encapsulated much of life in and around the Tularosa Basin at the close of the 19th century, and endures as a compelling mystery today.

The arrival of the railroad at the newly established railroad town of Alamogordo in 1898 brought the Tularosa Basin into wider contact with the rest of the nation, but after the conclusion of the turbulent events of the 1890s, the area remained little changed during the early years of the 20th century. The main economic activity continued to be cattle ranching, with ranchers relying on a mixture of their own private property and large grazing leases of federal lands in order to make a living in the sparsely vegetated Chihuahuan Desert landscape. The carrying capacity for grazing was calculated at only five or six cattle per 640 acres in some areas of the Tularosa Basin (Eckles 2013:67). With the capacity for grazing so minimal, it took many thousands of acres to make cattle grazing a feasible endeavor for ranching families in the area.

New Mexico became the 47th state of the US on January 6, 1912. Thomas Catron of Mesilla, and Albert Fall, who resided in Las Cruces, were elected as the first US Senators of the state, ensuring that southern New Mexico was well-represented. As a state, New Mexico began to benefit from infrastructural improvements, and a state highway system was well underway by the 1920s. The old trail between Alamogordo and Las Cruces through San Augustine Pass was replaced with US Highway 70 during the 1930s (Wallace 2004:118). However, the lives of the people in Tularosa Basin area were not much affected. The area remained much the same by the time White Sands National Monument was established in 1933 to preserve the unique white gypsum dunes that formed from the winds blowing off the Lake Lucero playa in the basin interior. However, the entry of the US into WW II would change the area forever.

With its open air space and reliably clear weather, the Tularosa Basin was an ideal place for training military pilots. The first flight training facility was under development for the training of British pilots when the attack on Pearl Harbor brought the US into the war in December 1941. The training school was subsequently re-directed into the Alamogordo Army Air Field and US bomber flight crews began training there in May 1942 (Kennedy 2009:19). The greatest conflict of the 20th century would bring many changes to the Tularosa Basin, and would also re-define concepts of offensive and defensive weapons for the remainder of the century.

6.2 The Establishment of White Sands Missile Range

In 1936, J. Frank Malina, a graduate student from the California Institute of Technology (Caltech) Guggenheim Aeronautical Laboratory (GALCIT), and a group of students under the guidance of Dr. Theodore von Karmen initiated research into rocket propulsion. The goal was to eventually develop a sounding (research) rocket capable of reaching altitudes of 100,000 feet or higher (Carroll 1974:3). The GALCIT group made steady progress, and in 1939 the group began work on Jet-Assisted Take-Off (JATO) units for aircraft. This early JATO work was first supported by the National Academy of Sciences, but as the war in Europe began to loom larger the Army Air Corps offered support for the JATO development (Carroll 1974:3). The emphasis on developing a workable JATO unit shifted the GALCIT group's focus away from liquid-propellant and towards long-burning solid propellant, whose simplicity and economy was required for the expendable JATO unit.

Prior to the GALCIT work on the JATO, solid propellants were based on black powder rockets and burn times of over three seconds had never been achieved. Beyond three seconds, the combustion pressure of the rocket motor spiked and exploded the motor. By working from a theoretical model first and then developing an improved design of solid propellant motors, a working group led by John W. Parsons developed a solid propellant motor with burn times of eight seconds, ideal for JATO units. However, early results showed that these units quickly deteriorated in storage and, as a result, exploded during use. The GALCIT group was again forced to reexamine the fundamentals of the system, this time looking at the propellant mixture itself (Carroll 1974:4).

Parsons next developed a propellant mixture based on asphalt, an inspiration that struck him as he watched a roof being constructed. The asphalt based propellant used potassium perchlorate as an oxidizer, and after being heated into a liquid form, could be poured into the motor body. The asphalt-perchlorate mixture provided a castable, long burning, and most importantly, stable mixture for JATO motors. This mixture was used to fulfill a Navy contract for JATOs in 1942 (Carroll 1974:4).

As GALCIT was not financially or physically structured to handle mass production of the Navy contract JATOs, in 1942 GALCIT project personnel founded Aerojet Engineering Corporation. By 1944, the Aerojet Corporation had mastered JATO production and John Parsons left GALCIT to work with Aerojet full time (Carroll 1974:6). Meanwhile, the completion of the JATO solid propellant work left GALCIT available for new projects, and news of the German missile program from Europe inspired Von Karmen to further the liquid propellant research. Von Karmen, J. Frank Malina, and Hsue-Shen Tsien prepared a memorandum outlining the proposed liquid-propellant work in 1944 (Carroll 1974:7). This memorandum was the first GALCIT document to use the title of Jet Propulsion Laboratory (JPL).

The JPL memo was a major turning point for US rocket and missile development. The German use of missiles in Europe was the major focus of the Army Ordnance Department Guided Missile Program and the JPL memo received a very positive reception by Army Colonel George W. Trichel of the Rocket Development Branch of the Army Ordnance Department, who developed a contract to expand the JPL liquid propellant research effort (Kennedy 2009:14; Miles 1961). This contract was the Army Ordnance-California Institute of Technology (ORDCIT) contract with Caltech, which was instrumental in the development of the liquid propellant Private test vehicle series. The testing of the ORDCIT Private series of rockets was undertaken by JPL in California in 1944 (Carroll 1974:8). The Private A was built on an Aerojet JATO with a primitive booster composed of four Army T-22 artillery rocket motors. This ostensibly made it the first American two-stage rocket (Kennedy 2009:14). The Private A launches were conducted at Leach Springs, a location within Camp Irwin, California in early 1944. The next ORDCIT rocket, the Private F, was launched at the Hueco Range at Fort Bliss, Texas.

The next ORDCIT experimental prototype was the Corporal series, which was a larger and more powerful rocket that required a larger range in order to test it safely (Kennedy 2009:16; Miles 1961). Early scale model tests of the rocket were conducted in California, but the projected range of the full size rocket required a larger overland test range. Concurrently, intelligence gained through the course of WW II further emphasized the need for enhanced missile testing facilities comparable to those used by Germany.

As hostilities drew to a close in Europe, the US was able to capture parts, equipment, and research materials from the German V-2 rocket program at Mittelwerk prior to the Russian advance into eastern Germany. Additionally, Werner Von Braun, chief scientist of the German

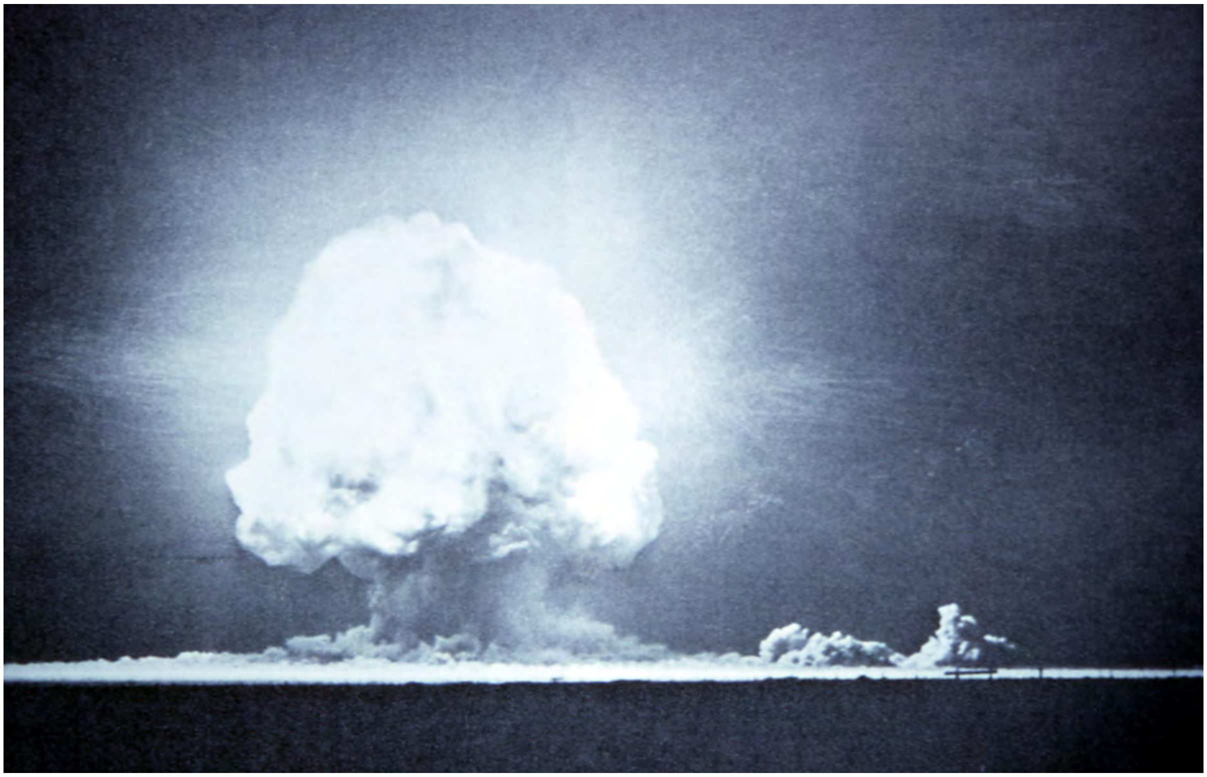

Figure 8. The flash and mushroom cloud of the world's first atomic bomb at the Trinity Site.

missile program, and key members of his staff surrendered to Allied forces on May 2, 1945 (Eidenbach et al. 1996). With both the parts and the minds behind the V-2 program in hand, the US now possessed the means to accelerate the rocket research the ORDCIT program had begun. In support of this, Project Hermes was established by the Army in 1944 as a parallel program to ORDCIT with General Electric (GE) selected as the prime contractor. Both programs required a suitable testing and proving ground; the Army began to search for an appropriate location for a new test range (Kennedy 2009).

The proposed proving ground required flat and open ground, a sparse population, and predominantly clear weather. Other preferred characteristics included surrounding hills or mountains for observation sites and natural barriers, access to railroad lines and utilities, and proximity to an established military post for support. The Tularosa Basin was identified as the best choice, possessing nearly all of the desired characteristics. The location was selected in February 1945 and named WSPG after the adjacent National Monument. Some of the land in the proposed proving ground was already under federal lease, and additional property was acquired from private landowners in the area via annual lease payments. The lease payments for the use of the ranchers' properties were used in lieu of outright purchase of their lands, as the range was conceived as being a temporary extension of the existing bombing ranges, and it was believed that the new missile mission would eventually be completed (Eckles 2013:87). This, of course, was not the case and the formation of the new proving ground effectively ended the ranching lifestyle in the Tularosa Basin which dated back to the 1870s. WSPG was formally established by July 1945; on July 16, 1945 the world's first atomic bomb was detonated at the Trinity Site in the northern portion of the new range. The flash and rumble of the Trinity explosion was reported as far away as Silver City, New Mexico and El Paso, Texas (Sonnichsen 1960).

Figure 9. Frank Malina stands by the WAC Corporal at WSPG (*US Army photo)*.

On September 26, 1945 the ORDCIT project launched a Tiny Tim rocket modified as a booster for the WAC Corporal at the newly established WSPG, the first rocket launched at the new range (Kennedy 2009:29). On October 11, 1945, the first fully fueled WAC Corporal launch reached an altitude of 235,000 feet, the altitude record for an American rocket at the time (Kennedy 2009:29). Meanwhile, the first of the captured V-2 materials were transported to the range and GE personnel working under Project Hermes began to sort, catalogue, clean, and assemble the various German missile components. Parts that were missing or damaged were fabricated as needed. The program progressed quickly, and the first American launch of a V-2 missile took place at WSPG on April 16, 1946 (Kennedy 2009:29).

As the range continued to develop, the late-1940s and early-1950s proved to be a significant period of advancement for the range instrumentation and communications systems. The installation of range-wide instrumentation, communications, and timing networks was a significant, but often overlooked, part of the effort required to turn the desert landscape of the Tularosa Basin into a world-class missile test range. In many ways, the capability to precisely track, measure, record, and generate data from tests, while synchronizing these activities across long distances, is what truly defined the facility as a proving ground. Pioneering work on range instrumentation systems was undertaken by a group led by Ernst Steinhoff and a select group of optical, electronics, and geodesy experts at Holloman Air Force Base. Steinhoff originally was brought to the US as part of Operation Paperclip and came to HAFB in 1949 after working at Fort Bliss. There he selected additional German experts that were brought into the country in 1951 as part of Project 63, which was an Army program to place knowledgeable German scientists and engineers into private sector positions within the aerospace industry (HAFB 1949; Mangum 1951). Steinhoff and his instrumentation group published early guidelines and plans

Figure 10. Little Bright eyes, one of the first tracking telescopes at WSMR.

for range instrumentation systems and infrastructure at HAFB that were soon incorporated at WSPG as well.

Early instruments that met the requirements for range instrumentation were limited, and existing equipment had to be adapted to fit the role. Some of the best early optical instruments were Askania cinetheodolites recovered from the German rocket program and re-used at WSPG. Fastax and Mitchell high speed cameras and surplus WW II SCR-584 radars were also staples of the early range instrumentation, while more specialized instruments had to be custom fabricated. For example, the first tracking telescope was hand-assembled by planetary astronomer Dr. James B. Edson (Delgado 1981; Mabe 1958:2). This early precision instrument was known as "Little Bright Eyes" and was built on a surplus M45 gun mount and relied on telescopes pieced together with spare refractors, a 35 mm motion picture camera, and a pair of high power Japanese Navy binoculars Edson acquired via barter during WWII (Delgado 1981). Edson was unable to remain at WSMR, but recruited fellow astronomer Clyde Tombaugh to continue the tracking telescope effort. In December 1946, Tombaugh captured a V-2 tumbling near the apex of its flight, a previously unknown flight characteristic (Mabe 1958:2). This landmark film heralded the tracking telescope as a revolutionary new kind of instrumentation that was critical to further missile development.

Figure 11. Clyde Tombaugh (*foreground)* and four unidentified men work on the Bright Eyes II at WSPG.

By the late 1950s, technology had caught up to the need for range instruments, and the instrumentation became increasingly specialized and sophisticated. New instruments included the AN/FPS-16 radar, the first tracking radar built expressly for use at test ranges. New optical instruments included two new tracking telescopes; the advanced Intercept Ground Optical Recorder (IGOR), developed by Clyde Tombaugh, and the Recording Optical Tracking Instrument (ROTI). Both of these devices possessed far greater ranges than the original Bright Eyes and were significant, state of the art advances at the time of their introduction. Also during this period, the Army contracted with Land-Air Corporation for the operation and maintenance of most of the range instrumentation. This greatly streamlined the compatibility and standardization of the range instrumentation, the repair and operation of which was formerly handled by a mixture of various contractors and military personnel.

6.3 WSMR through the Cold War

As WSPG was established in the desert landscape of the Tularosa Basin in the immediate postwar years, the Soviet threat coalesced and the Cold War assumed a recognizable form. Following the end of the war, the Soviets began to take an increasingly aggressive stance in Eastern Europe, prompting Winston Churchill to deliver his "Iron Curtain" speech in March 1946. This speech is widely considered by the public and many historians to mark the beginning of the Cold War. The relations between the West and Soviet Union continued to degrade, culminating in the Berlin Blockade of 1948 to 1949. Following the end of the Berlin Blockade and the inability to come to treaty terms with the Soviet Union, Germany was partitioned into the Federal Republic of Germany (West) and the German Democratic Republic (East), a division that would remain throughout the Cold War. The defense of West Germany against a potential Soviet advance was a major strategic priority for the US and its allies for the remainder of the Cold War. In the spring of 1949, contemporaneous with the Berlin Blockade, the US, Canada, and 10 western European countries signed a mutual defense treaty that created the North Atlantic Treaty Organization (NATO). NATO member countries each committed troops and resources to the defense of Western Europe against Soviet expansionism. The Soviet equivalent was the Warsaw Pact, which consisted of the communist countries of Eastern Europe including Poland, Czechoslovakia, Hungary, Romania, and Bulgaria (Lavin 1998:18).

For the early years of the Cold War, US military policy focused on the use of the atomic bomb as a deterrent against Soviet military aggression in Europe. The national defense budget was greatly reduced from $81.5 billion in 1945 to $44.7 billion in 1946, and then to $13.1 billion in 1947. However, missile research and development continued, albeit on a smaller scale than what otherwise might have been possible (Lonnquest and Winkler 1996:19).

Due to the post-war budget constraints, much of the early effort at WSPG focused on the use of the captured German V-2 missile materials and the creative use of available surplus materials. In November 1944, the Army established Project Hermes as a long-term ballistic missile research and development effort with GE as the prime contractor. GE worked in parallel with ORDCIT, and was responsible for the processing of the V-2 materials that began to arrive at WSMR in 1945.

The first launch area at WSPG, Army Launch Area 1, later known as Launch Complex 33 (LC-33), was constructed about six-and-a-half miles to the east of the headquarters. The WAC Corporal became the first rocket launched at WSPG on September 26, 1945 (Kennedy 2009:29). Around the same time, the recovered German V-2 rocket equipment began to arrive via railroad, generating a massive wave of activity at the new range. The development of the V-2 program under Project Hermes was quickly undertaken at WSPG, and the first American launch of a V-2 took place on April 16, 1946 (Kennedy 2009:37). The V-2 program at WSPG was active through the remainder of the 1940s. In addition to the V-2 work, Project Hermes developed a number of other experimental projects, including the Hermes A-1 and A-2 series, A-3 rocket, Hermes C1, Hermes II, and the Bumper series. The Air Force was also active at the range during this period, with the development of the MX-774, NATIV, and GAPA missile platforms, while the Navy developed the Aerobee and the innovative Viking atmospheric research rocket (Kennedy 2009).

While American missile technology progressed at WSPG, Western strategic planners were increasingly concerned by the Soviets' technological advances. These included the introduction of the Soviet Tupolev Tu-4 long range bomber in 1947, which was a reverse engineered copy of the Boeing B-29 Superfortress. The Tu-4 had a range of nearly 3,500 miles, which would allow it to reach targets along the US coast in a one-way flight. Even more worrisome was the end of the US monopoly on nuclear weapons on August 29, 1949, when the Soviet Union detonated its first atomic bomb at the Semispalatinsk Test Site in Kazakhstan (Kennedy 2009:70). Within a few short years, the Soviets had developed both the atomic bomb and the ability to deliver it to targets in Europe and the US, and this situation demanded a serious evaluation of the capabilities of the US early warning and air defense systems against the threat of atomic-bomb equipped Soviet bombers.

In response to the evolving Communist threat, the Truman administration in 1947 pledged to contain Soviet expansion in Europe, which became known as the Truman Doctrine. The same year, the National Security Act substantially restructured the US military and intelligence agencies, creating what would become the Department of Defense (DOD) and separating the Army Air Forces into the independent service branch of the Air Force. The creation of the Air Force initiated a period of friction with the Army as both organizations struggled to delineate under whose jurisdiction the development of new rocket and guided missile technology fell.

At WSPG, the division between the Army and Air Force was expressed in a lengthy debate about how the range was to be divided between the two service branches. This issue was finally settled by the Integrated Range agreement of 1953. The Integrated Range allowed the Army, Air Force, and Navy to use the same ranges and test facilities. It also effectively combined the

WSPG and Holloman ranges into a single large range accessible to all three service branches, but under the command control of the Army (Redmond 1957).

By the mid-1950s Research, Development, Testing, and Evaluation (RDT&E) work on missiles at WSPG had expanded beyond the V-2 and Hermes series into new, large solid propellant vehicles such as the Sergeant missile. Work on Project Hermes ended at WSPG in 1954. Although Project Hermes never produced a deployable ballistic missile system, it did make substantial contributions to the advancement of guidance, tracking, and propulsion technologies. It also played a major role in the growth of WSPG; at its peak in the early 1950s, the project directly employed more than 1,250 people (Kennedy 2009:61). Additionally, the Hermes C1 system, a design that dated back to 1946, was never built but served as the basis for the Redstone ballistic missile that was completed in 1952 (Redstone Arsenal 2015a).

Communist expansionism in Asia contributed to a pessimistic, if not paranoid, outlook in the West during the late 1940s and the early 1950s. By 1949, Communist forces under the leadership of Mao Zedong had prevailed over the Nationalists in China, forcing Chiang Kai-Shek and the remnants of his government into exile in Taiwan. Soviet forces had occupied the northern half of Korea since 1945, ostensibly in preparation for the invasion of Japan, but continued to entrench themselves following the surrender of Japan. In agreement with the Soviet Union, the US had occupied Korea south of the 38th Parallel, and by 1948 independent governments had been established in both halves of the country. This temperamental stalemate finally broke on June 25, 1950 when North Korean forces invaded South Korea, initiating the US involvement in the Korean War.

The Korean War ended in 1953 and reestablished the boundary between North and South at the 38th Parallel which remains today. The Korean War was significant in that it clearly demonstrated that the US could no longer simply rely on the tremendous surplus of WW II-era conventional weapons, but would need to devote more energy and funding to the development of new technology and weapons. The Korean War also demonstrated that the threat of nuclear weapons was not enough to prevent the outbreak of conventional warfare in regional conflicts, in which the consequences of deploying nuclear weapons outweighed their strategic value (Kennedy 2009:72). It also was the first of several proxy conflicts where the Cold War superpowers would indirectly engage each other via limited wars in satellite states (Salmon 2011:14).

After the onset of the Korean War, spending on defense increased drastically, and programs such as the Nike Ajax, which had progressed slowly through the 1940s due to lack of support, were placed on expedited schedules. Kennedy (2009:72) notes that in 1951, Army spending on missile programs was increased to $55.4 million dollars, nearly equal to the $56.5 million dollars that had been allocated in the five-year period from 1944 to 1949. This re-invigorated efforts to develop new tactical missiles and a nationwide network of air-defense systems. The Navy, Air Force, and Army independently developed ground-to-air defensive missile systems during the 1950s.

This period also saw the release of the Corporal missile, the Army's first surface to surface tactical missile. The Corporal was a large liquid fueled missile capable of delivering a nuclear warhead at ranges up to 75 miles. The Corporal was tested at LC-33, and the improved Type II Corporal first flew at WSPG in 1953. The Corporal tactical missile was the culmination of the JPL Corporal series of research vehicles, and was essentially rushed into production to meet the Army's need for a surface to surface missile. It was rather unwieldy and complicated to launch in the field, and only remained in service until 1964 when it was replaced by the more reliable and field-worthy Sergeant missile. The Hawk missile, primarily tested at LC-32, was also under development by the mid 1950s. The Hawk missile and its various improved versions provided a portable, versatile anti-aircraft missile that remained in service for decades. The Navy utilized LC-35 in the development of the Talos anti-aircraft missile during the 1950s, which entered service in 1959. A short-lived prototype of a land-based Talos air defense installation, the Talos Defense Unit, was also tested from 1957 to 1959 at what is now LC-34.

Figure 12. A Nike-Ajax launch at the Red Canyon Range in 1956 (*photo by JP Moore, courtesy frontier.net)*.

Between 1954 and 1957 Army anti-aircraft gun batteries across the country were converted to missile battalions armed with the Nike-Ajax missile, America's first guided air defense missile (Berhow 2005:19). The training of these battalions was a major undertaking for the Army, and in 1953 the Red Canyon Range Camp was established in the northeast corner of WSPG for the training of air-defense units. In addition to training soldiers in how to operate and launch the missile, the camp also served as an important tool for educating foreign and public officials about the Nike Ajax. From 1953 to 1959 the camp hosted more than 10,000 visitors from 45 countries and 40 states, and approximately 3,000 Nike Ajax missiles were launched from the site (Eckles 2013:241). Much of the Nike Ajax, and later the Nike Hercules, RDT&E work was completed at WSMR Launch Complex 37 (LC-37) during the 1950s.

The technology and capabilities of ballistic missiles evolved very quickly during the 1950s, and by the end of the decade an attack by long range ballistic missiles eclipsed fears of a strike via bomber aircraft. By 1957, it was apparent to the military establishment that the future of long-range delivery of nuclear weapons was not with aircraft but with long-range ballistic missiles, generally referred to as Inter-Continental Ballistic Missiles (ICBMs) or shorter range Medium and Intermediate Range Ballistic Missiles (MRBMs and IRBMs). The arcing trajectory and extremely high speeds of these missiles made their detection and interception very difficult, much more so than conventional bombers. Additional impetus was given to the development of anti-ICBM defense systems by the successful launch of a Soviet ICBM in August 1957, followed by the launch of Sputnik I in October of that year (Missile Defense Agency 2009). American efforts lagged behind the Soviets, and the fear that the Soviets held the strategic advantage in missilery became known as the Missile Gap. John F. Kennedy successfully used the Missile Gap as a campaign issue in his 1960 presidential bid (Werrell 2005:186), and it also added urgency to the US Space Program, energizing the Space Race. Variants of the Redstone missile, whose origins could be traced directly to Project Hermes, launched into the orbit the first American satellite in 1958 and the first American astronaut in 1961 (Kennedy 2009:61).

The anti-aircraft oriented air defense systems created by the Army and the Air Force (the Nike Ajax and Hercules and the Air Force BOMARC) were ineffective against ICBMS and IRBMs, which rendered these sophisticated systems semi-obsolete. These systems were designed for intercepting aircraft, which approached at low angle trajectories at lower speeds and altitudes than ballistic missiles. Due to the high angle trajectories and very high speeds of IRBMs and ICBMs, the window for interception is minimal; early ICBMS traveled at speeds up to 5,000 miles per hour at altitudes up to 100 miles. This required powerful early warning radar networks, long-range precision guidance systems, rapid automated responses, and high-performance missiles that simply did not exist as of the late-1950s (Schaffel 1991:255-256). Accordingly, next generation Ballistic Missile Defense (BMD) and Anti-Ballistic Missile (ABM) systems became the primary focus of land-based air defense systems. The Army began to modify the existing Nike program into a BMD system known as the Nike-Zeus in 1957, while the Air Force gradually phased out its BOMARC installations and focused on its early warning radar and ICBM programs.

Figure 13. A West Point Class poses in front of the Nike Zeus at WSMR (*photo courtesy US Army Space and Missile Defense Command)*.

WSPG was re-designated White Sands Missile Range (WSMR) in 1958, a change that reflected the emphasis on the development of ICBMs and BMD systems that were a major focus at the time due to the Missile Gap and the ongoing Cold War arms race. In 1962, WSMR initiated the Advanced Ballistic Re-Entry Systems (ABRES) program, which studied the re-entry characteristics of ICBMs using the sophisticated Radar Advanced Measurement (RAM) and Radar Advanced Measurement Program for Analysis of Re-entry Techniques (RAMPART) systems. The goals of this program were to improve both offensive and defensive systems (Feit et al. 2014; WSMR 1968a). The ABRES program established the WSMR Green River Test Site (GRTS), in Green River, Utah. It served as a launch site for the Air Force Athena missile, which impacted at White Sands. The ABRES program launched Athena missiles from Green River to WSMR until 1973. Following the Athena launches, the GRTS served as the launch area for the Pershing missile through the mid-1970s (Feit et al. 2014; WSMR 1968a).

In addition to ICBM and BMD development, WSMR made important contributions to the American Space Program. During the late 1950s and 1960s the centralized tracking, command, and communications networks pioneered by Ozro Covington at WSMR became the basis for the global networks created for support of the Mercury and Apollo Programs. WSMR participated in the tracking networks for the Mercury, Gemini, and Apollo Programs, using the AN/FPS-16 radar to track the orbiting spacecraft (Corliss 1974; Tsiao 2008). Across the San Andres Mountains from WSMR, the NASA Johnson Space Center established the Propulsion Systems Development Facility (PSDF) in 1963 to support the development of Apollo propulsion and power systems. In 1965, the PSDF was renamed the White Sands Test Facility (WSTF) and it continues to be an important test facility of the Johnson Space Center today (NASA 2015).

WSMR also provided a launching location for testing of the NASA Little Joe II vehicle. The Little Joe II was specifically designed to test the Apollo Launch Escape System (LES), which separated the Apollo Command Module from the main vehicle body in the event of an emergency abort. The Little Joe II and the Apollo LES were tested at LC-36 between 1963 and 1966. LC-36 had formerly been the home of Redstone missile testing at WSMR.

As the American Space Program coalesced, the US and Soviet relations reached a dramatic nadir during the Cuban Missile Crisis in 1962. Cuba, whose communist government had been established in 1959, agreed to host Soviet MRBM and IRBM installations in mid-1962. These missiles were equipped with nuclear warheads and could easily reach much of the continental US. The US promptly established a blockade against further Soviet missiles entering the country and demanded that the existing installations be dismantled, resulting in a tense 13-day standoff with the Soviet Union in mid-October of 1962. The stalemate was probably the closest that the two nations came to an actual nuclear exchange during the Cold War. A settlement was reached between President Kennedy and Soviet Premier Nikita Khrushchev, where the Soviets would remove the nuclear weapons from Cuba in exchange for the US secretly removing nuclear equipped Jupiter MRBM installations in Italy and Turkey. As a result of the crisis, both the US and Soviet Union undertook steps to improve communications, as expressed in the establishment of the Moscow-Washington teletype hotline in 1963 (Salmon 2011:23).

On June 5, 1963, President John F. Kennedy visited WSMR to view a series of missile demonstrations, an event known as Missile Exercise White Sands or Project MEWS (Eckles 2013:291). While the visit was brief, President Kennedy viewed firings of the Honest John, Little John, Sergeant, and Hawk missiles from LC-32, followed by launches of the Nike Hercules, Navy Talos, and a Nike Zeus at LC-37 (Eckles 2013:292-293). The timing of President Kennedy's visit to WSMR was not coincidental, with the Cuban Missile Crisis less than a year behind and the Missile Gap and Space Race still very prominent in the public consciousness. Earlier in the year President Kennedy attended a similar demonstration at Redstone Arsenal, and during the same tour he also visited the US Air Force Academy and NORAD in Colorado. After the visit to WSMR, he continued on to the Naval Ordnance Test Station, China Lake, California where he observed another series of weapons demonstrations. These highly publicized visits helped to encourage the public's confidence that America's military and technological prowess remained competitive against that of the Soviets (Eckles 2013:291).

Figure 14. President Kennedy shakes hands during his June 5, 1963 visit to WSMR (*US Army photo)*.

During the early 1960s, the Army became concerned with the concept of Forward Area Air Defense (FAAD). FAAD focused on ways to protect frontline forces from low-flying strafing attacks from jet aircraft, and also focused on weapons that could counter the quickly evolving threat of tactical helicopters. FAAD revolved around the development of highly mobile air defense systems that could keep pace with troop movements in the field or be man-portable, attributes that even the mobile Hawk system did not possess. Several systems were developed in the effort to meet the need for FAAD defense, but not all were successful. The Mauler system, a self propelled anti-aircraft missile unit, was tested at WSMR in the early 1960s before the concept was abandoned due to a variety of technical problems. The more successful, man-portable Redeye system was also tested at WSMR during the 1960s, and was eventually developed into the Stinger portable antiaircraft missile. The Chaparral antiaircraft missile was a self propelled unit that utilized a missile based on the Navy-developed Sidewinder, and was also under development at WSMR by the late 1960s.

Despite the thaw in US-Soviet relations following the Cuban Missile Crisis, the US soon became entrenched in another war against an expansionist Communist state in Asia. After a purported North Vietnamese attack on the USS Maddox and the USS Turner Joy in August 1964, known as the Gulf of Tonkin incident, Congress passed a resolution proposed by President Johnson to commit conventional US military forces to the conflict without an actual declaration of war (Lavin 1998:40). The military build-up on both sides of the conflict rapidly escalated in the following years, with the North Vietnamese Army (NVA) committing conventional military and supporting the massive guerrilla campaign of the Viet Cong in South Vietnam. In January 1968, the NVA and Viet Cong launched the widespread Tet Offensive across the country, which caught US forces by surprise but ultimately was a tactical failure. However, the Tet Offensive was an ideological success in that it made a victory in Vietnam seem unlikely to the American public and caused a dramatic increase in the already simmering opposition to the war (Lavin 1998:40; US Army Center for Military History 2009:214).

The 1960s were also an important period of development for a variety of tactical anti-tank missiles at WSMR. The Shillelagh missile, a guided missile that was designed to be fired from the barrel of the lightweight Sheridan tank, incorporated significant developments in line-of-sight guidance technology. The Shillelagh/Sheridan system did not prove to be very successful in the field, but its guidance system was improved and incorporated into the Tube-launched, Optically- tracked, Wire-guided (TOW) anti-tank missile. The TOW was one of the most successful portable anti-tank missiles ever designed, variants of which were used well into the 21st century. Both the Shillelagh and the TOW were tested at the SMR, and the anti-tank mission continued at the SMR into the 1970s with testing of the man-portable Dragon system and the Copperhead guided artillery shell.

The incoming Nixon administration in 1969 inherited a very unpopular war, and began to take steps to withdraw US forces while leaving South Vietnam intact. These efforts finally led to the signing of the Paris Peace Accords in 1973, which established a temporary ceasefire and allowed the withdrawal of US forces from Vietnam. South Vietnam nationalist forces were expected to maintain the partition against North Vietnam without further US support. The ceasefire was short-lived, and by 1975 the South Vietnam government had collapsed and Vietnam was reunified under a Communist regime (Salmon 2011:26).

Despite reduced spending on research and development due to the cost of supporting the Vietnam War, technological advances continued to be made at WSMR. During the early 1960s, the Nike Zeus Ballistic Missile Defense system was tested at WSMR, after which field testing operations for the missile were moved to Kwajalein Missile Range in the Marshall Islands. The Nike Zeus was not deployed as a BMD system due to several concerns about its targeting capabilities. The improved Nike X system was developed at WSMR and incorporated a modified Nike Zeus missile, now renamed the Spartan missile, and the high-speed Sprint missile. The Sprint was developed and tested at WSMR at LC-50 (Eckles 2013:9). The Nike X also incorporated a new phased array radar system that was capable of detecting and tracking multiple targets simultaneously, a major advance over the Nike Zeus. The prototype of this system, the Multi-Function Array Radar (MAR), was built and tested at WSMR during the early 1960s (Eckles 2013:456; Lonnquest and Winkler 1996:111). The Nike X served as the basis for the Sentinel and Safeguard BMD systems proposed during the 1960s.

The Sentinel BMD system, reorganized as the Safeguard system in 1969, possessed political momentum even though the prevailing anti-military sentiment of the time made the systems unpopular with the public, particularly in cities where the missile batteries were to be installed. The Federation of American Scientists added intellectual weight to the grass roots movement that opposed the installation of a nationwide BMD system (US Army Center of Military History 2009:214). During the same period, the Soviet Union also developed and fielded a series of BMD systems, including the Griffon, Galosh, and Gammon (Werrell 2005:189-191). The Soviet investment in BMD systems was much higher than that of the US, estimated at $4 to 5 billion dollars by 1967 compared to the $2 billion dollars expended by the US (Werrell 2005:191). The continuing cost of developing these systems in order to maintain parity with US BMD technology likely influenced Moscow to engage in arms limitation talks.

In 1969, the first of the Strategic Arms Limitation Treaty (SALT) talks was conducted in Helsinki, Finland. The SALT talks eventually led to the signing of the Anti-Ballistic Missile (ABM) Treaty by the United States and Soviet Union in 1972. The ABM Treaty limited the number of both deterrent and defense missile systems, and while research and development of these concepts continued, it was at much diminished scale for the remainder of the Cold War. By the mid-1970s the ABM Treaty, along with increasingly negative public sentiments, ended the era of nationwide anti-aircraft and BMD systems. The funding for BMD systems dropped from around $1 billion dollars annually in the late 1960s to one-tenth that amount by 1980

(Werrell 2005:196).

Despite the reduction in defense budgets in the 1970s, pioneering efforts in new technology continued at WSMR. Examples include early work on lasers and the study of atmospheric effects on laser beams (Eckles 2013:453). This work culminated in the Mid-Infra-Red Advanced Chemical Laser (MIRACL) which was first fired or "lased" in 1980 (Federation of American Scientists 2015). In 1976, WSMR was selected as the site of the DOD-wide laser development facility known as the High Energy Laser System Test Facility (HELSTF), construction of which was undertaken at the former MAR site during the early 1980s. By 1980, a detachment of the Navy responsible for the testing of sub-systems related to the Sea Lite Beam Director was stationed at WSMR (Bingham 1980:14). HELSTF was completed and officially operational in 1985, and the same year the MIRACL laser was used to destroy a static Titan I booster (Bingham 1985:10).

The Army's search for viable FAAD antiaircraft systems continued into the 1970s. While the Chaparral missile was developed into a deployed system, its performance was not optimal in all weather conditions and it was slow to acquire targets. Seeking a more versatile solution, the Army awarded a contract for the development of an American version of the French-German Roland anti-aircraft missile. RDT&E firings of the Roland were conducted at WSMR during the 1970s and 1980s. Primarily due to the escalating costs of the project, the Army Roland program was substantially scaled down and the weapon system was only released on a very limited basis. In the interim, significant improvements were made to the Chaparral, obviating the need for the Roland. With improved all-weather and targeting capabilities, the Chaparral remained in Army service until the 1990s.

The reduced funding levels and transition to a volunteer force in the 1970s left the Army understaffed and poorly equipped, a period that historian Mary Lavin refers to as the "Hollow Army" (Lavin 1998:52). However, by the mid-1980s the state of readiness of the Army conventional forces was substantially improved due to the increased defense budgets of the Carter and Reagan administrations (Lavin 1998:52). The Reagan administration also launched the Strategic Defense Initiative (SDI), a plan that would protect the US from a ballistic missile attack using, in part, advanced concepts such as orbiting intercept systems and lasers. The SDI was promoted as an alternative to the deterrent measure of massive nuclear retaliation. The concept of massive retaliation, or Mutually Assured Destruction (MAD), as a deterrent to nuclear attack was established during the 1950s. MAD remained the major defense strategy against an ICBM attack since ABM systems had been banned by treaty in 1972. With the SDI, President Reagan sought to "create a nationwide defense shield against ballistic missiles that would make nuclear weapons impotent and obsolete" (Werrell 2005: 198; Lonnquest and Winkler 1996:116). Although the deployment of BMD systems like those proposed in the SDI would violate the ABM Treaty, there was no limitation on their research and development. The SDI program never produced a functional system, but proponents of the effort hold that it hastened the end of the Soviet Union by forcing it to invest in unproductive defense programs that overburdened its already stagnant economy (Lavin 1998:58; Salmon 2011:28; 32).

The HELSTF facility and MIRACL programs at WSMR were part of the effort to develop laser weapons for the SDI (Eidenbach et al. 1996:189; Eckles 2013:455). The Patriot Surface to Air Missile (SAM), which would later become well known to the American public during the Gulf War, was also developed in this period and deployed in 1984 (Werrell 2005:202-203). The Patriot proved to be an effective BMD system against the Soviet-designed Scud missiles, and was the only US BMD system actually used in combat (Werrell 2005:204). Also during the 1980s, the NASA WSTF became home to the primary ground terminal for the NASA Tracking and Data Relay Satellite System (TDRSS), which continued the long association of WSMR with the American Space Program. The TDRSS is the modern descendent of the NASA global networks used for the Mercury and Apollo Programs (Tsiao 2008).

In DOD guidance, the year 1989 is generally acknowledged as the end of the Cold War period, when revolutions against the Communist regimes in Poland, Hungary, East Germany, Bulgaria, Czechoslovakia, and Romania initiated the dissolution of the Warsaw Pact and the Soviet Union. However, the Soviet Union was not officially dissolved until December 26, 1991. After the collapse of the Soviet Union in 1991, WSMR focused on the development of technology and weapons suited for the changing nature of defense programs in the Post-Cold War era. Examples of these systems include the Theater High Altitude Area Defense (THAAD) missile, a modernized BMD system, and the Tactical High Energy Laser (THEL) System (Eckles 2013).

6.4 Fundamentals of Missile Ranges

Army guidance for determining historical significance under the NRHP criteria has categorized Cold War-era missile ranges as belonging to the sub-theme of *Proving Grounds* under the encompassing *Materiel Development* category (Lavin 1998). These facilities do not operate in a vacuum, however, as "the relationship between proving grounds and RDE (*sic*) centers is complimentary and mutually supportive" (Lavin 1998:70). So it is important to make the distinction between an entire military facility dedicated to the mission of testing rockets and missiles and the individual facilities within the larger range that contribute to an actual live rocket or missile test. Missile Ranges are discreet entities and, by their potentially catastrophic failures in launch and impact phases, are typically far removed from populated areas.

There are only a handful of actual land-based missile test ranges in the US. The largest are WSMR and the Naval Air Weapons Station (NAWS), China Lake, California. Containing land masses of approximately two million and one million acres, respectively, these ranges are designed to accommodate safe launches as well as ample impact areas for modern missile systems which can travel extraordinary distances. There are also missile test sea ranges, such as the Eastern Test Range and the Navy's Point Mugu, where land or ship-based launches occur and fall safely into the ocean. However, the logistics of locating instrumentation sites and the recovery of launch vehicles and related materials are much more complicated at these over-water ranges. This makes the land-based ranges particularly valuable assets, especially for types of testing that require extensive instrumentation and data collection.

A great deal of research and effort goes into getting a test missile or rocket to the actual launch phase, much of it done in partnership with private industry. A single missile is often comprised of thousands of components, the design and testing of which requires the efforts of numerous engineers, technicians, and sub-contractors. A "launch complex" serves as the final destination for a test article prior to launch, consisting of a distinct collection of buildings and structures designed to prepare the missile for lift-off. Depending on the type of launch complex, typical support facilities include launch pads, control rooms, assembly buildings, environmental conditioning chambers, general maintenance facilities, blast barricades, munitions storage magazines, instrumentation shelters and support buildings, and miscellaneous facilities. Depending on the range and the types of missiles undergoing testing, the building types, construction methods, and sizes can vary greatly.

Central to all launch complexes is a launch or flight control building from which all launches are controlled. Again, launch control building formats are largely determined by the type of vehicles being tested and can range from simple barricades to elaborate, reinforced concrete bunkers. However, almost all are permanently constructed and offer some degree of impact protection. At LC-32, the original control buildings are robustly constructed, but modestly sized, concrete blockhouses. The Sergeant blockhouse (Property 20525) is incorporated into an assembly building, a somewhat unusual configuration, while the Hawk blockhouse (Property 20542) is an independent, free-standing building.

As mentioned earlier, missiles are comprised of numerous components, most of which arrive for testing as individual components. These typically include the missile or rocket body, motor (fueled either by liquid or solid propellant), electronic guidance systems, fuze (detonator), and warhead. These are put together for testing in a specialized assembly building that usually incorporates a characteristic two or three story “high bay” portion designed to accommodate overhead cranes and upright assembly of the missile. As with other launch complex infrastructure, the types, construction methods, and sizes of assembly buildings are determined by the needs of the missile undergoing assembly.

The pre-launch process can also include environmental conditioning of test articles before launch, particularly subjecting a launch vehicle to extreme heat or cold in order to evaluate performance during unfavorable conditions. Depending on the facility, the environmental testing may be housed in simple, steel-frame buildings or in reinforced concrete structures to house the heat and cold conditioning. In some cases, conditioning is not used to simulate climatic extremes but instead to maintain a missile within a prescribed temperature range prior to launch to ensure its correct operation and performance.

Launch pads come in a variety of configurations from simple concrete pads to elaborately configured structures with built-in instrumentation, electrical, and control systems. Most missiles are launched from removable steel frameworks or purpose built launchers which serve as the mounting structure. The Navy also employs actual shipboard-type missile launchers at their launch complexes, as seen at LC-35. In and around the launch pad are a variety of steel superstructures, some that serve as overhead gantry cranes, others for instrumentation mounts. Conversely, depending on the type of missile, the launcher could be completely mobile, mounted on a truck, trailer, or armored vehicle.

Immediately adjacent to launch pads can be found the ubiquitous blast barricade. These barricades are designed to provide protection for personnel and properties from testing activities that produce heat and flame or that might result in an accidental explosion (Thompson and Tagg 2007). The most common type are simple earthen berms, which offer excellent protection with a minimal investment. In some cases, these berms are mantled with asphalt to protect them from erosion, and this type is the most common at LC-32. Other blast barricades are constructed of reinforced concrete or heavy timber structures infilled with earth. Both of these types of barriers are also found at LC-32.

Munitions storage magazines are also typically found in the vicinity of launch facilities. While the use of live warheads is not routine in missile testing, it does occur and accommodation for the safe storage of such components must be considered. Often the magazines are used for storing squibs, fuzes, or arming devices that possess a small explosive charge. The simple, "box-type" is found at LC-32; larger, igloo-types are also commonly found within the vicinity of missile launch sites.

Common to all missile launch complexes are the often-overlooked below-grade cable trenches. Cable trenches are subterranean reinforced concrete channels designed to be regularly accessible and are simply covered with heavy steel plates that can support vehicular loads. Similar features used for the installation of cables into conduit are known as pull boxes. With more permanent and often distant facilities such as camera shelters, the cables are installed into buried conduit with interspersed pull boxes, whereby technicians can pull the cables through the conduit from grade. Like blast barricades and munitions magazines that provide protection for technicians, it is critical to protect electrical and control wiring from the force and heat generated from the launches themselves. Subterranean routing also serves more prosaic functions; as with urban utilities, underground installation reduces surface clutter and protects cables from traffic and weathering.

During and after launch, a test article's flight characteristics are captured through a variety of instruments. Missile range instrumentation consists of two major types: optical and electrical. Optical instrumentation includes tracking telescopes, fixed and tracking motion picture cameras, and cinetheodolites. Cinetheodolites combine a motion picture camera with a theodolite, recording azimuth and elevation data on the film of the test flight. Electrical instrumentation consists primarily of radar and telemetry systems. Instrumentation radars such as the AN/FPS-16 provide high accuracy measurements of the test article's speed and position in space, and complement other data collection methods during test events. Radars are also critical for maintaining range safety as they allow range control to monitor a missile's trajectory in real time. If the missile begins to move outside its designated flight corridor, it can be shut down remotely to prevent the missile from entering populated areas. Telemetry systems use sensors on-board the test vehicle to relay information regarding its operation to ground recording stations via radio transmission. Typical telemetry data includes measurements of skin temperature, internal pressures, battery levels, fin positions, and timing information (Eckles 2013:156). Each of these instrumentation devices is carefully synchronized to a central timing station to assure the varied types of data are precisely aligned in time. Similarly, all range instrumentation is integrated into a precisely surveyed spatial grid that covers the range horizontally and vertically. This allows all instrumentation measurements of a test article's flight path to be translated into highly accurate spatial coordinates. Support infrastructure for range instrumentation is typically substantial – entire buildings are utilized for instrumentation maintenance and storage, film processing, and workshops. At LC-32, ribbon-frame camera stations were positioned along the north and south boundaries of the complex and camera instrument pads were strategically positioned around both the Sergeant and Hawk launch areas. Later programs at LC-32 mostly relied on mobile instrument mounts that did not require the construction of permanent instrument pads. High quality instrumentation allows missile ranges to capture the data needed to properly test and evaluate missile systems, and is also essential to maintaining range safety. Eckles (2013:157) relates that for every significant test at WSMR, about half of the data collection equipment used is dedicated to maintaining missile flight safety.

The destination of a missile after it is launched is an impact area or a target. Impact areas can be as simple as demarcated areas on the ground, and the missile's performance is evaluated by how closely it strikes the designated target zone. However, since the mid-1950s most missile systems are much more specialized and are designed to destroy aircraft, tanks, bunkers, or other missiles. For this type of testing more specialized targets are required. Anti-aircraft missiles targeted "droned" surplus planes and dedicated aerial target drones such as the Ryan Firebee. In many cases, the missile's flight was programmed to pass within a close distance of the aerial target without actually impacting it, thus saving the drone target for another test while still verifying the effectiveness of the missile. Special telescopic optical instrumentation is used to record data on "miss-distance" for this type of testing. Drone aircraft made especially for missile testing were first manufactured in the 1950s, and remain a mainstay of test range targets today. Anti-tank missiles were tested against a variety of targets, including simple targets such as wire mesh stretched across wood frames. Live anti-tank missiles were fired at steel plate targets and obsolete tanks to evaluate armor piercing capabilities. Some missiles designed to strike other missiles require the use of target missiles, which are usually retrofitted from retired surplus missile systems. For some tests, WSMR launched missiles from off-range locations which safely impact within the range boundaries, allowing for the testing of long range systems over hundreds of miles. In the 1990s, the Hera Target Missile was used for this purpose and was assembled from surplus Minuteman ICBM boosters.

While the launch complexes at WSMR are widely variable as they were each designed to support different programs, most contain the typical launch complex elements as described here. In order to provide a more comprehensive consideration of LC-32, the other primary WSMR launch complexes and their defining programs are summarized in the following section. Following this discussion, a more detailed treatment of LC-32 and the programs it supported is presented. The specifics of the LC-32 building types, their function, individual descriptions, and physical integrity are discussed in Chapter 7.

6.5 WSMR Launch Complexes

The Launch Complexes at WSMR are primarily located along the north side of Nike Avenue at the southern end of the range (Figure 13). The identified launch complex areas along Nike Avenue are numbered LC-30 through LC-42, but not all of these locations have been developed. WSMR documentation indicates that LC-30, LC-31, and LC-39 to LC-42 as areas "reserved for launch complex expansion", and no construction is known to have occurred at these proposed launch complex locations (WSMR 1968b:63). WSMR literature indicates that LC-30 and LC-31 are the two launch complexes nearest the main cantonment; however, neither of these locations is associated with any substantial programs or construction (WSMR 1968b:63) and LC-32 is the first launch complex encountered east of the cantonment with substantial built environment (Eckles 2013:7). Originally the launch complexes at WSPG were known as "Army Launch Areas", and LC-33 was Army Launch Area 1, LC-32 was Army Launch Area 2, and so on. The most commonly cited explanation for the change in numbering, though possibly apocryphal, is that it was a product of the competition between Cape Canaveral and WSMR as launch locations for the emerging space program. WSMR advocates wanted to compare more favorably with the dozens of launch complexes at Cape Canaveral, so the launch complex numerical designations were arbitrarily started at 32 to sound more impressive (Eckles 2013:7-8). The primary launch complexes are summarized beginning with LC-32, and then moving east along Nike Avenue. Other launch complexes located elsewhere at WSMR and off-range are also summarized below following the Nike Avenue areas.

6.5.1 Launch Complex 32 (LC-32)

LC-32, originally Army Launch Area 2 (ALA 2), was established in 1955 in support of Hawk and Sergeant missile testing. The Hawk launch area was located at the east end of the complex, and the Sergeant at the west. This created a symmetrical plan for the complex, and both the Sergeant and Hawk areas were designed with roughly similar layouts and features. Each area had an independent blockhouse and launch pad connected by a subterranean cable trench, along with attendant blast barricades, assembly buildings, and assorted infrastructure. The early symmetrical design of LC-32 was gradually modified and expanded through the 1960s in support of the Hawk program, and eventually included a series of aerial target launch complexes along its eastern margin. As of 1968, the complex included four launch pads, a blockhouse, and buildings for missile assembly, maintenance, check-out, communications, and storage (WSMR 1968b). The complex was still primarily identified with the Hawk and Sergeant systems into the late-1960s. By the 1970s, the Sergeant missile was retired from Army service but testing of improved versions of the Hawk system continued at LC-32. The Roland anti-aircraft missile RDT&E program was conducted at LC-32 beginning in the 1970s, and aerial drone target launch complexes were installed at the complex in the years 1975 to 1977. Other secondary programs that passed through the complex included the canceled Mauler Missile of the 1960s and the Patriot Missile. During the 1990s, the Hera target missile was launched from LC-32 and a large climatic controlled assembly building and launch pad were constructed next to the former Sergeant Launch Pad. The Hera assembly building was constructed on rails and was moved away from the missile once it was ready to launch, in the same fashion as a gantry crane. More recently, the complex hosted the NASA Orion Launch Abort System test and the development of Japanese missile systems derived from the Patriot missile (Larry Carreras

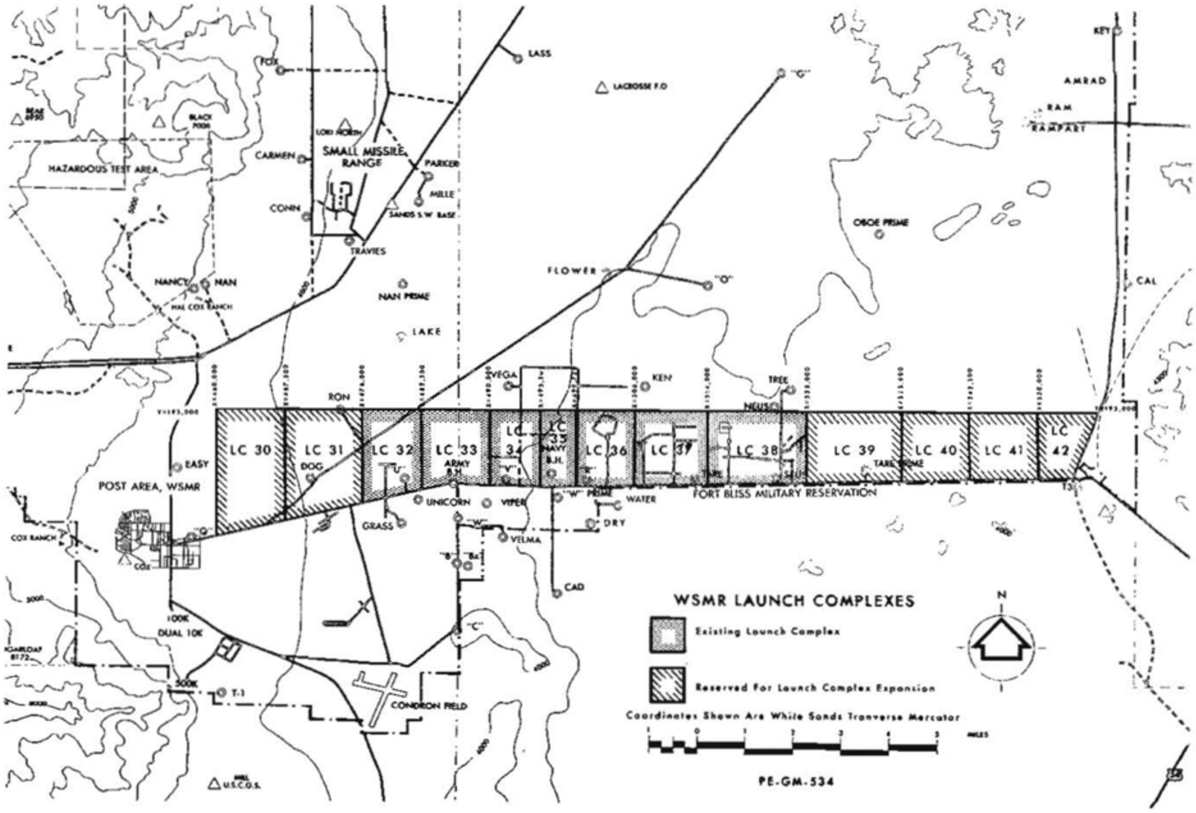

Figure 15. An overview map of the WSMR Nike Avenue launch complexes included in a 1968 summary report on the range (*adapted from WSMR 1968a)*.

personal communication 2015).

6.5.2 Launch Complex 33 (LC-33)

LC-33, originally Army Launch Area 1 (ALA 1), was the first launch complex established at WSMR and is the most well known for its historic associations with early rocket and missile launches at the range. The first rocket fired at WSMR, the WAC Corporal, was launched at LC-33 in the fall of 1945 (Eckles 2013:8). The first American V-2 launch took place at LC-33 on April 16, 1946 (Eckles 2013:179). It was the primary Army launch complex at WSPG until the mid-1950s, when the volume of test programs necessitated the construction of additional launch complexes such as LC-32 and LC-37.

One of the first support structures constructed at LC-33 was the Army Blockhouse, which was built at LC-33 between July and September of 1945 at a cost of $36,000. Constructed to protect personnel and control equipment during launches, the blockhouse is one of the oldest surviving buildings at WSMR (Eckles 2013:177-178). The blockhouse was intended to withstand the impact of a V-2 missile crash; although at the time of its construction no standards or guidelines existed for the construction of such a building. So the designers of the blockhouse, Dr. Del Sasso of Caltech and Lieutenant Colonel Harold Turner, simply relied on very robust reinforced concrete construction, essentially “overbuilding” the blockhouse (Kennedy 2009:28). The outer walls of the squat, square building are 10 feet of reinforced concrete; the pyramidal roof is

Figure 16. A V-2 on the gantry at LC-33 in 1951 (*courtesy WSMR Museum Archives)*.

24 feet thick at its apex while the floor of the building is eight feet thick (Kennedy 2009:28). The building enclosed 937 square feet of interior space that housed the firing controls and telemetry equipment. It is equipped with three viewing ports of blastproof glass along with a blastproof steel door, and was also equipped with wash-down system mounted on the apex of the roof to decontaminate the building exterior in the event of a liquid fueled missile explosion (Kennedy 2009:28).

One of the other early structures at the complex was the WAC Corporal Launch Tower. Standing 102 feet in height, it was constructed approximately 600 feet to the north of the blockhouse. The tower guided the WAC Corporal for the initial portion of its flight until it gained enough speed to self-stabilize, an arrangement that would soon also be used for the Navy Aerobee sounding rocket series.

The early V-2 firings took place near the WAC Corporal Launch Tower and relied on German field equipment to transport and erect the missile. The German designed and built *Meillerwagon* was a transport trailer with a built-in lift frame and hydraulics that lifted the V-2 into an upright position on the firing stand. An extendable ladder and the *Meillerwagon* lift frame provided access to the missile for additional preparation and servicing once it was in the vertical position (Kennedy 2009:38). This system was not ideal, and an improved gantry crane was constructed between August and November 1946. The gantry crane at LC-33 is of the launch complex's most visible structures. It consists of two 60 foot tall steel towers linked at their tops by upper cross members and is nearly 30 feet wide. The towers are affixed to railroad car wheels so that it can be moved along a set of tracks set into the concrete slab foundation of the launch complex. The gantry was equipped with a hoist at its top to aid in missile assembly and three sets of adjustable work platforms allowed stable access to the vehicle along its full height. After a vehicle was erected and prepped for launch, the gantry could be moved out of the way via the rails and electric motors that powered each wheel (Eckles 2013:176). The gantry was used to assemble V-2, Hermes, Corporal, and Viking missiles at LC-33 in the early days of WSPG.

LC-33 was also the location of several other historic early rocket and missile programs. These included the Navy Viking sounding rocket, which was launched from LC-33 before the program was shifted to LC-35 in 1952 (Kennedy 2009:98). Also flown from LC-33 was the Hermes missile series, a developmental contract with GE that began with the assembly and testing of the V-2, but also included an array of experimental projects. One was the Hermes A-1, an antiaircraft missile that was based on the German *Wasserfall* prototype. Another prototype was the Hermes II, which combined a modified V-2 booster with a second stage ramjet engine. It was a Hermes II that went off course on May 29, 1947 and crashed in the outskirts of Ciudad Juarez, Mexico (Kennedy 2009:57). The Bumper series, which combined a V-2 and a WAC Corporal into a two-stage sounding rocket, was also a Hermes project that GE developed in partnership with JPL (Kennedy 2009:49). The fifth launch in this series, the Bumper 5, reached an unprecedented altitude of 244 miles on February 24, 1949. At the time this was the highest altitude ever reached by a manmade object (Kennedy 2009:51). On October 4, 1946, a V-2 carrying a special camera assembled by Clyde T. Holliday captured the first images of the earth from space, showing the curvature of the earth clearly (Holliday 1950). Other missiles tested at LC-33 were the Corporal, the Army's first tactical missile, and early flight tests of the Nike Ajax before the program was moved to LC-37.

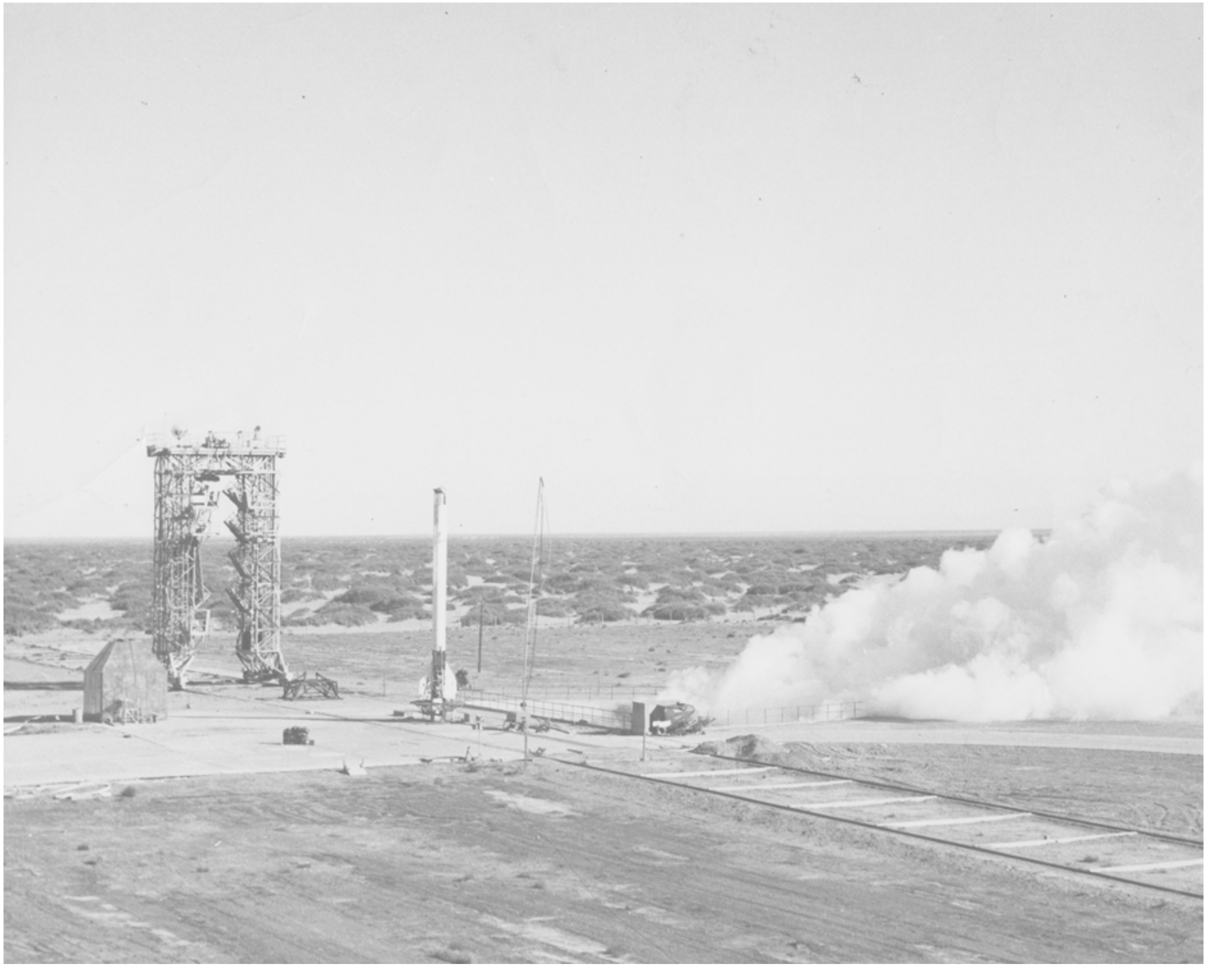

Figure 17. Static test of the Viking 7 at LC-33 in 1951. The LC-33 gantry is at the left of the photo (*courtesy WSMR Museum Archives)*.

LC-33 remained active through the 1960s, and a 1968 range summary described it as including 13 launch sites, two gantries, three blockhouses, several types of support buildings, and several explosive storage bunkers (WSMR 1968b:62). The WAC Corporal Launch Tower was dismantled after the completion of the program, but both the Army Blockhouse and V-2 Gantry at LC-33 are preserved as historic structures. The historic core of LC-33 was named a New Mexico State Historic Monument in February 1983, and was recognized as a National Historic Landmark on October 10, 1985. Portions of the LC-33 are still in use today in support of the Multiple Launch Rocket System (MLRS) and the Tactical Missile System (TACMS) (WSMR 2010).

6.5.3 Launch Complex 34 (LC-34)

LC-34 supported testing of a variety of anti-aircraft missile systems during the 1960s and 1970s. As most of the systems fired at LC-34 were either mobile or man-portable, the complex lacks the extensive support infrastructure associated with many of the WSMR launch complexes.

LC-34 was originally built to support the Redeye and Mauler anti-aircraft missile vehicle programs in 1962 (WSMR 1968b:62). The Redeye was a man-portable, shoulder fired anti-aircraft missile system that was designed to counter low altitude aircraft threats. It was designed to be used with the Mauler anti-aircraft missile to provide a layered FAAD system. The Mauler was a self-propelled vehicle based system, which was ideal for its intended application. However, the concept encountered many "packaging" and technological issues that slowed its development and ultimately led to its cancellation in 1965.

After the cancellation of the Mauler program, LC-34 was used in support of the Chaparral anti-aircraft system. Like the Mauler, the Chaparral was a mobile, self-propelled system. It was designed around the established Sidewinder heat-seeker missile, and the original prototype of the system was developed and tested at NAWS China Lake, California. The Army adopted the development of the system for use in FAAD in the wake of the Mauler program cancellation.

The Redeye missile underwent a series of improvements, and by the 1970s had evolved into the Stinger missile. The Stinger was a man-portable, shoulder fired missile like the Redeye, but was significantly more advanced. As an extension of the Redeye, Stinger firings were also conducted at LC-34; in September 1976, Sergeant Richard Vincell was the first Army gunner to fire the Stinger at LC-34 (Missile Ranger 1976:1).

In 1978, LC-34 hosted a joint firing program of the Roland missile. For this program, both French and German Roland units and the American adaptation of the missile were tested to evaluate compatibility and interchangeability of the different versions of the system (Missile Ranger 1978:17).

Beginning in 1974, testing of the Navy Rolling Airframe Missile (RAM) was conducted at LC-34. The RAM was designed to protect the fleet from anti-ship cruise missile threats and was a very successful program. Modern variants of the missile have been adopted by the navies of many allied nations. The RAM underwent an extensive improvement program and flight tests of the missile against drone targets were launched at LC-34. The complex also supported testing of various configurations of RAM missiles, support equipment, and launchers (WSMR 2010).

6.5.4 Launch Complex 35 (LC-35)

LC-35 is another early launch complex at WSMR, and was established in 1946 by the Navy Unit at WSMR. A blockhouse was constructed as part of the complex, and was essentially a slightly smaller version of the Army Blockhouse at LC-33. LC-35 is most well known for the USS Desert Ship LLS-1 (Land Locked Ship 1) which provides a realistic replica of a Navy ship for the testing of ship borne missile systems. The Desert Ship was added to the complex in 1951 (Eckles 2013:205). A replica deckhouse of a CG-10 class cruiser ship was added to the complex in 1954, to the west of the Desert Ship, and both remain in use today (WSMR Museum 2015b).

In 1947, the first launch tower for the Aerobee sounding rocket was constructed at LC-35. The Aerobee was a high altitude sounding rocket that was similar in concept to the older WAC Corporal but offered improved altitude and instrumentation capabilities. In 1965, the Aerobee launch tower at HAFB was relocated to LC-35 and established near the existing tower. The

Figure 18. A Talos missile on its launcher rail at LC-35 in 1958, USS Desert Ship in background (*courtesy WSMR Museum Archives)*.

Figure 19. A synchronized dual Aerobee launch at LC-35, date unknown (*photo from Jerry Crouch Collection)*.

dual Aerobee launch towers allowed the Navy to effectively double the instrument payload of the Aerobee by launching two at once. The first Aerobee double launch occurred on April 14, 1966 with the Aerobee launches occurring eight minutes apart (Eckles 2013: 204). Some later launches were synchronized, with both Aerobees launching simultaneously. The last Aerobee launch from the dual towers occurred in 1986; in later years the two towers were dismantled (WSMR Museum 2015b). Most of the research and sounding rocket launches are now conducted at nearby LC-36.

A replica ship deck was constructed to the north of LC-35 in 1949 for a test known as Operation Pushover. In these early days of V-2 testing, data was needed for many aspects of V-2 launches including the question of what would happen if a ready-to-launch V-2 toppled over on a ship's deck during a sea launch. Operation Pushover provided answers to this question, and a fully fueled V-2 was rigged to topple over onto the deck during the launch sequence. This caused a large explosion that ripped a substantial hole in the deck (Helfrich 2007:4).

The Navy Viking research rocket launches nine through 12 were launched from LC-35 after the program was relocated there from LC-33 in 1952. A gantry crane and a blast pit were added to LC-35 to support the Viking launches, and Viking 9 blasted off from LC-35 on December 5, 1952 (Helfrich 2007:4). Viking 12, the last of the series launched at WSPG, was fired from LC-35 in 1955 (Kennedy 2009). The Viking gantry was relocated to Cape Canaveral, Florida to be used with the Vanguard program, America's first satellite launch vehicle that was based on the Viking. The blast pit was filled in sometime around 1960 as it created pedestrian and vehicular hazards (Helfrich 2007:4-5).

LC-35 was a significant testing location for the Talos missile, testing of which was conducted at WSMR for over 20 years (Helfrich 2007:5). Rail launchers for the Terrier and Tartar missiles were also installed at the complex. Although the early RDT&E testing of the Terrier and Tarter was conducted at China Lake, California, the testing program for these missiles was consolidated to LC-35 in 1966 (Helfrich 2007:5; Kennedy 2009:144). During the mid-1960s, the development of the Advanced Surface Missile System began, and this evolved into the Aegis Combat System. The Standard Missile-2 and Aegis fleet fire control system were tested at LC-35 before the system entered Navy service in 1983 (Helfrich 2007:6).

In 1977, a Navy Mk 39 5/54 Gun weighing over 73,000 pounds was relocated to LC-35 as part of the testing program for the 5-inch Guided Projectile program (Helfrich 2007:6; WSMR Museum 2015b). A Mk 5 Guided Missile Launcher was moved to LC-35 in 1977 for testing of the Standard family of missiles, which included the Terrier Extended Range and Tarter Medium Range missiles. Standard Missiles were also launched as part of the Vertical Launch System (VLS) testing at LC-35 (WSMR Museum 2015b). The VLS allowed more missiles to be carried aboard ships and launched at higher firing rates. The VLS is now the standard launch system used by the US Navy (Helfrich 2007:6).

In more recent years, LC-35 supported testing of the Evolved Seasparrow Missile (ESSM), various improved versions of the Standard Missile family, Sea Lance, and Vertical Launch ASROC systems (WSMR 2010). The LC-35 5-inch gun was last fired in 1996, and it was moved to the WSMR Missile Park in 2006. The Mk 5 Launcher was also moved to the Missile Park in 2006 (WSMR Museum 2015b).

6.5.5 Launch Complex 36 (LC-36)

LC-36 was originally constructed for RDT&E support of the tactical Redstone missile. It originally included a single launch pad and a track mounted gantry large enough to assemble and prepare the large Redstone missile for launch. The Redstone launches at LC-36 ended by 1962, and the launch complex was then used by NASA for launches of the Little Joe II (Eckles 2013:9). The Little Joe II was a special purpose launch vehicle designed for the testing of the Apollo Launch Escape System (LES). The LES was an emergency rocket system that would pull the Command Module away from the launch vehicle in an abort situation, launching the crew to safety. The LES would then deploy a parachute recovery system for a safe landing (Dotts 1973). The Little Joe II followed the original Little Joe, which had served the same purpose for the earlier Mercury space capsule. As the Apollo capsule was much larger than the Mercury capsule, the Little Joe II was also larger in order to properly simulate the diameter of the Saturn rockets that were used to launch the actual Apollo space capsule. The Redstone gantry was modified for use with the Little Joe II, and the system was tested at LC-36 between 1963 and 1966, with launches simulating the LES system at various flight stages (WSMR Museum 2015c). On January 20, 1966 the final Little Joe II vehicle was launched from LC-36 and began a programmed tumble maneuver nine miles downrange at an altitude of nearly 15 miles; the LES functioned perfectly and fired the abort rocket carrying the command module away from the vehicle before landing by parachute (WSMR Museum 2015c).

Following the completion of the Little Joe testing, LC-36 was adopted by the Navy for a long series of sounding rocket launches. The Navy Research Rockets Branch at WSMR provided launch services at LC-36 for a number of organizations, often sponsored by NASA, Naval Research Laboratory (NRL), and the USAF (WSMR Museum 2015c). Many universities with upper atmospheric and space research projects had experimental payloads carried aloft by sounding rockets launched at LC-36, and the Navy and the New Mexico State University (NMSU) Physical Science Laboratory (PSL) provided the necessary technical support (WSMR Museum 2015c).

One of the most long-lived sounding rockets was the Aerobee, originally developed by the Johns Hopkins University Applied Physics Laboratory (APL) for the NRL. The Aerobee was based on the ORDCIT WAC Corporal, but was scaled up in order to carry a larger payload. The Aerobee was produced by the Aerojet Corporation, and the name is derived from "*Aero*jet" and the APL "Bumble*bee*" project. All Aerobee sounding rockets were tower-stabilized during launch, and a launch tower was established at LC-36 when the launches were relocated there in the 1960s. Additional facilities were added in 1968 for the Aerobee 250 test program (WSMR 1968b:64). Numerous Aerobee sounding rockets, including the 150, 250, and 350 series, were launched from LC-36. The distinctive Aerobee 350 launch tower at LC-36 is enclosed in its lower portion, with the tower extending through the apex of the pyramidal roof.

Another well-known sounding rocket, the Black Brant, was also launched from LC-36 beginning in the 1970s. The Black Brant was built by Canadian firm Bristol Aerospace and it was introduced in 1961. Like the Aerobee, there were numerous versions of the sounding rocket, with the Black Brant V (BBV) being one of the most popular. The larger BBV model was launched from the Aerobee 350 tower at LC-36 beginning in 1972 (WSMR Museum 2015c). The Black Brant series has an excellent success rate and remains in use today.

LC-36 continues to be used as the primary sub-orbital rocket launch facility at WSMR. As of 2010, it is described as including four active launchers with environmental shelters and one mobile launcher (WSMR 2010).

6.5.6 Launch Complex 37 (LC-37)

LC-37, originally known as Army Launch Area 3 (ALA-3), was the primary launch location for Nike Ajax and Nike Hercules RDT&E. Early testing of the Nike Ajax was located at LC-33, but it was gradually shifted to LC-37 during the early 1950s (Piland 2006a:4). The complex includes seven Nike launch sections with varying degrees of completeness; some were minimal installations while others included launch crew bunkers (Piland 2006a:4). The Integrated Fire Control (IFC) complexes for the Nike systems were located near the south end of the complex, just north of Nike Avenue. The various Nike tracking and guidance radars were

Figure 20. The Little Joe II on its launcher at LC-36 in 1966. The assembly gantry has just been removed in preparation for launch (*courtesy WSMR Museum)*.

co-located near the IFC complexes and were replaced and modified as the Nike series progressed from the Ajax, to Hercules, to Improved Hercules (Piland 2006a:5). At the west end of the complex are several Quonset buildings and the former Nike Assembly and Test building, as well as several Nike Ajax fueling stations (Piland 2006a:4).

Figure 21. A Nike Hercules missile on launcher rail at LC-37, July 1971 (*US Army photo)*.

The Hibex and Upstage missile programs were active at the complex in the late 1960s (WSMR 1968b:64). The Hibex launch area was established west of the Nike Assembly and Test building, and 10 Hibex missiles were launched there in 1965 and 1966. As the Nike Hercules missiles were phased out in the 1970s, the volume of activity at LC-37 gradually decreased. More recently, this area was converted to the THAAD launch area (Piland 2006a:5). The Advanced Gun Munitions Test Site (aka Squirt Site) was also established at LC-37, which consists of a gun mount structure, a permanent bunker, and a related concrete pad. The site was also used for firings of the VLS (WSMR 2010).

6.5.7 Launch Complex 38 (LC-38)

LC-38, formerly Army Launch Area 5 (ALA 5), was originally developed to support the development of the Nike Zeus Anti-Ballistic Missile system (Eckles 2013:9). The Nike Zeus was the nation's first missile specifically designed to intercept ICBMs and it was a complicated and elaborate system that required state of the art radar and computer systems. The Nike Zeus development was authorized in 1957, and the first firing of the Nike Zeus A occurred in August 1959 while the first launch of Nike Zeus B took place a year later. A total of 72 Nike Zeus launches took place at WSMR, and launches of the missile were also conducted at Point Mugu California, and at Kwajalein Island in the Pacific (Piland 2006b:5).

As originally built, the Nike Zeus launch area at LC-38 consisted of two RDT&E launch cells, each with an associated earthen blast berm. Another tactical launch cell was located in the launch area, which was also associated with a launch control building separated from the launch cell by an earthen blast berm. Additionally, the five radar facilities required for the detection, targeting, and guidance of the missile were located at various positions across the complex (Piland 2006b:4). Most of the assembly and checkout of the Nike Zeus was completed in a large hangar building known as Missile Assembly Building 16 (MAB 16) visible from Nike Avenue. A water tower located near this building is also prominent from Nike Avenue. A large igloo style building was located in the western portion of the complex where final assembly and explosives handling took place (Piland 2006b:4). The launch complex also included a dedicated airstrip and a mess hall, which was unique among the WSMR launch complexes (Piland 2007a:4).

The Nike Zeus eventually shifted into the more advanced Nike X, which became the basis for the Sentinel and Safeguard national missile defense systems. The Nike X system was a tiered ICBM defense that relied on two missiles: a modified Nike X known as the Spartan that targeted incoming ICBMs in the upper atmosphere and the Sprint missile for intercepting ICBMs that reached the lower atmosphere. The Nike Zeus missiles were launched from LC-38, while the Sprint was launched from LC-50 (discussed below). The Spartan missile was not tested at WSMR, but was launched from the Kwajalein and Meck Islands in the Pacific (Piland 2007b:4). The Spartan and Sprint missiles were eventually incorporated into the proposed nationwide Safeguard ICBM defense system, but due to the nuclear arms limitation treaties of the early 1970s, only one installation of the system was ever built.

After the Sprint program ended in 1970, LC-38 began to be used by Raytheon for the SAM-D program (Piland 2007b:4). The SAM-D system was eventually developed into the Patriot air defense system, and the Raytheon Patriot still utilizes the LC-38 facilities today (Eckles 2013:9; Piland 2007b:5). The SAM-D and Patriot program developed a new launch area to the north of

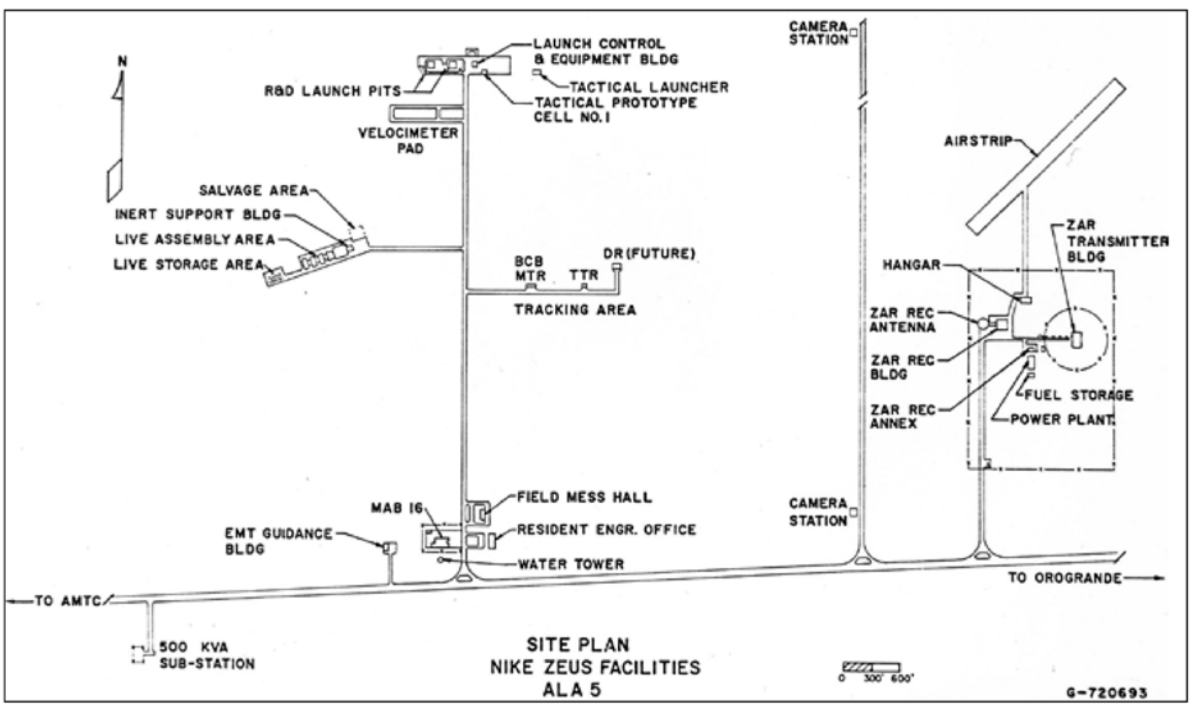

Figure 22. Layout map of LC-38 as it appeared during the mid-1960s (*adapted from Piland 2007)*.

the old Nike Zeus launch cells (Piland 2007b:5). The Vulnerability Assessment Laboratory (VAL) converted a shielded room within the Nike Zeus Discrimination Radar (DR) building to an Anechoic (non-reflective) chamber during the 1980s, but it was later destroyed in a fire (Piland 2007b:5).

Figure 23. A Nike Zeus missile on launch rail at LC-38, circa 1960s (*adapted from Piland 2006)*.

6.5.8 Launch Complex 50 (LC-50)

LC-50 was built expressly for the Sprint missile, which was part of the Nike X BMD system, later the Sentinel and Safeguard systems. Also known as the Sprint Site, the launch complex is located in a somewhat unusual location to the north of the Nike Avenue launch complexes and south of Highway 70 (Eckles 2013:9). The construction of the complex began in 1964 and the first Sprint launch took place on November 17, 1965 (Piland 2006c:5). The Sprint was a short range, high speed missile designed to intercept incoming ICBMs in the lower reaches of the atmosphere if they escaped interception by the longer range Spartan missile. At this stage in their flight, ICBM reentry vehicles are traveling at maximum speeds and the Sprint had to fly extremely fast to intercept them. The Sprint missile was most likely the fastest man-made object in the world at the time; it reached a speed of Mach 10 in approximately five seconds and generated acceleration forces of 100 Gs during its boost phase (Eckles 2013:9). In the words of Doyle Piland who worked with the Spartan system at WSMR and Kwajalein Island:

> In unclassified briefings, they would say that the time from launch until it had traveled a mile was less than a heartbeat. The words fast, quick, etc. are grossly inadequate to describe the Sprint. Sudden and instant are more appropriate words [Piland 2006c:4].

The Sprint was designed to be housed and launched from a protective silo, and several of these were constructed at LC-50. The silos were designed to be built underground, but the proximity to the water table at the LC-50 location required that the silos be constructed into an artificial hill to avoid inundating them. These above ground, but buried, silos at LC-50 were referred to as “test cells” (Eckles 2013:9). The Sprint missile was assembled and inspected at LC-38 then it was transported to LC-50 on a transporter/loader vehicle and loaded into the test cell (Piland 2006c:4). The mound included four such test cells, one of which was used for instrumenta-

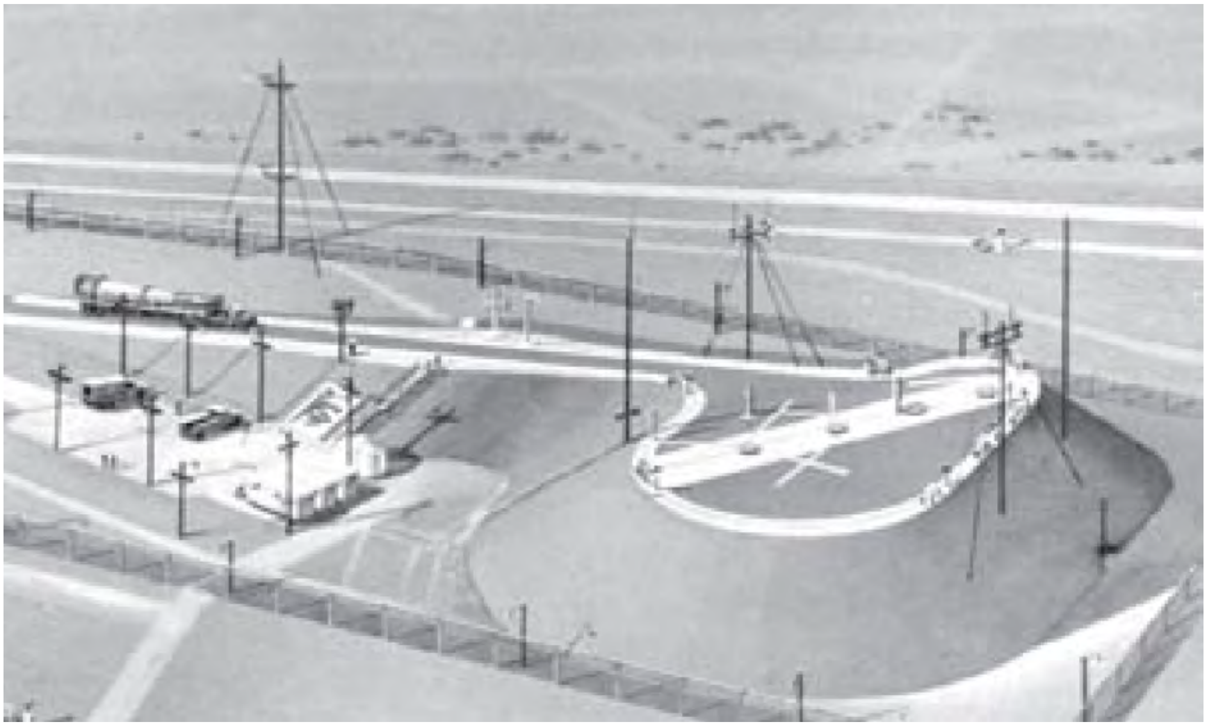

Figure 24. Concept drawing of Sprint launch complex at LC-50 (*adapted from Piland 2006)*.

tion only. A long ramp extending from the mound allowed access for the transporter/loader vehicles that delivered the missiles to the test cells. Built into the ramp was a bunker structure that served as a control room and a personnel shelter (Piland 2006c:4). At the bottom of each test cell, beneath the loaded Sprint missile, was a dome shaped device. This device acted as a piston, which was driven by an explosive charge. Upon launch, the Sprint was blasted out of the cell vertically by the piston device. The Sprint launched so quickly and with such minimal preamble that ordinary test cell doors would not open quickly enough. Instead the Sprint used expendable fiberglass and foam lids that were perforated by explosive charges as the missile launched, allowing the Sprint missile to blast through them as it exited the test cell (Missile Ranger 1968:4). The first stage of the missile fired after it cleared the cell by a few feet, rapidly accelerating it towards the target (Piland 2006c:4-5). At its maximum speed, the air drag on the missile's skin heated it hotter than the interior of the missile's solid propellant motor, causing it to glow incandescently (Federation of American Scientists 1998).

A total of 42 Sprint missiles were launched from LC-50, with the last launch occurring on August 12, 1970. During the third launch of a Sprint at LC-50 in March 1966, the missile's first stage exploded and destroyed the test cell. Fortunately, none of the personnel at the site were injured (Eckles 2013:9).

Designed expressly for the Sprint testing, LC-50 was not as amenable to adaptive re-use with different programs as other WSMR launch complexes. Its location away from Nike Avenue also made it less accessible. It is perhaps for these reasons that the complex appears to have seen little use since the Sprint program. Piland (2006c:4) notes that in recent years a few differ-

Figure 25. A Sprint missile blasts off at LC-50 (*courtesy WSMR Museum)*.

ent small missile test programs have been active at the site, but does not describe the programs.

6.5.9 The Small Missile Range

The Small Missile Range (SMR) is located north of Highway 70 and is not part of the Nike Avenue group of launch complexes. The SMR is a de facto launch complex, but also included downrange instrumentation and impact areas that allowed it to serve as a semi-independent sub-range within WSMR for the testing of small rockets and missiles. The SMR was established in 1953 and largely supported testing of the Loki anti-aircraft rocket, a barrage rocket system that was based on the German Taifun prototype. After the cancellation of the Loki program in 1955, the SMR continued to support a number of tactical missile test programs, particularly anti-tank systems. Testing of these smaller programs at the SMR kept the main launch areas along Nike Avenue available for bigger projects and also reduced the need for road closures due to over flights of US 70 (Eckles 2013:28). The SMR also featured an independent instrumentation network that allowed it to operate in a relatively autonomous fashion from the main range instrument network. The SMR instrument network consisted mostly of high-speed cameras that were suitable for the shorter ranges and altitudes anticipated of the SMR programs, and this network of camera shelters is one of the defining attributes of the complex.

Testing activities at the SMR began with the Loki Program in 1953, although further development of the Loki as an anti-aircraft weapon was halted in 1955. However, the Loki saw a much longer service life as the Loki-Dart sounding rocket. On the heels of the Loki, testing of the Little John Rocket began in 1956, and the Dart Anti-Tank Missile underwent testing at the SMR beginning in 1954. The Dart development was canceled in 1958, but it was the first of several anti-tank developments tested at the range. The Little John was tested at the SMR through the early 1960s, and continued to be used as a range workhorse test vehicle into the 1970s. These three programs were largely responsible for the construction of many of the buildings present at the range today.

The Lacrosse missile was tested at the SMR during the late 1950s and early 1960s, and briefly entered service before being retired in 1964. The anti-aircraft Redeye and Mauler systems were also tested in part at the SMR during the early 1960s prior to the establishment of LC-34, although only the Redeye entered service with the Army, eventually evolving into the Stinger system. Also during this period, the Shillelagh Program initiated testing and development at the SMR, beginning in 1963. The Shillelagh/Sheridan gun launched missile program was very active at the SMR throughout the 1960s. The TOW and Dragon anti-tank missiles were also tested at the SMR during the late 1960s and early 1970s. By the early 1970s, the Copperhead guided projectile, a non-rocket guided artillery round, began testing at the SMR. The Copperhead testing was the major testing activity at the SMR through the 1970s. Anti-tank weapon development at the SMR continued with the Kinetic Energy Missile (KEM) testing of the 1980s, including the Air Force Hyper-Velocity Missile and the follow-on Line-of-Sight Anti-Tank (LOSAT) missile in the 1990s.

The SMR also was an important location in the development of sounding rockets for the study of upper atmospheric conditions and meteorological research, and many examples of this technology were in fact pioneered at the SMR. The Loki-Dart, Super Loki, All Purpose Rocket for Collecting Atmospheric Soundings (ARCAS), XM-75, and High Altitude Research Project (HARP) gun launched probes all underwent testing and development at the SMR. Some of

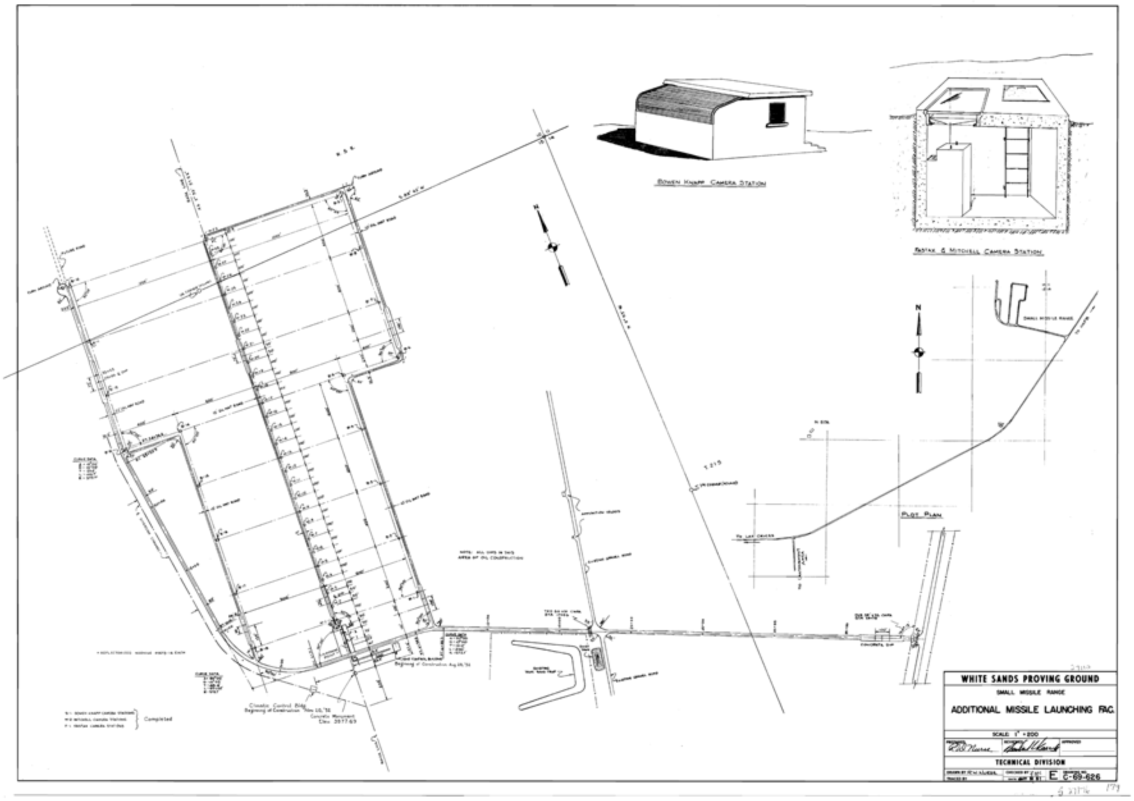

Figure 26. A 1951 map of the SMR with inset drawings of its camera shelter buildings.

the sounding rockets, such as the Loki-Dart and Super Loki, were regularly launched at the SMR for many years as part of the ongoing Atmospheric Science Laboratory (ASL) meteorology program, and the spent motors of these rockets remain scattered across the SMR today. Through these sounding rockets, substantial contributions were made to the scientific study of the upper atmosphere, and the monitoring of upper atmospheric winds was also critical in plotting trajectories for missile test flights.

6.5.10 Up-Range and Off-Range Launch Complexes

By the end of the 1950s, Army missiles were capable of ranges exceeding the boundaries of WSMR, and the Army began to consider ways to extend the boundaries of the range, at least temporarily. By 1960, the Army had established land-use agreements with private land owners at the range's northern boundary which allowed a 40 by 40 mile extension to be used temporarily for long range tests. This area was known as the Firing In Extension (FIX) area (Eckles 2013:249) and allowed for additional space for longer missile flight tests and also provided a safety buffer for missiles that impacted at the northern limits of the range.

The northern range area also provided locations for launching missiles as targets to be intercepted over the central part of the range by missiles launched from the Nike Avenue launch complexes. During the 1960s, the Zeus Up Range Facility (ZURF) was established approximately 90 miles north of the main WSMR cantonment, a few miles northwest of the Trinity Site. The small launch area was used to launch Nike Hercules missiles south as targets for the Nike Zeus missile (Eckles 2013:133; WSMR 1968b:64).

Another up-range launch complex is the Navy Sulf Site located at the northwest end of the range. This facility includes a blockhouse, assembly building, environmental shelter, and several Navy missile launcher rails (WSMR 2010). Refurbished Talos missiles, known as the Vandal, were launched from this site as targets for the Navy Standard Missile and the HELSTF laser. The Storm Target Missile, similar to the Hera, was also launched from this location for intercepts mid-range (Eckles 2013:23). The WSMR website also notes that this facility is used "to launch technology demonstrators or unique science and engineering payloads into sub-orbital trajectories" (WSMR 2010).

During the THAAD and Patriot Advanced Capability 3 (PAC-3) testing of the mid-1990s, a small permanent launch complex was established within the FIX area on the Donaldson Ranch. This small launch complex and supporting instrumentation sites were established in 1994 and thus dubbed LC-94 (Eckles 2013:250). The complex supported launches of the Hera and Storm Target Missiles and included a large rail mounted environmental shelter for the assembly and pre-flight conditioning of the missile (Eckles 2013:250). The Hera was also launched at LC-32 and a similar shelter is found there.

Although the FIX improved the distance missiles could safely travel within WSMR, it was still not enough space for long distance flight tests of systems like the Redstone and Pershing. In order to adequately test the long range capabilities of systems like the Redstone, Sergeant, and Pershing, the Army began to plan for an extended firing corridor involving leased or purchased tracts of land outside of WSMR. By 1958 the Air Force had successfully flown Matador and Mace missiles, early versions of cruise missiles, 700 miles from HAFB to Wendover, Utah (Eckles 2013:248). The concept of extended off-range firings was validated, but the logistics of land-use agreements, evacuations, safety corridors, and booster drop zones took WSPG planners several more years to overcome.

In 1960, WSPG worked out an agreement to use Fort Wingate outside Gallup, New Mexico for Redstone flight tests. Fort Wingate was a WW II era munitions depot that was no longer used as of 1960. The Redstone was launched from Fort Wingate to impact areas within the large range interior of WSPG. Although Fort Wingate was not used for Redstone launches, it was later used for launches of the Pershing missile beginning in 1963 (Eckles 2013:253). In the 1990s, the site was used again for launches of the Hera and Storm Target Missiles for testing of the THAAD and Patriot PAC-3 missiles. Established in 1996, the Hera launch site at Fort Wingate became known as LC-96 and includes administrative offices, a missile assembly building, launch control shelter, and a launch pad with environmental shelter (WSMR 2010). The launch pad and shelter are similar to those at LC-32 and LC-94 (Larry Carreras personal communication 2015).

The earliest true off-range firings were of the Sergeant missile which was launched from a site on the San Augustin Plains outside Datil, New Mexico in 1963. The San Augustin Plains site was only a temporary location and did not include any substantial infrastructure or facilities (Eckles 2013:252; Wind and Sand 1963:1).

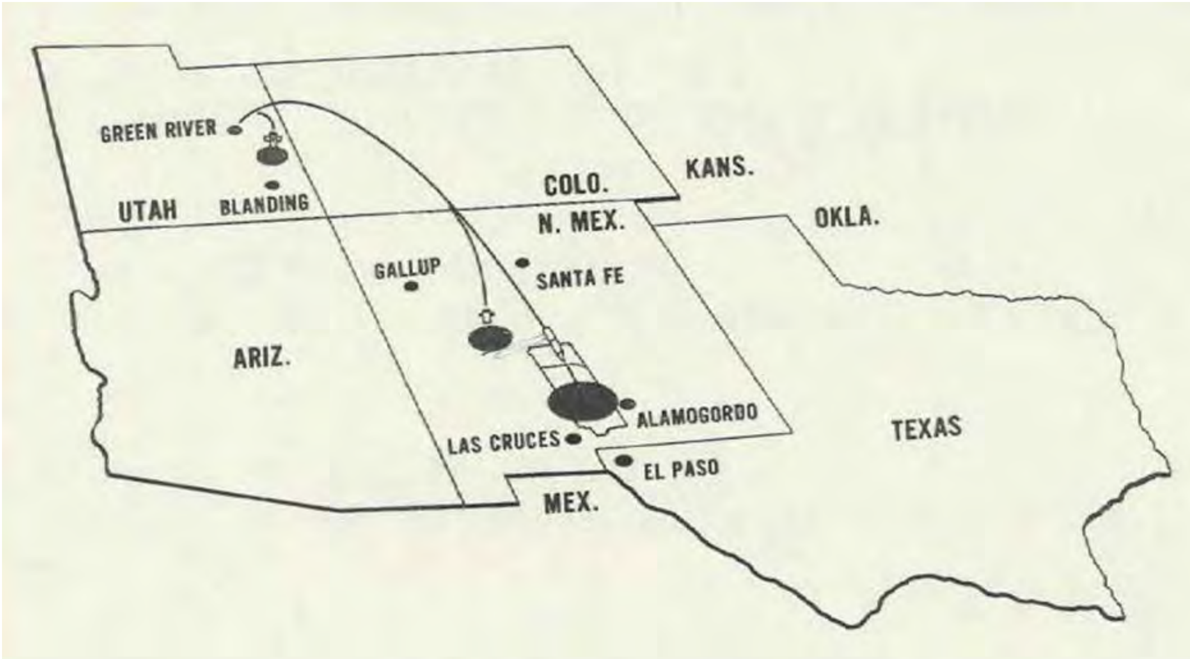

Figure 27. Flight path of Athena missiles launched from GRTS to WSMR (*adapted from WSMR 1968b)*.

Perhaps the most developed and best known off range location is the GRTS located outside Green River, Utah. The GRTS was established in support of the ABRES program in 1962, which studied the re-entry characteristics of ICBMs using the sophisticated RAM and RAMPART systems. The goals of this program were to improve both offensive and defensive systems (Feit et al. 2014; WSMR 1968a). The ABRES program launched a sub-scale Air Force ICBM missile known as the Athena, which impacted at White Sands. The ABRES program launched Athena missiles from GRTS to WSMR from 1964 until 1973. Following the Athena launches, the GRTS served as the launch area for the Pershing missile through the mid-1970s (Feit et al. 2014; WSMR 1968a). As of the late 1960s, the GRTS included three launch pads, two AN/FPS-16 radar installations, one blockhouse, an operations building, magazines, a meteorological rocket launch facility, and a variety of pre-manufactured steel buildings (Eckles 2013:254; WSMR 1968b:64). Other off-range locations in southeastern Utah used for Pershing launches included Gilson Butte and Black Mesa, but these locations primarily consisted of permanently located survey points for use in situating mobile instrumentation and tactical launcher systems (WSMR 1968b).

6.6 Establishment of LC-32

The 1950s was a boom decade for WSPG, as funding expanded in the wake of the Korean War and political and social perception of the various technological "gaps" with the Soviet Union encouraged the development of new missile systems throughout the decade. The number and variety of test programs at WSPG quickly expanded during this period and most of the launch complexes at the range were established to support the proliferation of missile programs. The establishment of LC-32 was part of this general expansion at WSPG.

The architectural plans for the first installations at LC-32 were drawn up in early 1957 with revised as-built dates added in April of 1958. The plans clearly show that the new complex was built to support two major programs; the Hawk anti-aircraft missile and the Sergeant tactical missile. Both of these systems were state of the art as of 1958. The Hawk was the Army's first mobile anti-aircraft missile and was capable of engaging even the fastest of jet aircraft. The Sergeant was the first solid-propellant missile of its size and payload. Compared to its liquid propellant predecessor the Corporal, it was significantly more reliable and faster to launch in the field.

The launch complex was divided almost symmetrically into the Sergeant area to the west and Hawk area to the east. A primary access road traveled north from Nike Avenue and a "Y" intersection branched off into each area. A small guardhouse along the main access road supervised entry into the complex. Both areas included similar facilities; each had a single launch pad supported by a blockhouse and assembly building, with a cable trench providing wiring connectivity to the launch pad. An existing timing and distribution station, the Uncle Site, was located to the southeast of the Hawk area.

Also built in 1958, but identified on a separate architectural drawing set, was the supporting instrumentation for the launch complex. Six ribbon frame camera stations were plotted for LC-32, arranged along the north and south margins of the complex. The Sergeant area included a series of leveled, paved sites for the positioning of mobile instruments.

In 1959, several substantial additions were made to LC-32. The Hawk Fixed Battery, a prototype of a permanent Hawk installation, was added just to the east of the original Hawk launch area. The launch area of the Fixed Battery was partially enclosed by a blast berm, with additional interior blast berms separating the three launch pads (Figure 30). Supporting buildings outside the bermed area were also part of the installation and connected to the launch pads via an underground cable trench.

Also in 1959, the Hawk Assembly Area was constructed in what became known as LC-32 South. This location provided assembly and work space for both Raytheon and government Hawk technicians that were formerly located in the Tech Area of the main cantonment. This location was just south across Nike Avenue from LC-32 and greatly simplified the logistics of supporting test flights. An additional Hawk launch area, known as the Hawk Annex or LC-32 East, was added to the east of the Hawk Fixed Battery in 1959 as well. This location included several mounds for situating Hawk radars, a maintenance building, and launch pads. According to Glenn Moore, this area was used for government firings of the Hawk missile

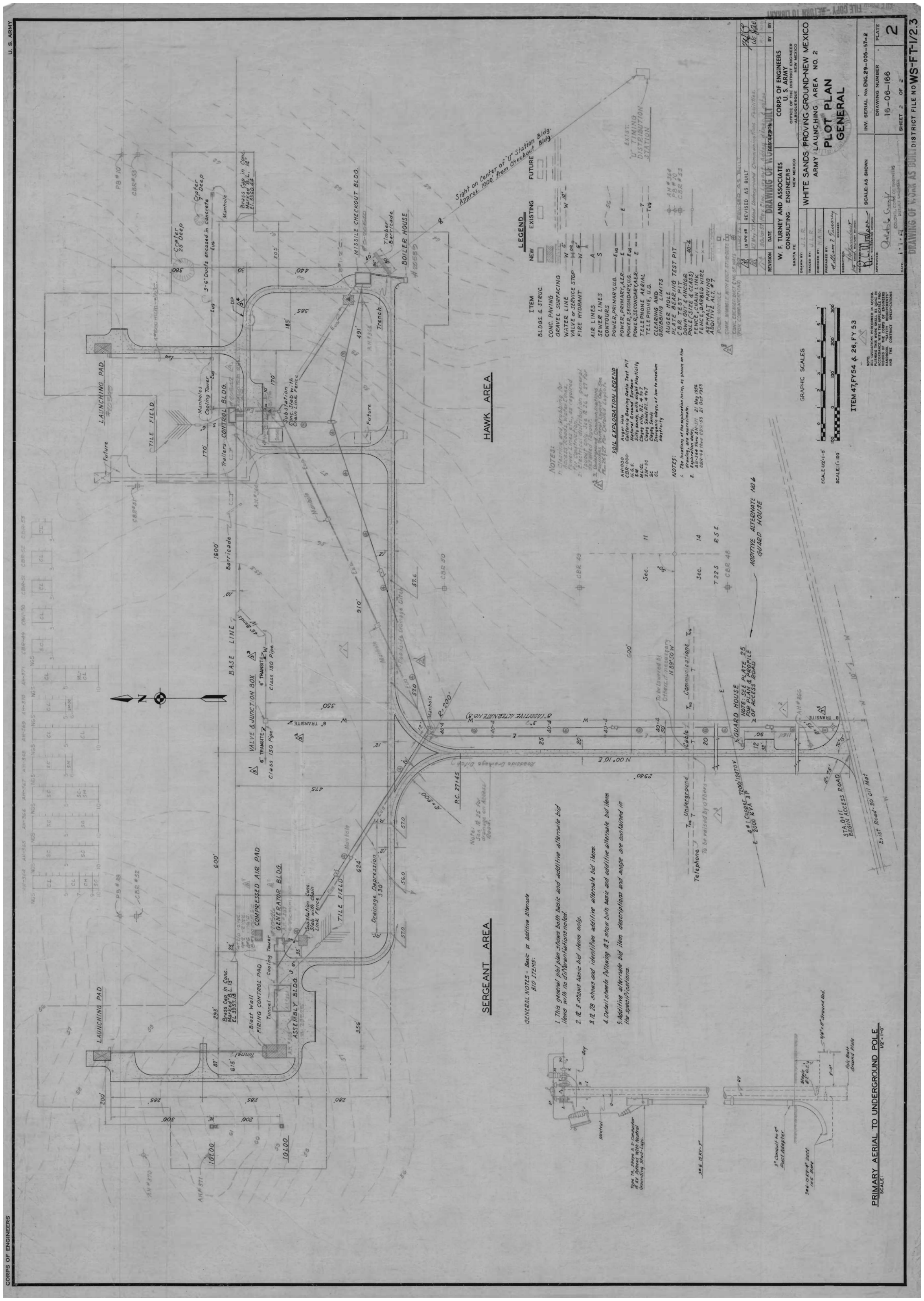

Figure 28. The original layout of LC-32 from the 1958 WS-FT plans showing the Hawk and Sergeant areas at the complex.

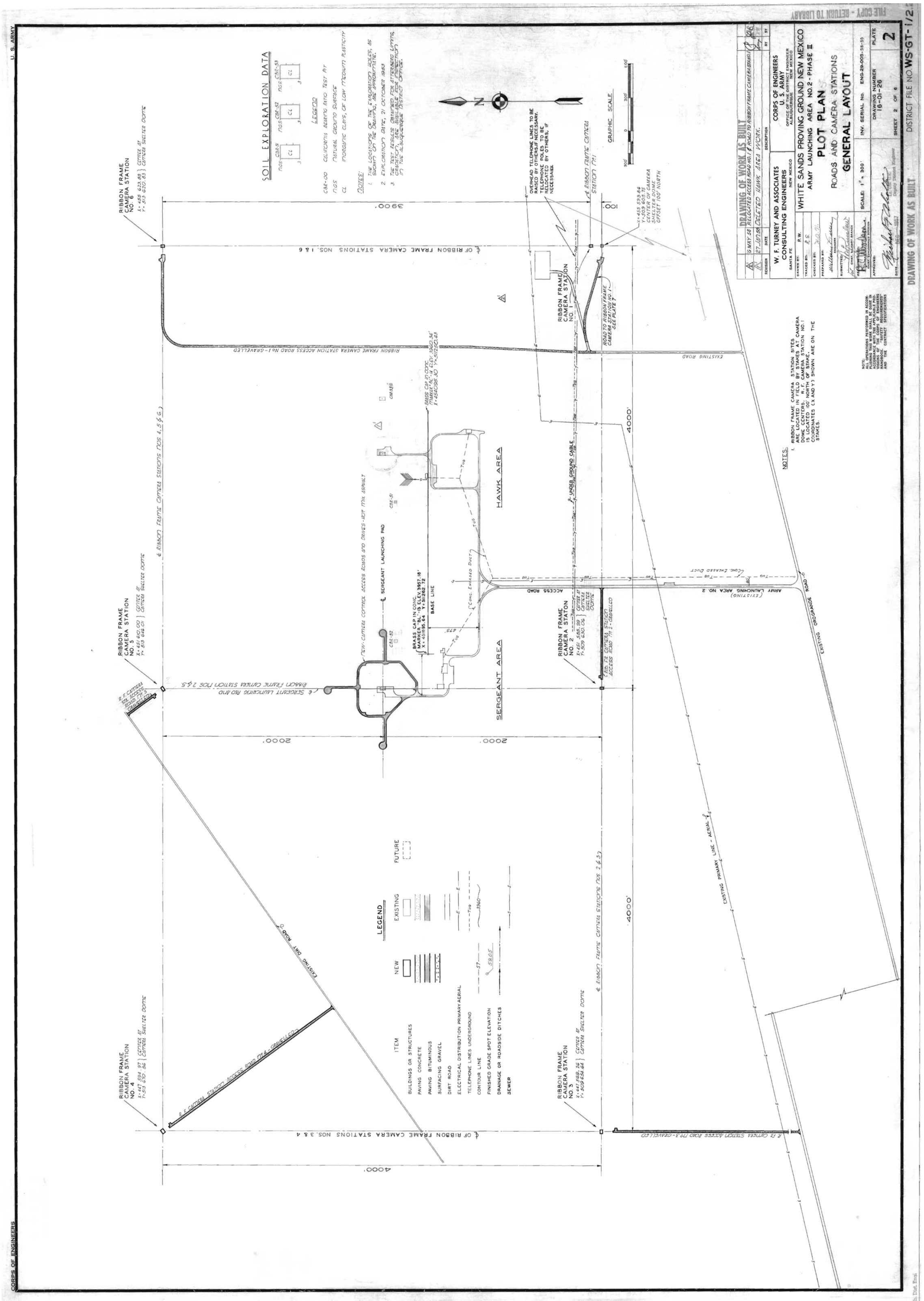

Figure 29. The location of the surrounding Ribbon Frame Camera Stations at LC-32, from 1958 WS-GT plans.

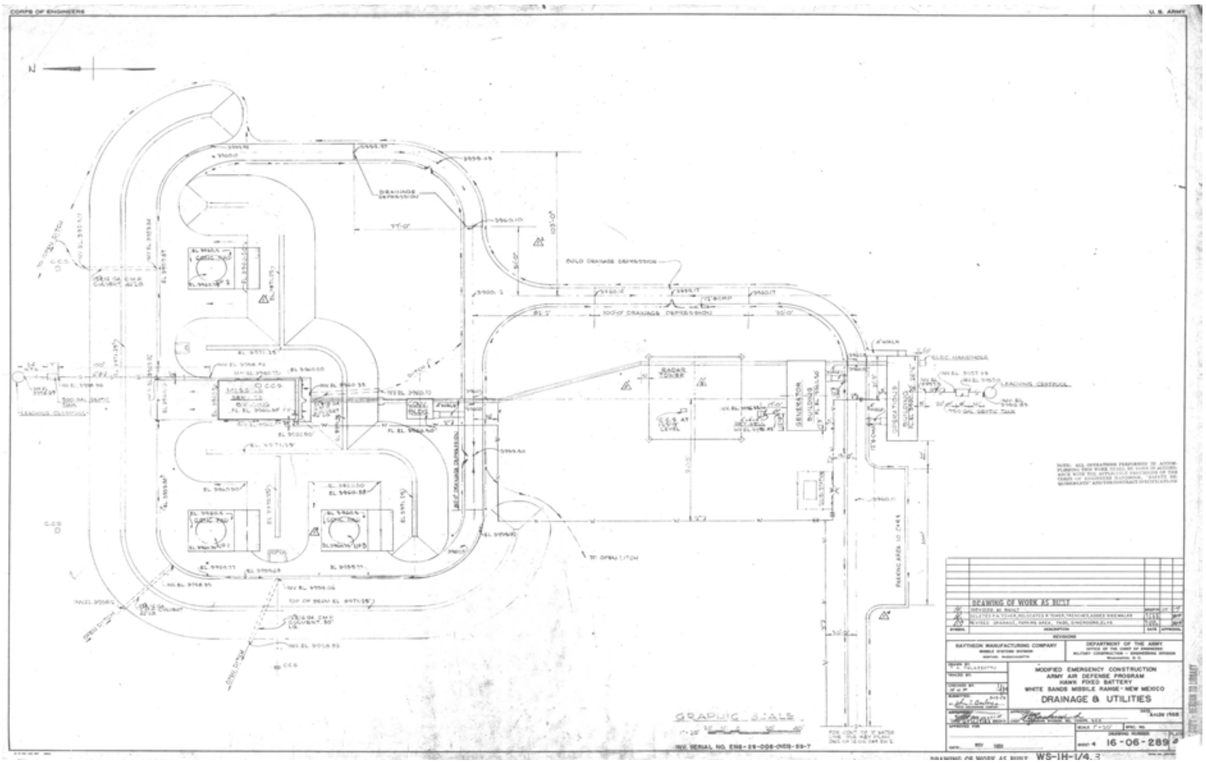

Figure 30. Overview of Hawk Fixed Battery installation from 1959 WS-IH plans.

while Raytheon conducted firings at the original Hawk launch area (Glenn Moore personal communication 2015).

According to architectural drawings for the launch complex, the original layout and facilities were designed collaboratively by the Albuquerque District Army Corps of Engineers and the architect and engineering (A&E) firm of W.F. Turney and Associates. W.F. Turney was formerly of the partnership Herkenhoff and Turney of Santa Fe. Little is known of the A&E firm – the principals, Gordon E. Herkenhoff and William F. Turney, were based in Santa Fe but their projects went as far afield as Southern California and Colorado. A former employee described the firm as surveying parcels of land in and around Santa Fe for new housing divisions, state offices, and private businesses during the post-WW II building boom (Pacheco 2013). The firm seems to have specialized in large-scale water, sewer, and paving projects for both municipalities and government projects; an example of which was a runway extension at Holloman Air Force Base. The partnership was dissolved in 1953 and both Herkenhoff and Turney subsequently created individual entities bearing their respective names (City of Las Cruces 2014).

Some of the architectural drawings were originally prepared by A&E firm of Kenneth S. Clark and Philippe Register based out of Santa Fe. They were subsequently "site adapted" by W.F. Turney and Associates. These drawings were specific to astrodome installations and movable instrumentation shelters and were probably recycled for use at LC-32 due to the highly standardized nature of these building types and installations. The firm of Clark and Register was originally a private architectural practice in Santa Fe founded by Kenneth Clark in 1950. Prior to partnering with Register, Clark worked as an assistant state architect for the Works Progress

Administration during the Depression in addition to serving in the Army Reserve. His first private architectural firm was the partnership Kruger and Clark which was established in 1938. Clark left the practice to serve in the Army Air Force from 1942 to 1945. The partnership of Clark and Register was established in 1956 and worked on a series of DOD projects in New Mexico, including a series of instrumentation structures at WSPG. In 1961, Clark returned to independent practice and was involved with a hospital project at WSMR in 1963 (Moore et al. 2010:85).

LC-32 played an important role in the development of the Hawk missile system, which was arguably one of the most successful missile systems developed during the Cold War. While the Sergeant missile was eventually replaced by the more advanced Lance missile, an extensive series of improvement programs kept the Hawk missile relevant and effective well into the 1990s. Launch complexes for the launching of aerial drone targets, a critical component of testing anti-aircraft missiles like the Hawk, were constructed along the eastern margin of LC-32 during the 1970s. LC-32 also hosted testing of the Roland anti-aircraft missile in the 1970s and early 1980s.

Although technically post-dating the end of the Cold War, the Hera Target Missile supported by LC-32 in the mid-1990s was an outgrowth of the SDI that was a hallmark of the late Cold War. The Hera was a target for testing of the THAAD and Patriot PAC-3 missiles that were developed as part of the SDI.

To provide a more complete understanding of the history of LC-32 and its significance to Army Cold War missile RDT&E, each of the major programs supported by the launch complex are summarized in chronological order. Additional minor programs that were also tested at LC-32, however briefly, are also summarized. The post-Cold War Hera Target Missile program is also included due to its Cold War roots and significant contribution to the built environment of the complex. Finally, the very recent Orion Launch Abort System (LAS) program is also discussed. Although insufficient historical perspective exists to consider the Orion LAS properties as historic resources, it is discussed here as the program made substantial alterations to the built environment of LC-32. These recent alterations are significant to the consideration of LC-32 as a Cold War-era historic district, which is discussed in Chapter 8.

6.7 Research, Development, Testing, and Evaluation Activities at LC-32

RDT&E activities were carried out at LC-32 throughout the Cold War. RDT&E activities can be split into two general stages: Research and Development (R&D) and Testing and Evaluation (T&E). Each stage informs the other, but emphasizes different steps in the developmental process. R&D focuses on development of new technologies and is primarily conducted in laboratories, while T&E focuses on applied testing of new technologies and systems. As a launch complex at WSMR, activities at LC-32 were mostly oriented towards T&E activities. The basic sequence of T&E is summarized as:

> The process of conducting T&E for missiles consists of three levels of testing: developmental testing, technical evaluation, and operational testing. Developmental testing was done during the earliest stage of development in order

> to gather preliminary information about the performance of a weapon system. Information gathered during developmental testing then could be incorporated into the missile design. Technical evaluation represents the second stage of testing, intended to verify that the missile system meets the technical specifications, such as the anticipated performance characteristics. Technical evaluation was carried out by highly skilled technicians to ensure that the weapons system works as advertised. Operational testing was the third level of testing. This final test stage was intended as a check to the technical evaluation, prior to issue to the fleet. Unlike the earlier T&E stages, operational testing was carried out by military personnel [Best et al. 1995:177].

The earliest stages of T&E are generally completed on constituent parts of a rocket or missile design, such as the propellant, motor, or warhead. These early stages of development are often conducted at contractors' facilities and were not consistently carried out at LC-32. The latter stages of T&E involving flight, guidance, and production prototypes were the primary activities carried out at LC-32 throughout the Cold War. Flight testing of rocket and missile systems usually includes unguided Launch Test Vehicles (LTVs), which are primarily concerned with verifying the function of motors and propellants. The next step is referred to as Guided Test Vehicle (GTV) testing, which adds the guidance or control system to an inert missile for testing. If GTV testing is successful, the process will move forward with warhead and fuse tests on an actual armed missile. Once these tests are successfully completed and a production prototype is produced, the production system is extensively flight tested to prove the operation of the complete system prior to issue as a combat ready weapon.

The Army also began to emphasize acceptance testing during the 1960s, which tested samples of missile production runs as a quality control measure before purchasing an entire lot. Following the approval and issue of a missile, improvements to guidance and targeting systems were also often tested at LC-32, with the numerous improvements to the Hawk system being a prime example. In other cases, missile systems already in service were launched by their crews in order to maintain readiness and proficiency. The Sergeant Annual Service Practice (ASP) rounds launched at LC-32 are a good example of this type of firing. Obsolete rocket and missile systems were also used as test platforms for the T&E of new guidance systems or other experimental equipment. Missiles were also launched as targets for other missile systems, such as the 1960 Hawk intercept of an Honest John rocket (Kroehnke 1960:1).

The first system to be tested at LC-32 was the Hawk, followed in short order by the Sergeant. The testing needs of these two programs influenced the design and layout of the original LC-32 facilities. The launch facilities remained in use throughout the Cold War and supported additional programs, and the complex was gradually expanded and modified through time.

6.8 The Hawk Missile Program

The Hawk missile was the first mobile, medium-range, guided anti-aircraft missile designed in the US. It was also one of the most successful American missile systems, and is today likely the oldest SAM system still active in global inventories. Jim Eckles, former Public Affairs liaison at WSMR, refers to it as "one of the most successful air defense missile systems ever built" (2013:212).

Figure 31. Basic Hawk missiles on mobile launcher trailer, circa early 1960s (*courtesy Redstone Arsenal)*.

6.8.1 Development

The Nike Ajax system provided the nation with its first air defense system, but the system was limited to fixed batteries at static locations. While the Nike Ajax provided protection for significant targets such as major cities and strategic military installations, a mobile system that could move along with ground troops was needed. In late 1950, the Army Committee on Guided Missiles of the Research and Development Board recommended that funding be allocated for the development of new systems to fill this significant gap in air defense. Early specifications for the system called for a homing-all-the-way guided SAM that would be effective against both aircraft and missiles traveling at speeds up to 600 knots and at altitudes from 500 to 30,000 feet. It would have an effective range of up to 10 miles (US Army Center of Military History 2009:224). The developmental missile was designated as the SAM-A-18 Hawk, which according to some sources was an acronym for Homing All the Way Killer (Parsch 2002a). However, other sources relate that the name originally referred to a bird of prey, but was retroactively converted to an acronym (Eckles 2013:213). Both usages appear in Army references to the missile system.

By March 1951, the Hawk concept system was approved as an Army SAM project and funding was allocated later the same year. Various approvals both within the Army and with the Secretary of Defense followed during 1952 to 1953 while the specifications for the system were refined. The anti-missile capability of the Hawk was removed as a requirement along the way, emphasizing instead the anti-aircraft function of the missile. In June 1954, a contract was awarded to Raytheon for the design, development, and testing of a complete Hawk missile (US Army Center of Military History 2009:232). A separate contract was awarded to Northrop for the development of the launcher, radar, and fire-control systems for the missile (Kennedy 2009:140).

Table 1. Original Properties Constructed for Hawk Testing at LC-32.

Property Number	Property Name	Year Built
20539	Boiler House	1958
20540	Missile Checkout Building	1958
20541	MTCE Laboratory Building	1958
20542	Control Building/Blockhouse	1958
20543	Septic Tank and Field	1958
20544	Cable Tunnel	1958
20545	Control Facility /Launch Pad	1958

The Hawk missile was intended to be a low-to-medium altitude, short range system that would support the Nike Hercules (Berhow 2005:29) against very low-flying aircraft targets, but still be effective at altitudes up to 30,000 feet. Used in tandem with the Nike Hercules, it provided a net of air defense that covered altitudes from nearly ground level to 150,000 feet. The Hawk missile was 16 feet long and 14 inches in diameter, a relatively small size that made it readily transportable. The missile was designed around a single stage solid fuel motor developed by Aerojet that behaved like a two-stage motor as it contained two different propellants with different burning rates that burned sequentially (Eckles 2013:212; Parsch 2002a). The first propellant burned for about five seconds and accelerated the missile from the launcher, while the second propellant burned for about 20 seconds and sustained the missile's flight towards the target (Eckles 2013:212; Kennedy 2009:140). The missile was controlled in flight by trailing edge control surfaces on its distinctive set of four large triangular fins. The Hawk was armed with a 119 pound high-explosive, blast-fragmentation warhead equipped with both proximity and impact fuzes (Kennedy 2009:140).

The first Hawk missile was launched at WSPG on August 16, 1955 from LC-32 in order to test the aerodynamics and flight characteristics of the missile airframe (Eidenbach et al. 1996:87; US Army Center of Military History 2009:232). On June 22, 1956 a Hawk missile armed with a live warhead flew directly into the nose of a drone QF80 fighter jet, utterly obliterating it (Arsenal 2015b). When it entered Army service in 1960, the Hawk was designated as the M3, which was changed to MIM-23A in 1963 (Parsch 2002a).

6.8.2 Hawk Facilities at LC-32

The Hawk and Sergeant missile programs were the two primary programs that LC-32 was constructed in support of in 1958. As originally laid out, LC-32 was symmetrically divided between the Sergeant area on its west side and the Hawk area at its east side. Primary buildings constructed for the Hawk missile testing included the Missile Checkout Building (Property 20540), Control Building/Blockhouse (Property 20542), and the Launching Pad (Property 20549). A variety of supporting facilities and infrastructure components were also constructed at this time.

The Hawk mission was quickly expanded at LC-32 and another dedicated Hawk area was constructed to the east of the original Hawk facilities in 1959. This location was identified as the "Hawk Fixed Battery", and was a prototype of a permanent Hawk missile installation

Table 2. Properties Constructed as Part of the Hawk Fixed Battery.

Property	Name	Build Date
20546	Underground Fuel Storage Tank	1959
20547	Operations Building	1959
20548	Generator Building	1959
20549	Instrument Pad	1959
20551	Septic Tank and Drain Field	1959
20552	Converter Building	1959
20553	Blast Barricade	1959
20554	Septic Tank and Drain Field	1959
20555	Missile Service Building	1959
20556	Launcher 3	1959
20557	Launcher 1	1959
20558	Launcher 2	1959
20559	(Int) Blast Barricade	1959
N/A	CW Radar Tower	N/A
N/A	Pulse Acquisition Radar Tower	N/A

that, had it been deployed, would have been comparable to a Nike Ajax or Hercules installation. The original architectural drawings for the installation are entitled "Modified Emergency Construction / Army Air Defense Program." Unlike the usual mobile Hawk battery that relies on portable launchers and field equipment, this installation was constructed with permanent concrete launch pads and support buildings surrounded by substantial earthen blast berms. According to Stephen Lowery, a Raytheon employee who has worked with the Hawk program at WSMR since 1976, the Hawk Fixed Battery was a prototype considered for installations in south Florida and the Florida Keys (Stephen Lowery personal communication 2015). Although the Cuban Missile Crisis was still several years away at the time of the construction of the Hawk Fixed Battery, the communist revolution in Cuba was ongoing throughout the 1950s and may have encouraged advance planning for air defense installations in southern Florida. The Hawk Fixed Battery effort was abandoned by 1962, although traditional Hawk batteries were deployed to Florida during the Cuban Missile Crisis.

The Hawk Fixed Battery consisted of three launch pads surrounded by the Property 20553 blast berm. Within the Property 20553 berm, additional interior blast berms isolated each launch pad from the central Missile Service Building (Property 20555). The outer Property 20553 berm remains in place but the interior berms have been removed. Properties 20547 and 20548 were also part of the Hawk Fixed Battery installation and served as the Operations Building and Generator Building respectively. A Converter Building (Property 20552) was also part of the facility and was located north of Property 20548 and south of Property 20555; it has been demolished. A large radar tower located north of Property 20548 was also identified in the plans, but there is no indication of its installation today. Other than the drawings, no records exist of the radar tower and neither Bill Jones nor Glenn Moore recalled such a structure at this location. It therefore appears likely that the elaborate radar tower in the architectural drawings was never actually constructed. No such property is identified in a 1963 WSMR property summary

Table 3. Properties Constructed at LC-32 as part of the Hawk Annex.

Property Number	Property Name	Year Built
20746	Missile Maintenance Building	1959
20747	LP Tank	1959
20749	Instrument Pad	1959
20750	Instrument Pad	1959
20751	Instrument Pad	1959

which also suggests that the planned radar tower was never completed. Various other infrastructure facilities were associated with the installation, including a cable trench that connected the Generator Building (Property 20548) and the Missile Service Building (Property 20555), a septic tank and drain field (Property 20551), and an underground fuel storage tank (Property 20546).

The Hawk Fixed Battery properties continued to be used by the Hawk program even after the fixed installation concept was abandoned. During the 1960s, the Hawk Fixed Battery area was used for pre-launch systems checks of the Hawk missile and guidance equipment (Glenn Moore and Bill Jones personal communication 2015). Moore also believed that at least a few Hawk launches were conducted from the Fixed Battery (Glenn Moore personal communication 2015). As of the mid-1970s, the Hawk Fixed Battery launch pads were used as outdoor storage areas and Property 20555 was used for Hawk electronic chassis repair (Stephen Lowery personal communication 2015). Much of the Hawk Fixed Battery infrastructure was later removed and the area is substantially modified from its original layout today.

An additional series of facilities was added to the eastern margin of LC-32 in 1959, an area referred to as the "Hawk Annex" in the 1982 WSMR Master Plan for the launch complex. According to Glenn Moore, this area was used for firings of the government Hawk program, while the Raytheon firings were conducted at the main Hawk launch area (Glenn Moore personal communication 2015). These facilities consisted of a Missile Maintenance Building (Property 20746), an LP Tank (Property 20747), and a series of Instrument Pads (Properties 20749, 20750, and 20751). By the mid-1970s this area was extensively modified when the Multiple Target Launch Complex (MTLC) for drone launches was constructed. The existing Hawk facilities were modified for use with the drone target launch complexes at this time.

In 1959, a complex of buildings was established south of LC-32 across Nike Avenue in support of the Hawk missile for use by Raytheon and government employees working on the program (Wind and Sand 1959:1). Assembly, hazardous operations, and laboratory facilities formerly located at the WSMR Tech Area were relocated to this location. The primary facility in this area was known as the "Hawk Hanger" (Property 21759) which was the hub of activity for the Raytheon Hawk team into the mid-1970s (Missile Ranger 1971:1). The government personnel working on the Hawk program were based in the nearby Property 21756 (Glenn Moore personal communication 2015).

Table 4. Hawk Firings at WSMR, 1955 to 1988 (*WSMR Museum 2015a)*.

Year	Type	Total Firings
1955	Basic Hawk	5
1956	Basic Hawk	21
1957	Basic Hawk	27
1958	Basic Hawk	48
1959	Basic Hawk	83
1960	Basic Hawk	65
1961	Basic Hawk	57
1962	Basic Hawk	54
1963	Hawk Eng	2
	Hawk Ind	30
1964	Hawk Engr Test	29
1965	Basic Hawk	29
1966	Hawk ATBM	5
	Hawk Ind	8
	Hawk Self-Propelled	2
1967	Basic Hawk	14
	Hawk ATBM Ind	7
	Hawk Self-Propelled	7
1968	I-Hawk	22
	Hawk Ind	9
	Hawk Self-Propelled	7
1969	I-Hawk	17
	Hawk Self-Propelled	1
1970	I-Hawk	13
1971	I-Hawk	58
1972	I-Hawk	6
1973	I-Hawk	27
1974	I-Hawk	42
1975	I-Hawk	31
1976	I-Hawk	33
1977	I-Hawk	28
1978	I-Hawk	18
1979	I-Hawk	23
1980	I-Hawk	19
1981	I-Hawk	11
1982	I-Hawk	6
1983	I-Hawk	14
1984	I-Hawk	13
1985	I-Hawk	14
1986	I-Hawk	7
1987	I-Hawk	6
1988	I-Hawk	13

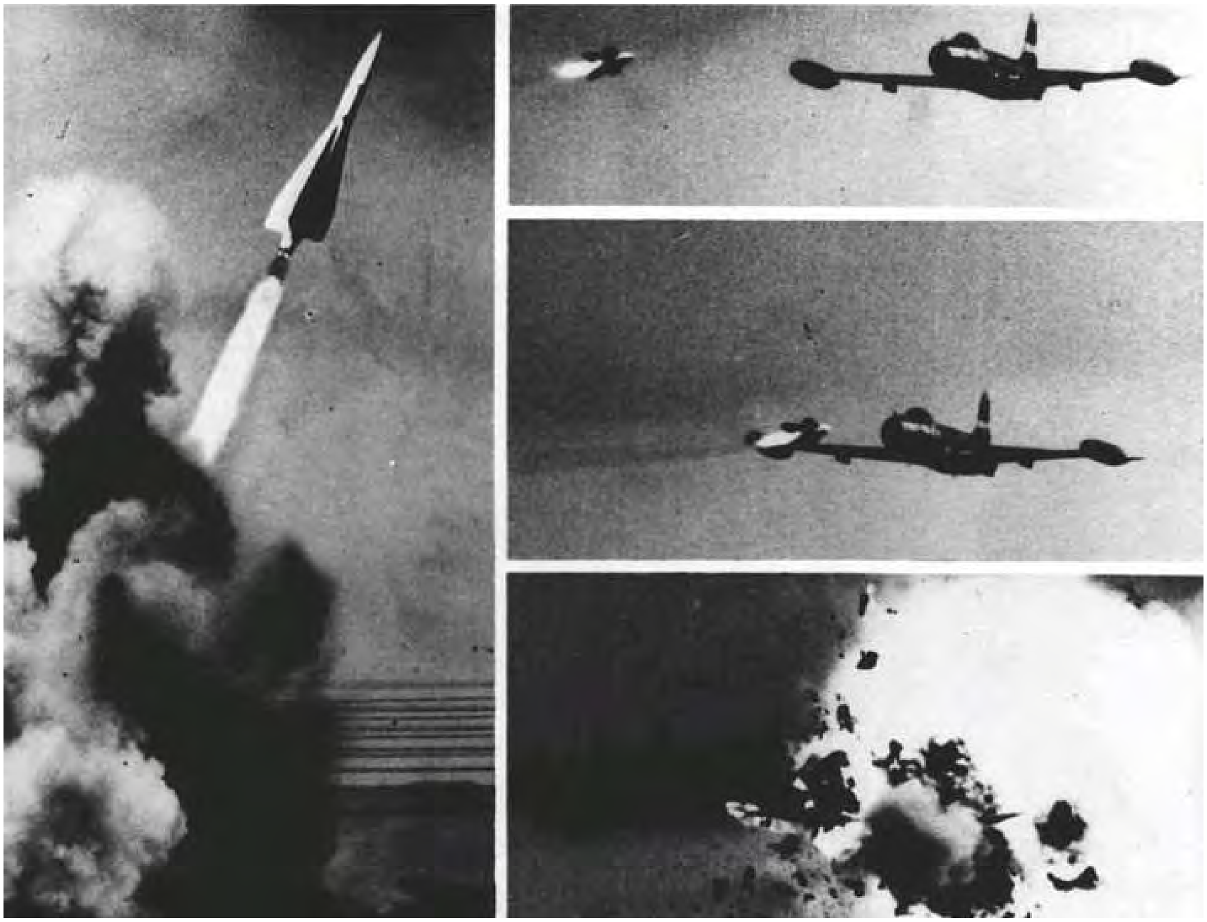

Figure 32. A Hawk missile intercepts a QF-80 drone fighter in 1958 (*courtesy Redstone Arsenal)*.

6.8.3 Operation and Improvements

The Hawk system is unique in that it is capable of intercepting very low-flying aircraft at "tree-top" levels, and its mobile equipment is transportable by helicopter or other aircraft. Hawk missiles are transported and launched using M192 launcher trailers, which have a capacity of three missiles (Parsch 2002a). Six M192 launchers are the typical armament of a Hawk missile battery, and could be reloaded using M501 loader/transporter vehicles in about three minutes (Fort Bliss 2009:11). The Hawk system relies on several portable radar and control systems. The Hawk radars include the C-band Pulse Acquisition Radar (PAR) for medium and high altitude target detection; the Continuous Wave Acquisition Radar (CWAR) for low altitude target detection; and the High-Power Illuminator (HPI) which tracks the targets and provides target illumination for the missile's onboard Continuous Wave (CW) X-band radar seeker. The Hawk's CW radar seeker could detect targets at ranges from 1.25 to 15 miles, giving it a wide range of engagement distances (Parsch 2002a). An additional, supplemental radar that was also used in the system was the Range Only Radar (ROR), a K-band radar used to provide range distances in the event that the primary radars were jammed by countermeasures (Fort Bliss 2009; Parsch 2002a). Each Hawk battery was organized around the Battery Control Center

Figure 33. An I-Hawk launch at LC-32 in 1983 (*courtesy WSMR Museum Archives)*.

(BCC), where the primary control system and personnel were located (Fort Bliss 2009:11).

The Hawk missile was almost continually improved and modified during its service, and the system went through numerous iterations as it was gradually modernized. These improvement programs made the system a staple of WSMR testing throughout most of the Cold War (Eckles 2013:212). One of the first, and most significant, was the Hawk Improvement Program (HIP) which began in 1964. The program originally included the addition of Anti-Tactical Ballistic Missile (ATBM) capability to the system, but this requirement was soon dropped from the improvement program (Essary 1986:16). The HIP involved major upgrades to the Hawk missile and its support equipment. The PAR, CWAR, HPI, and ROR radars were all replaced by upgraded versions with enhanced capabilities and ranges. The program also replaced most of the Hawk electronics with solid state components, making the missile and its systems more reliable and minimized maintenance in the field, a concept referred to as the "wooden round" (Wind and Sand 1967:6). The Hawk missile itself was replaced by the Improved Hawk or I-Hawk (MIM-23B), with an extended range of 22 miles and operational ceiling of 59,000 feet (Eckles 2013:212; Parsch 2002a). Raytheon continued to be the prime contractor for the I-Hawk program, and was awarded a $4.5 million contract for the program in 1966 (Wind and

Figure 34. A SP-Hawk unit at WSMR, circa mid-1960s (*courtesy Redstone Arsenal)*.

Sand 1966:3). An additional contract of $1.1 million was awarded to Boeing for the I-Hawk improvements in 1968 (Wind and Sand 1968:1). Work on the I-Hawk was conducted at Redstone Arsenal with the majority of the flight testing accomplished at LC-32. Firings of the I-Hawk began in October 1966 at LC-32, with the initial Engineering Design Test (EDT) launches. The final test phase flights of the I-Hawk, known as Initial Production Testing (IPT), were conducted at LC-32 in 1971 (Missile Ranger 1971:1). The last Basic Hawk test program ended in 1969, at which point approximately 382 Basic Hawk missiles had been fired at WSMR (Essary 1986:16). Following the successful IPT phase, Basic Hawk systems were gradually replaced with I-Hawk systems in the US and abroad throughout the first half of the 1970s (Redstone Arsenal 2015b). Additional tests of the I-Hawk, such as NATO and Japanese Lot Acceptance Tests, continued to be conducted at LC-32 and by 1986 approximately 310 I-Hawk missiles had been fired at WSMR (Essary 1986:16).

In 1967, the Army tested a self-propelled version of the Hawk called the SP-Hawk, which mounted the missiles on a modified M548 tracked troop transport vehicle. The intent was to provide an interim FAAD system for front line troops, as the Chaparral was still under development and the Mauler FAAD system development had been halted due to technical issues.

Figure 35. Loading an I-Hawk launcher trailer using the M501 loader vehicle, circa early 1990s (*courtesy Federation of American Scientists)*.

The modified transport was designated as the M727, and the SP-Hawk was issued to missile battalions in 1969 (Parsch 2002a). However, SP-Hawk was a short lived variant; it was abandoned in 1971 as the Chaparral FAAD system entered service (Redstone Arsenal 2015b).

Beginning in 1977, the Army began a multi-year Product Improvement Plan (PIP) for the Hawk system, as a systematic series of upgrades that primarily focused on the ground equipment of the system. The PIP involved three phases, and the improved versions of the Hawk radars and support equipment were released throughout the decade of the 1980s. The ROR was rendered obsolete by the PIP Phase III and is no longer part of the Hawk System. During the early 1990s, these and other upgrades allowed the Hawk to achieve Theater Missile Defense (TMD) capabilities, and Hawk units in use by the Marine Corps were upgraded to the TMD version by the mid-1990s. More recently, a modernized version of the missile known as the Hawk XXI, was developed by Raytheon in partnership with Kongsberg of Norway. This version of the system eliminates the PAR and CWAR radars and upgrades the system with an AN/MPQ-64 Sentinel three-dimensional radar and an advanced centralized fire distribution control center. As of 2012, the Hawk XXI is reportedly in use by 17 countries (Air Force Technology 2012).

6.8.4 Hawk Deployment and Legacy

The Hawk has an impressive record of service, including successful deployments in combat and involvement in many historic Cold War conflicts and events. The Hawk system became operational in 1959, but was mostly deployed in locations outside the US. Two units were deployed in the Homestead-Miami and Key West areas of Florida during the Cuban missile crisis (Berhow 2005:29). As a result of the Cuban Missile Crisis, over 300 requisitions for Hawk missiles and supporting equipment were processed by Raytheon in 1962 (Redstone Arsenal 2015b).

Figure 36. A Hawk missile intercepts a Lance tactical missile in 1996 (*courtesy Federation of American Scientists)*.

In 1965, the Hawk became the first SAM deployed to the front during the Vietnam War, when the Marine Corps "B" Battery of the 1st Light Anti-Aircraft Missile Battalion deployed the system at the DaNang airfield. Also in 1965, the first Hawk battalion was deployed to Israel. Two years later, the first combat firings of Hawk occurred when Israeli troops downed several Egyptian jets during the Six Day War (Redstone Arsenal 2015b). Also in 1967, the US signed a memorandum of understanding for Japanese production of the system under license. In 1972, the Imperial Iranian Air Force purchased 24 I-Hawk batteries, a deal valued at nearly $280 million. At the time, this was one of the largest military sales ever made by Army Missile Command (MICOM), and the Iranian Hawk program was known as Peace Shield. The program came to a sudden and complete halt during the 1979 Iranian Revolution and subsequent Iran Hostage Crisis (Redstone Arsenal 2015b). During the latter half of the 1980s, Hawk and TOW missiles were the subject of illicit arms sales to Iran as part of the Iran-Contra scandal.

The Hawk missile effectively reached global saturation by the mid-1980s; in 1986, the system's 30th year of service, it was in use by the US Army, Marine Corps, and 20 allied nations (Redstone Arsenal 2015b). However, by this time the successful development of the Patriot and portable Stinger missiles was gradually beginning to supplant the Hawk. During the late 1980s at WSMR, the Hawk was modified to receive targeting data from Patriot to engage short range ballistic missile targets, linking the two systems together into a layered air defense network. This proved the anti-tactical ballistic missile (TBM) capabilities of the system, and modification to the Hawk (primarily software enhancements) was undertaken to improve the anti-TBM capability.

Although no American Hawk missiles were fired during Operation Desert Storm in 1990, Kuwaiti Hawk air defense units downed an estimated 23 Iraqi aircraft during the Kuwait invasion, again demonstrating the lethality of the system (Redstone Arsenal 2015b). Despite the continual improvements to the system, the Army retired the Hawk by 1994, and Army National Guard units retired the system by the late 1990s. The Marine Corps also phased out the Hawk by 2002, relying instead upon the smaller but shorter range Stinger missile into the new millennium (Kennedy 2009:140). While the system is no longer used by US Armed forces, various versions of the system remain in active use by some allied (and formerly allied) nations. According to Wikipedia, Egypt and Jordan placed orders for replacement Hawk motors as recently as 2014.

6.9 The Sergeant Missile Program

The Sergeant missile was a significant advance in tactical missiles as it was the first solid-propellant missile that offered comparable payload capacity and range to existing liquid propellant systems. Solid propellant systems eliminated the time consuming and dangerous fueling operations required of liquid fuel systems, and were generally faster to deploy and easier to maintain in the field. It was for these reasons that the Sergeant missile replaced the existing Corporal missile, which was the first US developed tactical missile system.

Figure 37. An Army Sergeant examines the Sergeant missile in a 1960s promotional photo (*courtesy Redstone Arsenal)*.

6.9.1 History of Development

The development of the Sergeant missile can be traced all the way back to Caltech's early efforts to develop a solid fuel JATO booster for aircraft. As the search for better solid-propellants continued in the late 1940s, the basic technologies for a large solid propellant missile were developed.

The ORDCIT WAC Corporal had led directly to the development of the Corporal tactical missile, the first US developed guided tactical missile (Carroll 1974:9). However, from the beginning it was intended as an interim system until an improved weapon could be developed (Kennedy 2009:125). The Corporal missile had several significant shortcomings as a tactical weapon. The Corporal was a large, complicated system that required a battalion of 250 personnel and 35 vehicles. Such a massive support component was a logistically difficult to manage and slow to mobilize, and setting up a Corporal missile for firing took around nine hours (Kennedy 2009:125). Additionally, the liquid propellant motor of the Corporal required caustic fuels that required careful handling and fueling procedures. A solid propellant replace-

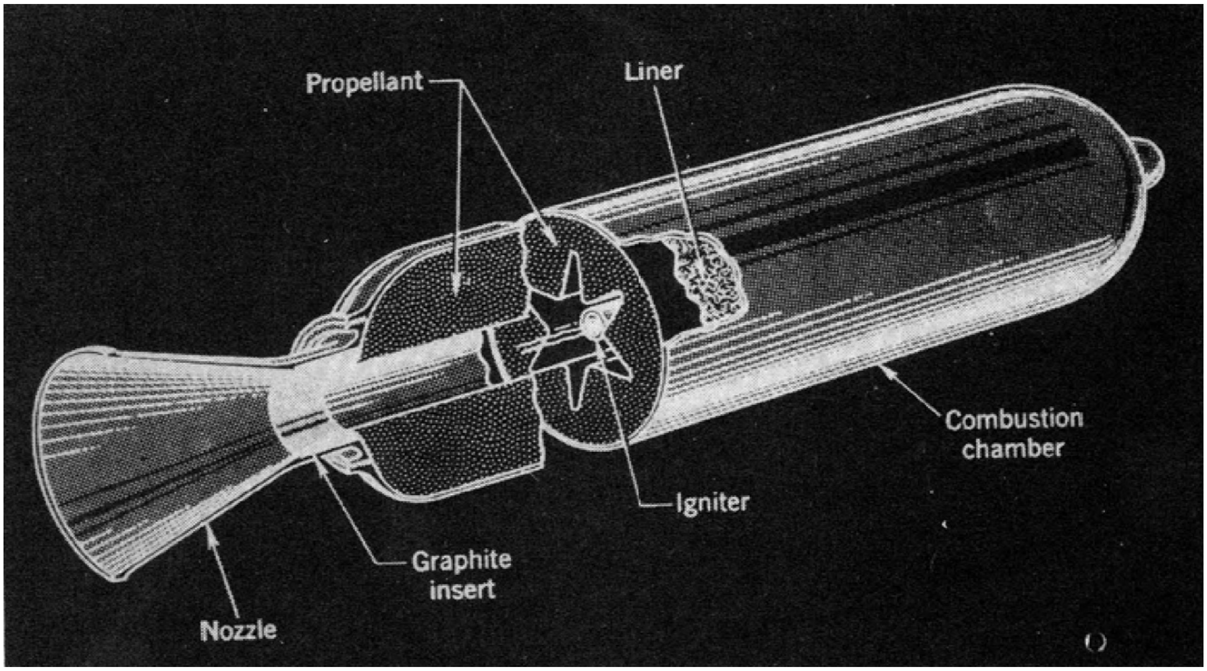

Figure 38. Illustration of the star shaped combustion chamber used in solid propellant motors (*adapted from Carroll 1974)*.

ment would offer simpler and faster operation and set-up, safer handling, and lower costs.

The advantages of a large, solid propellant vehicle were obvious to the ORDCIT planners and engineers. Even as the Corporal was under development, there was a resurgence of interest in solid propellants at JPL. Key to the improvement of solid propellants was Charles Bartley, who sought to improve upon the asphalt-perchlorate solid propellant mixture used in JATO boosters. Although a major advance, the asphalt based propellants suffered from expansion and contraction problems in temperature extremes; they turned to liquid tar in very hot areas and froze and cracked in very cold climates (Carroll 1974:10). Bartley found that a synthetic polymer-based propellant did not suffer from these disadvantages, but finding polymer that offered the desired elastic properties that was amenable to mass production was difficult. Bartley eventually found a new polysulfide polymer compound manufactured by Thiokol that met all these requirements, which promised the next leap forward in solid propellant technology (Carroll 1974:10).

However, by 1947 problems with controlling the burn rate of the new propellant emerged. The combustion area tended to expand in a non-linear fashion into a convex shaped cone, a phenomenon Bartley and his staff referred to as “coning.” The coning problem made a predictable burn rate nearly impossible, and the problem was a major hurdle in solid propellant motor development. However, redesigning the rocket motor combustion chamber into a star shape proved to be the answer. First experimented with by a British rocket research group in the mid-1930s, the star shaped combustion chamber only burns along a longitudinal star-shaped perforation in the propellant grain (Carroll 1974: 14). This insulated the motor combustion chamber walls, and as the star shaped chamber burned into a more cylindrical form it provided a very steady curve in pressure and thrust (Carroll 1974:14). With this design change, the JPL

Figure 39. Holger Toftoy, Deputy Commanding General of the Army Ordnance Missile Command at Redstone Arsenal, demonstrates a scale model of the Sergeant missile system, circa 1950s (*courtesy Redstone Arsenal)*.

solid propellant team of Bartley, John Shafer, and Henry Thackwell overcame the last significant obstacle with polysulfide based solid propellants. In doing so, they also established the technology and manufacturing methods required to produce very large solid propellant motors that provided the same thrust as liquid fuel propellants (Carroll 1974:20).

The solid propellant work of Thackwell and Shafer attracted the attention of Army Ordnance, who issued a contract for the development of a solid propellant sounding rocket. This sounding rocket was known as the Sergeant, but the rocket was not a direct ancestor of the later Sergeant tactical missile. This was primarily due to the fact that the project suffered from repeated motor explosions during testing. In 1948, the contract was canceled by Army Ordnance and caused JPL to reduce its solid propellant division (Carroll 1974: 21). Thackwell moved to Thiokol, where he was instrumental in developing the RV-A-10 rocket as a joint project with General Electric (GE). At the time, GE was developing the Hermes A2 as a solid-propellant tactical missile and Thackwell's experience with solid propellant systems was an obvious incentive to partner with Thiokol. The Hermes A2 was under development from 1949 to 1953, during which time the Army had already progressed with development of the liquid fuel Corporal missile (Kennedy 2009:150). The RV-A-10 development moved slowly, but in 1953 four test vehicles were successfully launched from the Air Force Missile Test Center (AFMTC) at Cape Canaveral, Florida (Carroll 1974:22).

Figure 40. A Sergeant Launch from LC-32, 1969 (*courtesy WSMR Museum Archives)*.

Around the same time as the RV-A-10 tests, the Army formally requested a solid fuel replacement for the Corporal missile. This project went to JPL rather than Thiokol-GE, apparently because it was easier to utilize existing contracts with JPL than develop a new contract with Thiokol-GE. The new design was based on the RV-A-10 prototype but was longer and heavier. The new missile was designated the Sergeant surface-to-surface guided missile, and it was based on the polysulfide solid propellant, star-design motor that had been pioneered at JPL by Bartley, Shafer, and Thackwell (Carroll 1974). With the start of the Sergeant program, the JPL effort to develop a reliable solid propellant motor came full circle.

Unlike a liquid propellant motor which can be controlled by limiting the propellant flow, the solid propellant motor of the Sergeant could not be shut down after it was ignited. Therefore, the Sergeant was equipped with air brakes to adjust its speed and trajectory once it was in flight (Kennedy 2009:150). Compared to its predecessor Corporal missile, which used a command guidance system that was subject to jamming, the Sergeant used an onboard inertial guidance system that required minimal ground equipment and was much less susceptible to countermeasures (Kennedy 2009:150; Parsch 2005). The guidance system for the Sergeant was developed by Sperry Corporation, which also replaced JPL as prime contractor for the system in 1960 (Kennedy 2009:150; Redstone Arsenal 2015c).

Table 5. Properties Constructed in Support of the Sergeant Program at LC-32.

Property	Name	Build Date
20483	Ribbon Frame Camera Station 3	1959
20494	Ribbon Frame Camera Station 4	1959
20500	Instrument Pad	1959
20502	Ribbon Frame Camera Station 2	1959
20505	Ribbon Frame Camera Station 5	1959
20508	Instrument Pad	1959
20509	Instrument Pad	1959
20510	Guard House	1958
20511	Instrument Pad	1959
20512	Instrument Pad	1959
20513	Instrument Pad	1959
20514	Instrument Pad	1959
20515	Magazine	1958
20516	Magazine	1958
20517	Instrument Pad	1959
20518	Instrument Pad	1959
20519	Instrument Pad	1959
20520	Launching Pad	1958
20521	Cable Tunnel	1958
20522	Instrument Pad	1959
20523	Instrument Pad	1959
20524	Firing Control Pad and Blast Barrier	1958
20525	Missile Assembly Building	1958
20526	Generator Building	1958
20527	Compressed Air Pad	1958
20528	Septic Tank and Drain Field	1958
20529	LP Tank	1958
20701	Ribbon Frame Camera Station 1	1959
20706	Ribbon Frame Camera Station 6	1959

6.9.2 Testing at WSMR

The Sergeant was tested between 1954 and 1960, and LC-32 at WSMR was the primary location for its development. The Sergeant launch area was located in the west portion of LC-32, sometimes referred to as LC-32 West, and was the counterpart to the Hawk area at the east side of the complex. The first Sergeant experimental missile was tested in 1956, and the first fully guided Sergeant missile was launched on May 1, 1958 from LC-32. The guided flight suffered a guidance system malfunction and impacted over two miles beyond and 16 miles to the right of the designated target area (Kennedy 2009:151). The minimum range of the Sergeant was 25 miles and its maximum range was 75 miles, which allowed it to be tested mostly within the confines of WSPG.

Table 6. Sergeant Firings at WSMR, 1956 to 1988 (*WSMR Museum 2015a)*.

Year	Type	Total Firings
1956	Sergeant	4
1957	Sergeant	4
1958	Sergeant	11
1959	Sergeant	6
1960	Sergeant	12
1961	Sergeant	11
1962	Sergeant	13
1963	Sergeant	20
1964	Sergeant ASP Support	9
	Sergeant Maint Eng	1
1965	Sergeant	8
1966	Sergeant	4
	Sergeant ER	28
1967	Sergeant	4
1968	Sergeant	5
1969	Sergeant	3
1970	Sergeant	3
1971	Sergeant	3
1972	Sergeant	4
1973	Sergeant	3
1974	Sergeant	2

Facilities constructed by 1958 at LC-32 in support of the Sergeant missile included the Launch Pad (Property 20520), Cable Tunnel (Property 20521), two Magazines (Properties 20515 and 20516), Missile Assembly Building/Blockhouse (Property 20525), and Firing Control Pad/ Blast Barrier (Property 20524). Additional properties added in 1959 included a series of instrument pads and ribbon frame camera stations.

While most of the Sergeant flights were launched from LC-32, the missile was also launched from off-range. In mid-May 1963, the Sergeant was launched from a primitive location near Horse Springs on the Plains of San Augustin in western New Mexico. Three Sergeant missiles were launched from the Plains of San Augustin location between May 13 and 16, 1963. Eckles (2013:252-253) relates that Fred Walters, a DOVAP radar technician, stated that the long, west-to-east trajectory provided by the off-range launch was necessary to test if the earth's rotation would impact the Sergeant's inertial guidance system.

Although the off-range Sergeant launch area was only a temporary location, it still required a substantial effort to prepare the site and support the launch. The site was located about 20 miles southeast of Datil, New Mexico and was reached by a convoy of approximately 40 vehicles (McFall 2013:6). Personnel assigned to the site and directly involved with the off-range firings included 15 officers, 100 enlisted men, and 75 civilians. Major Milton Fogel was the Off-Range Site Commander and was in charge of the overall operation (Wind and Sand 1963:1). Lawrence McFall was assigned to the operation and vividly recalled:

> We learned that beer could be kept cool in a 2 to 3 foot hole dug in the floor of our squad tent with pasteboard covering the newly disturbed earth. An officer who liked beer as much as our small group went back to base and returned with six cases our second weekend out there. Except for the usual military discipline we experienced no harassment during our detail and generally remember having a great time [McFall 2013:6].

The Sergeant had the distinction of being the first Army missile to be fired off-range over a populated area, and demonstrated the off-range firings could be safely accomplished (Eckles 2013:252). This established a positive precedent and the Army's program of off-range firings soon expanded to include launches of the Pershing and Athena missiles from the GRTS in Utah.

US Army units equipped with the Sergeant missile were required to fire ASP rounds as part of their training with the system. These practice firings were conducted twice a year at WSMR beginning in 1962, and at least some of the firings took place at LC-32 (Missile Ranger 1971).

6.9.3 Deployment and Service

The Sergeant entered the Army inventory in 1962 and was designated the XM-15 guided missile, then re-designated as the MGM-29A in 1963 (Parsch 2005). Although the Sergeant was a relatively large missile at over 34 feet long and weighing over 10,000 pounds, it was still smaller than the Corporal missile it replaced, which was 45 feet long and weighed 11,000 pounds. The size reduction also helped to improve its mobility in the field compared to the Corporal (Eckles 2013:252; Parsch 2005). The Sergeant could be ready to fire in about an hour after reaching a launch site, versus the nine hours required to set up

Figure 41. A Sergeant missile on its portable launcher, circa 1960s (*courtesy Redstone Arsenal)*.

the Corporal missile for firing (Parsch 2005).

Designed to carry the W52 nuclear warhead, which was expressly designed for use with the Sergeant, the missile was primarily intended as a combat system that could deploy low yield nuclear warheads against Soviet targets should the Cold War escalate in Europe (Missile Threat 2015). Accordingly, of the seven Sergeant battalions trained and equipped by 1964, five were deployed to Europe, one to the Strategic Army Corps, and one to South Korea (Redstone Arsenal 2015c). It was mobile and air-transportable and could be fired by a six-man crew (Parsch 2005). Although the solid propellant motor of the Sergeant was a significant advancement when it first entered Army inventories in 1962, large, solid propellant motors soon became mainstays of long distance missiles. Both the Minuteman and Polaris ICBMs of the 1960s included solid propellant booster stages (Carroll 1974:22).

Although a major improvement over the Corporal, the Sergeant was nonetheless an intermediate stage of tactical missile development and was soon rendered obsolete by more advanced systems such as the Pershing and Lance. The Sergeant was retired from Army service in 1977 and replaced by the smaller, lighter Lance missile (Parsch 2005).

6.10 Mauler Missile

The Mauler was envisioned as part of the FAAD concept developed by the Army during the late 1950s and early 1960s. The missile and fire control systems were integrated into an armored vehicle platform as a self-contained system. It was designed to defend front line troops from strikes by enemy ballistic missiles and strafing attacks from jet aircraft and helicopters. No weapon in the Army arsenal at the time possessed such capabilities. It was intended as a partner system to the Redeye shoulder-fired anti-aircraft missile, capable of engaging targets at higher altitudes and longer ranges than the small, portable Redeye (Wind and Sand 1960:6).

Figure 42. The XM546 Mauler anti-aircraft vehicle system (*US Army photo*).

6.10.1 History of Development

Efforts to develop an effective air defense weapon for front line combat troops against attacks by missiles and strafing by low-flying aircraft had been initiated by the Army Ordnance Corps following WW II, but the proposed systems were based on conventional artillery weapons and were insufficient against high-speed missile and jet aircraft. The Mauler concept emerged as the best solution against the rapidly evolving aircraft threat during 1957 to 1958 after the can-

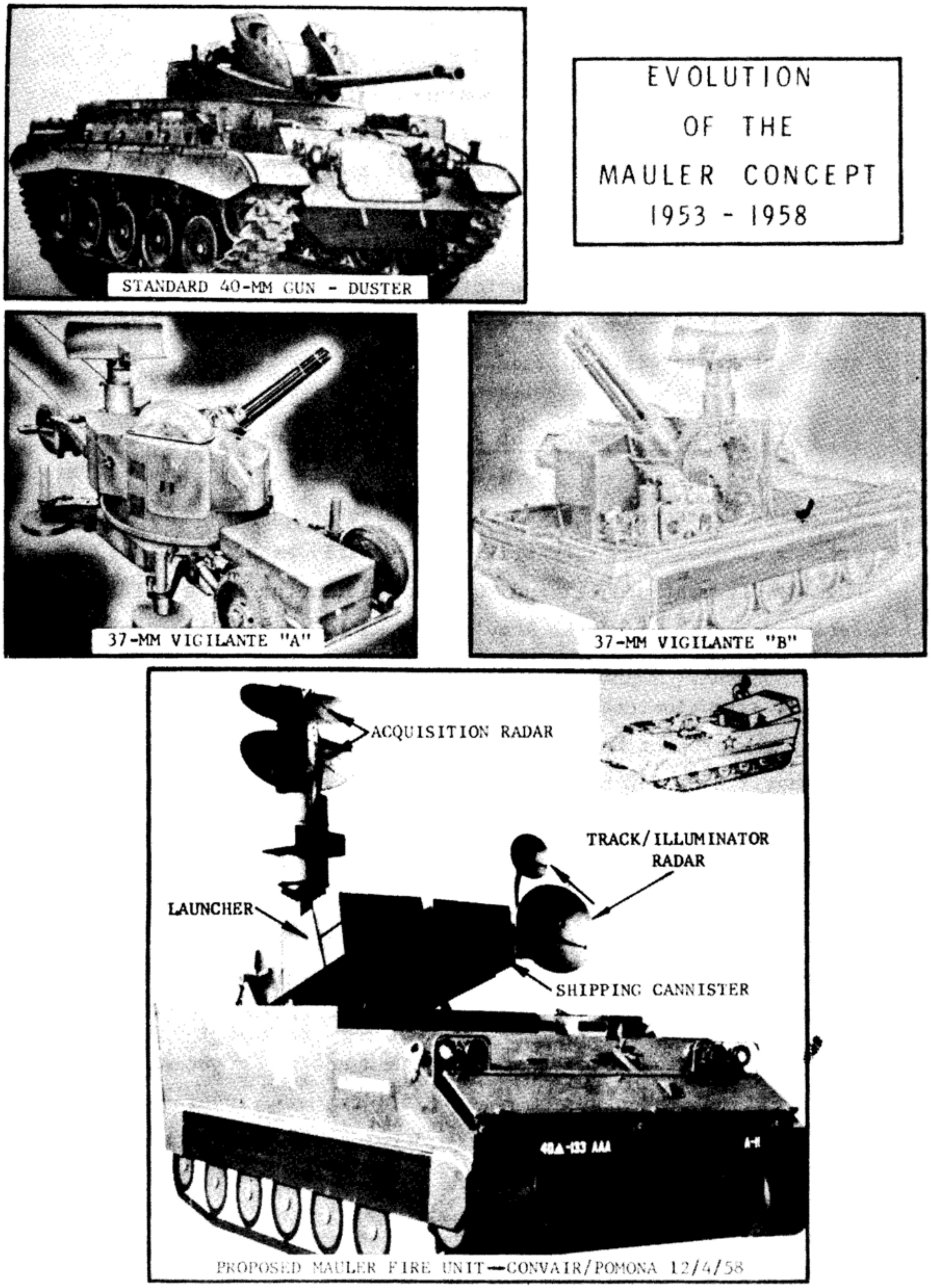

Figure 43. The evolution of the Mauler concept from the Duster and Vigilante anti-aircraft gun concepts (*figure reproduced from Cagle 1968)*.

cellation of several more conventional anti-aircraft programs such as the Duster and Vigilante anti-aircraft gun platforms (Cagle 1968:19-20). The Mauler was developed as a companion system to the Convair Redeye, which was under development at the same time.

The technical requirements of the proposed Mauler system were outlined in February of 1958, at which time management of the project was transferred from Redstone Arsenal to the Army Rocket and Guided Missile Agency (ARGMA), a predecessor to MICOM. After an extensive period of proposal review and funding difficulties, the Army awarded a contract for the development of the Mauler system to General Dynamics (Convair Division) in 1960. The system was built onto an XM-546 tracked vehicle, which was a modified version of the M-113 Armored Personnel Carrier. The Mauler missile was based on a beam-rider guidance system, which used an acquisition radar to detect the target and an illumination radar that tracked the target with an infrared beam via a fire control computer. When launched, the Mauler missile would fly into the illumination beam and track it all the way to the target (Cagle 1968).

The short range, surface-to-air Mauler system was unique in that it was contained on a self-propelled vehicle that also incorporated an internal power supply, target and guidance systems, and a complement of multiple missiles (Wind and Sand 1960:6). The single vehicle package of the Mauler allowed it to travel with troops and be fired without setting up required support systems and radars. While the Hawk was also a mobile system, it required a static position for the set up of its guidance and targeting radars, generator equipment, and fire control center. The Mauler was both self-contained and self-propelled, making it a much more effective system for forward deployment and quick relocation.

6.10.2 Testing at WSMR and LC-32

Early testing of the Mauler was conducted at the SMR during 1961 and 1962, before flight testing was relocated to the newly established LC-34 (Cagle 1968: 151-152; Eckles 2013:8, 28). Late in the testing of the Mauler, support facilities for the program were established at LC-32 as well. In 1963, Properties 21750, 21751, 21752, and 21756 at LC-32 South were transferred to the General Dynamics Convair Division for use with the Mauler testing program (Wilson 1963). These buildings were used as office, maintenance, and assembly space for the Mauler effort. Properties 20525 and 20526 at LC-32 West also briefly supported the Mauler program. In July of 1964, Property 20525 was transferred to the Mauler Test Branch for use as office space, missile assembly area, parts storage, and equipment storage space. The neighboring Property 20526 was also transferred to the Mauler program so that it could be used for office and equipment storage (Boyes 1964). It appears that LC-32 primarily supported assembly and support activities for the Mauler program, but one concrete pad at LC-32 East (Feature 298) may have served as an interim firing location.

The use of LC-32 facilities in support of the Mauler Program was short lived; after years of technological problems and funding shortfalls, the program was canceled in 1965. The LC-32 West properties were used briefly in support of the Hawk Missile program, and also the bi-annual Sergeant ASP firings. The properties at LC-32 South were allocated to the Redeye and Chaparral anti-aircraft missile programs, with the Hawk program eventually moving back into Property 21756, probably during the 1970s.

6.10.3 Problems and Cancellation

Despite being classified as high priority project by the Army, the development of the system suffered many setbacks due to funding gaps and shifting levels of commitment in the Army high command (Cagle 1968:57-58). The futuristic system was beyond the technology available and suffered numerous problems in development, which prevented it from advancing beyond the prototype stage. The fundamental problems with the Mauler development were summarized as:

> Beyond the backdrop of sporadic funding and constant program adjustments, the development of the engineering model weapon system floundered in a maze of complex electronic and packaging problems that clearly skirted the periphery of existing technology [Cagle 1968:168].

Problems with the Mauler prototype mostly stemmed from the mounting of the guidance system and launcher on the same vehicle. The blast, heat, and smoke of the launch caused the illumination radar to lose its target lock, rendering the guidance system useless.

After the unsatisfactory results of the 1963 GTV launches at LC-34, further testing was delayed and the entire Mauler program was reoriented as a Feasibility Validation Program (FVP) rather than as a tactical weapon development program (Cagle 1968:200; Parsch 2002b). The Mauler FVP was conducted into 1965 with additional launches at WSMR and successfully demonstrated the functionality of many aspects of the system. However, the program could not recover from the negative impressions it had created during the earlier testing phases. After a final evaluation, the Secretary of Defense approved the termination of the Mauler program on July 19, 1965. Nearly $200 million had been spent on the program from 1958 to 1965 (Cagle 1968:248). With the termination of the Mauler, the Army developed the Chaparral and Vulcan weapon anti-aircraft systems as interim solutions for FAAD deployment. Neither of these systems fully met expectations for FAAD, and the Army continued to search for a more viable solution into the 1970s. This eventually led to the adaptation of the European Roland Missile, which was also tested at LC-32.

6.11 Roland Missile

The need for a serviceable FAAD system to protect frontline forces from aerial attacks persisted into the 1970s. The Mauler had been intended to fulfill this role, but the program had been canceled in 1965 due to a variety of technical problems. By the 1970s, the FAAD concept had evolved into what the Army referred to as Short Range Air Defense (SHORAD), and the SHORAD requirement was met by the Chaparral anti-aircraft missile and the Vulcan anti-aircraft gun systems. The Chaparral missile was based on the heat-seeking Sidewinder, and was introduced as a short-term replacement system for the canceled Mauler in anticipation that a more sophisticated solution would be developed. Although the Chaparral and Vulcan weapon systems met the immediate need for SHORAD weapons, the performance of both was hampered by poor weather conditions and slow target acquisition times (Hamilton 2009:255). By the early 1970s, the Army had begun to test systems in use by NATO allies in order to find a more versatile all-weather alternative to the Chaparral and Vulcan.

6.11.1 Development

Figure 44. A European Roland launch at LC-32, mid-1970s. Property 20525 in background (*courtesy WSMR Museum Archives)*.

The Roland missile was a French-German developed air defense missile system that was first tested by the Army in 1972 (Figure 44). These tests were conducted at Redstone Arsenal in Alabama and at the Doña Ana Range on Fort Bliss (Hamilton 2009:255). The Roland offered all weather capability and was designed as a pod that could be fitted to a tracked or wheeled vehicle, or towed. The system carried a complement of 10 missiles, two ready to fire on launcher rails and an additional eight divided between two magazines. The launcher rails were automatically loaded from the magazines by a loading mechanism, and the Roland search and tracking radar could detect targets even while the vehicle was moving (Hamilton 2009:255). Along with the Roland, the Army also tested the British Rapier and French Crotale systems in 1974. The Roland emerged as the best alternative from these comparative tests, and in 1975 the Army awarded a contract to Hughes Aircraft for development of an American version of the Roland (Hamilton 2009:256).

The Roland missile offered all weather performance superior to the Chaparral, which at the time was a fair weather system only, as wet or cloudy conditions would prevent the missile from acquiring the target's heat signature. The heat seeking operation of the missile also made it vulnerable to simple countermeasures such as flares. The Roland was identifiable by a set of short, triangular fins in a cruciform pattern at both nose and tail of the missile, and was a compact 7 ft and 10.5 inches in length. The missile weighed 148 pounds and was capable of engaging targets at altitudes up to 18,000 ft.

The Army wished to enhance the modularity of the Roland system so that it could be mounted to wheeled trucks or tracked vehicles, and also operate independently of a vehicle from the ground position. This would also allow it to be air-transportable (Hamilton 2009:257). The ambitious Army Roland program initially called for 180 of the missile systems to be produced, with 6,186 missiles manufactured for use by four dedicated Roland anti-aircraft battalions. This deployment goal was estimated to cost $3.32 billion, a rather exorbitant amount given the reduced military spending that typified the late 1970s and early 1980s (Hamilton 2009:257).

Figure 45. Preparing the European Roland System for testing at LC-32, 1975 (*courtesy WSMR Museum Archives)*.

6.11.2 Testing at LC-32

The Army tested the Roland system at WSMR from 1975 to 1987, some of which was undertaken at LC-32 beginning in 1975. The architectural plans filed for the Roland RDT&E show that launch and support facilities for the program were also established at LC-34 and LC-35, so the program was not exclusively tested at LC-32.

The Roland testing re-used several of the properties in the former Sergeant area of LC-32. Period photography shows a launch of the European version of the Roland on the old Sergeant launch pad (Property 20520) in 1975. Additional photographs from 1982 show the American truck-mounted Roland unit being off-loaded at the same location. Property 20525, the former Sergeant assembly and blockhouse building was used as a launcher checkout, assembly, and repair area for the Roland (Giesey 1975). Additionally, the south side of the adjacent boiler building (Property 20526) was used as an electrical checkout and shop area (Giesey 1975; Sedillo 1975). The two former Sergeant magazine buildings (Properties 20515 and 20516) were also used by the Roland program, although Property 20516 was shared with the Aequare air-launched drone program (Sedillo 1975). Architectural plans indicate that other properties

Figure 46. An American Roland launch at LC-32 in 1984 (*photo courtesy WSMR Museum Archives)*.

associated with the program were temporary installations that consisted of two portable skid mounted buildings, two contractor trailers, and one metal shed. None of these temporarily installed properties remain at the site. One permanent installation constructed for the Roland testing was Property 20506, a latrine building located south of the Property 20525 Assembly Building. The latrine facility was necessitated by the influx of personnel into the area and the lack of sufficient existing restroom facilities in Properties 20525 and 20526.

The nature of the Roland testing at LC-32 is not entirely clear. According to a 1975 WSMR memo, it was expected that most of the non-firing missions would be conducted at LC-32 and the LC-32 Roland facilities would also support firing missions conducted at LC-34 (Giesey 1975). At least a few firings of the original French-German system were conducted at LC-32 as indicated by the period photographs of launches on the Property 20520 pad (Figure 46). The WSMR firing records do not indicate the location of launches, only summarizing annual totals (Table 7), so it is not possible to determine how many of the overall Roland launches took place at LC-32.

Table 7. Roland Firings at WSMR, 1975 to 1987 (*WSMR Museum 2015a)*.

Year	Type	Total Firings
1975	Roland	5
1976	N/A	0
1977	Roland	1
1978	Roland	64
1979	Roland	13
1980	Roland	7
1981	Roland	2
1982	Roland	1
1983	Roland	17
1984	Roland	7
1985	Roland	18
1986	Roland	9
1987	Roland	8

6.11.3 Deployment and Service

Unfortunately, the plan to convert the existing Roland system into the American version was not as simple as it initially appeared. The large scale deployment of a foreign designed weapon had never been accomplished by the Army, and in this regard the Roland project was without precedent. It required that over 100,000 technical drawings and specifications be translated from French and German into English, a major effort which increased the cost of fielding the Roland ten-fold. Furthering the funding shortfall, by 1982 the program's funding was substantially cutback in favor of the Stinger and Patriot air defense missile systems (Hamilton 2009:257). Seeking to recoup some of the $1.4 billion already invested in the system, the Army mounted the Roland on an M812A1 5-ton truck chassis rather than on the M109 tracked chassis and limited its production to 27 systems to be employed by one battalion (Hamilton 2009:257; Parsch 2002b). In an unusual move, the Roland was fielded exclusively with a New Mexico National Guard battalion that was stationed at Fort Bliss. The sole Roland battalion was activated in July of 1983 and remained so until 1988, remaining at Fort Bliss for its entire duration (Hamilton 2009:258). The final version of the system was designated as the XMIM-115A (Parsch 2002b).

By the time the Roland was retired from US service in 1988, technological improvements to the Chaparral guidance and targeting systems substantially improved its target acquisition capabilities under inclement conditions. With the increased effectiveness of the Chaparral, the Army effectively extended its in-service lifespan into the 1990s, which eliminated the need for the costly Roland missile. However, variants of the Roland continue to be employed by several allied European nations.

6.12 The Drone Target Program at LC-32

Aerial drone targets are an important part of anti-aircraft missile testing and almost all successful anti-aircraft missiles rely on realistic testing against aerial targets at some point in their development. Early drone targets used for the Hawk testing were drone F-80 fighter jets (QF-80), and some of the early successes of the Hawk were spectacular strikes against these full size targets. Of course, using full size planes as targets was an expensive proposition and the use of sub-scale, dedicated aerial drone targets was much more financially sustainable. Drone targets have therefore been an important component of Hawk testing throughout its long career.

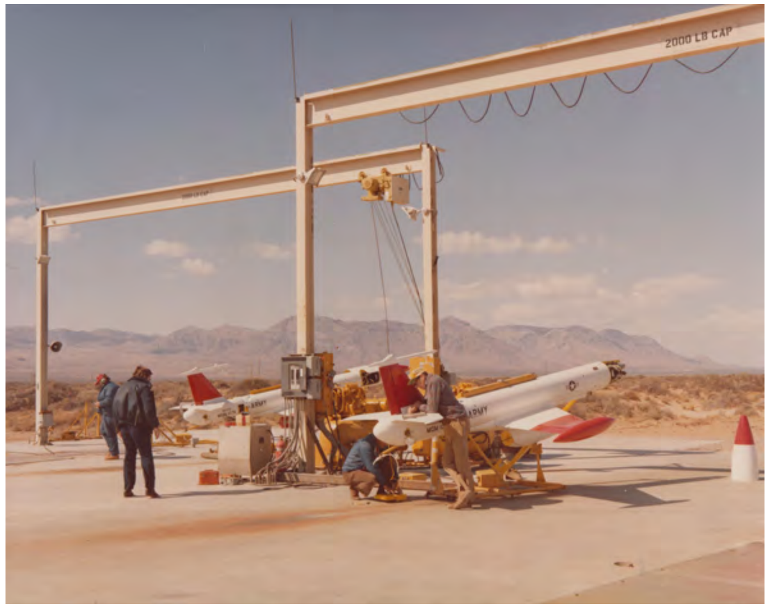

Figure 47. MQM-107 drones are prepped for launch at the LC-32 MTLC, 1980 (*courtesy WSMR Museum Archives)*.

Drone targets used for the testing of the original Hawk system (Basic Hawk) included the QF-80, QTM-61 Matador, Q-24, Q-2C, Towbee, XM-21, Q-4, Q-5, Petrol, KDB-1, OQ-19, 1025, 124E, and MQM-42A Red Head/Roadrunner drone, as well as other targets that included pole-mounted jammers and Little John, Honest John, and Corporal missiles (Essary 1986:16; Missile Ranger 1986:6).

Targets used for the testing of the more advanced I-Hawk system included the MQM-34D, MQM-61A, MQM-74C, MQM-107, MQM-42A Roadrunner, AQM-37A Jayhawk, BQM-34E, and the MQH-21 Helicopter drone (Essary 1986:16). Some of the Hawk intercepts of these drone targets were dramatic, including a hit against a MQM-34D that ran out of fuel and was descending via recovery parachute. The I-Hawk missile scored a direct hit against the helpless drone (Essary 1986:16).

6.12.1 Significant Drone Systems at WSMR

Some of the first mass-produced drones were simple piston driven, prop aircraft such as the Beechcraft MQM-61 Cardinal drone and the Northrop MQM-33 Radioplane, both of which were used as targets by the Army, Navy, and Air Force. However, these piston driven aerial drones lacked the speed and maneuvering capability to properly simulate the flight characteristics of jet aircraft. Beginning in the 1950s, jet powered aerial drone targets became com-

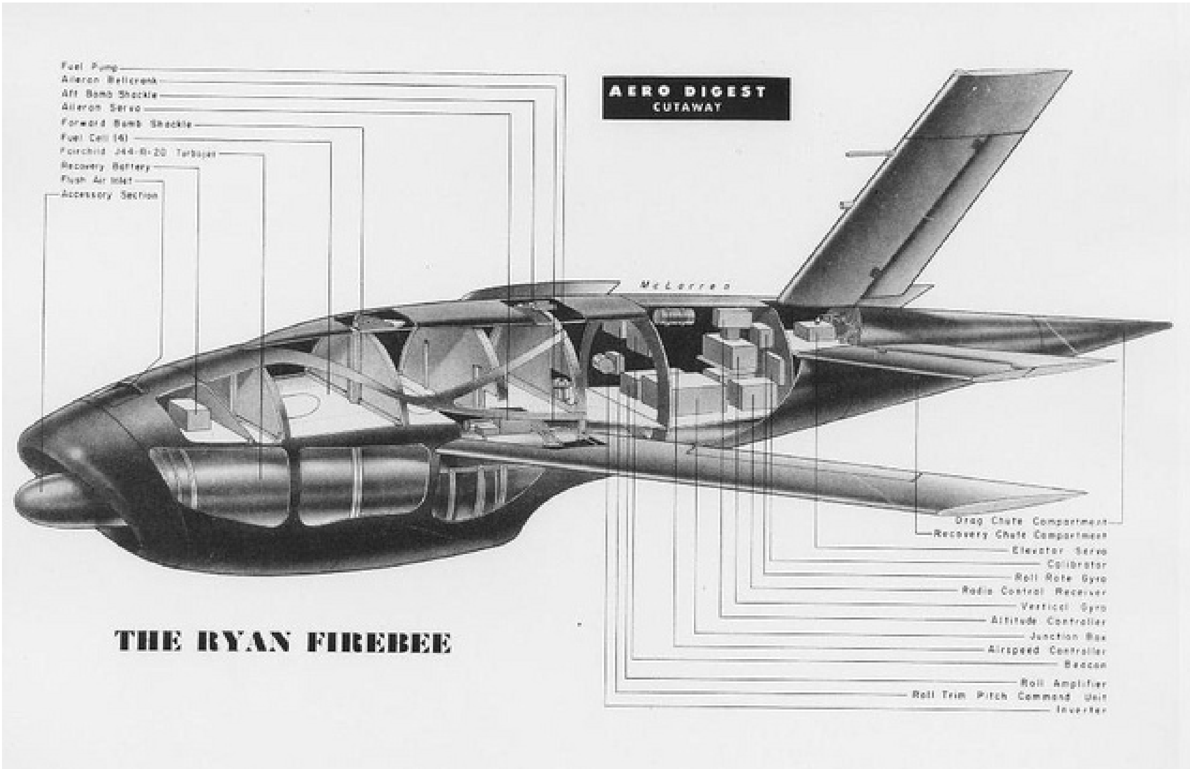

Figure 48. The first Firebee model with its distinctive, central conical air intake (*public domain image)*.

monplace. The most prolific jet powered aerial drone families include the Ryan Firebee and the Beechcraft MQM-107 Streaker. As both these drones were used extensively at WSMR and launched from dedicated facilities at LC-32, they are briefly described here.

6.12.1.1 The Ryan Firebee

The Ryan Firebee was the first jet powered drone aircraft and one of the most successful aerial target vehicles ever designed. Its development was initiated in 1948 when the Pilotless Aircraft Branch of the USAF requested designs for a jet-powered aerial target capable of high subsonic speeds. The USAF chose the design developed by Ryan Aircraft, and the project was designated as the Q-2. The first Q-2 drone flew in 1951 and within the year mass production of the drone aircraft was underway (Parsch 2003). The Ryan Q-2 Firebee was tested extensively at HAFB in 1953 (Wind and Sand 1953). The Air Force version was known as the Q-2A Firebee, and the Navy and Army also purchased versions of the drone target. The Navy version was designated as the KDA-1, and the Army variant designation was the XM21. The Army and Navy version of the Firebee were powered by Continental J69-T-19 turbojet engines with distinctive central, conical air intakes, and were boosted up to speed using an Aerojet JATO unit that dropped away once the primary engine took over (Parsch 2003). The Firebee had a maximum sustained speed of 690 mph, but could go as fast as Mach 1.5 for 14 seconds. It could operate at altitudes up to 60,000 feet and had a flight time of 45 minutes (WSMR Museum 2015d). All versions of the Firebee had onboard parachute recovery systems that allowed them to drop safely to the ground when they ran out of fuel. The drones could also be powered down and the parachutes deployed via radio command (Wind and Sand 1953:10).

Figure 49. The improved Firebee Q-2C configuration with its "chin" intake location (*photo courtesy WSMR Museum)*.

As both jet aircraft and missile systems improved throughout the 1950s, higher performance aerial target drones were required to maintain accurate simulations. Ryan responded with the Model 124, or Q-2C, a Firebee with a slightly larger airframe that was capable of significantly improved performance over the original. The Q-2C was equipped with a more powerful Continental J69-T-29 engine which required relocation of the air intake beneath the nose in a "chin" configuration. This improved Firebee phased out the original Q-2A/KDA-1/XM-21 version and became the standard subsonic Firebee configuration for decades. In 1963, the Q-2C designation was changed to the BQM-34A, and the Q-2C/BQM-34A is generally referred to as the Firebee I (Parsch 2003). The Air Force and Navy often launched these drones from larger aircraft; the ground-launched version of the drone used by the Army was known as the MQM-34D (Parsch 2003).

During the 1970s, the Army required higher performance from the MQM-34D for realistic evaluations of the Stinger man-portable anti-aircraft missile. The most economical option was to upgrade the existing MQM-34D drone with higher performance J85-GE-7 engines recycled from retired Air Force Quail bomber-launched decoy missiles. The improvement effort was successful, and the modified drones were known as the MQM-34D Mod II (Parsch 2003). The J85-GE-7 engines required a different intake configuration, so the MQM-34D Mod II can be identified by a large central "nose" intake rather than the "chin" intake of the original model (Parsch 2003).

Firing records show that the first WSMR Firebee was launched in 1961 and over 1,100 were launched through 1977, the date of the last available record (WSMR Museum 2015d). Doubtless many more have flown since that date as the drone remains in use at WSMR and many other locations.

6.12.1.2 The MQM-107 "Streaker"

Like the Ryan Firebee, the MQM-107 is a subscale aerial target drone. The MQM-107 was developed by Beech Aerospace Services as part of the Army Variable Speed Training Target (VSTT) design competition that was conducted in 1972. Beech entered their Model 1089 design in the competition, and after an extensive test program the company was awarded a production contract in 1975 (Missile Ranger 1986:8; Parsch 2004). The production model was designated the MQM-107A Streaker and was introduced into Army service in 1976.

The MQM-107 is powered by a Teledyne CAE J402-CA-700 turbojet engine located in a na-

Table 8. Firebee Launches at WSMR, 1954 to 1981 (*WSMR Museum 2015a)*.

Year	Type	Total Launches
1954	XQ-2 (USAF)	1
1955	Q-2 (USAF)	2
1956	Q2-A (USAF)	1
1957	Q2-A (USAF)	61
1958	Q2-A (USAF)	63
1959	Q2-A (USAF)	19
	GLXM-21	25
1960	XM-21 Q-2	57
	XQ-2C (USAF)	88
1961	Firebee	24
	XQ-2C	32
	XM-21 Q-2	84
1962	Firebee	147
	Q2-A	59
	Q2-C (USAF)	36
1963	Target Firebee	105
	Target Q-2 Formation	8
	Q-2C	152
1964	Firebee (USAF)	80
	Q-2C (USAF)	75
1965	BQM-34A (USAF)	14
	Firebee	64
	Q-2C (USAF)	40
1966	BQM-34A (USAF)	37
	MQM-34D	87
	MQM-34D Formation	8
1967	BQM-34A (USAF)	99
	MQM-34D	108
	MQM-34D Formation	27
1968	BQM-34A (USAF)	134
	MQM-34D	92
	MQM-34D Formation	11
1969	BQM-34A (USAF)	154
	MQM-34D	95

Table 8. Cont.

Year	Type	Total Launches
	MQM-34D Formation	11
1970	BQM-34A (USAF)	74
	MQM-34D	82
	MQM-34D Formation	11
1971	BQM-34A (USAF)	47
	MQM-34D	165
1972	BQM-34A (USAF)	85
	MQM-34D	37
1973	BQM-34A (USAF)	27
	MQM-34D (151)	28
	MQM-34D (319)	56
1974	BQM-34A (USAF)	1
	MQM-34D	95
1975	BQM-34A (USAF)	14
	MQM-34D	94
1976	BQM-34A (USAF)	5
	MQM-34D	122
1977	BQM-34A (USAF)	3
	BQM-34S	6
	MQM-34D	79
1978	MQM-34D	9
1979	MQM-34D	15
1980	N/A	0
1981	MQM-34D	11

celle under the main fuselage, and is accelerated from the launcher by a JATO booster which falls free once the primary engine is up to speed. In addition to the usual ground control, it can also fly preprogrammed missions. Like the Firebee, it uses a parachute recovery system that is engaged via radio control or automatically when the drone powers down. The Streaker flies at variety of speeds ranging from 230 to 575 mph and is capable of high G-force maneuvers near ground level (Parsch 2004).

It served as a target for the testing of Patriot, Stinger, Chaparral, Roland, and Hawk anti-aircraft systems at WSMR and was the Army's main target vehicle as of the 1980s (Missile Ranger 1986:8). The production of the MQM-107A ended in 1979 after almost 400 units were delivered to the Army (Parsch 2004). A performance improvement program started in 1980 resulted in the introduction of the MQM-107B, a variant with improved speed, payload, and maneu-

Figure 50. A MQM-107 Streaker drone launch at the LC-32 MTLC in 1983. Note the JATO booster (*courtesy WSMR Museum Archives)*.

vering capabilities (Missile Ranger 1986:8). About 200 MQM-107B drones were delivered to the Army by 1986, when it was replaced by MQM-107D. The MQM-107D was powered by the higher performance CAE J402-CA-702 engine, and nearly 700 of the MQM-107D were purchased by the DOD (Parsch 2004). In 1996, the improved MQM-107E model was released, and today many of the MQM-107D and MQM-107E remain in service. Raytheon took over production of the drone after it purchased Beech Aircraft in 1980.

6.12.3 Drone Launch Complexes at LC-32

The first dedicated drone launch complex, known as the Multiple Target Launch Complex (MTLC), was established at the east side of LC-32 in 1975. The launch complex consisted of two pairs of launch pads and gantry cranes for a total of four launchers. These launcher pairs, Property 20759 and Property 20760, shared a common launch control building (Property 20758) with an adjacent air compressor shelter (Property 20757). Period photography of the complex and comparison of the launcher rail hardware shows that this launch complex was used primarily for the launch of the MQM-107 drone. Its construction date strongly suggests that the complex was constructed expressly to support launches of the MQM-107 after it won

Table 9. MQM-107 Launches at WSMR 1976 to 1981 (*WSMR Museum 2015a)*.

Year	Type	Total Launches
1976	MQM-107	19
1977	MQM-107	30
1978	MQM-107	19
1979	MQM-107	12
1980	MQM-107	49
1981	MQM-107	8

the Army VSTT competitive design program in 1975. An additional pre-manufactured steel building, Property 20740, was also constructed in support of the drone launches as a weight and balance facility.

In 1977, a nearly identical complex was constructed to the east of Properties 20759 and 20760. This complex, consisting of Properties 20755 and 20756, shared the same layout as the neighboring multiple target launch complex. A primary launch control building (Property 20754) supported the four launch pads and an air compressor shelter (Property 20753) is located immediately behind the control building. Although both complexes are superficially identical, the launch rail hardware at Properties 20755 and 20756 indicates that this complex primarily launched the older MQM-34D (Firebee) drone rather than the MQM-107 models. Prior to the

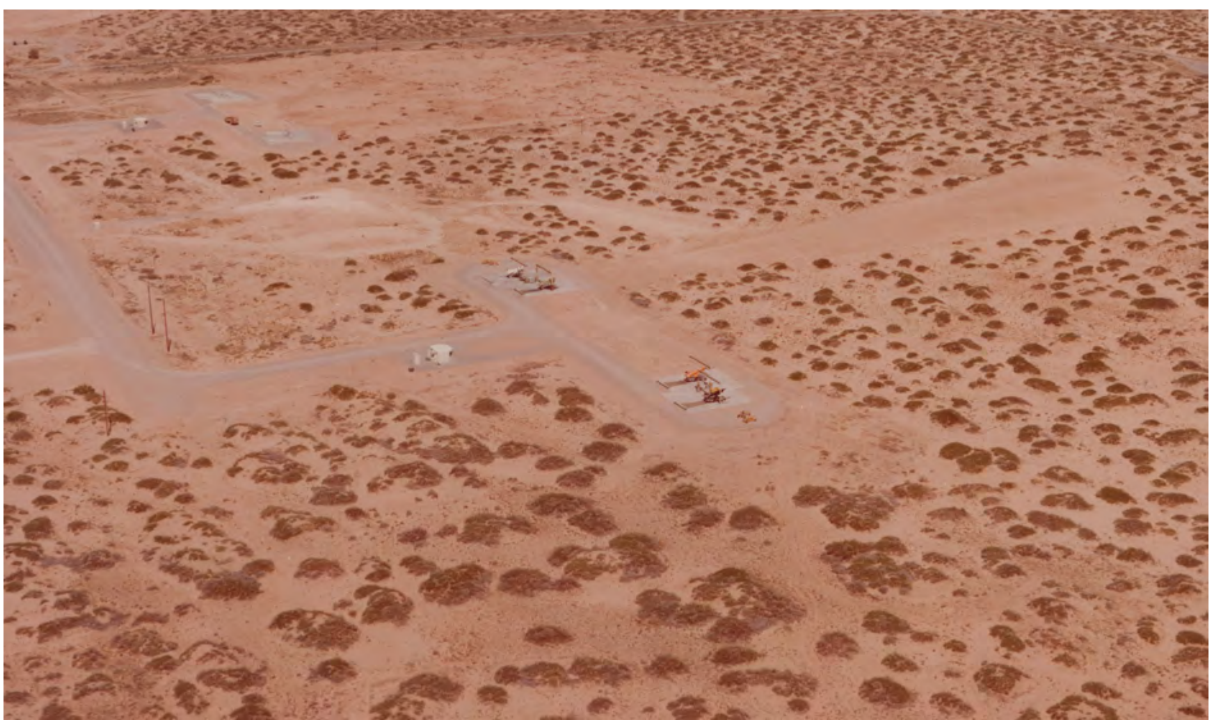

Figure 51. Aerial overview of the MTLC at LC-32, view to the northwest (*photo courtesy WSMR Museum Archives)*.

establishment of this complex, Teledyne Ryan launched the drones from a complex at B-Station North (Roberts 1976).

The two multiple target launch complexes were constructed in the area indicated as the "Hawk Annex" on the 1982 WSMR Master Plan and the addition of the drone launch complexes substantially altered this area. Several instrument locations in the Hawk Annex area (Properties 20749, 20750, 20751) were removed or substantially disturbed by the construction of the MTLC facilities and access roads. Additionally, one existing Hawk missile maintenance building (Property 20746) was converted for use as a drone repair facility in support of the MTLC. Additional MTLC support structures constructed in 1977 were two MQM-34D booster storage pads (Properties 20769 and 20770), an engine run-up test pad (Property 20765), and a fuel storage station (Property 20767).

Today the MTLC remains in use, and the drone maintenance program is based in Property 21759, the former Hawk Hangar building at LC-32 South. The current drone program is conducted under the Targets Management Office (TMO), a division of the Army Program Executive Office for Simulation, Training, and Instrumentation (PEO STRI).

6.13 The Patriot Missile

The Patriot Missile is a mobile, short-to-medium range anti-aircraft and ATBM system. The Patriot is probably the most recognized Army missile due to its highly publicized role in the Persian Gulf War, but its origins date back to the mid-1960s. Prior to its use in the Gulf War, the system had been under gradually accelerating development at WSMR for over twenty years.

Figure 52. A Patriot missile launched from the "dumpster on hydraulic lifters" (*courtesy WSMR Museum)*

6.13.1 History of Development

The Army originally conceived the Patriot as a projected replacement for the Hawk and Nike air defense systems that would be fielded during the 1970s. First known as the Army Air Defense System for the 1970s (AADS-70s), the Secretary of Defense renamed the developmental program the Surface-to-Air Missile Developmental (SAM-D). Three teams competed in the system concept phase of the program; Raytheon/Martin Marietta, Hughes/Douglas, and RCA/Beech (Redstone Arsenal 2015d).

In 1967, the Army awarded a contract to Raytheon for the advanced development stage of the system, an incremental development stage that was less costly and committing than full engineering development of the system. The first SAM-D test missile was launched in 1969 (Redstone Arsenal 2015d). Progress on the system remained modest due to budget limitations, and only after an Army evaluation of the SAM-D program in 1970 was an additional contract for the actual engineering development of the SAM-D awarded (Redstone Arsenal 2015d).

The program lingered through several reductions in funding and changes in scope during the following years, but gained momentum during the mid-1970s when it was supported by the incoming Carter Administration (Schubert and Kraus 1995:236). During this period, the missile was improved with the Track Via Missile (TVM) guidance system, which was an on-board guidance system that homed in on reflected radar energy from the target and took over guidance of the SAM-D during the terminal portion of the intercept (Schubert and Kraus 1995). The first TVM intercept against an aerial drone target occurred at WSMR in 1976 (Redstone Arsenal 2015d).

The program was renamed the Patriot in 1976 in recognition of the country's bicentennial and a production contract with Raytheon was awarded in 1980 (Schubert and Kraus 1995:237). The timing of the contract award was fortuitous for the Patriot program as it was well-positioned for the more expansive defense funding of the new Reagan administration. The generous budgets of the period allowed many early issues with the Patriot to be resolved and the system was fielded with European units of the Army Air Defense Command in 1985 (Schubert and Kraus 1995:237). The first version of the system was only capable of targeting aircraft, including helicopters, but the scope and capabilities of the system were expanded under the aegis of the SDI (Schubert and Kraus 1995:238).

The Patriot Missile battery consisted of linked launcher stations, each equipped with four missiles; Patriot batteries could include as many as eight launcher stations. The launchers doubled as shipping containers for the missiles and were boxy and ungainly in appearance; they were often described as "dumpsters on hydraulic lifters" (Schubert and Kraus 1995:237). The nerve center for the battery was the engagement control station, an air conditioned van outfitted with computers and control equipment. Vital to the operation of the system was the radar set, which was based around a sophisticated multifunction phased-array radar unit, a descendant of similar radars developed for Nike X during the 1960s. The other battery components included the antenna mast group, command post, and electric power plant (Schubert and Kraus 1995:238-239).

The Patriot Missile benefitted from its association with the well-funded SDI, and a technical improvement program had substantially improved the capabilities of the missile by the late-1980s. The Patriot Anti-tactical Ballistic Missile Capability 1 (PAC-1) version of the missile consisted solely of software upgrades that improved the missile's likelihood of achieving a "warhead kill", a direct hit on the warhead of an incoming missile. Less desirable but still effective was a "mission kill", where the incoming tactical missile was damaged and its course diverted. The PAC-1 upgrades were first tested at WSMR in 1986, during which a Patriot intercepted a Lance missile. In 1987, a PAC-1 Patriot intercepted another Patriot over WSMR. While the tests achieved mission kills of incoming missiles, the Army found that the PAC-1 was unlikely to make warhead kills. Despite this limitation, the Army issued a production contract for the PAC-1 version of the Patriot in 1988 (Schubert and Kraus 1995:238). Additional improvements to the warhead and fuze followed, and by the end of the decade the improved PAC-2 version of the system was nearing production. The PAC-2 upgrade substantially improved the missile's chance of making a warhead kill and was scheduled to gradually replace the existing PAC-1 version. However, before the PAC-2 rollout was completed the Patriot was called to duty as part of Operation Desert Shield in August 1990, beginning the most well-known chapter of the Missile's story (Schubert and Kraus 1995:238).

6.13.2 Patriot in the Gulf War

Although the Patriot was a highly influential system in the Persian Gulf War of early 1991, it was only by extraordinary measures that it arrived in time to be decisive in the conflict. The primary threat in the war was from Iraqi tactical ballistic missiles. These missiles were based on the outmoded Soviet Surface-to-Surface 1A (SS1A) Scunner, known as the Scud, which the Soviet Union retired during the 1970s but delivered in large numbers to affiliated states through the 1980s. Iraq improved the Scud into a version known as the Al-Hussein, which had an extended range of 400 miles at the expense of a lighter warhead and heavier motor and airframe (Schubert and Kraus 1995:239). This made the Iraqi Scud poorly balanced aerodynamically, which caused it to tumble when it reentered the atmosphere and break up into parts, with the primary pieces being the warhead, fuel tanks, and motor. This was known as the blossoming effect, and it acted as an unintentional but nonetheless effective countermeasure against interception (Schubert and Kraus 1995:239). The blossom effect of fragmenting Scuds made it significantly more difficult for the Patriot Missile to distinguish and target the warhead amongst the rain of incoming Scud constituent parts, particularly since the Patriot PAC-2 was rushed into the field.

The Patriot PAC-2 version was required for maximum effectiveness against the Scud missile, although it was pushing the limits of the system's design (Zimmerman 1992). The production of the PAC-2 version had barely begun when Patriot batteries were deployed to Saudi Arabia as part of Operation Desert Shield in August 1990. The production schedule called for the PAC-2 missiles not to be delivered until January 1991, so the production was drastically accelerated to meet the need in the Gulf. The only PAC-2 Patriot missiles available, actually the only three then in existence, were pulled from tests at WSMR and shipped overseas still bearing their "EXPERIMENTAL" stenciled labels (Schubert and Kraus 1995:243). Production of PAC-2 missiles continued around the clock; Martin-Marietta, the sub-contractor who manufactured the missiles, shipped them directly from the factory to Saudi Arabia (Schubert and Kraus 1995:243). The Desert Shield Patriot build-up proceeded just in time for the launch of Operation Desert Storm in January 1991.

The first engagement of Scud missiles by the Patriot occurred on the morning of January 17, 1991 when two Patriot PAC-2 missiles were fired to protect the Dhahran airport. The engagement appeared to be successful, marking a historic first for the system. Patriot batteries were placed to protect the Israel cities of Tel Aviv and Haifa in a diplomatic arrangement to prevent Israel from retaliating against Iraqi Scud missile strikes. Israeli involvement would have been extremely detrimental to the fragile US/Saudi coalition, and the protection offered by the Patriot batteries against Scud attacks helped deter Israel from entering the fray (Schubert

Figure 53. Patriot Missiles launched against incoming Scuds over Tel Aviv in 1991 (*courtesy Atlantic Sentinel)*.

and Kraus 1995:247). After the first two weeks of Operation Desert Storm, the Scud attacks quickly tapered off, mostly due to Coalition airstrikes against Scud launch sites. However, in a desperate maneuver as its ground forces suffered heavy losses, Iraq fired another salvo of Scuds on February 24 and 25 at targets in Israel and Saudi Arabia. The Scud missiles launched at Israel missed their targets and landed harmlessly in the desert, but one of the Scuds launched towards Saudi Arabia breached the Patriot defenses and impacted a temporary barracks building, killing 28 American Soldiers and injuring 97 (Schubert and Kraus 1995:250). This was the worst single incident of US casualties during the war and called into question the effectiveness of the Patriot. Within two days of this attack, Iraqi resistance had mostly crumbled and the President Bush suspended military operations, effectively ending the conflict. In total, 158 Patriot PAC-2s were launched against Scud missiles, but about 3,000 PAC-1 and PAC-2 Patriots were available to Coalition forces by the end of the conflict (Schubert and Kraus 1995:243).

The Patriot Missile was reported by the Army and the media as highly effective and the "Scud-Buster" missile became emblematic of the conflict and American technological and military superiority over the Iraqi forces. Yet post-war Congressional investigation of the missile's effectiveness did not support the initial positive reports, rather finding that Patriot may have had a success rate as low as nine percent (Cirincione 1992). Critics of the system argued that the widely televised images of Patriots exploding against Scud missiles in the sky were likely the result of proximity fuzes triggering the Patriot warhead against Scud blossoming debris, or the self destruct fuze destroying the missile as it passed the target. The Scuds themselves, inherently inaccurate, often broke up in terminal flight and missed their target due to aerodynamic drag (Cirincione 1992). However, definitive measures of intercept success during the war were lacking. Most estimates of the Patriot intercept success rate were based on analysis of low resolution commercial video footage, eyewitness accounts, and ground damage, all of which suffered from interpretative issues (Zimmerman 1992). Other congressional testimony provided during the investigation suggested that the Patriot success rate may have been as high as 50 percent in Israel and 80 percent in Saudi Arabia (Zimmerman 1992). Regardless of the actual figure, an Army history of the Gulf War describes the role of the Patriot as being particularly significant to the allied campaign as it was able to deal with the Scud threat, freeing air and ground forces from the time-consuming hunt for mobile Scud launchers, "in short, the Patriot reduced the Scud to a minor operational irritant" (Schubert and Kraus 1995:250).

6.13.3 Patriot at WSMR and LC-32

The Raytheon SAM-D/Patriot program was primarily based at LC-38 for much of its testing at WSMR, but it did influence facility usage at LC-32 and some flights of the missile were launched from the complex during the 1990s. The expansion of the SAM-D program in 1976 resulted in the relocation of Raytheon employees from Property 21759 to LC-38, which left the building available for use by the Teledyne-Ryan drone program (Glenn Moore personal communication 2015).

An area located north of the original Hawk launch area was used for Patriot launches during the mid-1990s. According to the archaeological inventory conducted in preparation for the launch site installation, the area supported two Patriot launch locations. A series of features (Features 101 to 105) were identified in this area during the current inventory which are consistent with remnants of Patriot mobile launch locations. These features included wiring, discarded launcher cell panels, wood pallets, and assorted debris.

Related to the testing of the PAC-3 version of the system, the Hera Target Missile was launched from LC-32 beginning in 1996. This program and its related facilities are described in the following section.

6.14 Hera Target Missile Program

During the mid-1990s, the development of the next generation of anti-ballistic missile systems required appropriate target vehicles for realistic simulations. Like aerial drone targets, these target missiles provided crucial real-world feedback on the accuracy and performance of these new systems.

6.14.1 Hera, PAC-3, and THAAD

The Hera was specifically designed as a target missile for the testing of the Patriot Advanced Capability-3 (PAC-3) ABM and the THAAD systems (Thongchua and Kaczmarek 1994). The Patriot PAC-3 and THAAD missiles were designed to intercept short and medium range ballistic missiles. The high-arc trajectories and very fast terminal flight speeds of these ballistic missiles make them very difficult to intercept. Both the Patriot PAC-3 and THAAD missiles were advanced systems developed under the aegis of the SDIO and its successor organization,

Figure 54. A Hera Target Missile on its launcher pedestal at LC-32 (*adapted from Walker et al. 2003)*.

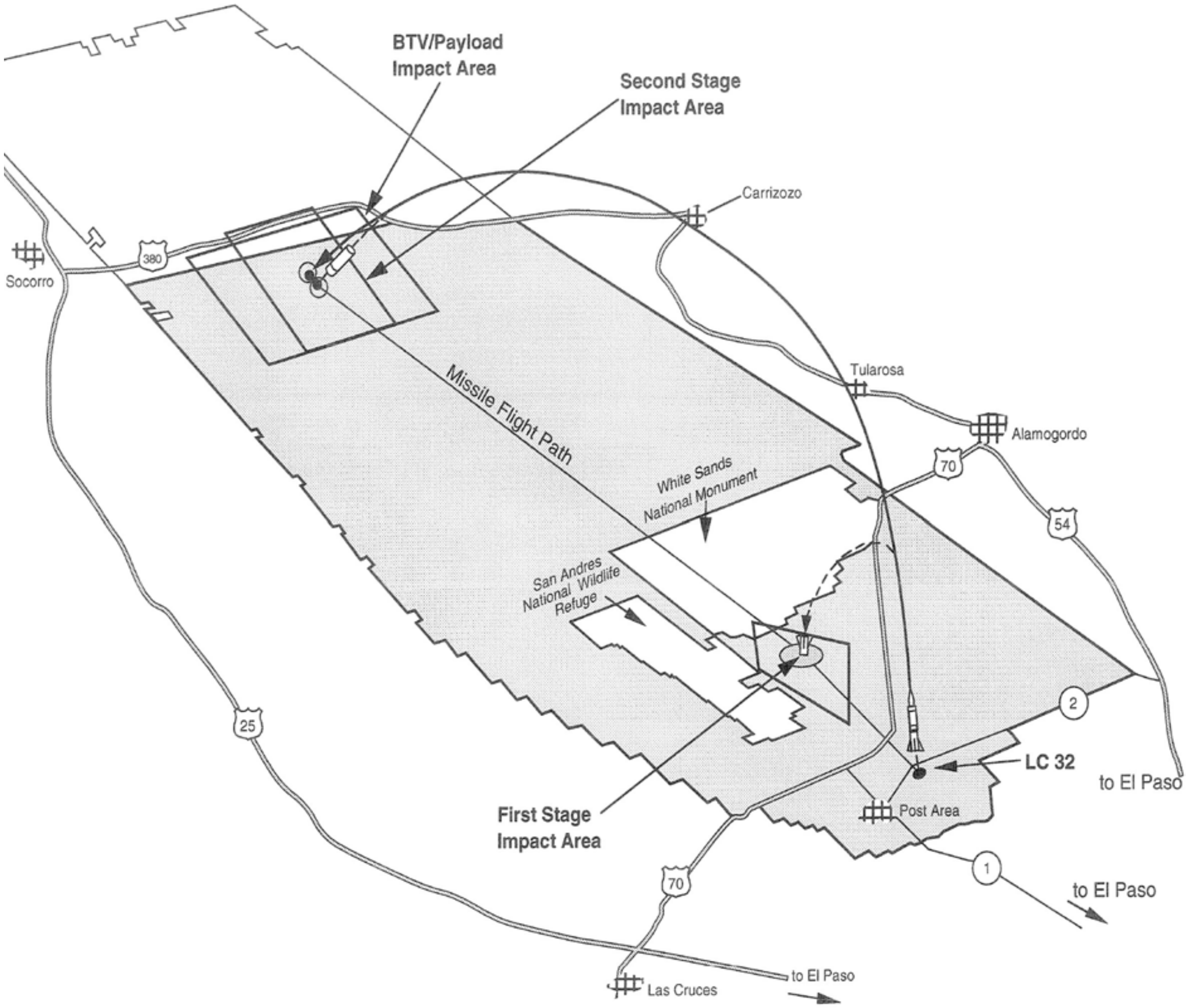

Figure 55. Flight path of Hera demonstration launches from LC-32 (*adapted from US Army Space and Strategic Defense Command 1995)*.

the Ballistic Missile Defense Organization (BMDO). Both systems were integral to the new TMD program, an effort to provide protection for US and allied military forces and civilian assets against enemy missiles fired within the theater of operations (Eckles 2013:258). These systems were "kinetic" interceptors; they lacked a warhead and relied on direct collision with the incoming missile at very high speeds to destroy it. The kinetic interceptors were capable of completely destroying the target missile, which was more effective than relying on explosives or shrapnel to disable it. A disabled ballistic missile will continue to travel along its flight path and can still impact with tremendous energy near its original target, while the high-energy collision of kinetic interceptors shatters incoming ballistic missiles into harmless fragments. This represented a significant advance in accuracy and was often referred to as "hitting a bullet with a bullet" (Eckles 2013:259).

The Hera missile was meant to provide a target that would simulate "medium range theater

Figure 56. Hera launch pad and shelter under construction at LC-32 in 1994 (*courtesy WSMR Museum Archives)*.

threats" and was therefore capable of significant altitude and range. A second target missile, the Storm, provided a target for short range theater threats (Thongchua and Kaczmarek 1994:1). The Storm was based on surplus Sergeant missile motors while the Hera was a two-stage missile built from spare Minuteman ICBM components. Developed by Coleman Research, the Hera missile's first stage was a modified Minuteman II second stage motor originally developed by Aerojet, and the second stage was the Minuteman I and II third stage booster originally designed by the Hercules Powder Company (Thongchua and Kaczmarek 1994:3-4). The use of the surplus Minuteman components significantly reduced the unit cost of the Hera missile, making it ideal for use as a target. It was a large missile at nearly 40 feet in length and weighing over 25,000 pounds. Several variants of the Hera were available that provided different ranges, trajectories, payloads, and terminal flight behaviors that could simulate a variety of threats (Thongchua and Kaczmarek 1994:5).

The Hera launches that occurred within WSMR took place at LC-32 or from LC-94 in the northern FIX area (US Army Space and Strategic Defense Command 1995:1). The missiles used for on-range firings had maximum ranges of approximately 120 km (Thongchua and Kaczmarek 1994:5). The Hera missile was also launched from off-range and intercepted over WSMR to better simulate the flight path of a medium range ballistic missile. The off-range firings were launched from Fort Wingate outside of Gallup, New Mexico during the late 1990s. The first successful off-range Hera launch occurred in 1998, and a Hera was successfully intercepted by a THAAD missile on June 10, 1999 (Eckles 2013:260).

6.14.2 Hera at LC-32

According to the Environmental Assessment conducted for the Hera Target Missile program, three Hera B target missile demonstration flights were conducted at LC-32 (US Army Space and Strategic Defense Command 1994). The program substantially modified the layout of the western portion of LC-32, which was originally the Sergeant launch area (Figure 56).

The Property 20525 assembly building and blockhouse was re-used for the Hera launches, and was modified with the addition of armor resistant steel plate on the block house windows, improvements to electrical and Heating, Ventilation, and Air Conditioning (HVAC) systems, and additions of required instrumentation and control equipment in the blockhouse (US Army Space and Strategic Defense Command 1994:25). Property 20526 was used for minor maintenance activities and for storage. A new pre-manufactured steel building was also constructed in support of the project, Property 2052A, for use as a maintenance facility for the program. A septic tank and drain field were established in support of 2052A, as well as a water supply line for a new fire hydrant. Additional construction at LC-32 undertaken as part of the Hera program included a fenced outdoor storage area and a series of office trailers located south of Property 20525. Only one of these office trailers remains in place (Property PB0019).

The most distinctive addition to LC-32 constructed for the Hera program is the Property 20521 launch pad and rail mounted conditioning shelter. Once assembled on the launch pad, the large shelter provided a climate controlled environment for the Hera missile, which required a stable temperature environment prior to launch. When the Hera was ready to launch, an electric winch and cable system retracted the shelter along its railed tracks to clear the Hera for launch (US Army Space and Strategic Defense Command 1994:29). The Hera launch pad and shelter were constructed immediately east of the old Sergeant launch pad, and the electrical and control wiring was routed through the original Sergeant cable tunnel and vault (US Army Space and Strategic Defense Command 1994:29). A large area to the east of Property 20521 was cleared for use as a "Transporter Erector Maneuver Area." The Hera launches at Property 20521 were controlled from the Property 20525 blockhouse. To improve access to the launch pad, the old Sergeant roads were re-surfaced and modified with widened turns, and a new access road was built to Property 2052A, which now serves as the primary access to the west end of LC-32 (US Army Space and Strategic Defense Command 1994:29).

Today the Property 20521 environmental shelter is used by the Japanese Chu-SAM program, as is the Property 20525 assembly building and blockhouse (Larry Carreras personal communication 2015). A mock-up Hera missile is located at the Property 20524 blast barrier, apparently as a souvenir from the program's tenure at LC-32.

6.15 The Orion LAS Program

The Orion Space Capsule was designed as the replacement for the retired Space Shuttle vehicle and was the core of the Constellation Program, which was the next phase of the human space flight program that was announced by NASA in 2004. The Constellation Program was to consist of five principal vehicle components: the Ares I launch vehicle for carrying astronauts to low-Earth orbit; the Ares V heavy-lift vehicle for launching astronauts or other cargo beyond low-Earth orbit to the Moon; the Orion capsule, which would carry astronauts into low-Earth orbit and beyond; the Altair lunar lander for Moon landings; and unnamed vehicles for traveling on the lunar surface. The initial Constellation engineering development focused on the most basic elements, the Ares launch vehicle and, in particular, the Orion capsule.


Figure 57. The Orion LAS on the launch pad at LC-32 (*adapted from Hackenburg and Hicks 2007)*.

6.15.1 Concept and Development

The Orion capsule was similar to the space capsules used during the Apollo Program of the 1960s, albeit a modernized design. The Orion capsule is considerably larger than the old Apollo capsule, and as designed could safely carry six astronauts and required life support equipment. Like its Apollo predecessor, the Orion would ride atop the Ares launch vehicle into orbit, then re-enter the earth's atmosphere and make a parachuted splashdown landing. Also like the Apollo, the Orion incorporated an abort system that would separate and propel the manned capsule away from the launch vehicle in the event of catastrophic failure on the launch pad or in early flight. This system was a modernized version of the Apollo LAS that was tested on the Little Joe II at LC-36 from 1963 to 1966.

Like the older version used with Apollo, the LAS rocket motors are built into a tower perched atop the capsule. In the event of a normal launch and ascent through the atmosphere into orbit, the unneeded LAS tower is jettisoned away. In the event of an emergency abort with the launch vehicle on the pad or in the early flight stages, the LAS motors would lift the capsule up and

Figure 58. Overview of Orion LAS facilities at LC-32 (*adapted from Hackenburg and Hicks 2007)*.

away from the malfunctioning launch vehicle. As the capsule ascended the altitude control motor keeps the capsule and LAS in an upright position. The heavy capsule makes the LAS aerodynamically unstable; without the altitude control motor its natural tendency is to flip end-for-end 180 degrees. At the apex of its flight, it does exactly this, flipping the capsule heat shield down (Davis 2014). At this point the LAS tower is separated from the capsule and carried away by a small jettison motor. As the capsule falls, it releases a triple parachute recovery system and drifts gently down to earth (Davis 2014).

6.15.2 Testing at LC-32

Like its predecessor during the Apollo era, the Orion LAS was also tested at WSMR. Construction of Orion facilities at LC-32 began on October 1, 2007. These facilities included a large assembly/hangar building identified as the Final Integration and Test Facility, a Launch Pad and Gantry, a Launch Services Pad, and an Operations Support Trailer (OST) located at Uncle Site. These facilities were completed by August of 2008 (Hackenburg and Hicks 2007). These facilities were built in the eastern area of LC-32, east of the main Hawk launch area and the Hawk Fixed Battery area. A Field Storage Area was also established to the south and east of Property 20541.

The first pad abort test took place at the Orion Launch Pad on May 6, 2010 at LC-32. During the test, the system worked perfectly. The LAS motors launched the vehicle off the pad at a high rate of speed, and carried the capsule aloft. At its apex it executed a perfect 180 degree spin and the capsule entered into parachute recovery mode and landed gently on the desert floor. Film footage of the test does not show the impressive gantry tower in use during the test. This was the first demonstration of the fully integrated Orion LAS system (Davis 2014).

Figure 59. The Orion LAS blasts skyward from LC-32 on May 6, 2010 (*from NASA video footage)*.

6.15.3 Program Cancellation

A total of six tests were originally planned for the Orion LAS at LC-32, consisting of two pad abort tests and four ascent abort tests (Hackenburg and Hicks 2007). However, the May 2010 pad abort test was the only test of the LAS conducted at WSMR. The Constellation Program was cancelled by the Obama administration as of 2009 following an extensive study by a review committee that found the program to be chronically underfunded and unlikely to achieve its major milestones on schedule. The Constellation cancellation ended the development of the Ares launch vehicles and Altair lunar lander vehicle; however, the Orion capsule design survived the program cancellation. The original Orion capsule design was restructured as a multi-purpose capsule known as the Multi-Purpose Crew Vehicle (MPCV). The Orion MPCV will be carried into orbit with the Space Launch System (SLS), a multi-stage launch vehicle that is derived from the Space Shuttle launch vehicle. On December 5, 2014 the Orion capsule was launched from Cape Canaveral using a Delta IV Heavy rocket in a test flight known as the Exploration Test Flight 1. This was the first launch of a NASA vehicle designed for human space travel since the retirement of the Space Shuttle in 2011; however, as an early test flight it was unmanned (Davis 2014).

The Orion LAS facilities at LC-32 are in good condition due to their recent construction, but at the time of the current evaluation they did not appear to be in use. Due to their recent construction, they were not recorded as resources during the current inventory. The inventory effort is discussed in further detail in Chapter 8.

6.16 Historic Context Summary

The establishment of LC-32 was part of the 1950s expansion at WSPG and the new complex was established in 1958 in support of two major programs; the Hawk anti-aircraft missile and the Sergeant tactical missile. The launch complex was divided almost symmetrically into the Sergeant area to the west and Hawk area to the east, with both areas offering generally similar facilities. An existing timing and distribution station, the Uncle Site, was located to the southeast of the Hawk area.

LC-32 was expanded in 1959 with the installation of the Hawk Fixed Battery, a prototype of a permanent Hawk installation. Also in 1959, the Hawk Assembly Area was constructed in what became known as LC-32 South. This location provided assembly and work space for both Raytheon and government Hawk technicians that were formerly located in the Tech Area of the main cantonment. An additional Hawk launch area, known as the Hawk Annex or LC-32 East, was added to the east of the Hawk Fixed Battery in 1959 as well. This location included several mounds for situating Hawk radars, a maintenance building, and launch pads for the government Hawk program (Glenn Moore personal communication 2015).

LC-32 was the key location for development of the Hawk missile system, which was arguably one of the most successful missile systems developed during the Cold War. While the Sergeant missile was eventually replaced by the more advanced Lance missile, an extensive series of improvement programs kept the Hawk missile relevant and effective well into the 1990s. The MTLC complex for the launching of aerial drone targets, a critical component of testing anti-aircraft missiles like the Hawk, was constructed along the eastern margin of LC-32 during the 1970s. LC-32 also hosted testing of the Roland anti-aircraft missile in the 1970s and early 1980s.

LC-32 also hosted limited testing of the Patriot missile during the 1990s as well as the Hera Target Missile program. Although these LC-32 programs postdate the Cold War, they were both outgrowths of the SDI that was a hallmark of the late Cold War. The Patriot was one of the few mature systems to emerge from the SDI, and the Hera was a target missile for testing of the THAAD and Patriot PAC-3 ABM systems that were also SDI spin-offs.

The Orion LAS, a modernized version of the Apollo LAS that was tested at LC-36 during the 1960s, was also tested at LC-32 within the last decade. Construction of Orion facilities at LC-32 began on October 1, 2007, with a test launch on May 6, 2010. Although insufficient historical perspective exists to consider the Orion LAS properties as historic resources, it is discussed here as the program made substantial alterations to the built environment of LC-32. The Hera and Orion LAS facilities made substantial alterations to the historic fabric of the complex.

The preceding historic context has provided the history of LC-32 and its test programs; now the specific properties and their roles in this history can hopefully be better appreciated. Therefore, this document now turns to the description of the buildings, structures, objects, and features recorded during the current inventory effort.

7. Description of Resources

Based on guidance provided in *Thematic Study and Guidelines: Identification and Evaluation of U.S. Army Cold War Era Military-Industrial Historic Properties* (Lavin 1998), the activities at LC-32 are best categorized under two Cold War historic themes: Materiel Development; and Air Defense, Ballistic Missile Defense, and Army Missiles. As one of the major launch complexes active in material development activities at WSMR during the Cold War, LC-32 qualifies for consideration under this historic theme. The theme of Air Defense, Ballistic Missile Defense, and Army Missiles is also relevant to LC-32, as several Army tactical and air defense missile systems were developed and tested at the complex throughout the Cold War.

The LC-32 inventory effort resulted in the recordation of 75 buildings, structures, and objects. As part of the inventory methodology, less significant resources representing remnants of LC-32 supporting infrastructure were recorded as features and are described separately. A total of 336 features were recorded in association with the buildings, structures, and objects at LC-32. The recorded WSMR properties were assigned a HCPI number and were documented on WSMR-specific HCPI forms, and the inventory was logged as NMCRIS activity number 134999. The HCPI documented properties include buildings, structures, and objects. The recorded resource locations are displayed in Appendix B.

The NPS defines buildings as properties that principally provide shelter for any form of human activity. Per New Mexico HPD guidance, only properties that fit the definition of a building in the common sense of having four walls and a roof are referred to as buildings. Structures are constructed properties that fall outside the typical definition of buildings, and primarily consist of launch pads, blast barricades, cable trenches, and instrumentation sites. Objects are less formal properties that are often of pre-manufactured origin and mobile in nature, such as missile assembly stands.

The following section presents a brief descriptive overview of each property followed by a summary of its use and evolution. For more in-depth detailed descriptions of the recorded properties, see the HCPI forms included within Appendix C. The properties are organized by sub-areas at LC-32 which were recognized historically and remain as identifiable spatial groupings today. Within each sub-area, the individual properties are categorized by building types as defined below.

7.1 Property Types

The recorded properties at LC-32 are grouped into several fairly discrete spatial and functional clusters, and the property descriptions are organized to reflect these sub-areas at the complex. Within each sub-area are several categories of properties whose purposes are reflected architecturally and functionally. Seven such property categories were identified for the recorded LC-32 properties: Launch Control Facilities, Missile Launch Facilities, Assembly and Maintenance Facilities, Instrumentation Facilities, Blast Barriers, Magazines, and Miscellaneous Facilities.

7.1.1 Launch Control

Launch Control facilities housed the personnel and equipment that controlled the firings at the launch pads, and often take the form of a concrete blockhouse. A "blockhouse" is a military term for single building fortification or redoubt whose construction dates back to medieval times. At missile ranges, launch control blockhouses are usually constructed to provide some degree of impact and blast protection against a mishap during the launch sequence or an errant missile; the degree of protection is usually scaled to the type of missile being tested and proximity to the launch site. For example, the massively constructed Army blockhouse at LC-33 was designed to withstand, in its designers' best estimations, the impact of a 28,000 pound V-2 falling from a height of several thousand feet. The launch control facilities at LC-32 are accordingly more modest in their standards, but nonetheless of substantial reinforced concrete construction. Property 20542, the Hawk control blockhouse is reinforced concrete building with a concrete gable roof. The concrete roof slab is three feet thick, while the walls are one and half feet of reinforced concrete. The blockhouse for the Sergeant program, Property 20525, is a slightly different design, as it is incorporated into the north elevation of a larger pre-manufactured steel assembly building. Both of these control buildings were hardwired to their respective launch pads via subterranean concrete trenches that provided sheltered, yet easily accessible, pathways for control wiring.

In addition to the control blockhouses constructed for the Hawk and Sergeant programs, smaller control blockhouses were constructed at the MTLC during the 1970s. These buildings, Properties 20754 and 20758, served the same function of providing a protective shelter for personnel and control equipment during the launch of aerial target drones.

7.1.2 Launch Facilities

Launch facilities at LC-32 consist primarily of concrete slabs and platforms of various sizes and complexity. Most are relatively simple concrete slab foundations that provided a solid surface for anchoring launchers, while others are more sophisticated and include built-in electrical conduits. The primary launch pad at LC-32 West is Property 20520, the original launch location for the Sergeant missile program. The series of launch pads established for the Hawk test program at LC-32 East include Properties 20530, 20531, and 20545. All of these launch pads incorporated both anchor hardware and inset electrical conduits and receptacles. Three additional Hawk launch pads were installed as part of the Hawk Fixed Battery, but only one of these remains intact.

A series of launch pads were installed as part of the MTLC during the mid-1970s. These launch pads were designed specifically for the launching of aerial target drones, particularly the MQM-34D and MQM-107 models. These drones are essentially unmanned jet aircraft rather than missiles, but require a JATO booster unit to boost them up to speed when launched from the ground. The drones are launched from a steel cradle unit centered on the launch pad, and each launch pad is equipped with an overhead gantry hoist for lifting and positioning the drones.

7.1.3 Instrumentation

The major defining characteristic of a missile test range is the ability to collect and analyze data on the performance of a missile throughout all stages of its flight, from launch to intercept. In order to do so, specialized instrumentation systems were developed. Most of these systems had humble beginnings as repurposed surplus war equipment after the end of WWII, but grew increasingly sophisticated and specialized in the following decades. Missile range instrumentation can be divided into three major groups: optical, electrical, and telemetry.

Optical instruments include cinetheodolites, high-speed cameras, and tracking telescopes. Optical range instrumentation can be grouped into two large categories: surveillance and metric. Surveillance optical instrumentation is primarily concerned with creating a record of an event not intended for precision measurements. Metric optical equipment, on the other hand, produces film or plate records from which precise measurements can be calculated. Metric optical instrumentation can be further divided into tracking and fixed devices (Delgado 1981).

Electrical systems are primarily radars of various types. Early range radars were based on surplus WWII SCR-584 units, but by the late 1950s units specifically developed as range instrumentation were introduced with the AN/FPS-16 radar. Another early radar system in use at WSMR through the 1960s was the Doppler Velocity and Position (DOVAP) system, which operated on the Doppler principle of wavelength compression and relied on a series of fixed receivers and a transponder on the test vehicle.

Telemetry systems use a variety of onboard sensors to collect data about the condition and operation of the test vehicle, and these measurements are relayed back to the ground via radio. These measurements typically include skin temperature, internal pressures, battery levels, fin positions, and timing information. Like other types of instrumentation, telemetry also serves an important role in monitoring a vehicle's flight for range safety purposes.

The establishment of LC-32 included a series of fixed, metric camera stations within and around the perimeter of the complex. This included a series of ribbon-frame camera installations along the north and south margins of the complex. The ribbon-frame camera was distinctive from standard cine camera equipment in that the speed of the film transport mechanism is continuous throughout the camera, while cine equipment uses an intermittent speed film transport mechanism. The continuous speed mechanism never slows the movement of the film even while it is being exposed, relying on very high shutter speeds to keep the image from being blurred. Intermittent speed film transport mechanisms used in cine equipment halt the film movement while the image is being exposed (Ehling 1967).

The Bowen-Knapp camera was a high speed ribbon frame camera developed by Dr. Ira Bowen of Caltech, a pioneer in optical design. Dr. Bowen developed the CIT-1 Ribbon Frame Camera as part of a collaborative effort between Caltech and the US Naval Ordnance Test Station (NOTS) at Inyokern, California during the 1940s (Bowen 1968; Delgado 1981). The hyphenated "Bowen-Knapp" designation of the camera is apparently due to the role of a Mr. Knapp, a government contact responsible for the funding of the project (Delgado 1981). The Bowen-Knapp CT-1 camera was developed into the CZR-1 series, which during its operational tenure was regarded as a state-of-the art high speed camera (Delgado 1981). At least one Bowen-Knapp camera shelter (Property 20712) is specifically identified at LC-32, but the camera types at the other ribbon frame camera stations are not discussed in realty data or the relevant drawing files.

In its original configuration, the Sergeant launch pad (Property 20520) was surrounded by a series of prepared instrumentation pads. These were likely locations for short-focal length, high speed cameras similar to the ribbon frame camera. As noted by a 1966 Army procedural manual on photographic instrumentation, early trajectory data was best captured with "…fixed cameras, which are located beneath and to the side of the trajectory" (US Army 1966:1). The LC-32 camera instrumentation was arrayed to capture important flight data in the critical first 10,000 feet of the trajectory. This initial portion of the missile's flight is where several major flight events occur, such as engine ignition and the pre-burnout flight details of yaw, pitch, roll, space position, velocity, and acceleration, all of which determine the final, post-motor burnout trajectory of the missile (Ehling 1967).

Timing and geodetic control networks are also a critical component of range instrumentation, as these systems provide the chronometric and spatial standards that allow all other instrumentation measurements to be comparable. A WSMR timing facility, Property 20710, at the Uncle Site actually predates the establishment of LC-32 and was a support facility of the range timing network.

7.1.4 Assembly and Maintenance Facilities

Assembly facilities are critical components for missile and rocket testing, and are where the actual missile is prepped and assembled prior to launch. With missile and rocket testing, the test item typically comes in multiple components that are assembled on site for a specific test or series of tests. These are typically comprised of a casing, motor (solid or liquid propellant), a warhead, and guidance and telemetry systems. With many variants in these components in the testing phase, an assembly facility was necessary to provide a setting in which to safely prepare test items for the range. This building type usually consisted of an open floor plan, overhead crane and hoist assemblies, and large doors for ease of egress. The majority of assembly buildings at LC-32 were originally constructed for the Hawk and Sergeant programs and included a variety of construction types. Several are pre-manufactured steel buildings, including Property 20525 (Sergeant) and Property 20540 (Hawk). Others are of more substantial concrete Masonry Unit (CMU) construction, such as Properties 20541, 20746, and 20756. The most impressive of these facilities is the large Property 21759 "Hawk Hangar" building, which was the primary assembly and maintenance building for the Raytheon Hawk program at LC-32. This substantial building combines CMU office and shop wings with a central high-bay steel frame hangar building with clerestory windows along its upper walls.

Maintenance facilities are necessary for the volume of testing that took place at the complex, which kept repair and maintenance activities on-site as much as possible to minimize downtime in the testing schedule. Not only were maintenance facilities important for the actual missiles, but they were important for maintenance of various radar and electrical systems that allowed the missile to operate properly. Electrical maintenance was especially important for 1950s systems like the Sergeant and Hawk that relied heavily on vacuum-tube electronics, which were much more maintenance intensive than later solid state electronics. These buildings also consist of a mixture of pre-manufactured steel buildings and more robust CMU and concrete construction.

7.1.5 Blast Barricades

Blast barricades are structures designed to protect personnel and equipment from the blast, shockwave, and shrapnel resulting from an explosion. These barricades also acted as shields from the concussion that accompanied a rocket or missile launch. The barricades were often constructed around assembly or storage buildings where warheads or propellant were handled to isolate the building in the event of an accident. At LC-32, these barricades were constructed using several methods. Some are more formal structures consisting of wood frameworks constructed of milled lumber that are filled with earth. In addition to being cost effective and expedient, sediment acts as an efficient dissipater of an explosive blast and offers excellent mass and density. Many of the barricades at the complex are earthen berms capped with asphalt to prevent erosion, a very durable and cost effective alternative. Both types are found at the LC-32 Hawk launch facilities. Some examples are constructed of poured, reinforced concrete as well, but are of less massive construction than the wood and earth barricades. Two of these concrete barricades are found at the LC-32 Sergeant launch area.

7.1.6 Magazines

Magazines are a relatively common sight on military test ranges. They come in a variety of sub-types and sizes but essentially serve to safely store ordnance. The magazines at LC-32 are of the standard explosive-type, used chiefly for storage. The stand-alone reinforced concrete structures each contain heavy duty steel doors and frames, lighting rods, and electrical grounding cables. Several of these associated with the MTLC were re-located from other locations across WSMR, demonstrating the versatility and portability of the smaller concrete "cube" type magazines.

7.1.7 Miscellaneous Facilities

Not all facilities fit neatly into categories and, depending on the type of site, the function of support facilities can vary greatly. LC-32 includes facilities that fall into the broad category of storage and general support buildings. The most commonly encountered type were portable, pre-manufactured steel buildings employed for a variety of uses across the complex. Another common type of miscellaneous support facility is the heating plant or boiler building that supplies heat to adjacent properties. Other types at LC-32 include air compressor stations, an engine run-up stand, and a fueling station. Construction types include simple, reinforced concrete structures, CMU buildings, and steel-frame pre-manufactured buildings. None of the miscellaneous facilities are notable for design or construction.

7.2 Building Styles

In terms of "style," the buildings, structures, and objects recorded at LC-32 are primarily determined by functional aspects and not easily categorized. These facilities were purpose-built for function and lack most attributes typical of defined architectural styles. Pre-manufactured buildings such as common gable-roofed, steel-frame semi-permanent buildings are easily identifiable. However, DOD guidance recognizes that some utilitarian facilities derive stylistic cues from the Modern movement. These permanent buildings follow a consistent design of post and lintel concrete structures infilled with CMU walls, or all CMU construction. Whether designed "in-house" by the Army Corps or by architectural-engineering partnerships like W.F. Turney and Associates of Santa Fe, stylistic cues such as a horizontal emphasis in elevations and windows, flat or very shallow gabled roofs, and a complete lack of decorative elements all point to International Modernism. This loosely Modernistic design style is seen in the Property 21756 Assembly Building and in the Property 20541 and Property 20746 Maintenance Buildings, although none of these buildings are good examples of the Modernistic style.

7.3 Property Integrity

In regard to the NRHP guidance on questions of "integrity," a discussion is presented in *Section 8.5, Integrity of LC-32 Resources.* In a more general sense, particularly in terms of the individual resources, some aspects of physical integrity should be noted. Many of the launch complex facilities are now unoccupied and ground cover is inevitably reclaiming the areas around these properties. Several buildings and structures were removed from the Hawk Fixed Battery portion of the complex, such as Property 20552. The east margin of the complex, formerly known as the Hawk Annex, was substantially altered by the addition of the MTLC in the 1970s. Constructed to be permanent and long-lasting, the basic physical integrity for major extant buildings at LC-32 is relatively high. However, most of the properties were subject to multiple cycles of re-use and adaptation, and are substantially modified from their original design and layout. Many of the Hawk facilities were stripped of their electrical and mechanical equipment and the buildings have slipped into a state of disrepair from gradual weathering and lack of upkeep. This undermines much of the interpretive value at both the individual and district levels. Additionally, the original layout and design of LC-32 was modified by the addition of new facilities within the last twenty years, primarily by the Hera and the Orion LAS activities.

The following presentation of the resources recorded during the current inventory is organized by spatial and functional sub-areas at LC-32. The delineation of the sub-areas was made in consultation with historic architectural drawings and maps of the LC-32 facilities and closely mirrors those sub-areas that were recognized at LC-32 historically. These sub-areas consist of LC-32 East, Hawk Fixed Battery, LC-32 West, LC-32 South, MTLC, Uncle Site, and LC-32 Dispersed Facilities. Within each sub-area, the recorded properties are organized by functional types which are discussed separately. Each property summary consists of a brief descriptive overview followed by a summary of its use and evolution. For more in-depth, detailed descriptions of the recorded properties, see the HCPI forms included within Appendix C. Wherever possible, the interiors of the buildings were examined and none were significant in terms of architecture or engineering, nor did they retain any fixtures that were associated with the identified periods of significance.

As only one of the recorded LC-32 resources are recommended as individually NRHP-eligible, no discussion of eligibility was included within the individual resource descriptions and histories. A full discussion of National Register eligibility and historic district considerations is presented in *Section 8, Discussion of National Register Eligibility and Historic District Consideration.* The individual property eligibility discussions are included as part of the HCPI forms attached in Appendix C.

7.4 LC-32 East Properties

The portion of LC-32 referred to here as LC-32 East consists of the original Hawk Launch Area established in 1958 (Figure 60). This area, opposite the Sergeant area to the west, was the primary flight test area at WSMR for Hawk missile testing for several decades. The location is bounded by the Hawk Fixed Battery to the east, Uncle Site to the south, the original range access road to the west, and mostly undeveloped desert to the north. Identified property types at LC-32 East include launch control facilities, launch facilities, assembly and maintenance facilities, blast barricades, and miscellaneous facilities.

7.4.1 LC-32 East Launch Control Facilities

Two launch control facilities were identified at LC-32 East, Properties 20542 and 20544. Property 20542 is a control blockhouse and Property 20544 is a subterranean cable trench that connects the blockhouse to the Property 20545 Launch Pad.

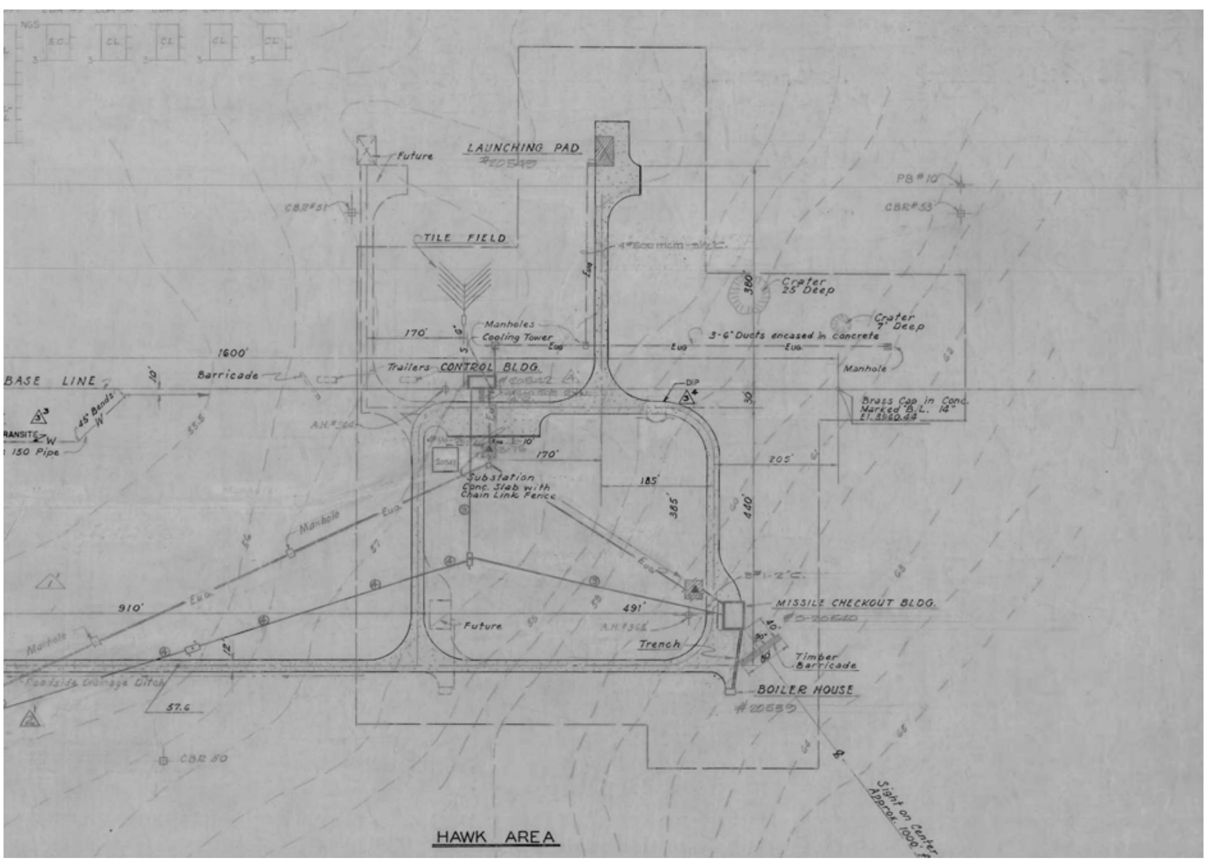

Figure 60. A 1958 map of the LC-32 East Hawk Area, from Drawing WS-FT.

7.4.1.1 Property 20542

Property 20542 is a one-story, launch control building. The tan-painted building is of plywood-formed reinforced concrete construction and includes a rectangular floor plan on a raised grade concrete slab foundation. The tan-painted, low-pitch, gable roof is also of reinforced concrete construction with slightly overhanging eaves on all elevations. The peak of the roofline is fitted with three lightning rods adjoined by braided grounding cables that extend to ground level. A post mounted, red dome light extends above the roofline, offset from the southwest corner of the building. Fenestration of the south elevation consists of one steel blast door. The single-hung brown door is flanked by concrete encased ventilation ducts with metal louvers. A concrete sidewalk leads to the entryway, which also includes an interior, single hung, aluminum replacement door. Signage was once mounted on the eave above the entryway. Explosion proof floodlights are offset from the corners of the wall, mounted below the overhanging eave. A third flood light is mounted on the west elevation, offset form the southwest corner of the building. Fenestration of the east, west and north elevations each consist of two fixed, single pane, blast-resistant windows. Each window is slightly recessed in a protruding steel frame and offset from the respective corners of the wall. The north elevation also includes six electrical

Figure 61. Property 20542, south and west elevations, view to the northeast.

boxes and associated conduit mounted to the wall between the two windows. A raised, rectangular HVAC pad is offset approximately two feet from the north elevation. The pad presently houses one unit and three additional units have been removed. A utility pole with mounted antennae, speakers and electrical cabling is present on the east end of the HVAC pad. A subterranean cable trench is offset from the northeast corner of the building, extending northward from the north elevation.

Figure 62. Empty interior of Property 20542, view to the northwest.

History of Use

Property 20542 was constructed in 1958 as the Control Building/Blockhouse for the Hawk program at LC-32, one of the original properties constructed at the complex. Aerial imagery entitled "Hawk Prototype under Construction" and dating to 1958 indicates that the construction and configuration of Property 20542 remains largely intact. Little documentation exists for its usage in the years following its construction, but given the longevity of the Hawk program at LC-32, it was likely used by this program into the 1980s. However, at the time of the current inventory the building was vacant and no longer in use.

7.4.1.2 Property 20544

Property 20544 is a subterranean cable trench that provides routing for electrical and control wiring between Property 20542 and Property 20545 at the former Hawk launch area. The cable trench is three feet deep by three feet in width, and constructed with poured concrete walls and floor that are six inches thick. Racks for wiring run along the interior walls of the trench. The top of the trench is covered by steel deck plates that are three feet wide by two and a half feet long and equipped with recessed steel handles. The trench has a north-south leg that connects to Property 20545 on its north end and intersects a perpendicular branch on its south end. The perpendicular branch of the trench connects to Property 20542 at its west terminus and dead-ends at its eastern terminus. The north end of the cable trench enters the west wall of the subterranean

Figure 63. Property 20544, leg north of Property 20542, view to the south.

"Blue Room" beneath Property 20545. The surface of the cable trench is equipped with a post-and-cable handrail, portions of which have been damaged or removed.

History of Use

Property 20544 was constructed in 1958 as a subterranean cable trench for the Hawk program at LC-32, and was among the original facilities constructed at the complex. Aerial imagery entitled "Hawk Prototype under Construction" and dating to 1958 indicates that the construction and configuration of Property 20544 remains largely intact. Little documentation exists for its usage in the years following its construction, but given the longevity of the Hawk program at LC-32 it was probably used into the 1980s. However, at the time of the current inventory the trench appeared to have been unused for an extended period.

7.4.2 LC-32 East Launch Facilities

Three launch facilities were identified at LC-32 East, Properties 20530, 20531, and 20545. Properties 20530 and 20531 are relatively simple launch pads located adjacent to one another and associated with the Property 20533 Blast Barricade. Property 20545 is offset to the east from these launch pads and is built above an underground control room that connects to the Property 20544 Cable Trench.

7.4.2.1 Property 20530

Figure 64. Property 20530, view to the south.

Property 20530 is a concrete launch pad located within the LC-32 Hawk launch area. The at-grade, rectangular pad measures approximately 62 feet by 22 feet and is bounded to the south, east and west by a blast barricade (Property 20533). Two 20 foot diameter, steel inset rings are centered on the north and south halves of the pad. The two rings are separated by an inset rectangular steel plate that measures 12 feet east-west by 3 feet north-south. The interior of the north ring once housed a launcher that has been removed, as evidenced by four mounts, each consisting of four bolts in a rectangular configuration. The lip of the ring and the launcher mounting bolts have been torch cut. One Crouse-Hinds Co. explosion proof 120/208 Volt outlet, an inset square steel access panel and a 15-inch diameter metal conduit are also situated within the ring. An additional Crouse-Hinds outlet and access panel are present immediately outside of the north ring. The aforementioned conduit extends underground to the east of the pad, emerging on the east side of the blast barricade. The asbestos conduit extends from the ground surface immediately east of the barricades and is capped with a metal conduit fixture that is stamped "1956" and anchored to the blast barricade. Additional electrical boxes and conduit are also mounted to the blast barricades. The configuration and associated elements of the south ring are identical to those of the north. However, the ring, launch mounts and footers remain in place and are painted yellow. Each launcher mount consists of a low concrete footer capped with a rectangular steel plate and four mounting bolts. Additionally, the large inset conduit extends to the south, emerging on the south side of the blast barricade. A wheeled, metal light tripod and two wood pallets with degraded sand bags are present on the east side of the pad. Four wood pallets are stacked on the north side of the pad. The structure is part of the Hawk launch complex associated with Properties 20531 and 20533.

History of Use

Property 20530 was constructed in 1958 as Hawk Site Launch Pad Number 3, part of the original Hawk facilities at LC-32. It was one of a pair of Hawk launch pads established at this time, both of which were surrounded by the Property 20533 Barricade. Aerial imagery entitled "Hawk Prototype under Construction" dating to 1958 indicates that the construction and configuration of Property 20530 remains largely intact. Given the longevity of the Hawk program at LC-32, the launch pads probably were used into the 1980s. However, at the time of the current inventory the pad was not in use.

7.4.2.2 Property 20531

Figure 65. Property 20531, view to the north.

Property 20531 is a concrete launch pad located within the LC-32 Hawk launch area. The at-grade pad measures 42 feet square and is bounded to the south, east and west by a concrete curb and a blast barricade (Property 20533). A 20 foot diameter steel inset ring is centered on the pad. The interior of the ring once housed a launcher that has been removed, as evidenced by four mounts each consisting of four bolts in a rectangular configuration. The lip of the ring and the launcher mounting bolts have been torch-cut. One Crouse-Hinds Co. explosion proof 120/208 Volt outlet, an inset square steel access panel, and a 15-inch diameter metal conduit are also situated within the ring. A stake and grounding strap are present on the east side of the pad adjacent to the curb line. The aforementioned conduit extends underground to the south of the pad, emerging on the south side of the blast barricade, sheltered by a plywood formed concrete blast barricade. The concrete blast barricade includes an 8-inch thick north wall and 12-inch thick wing walls. The asbestos conduit extends from the ground surface immediately south of the barricades' north wall beneath an angle iron and lumber shelf with a galvanized sheet metal hood. The asbestos conduit is capped with a metal conduit fixture that is stamped “1956” and anchored to the concrete blast barricade. Additional electrical boxes and conduit are also mounted to the blast barricades. The structure is part of the Hawk launch complex associated with Properties 20530 and 20533.

History of Use

Property 20531 was constructed in 1958 as one of the original Hawk Launch Pads at LC-32. It was one of a pair of Hawk launch pads established at this time, both of which were surrounded by the Property 20533 Barricade. Aerial imagery entitled “Hawk Prototype under Construction” and dating to 1958 indicates that the construction and configuration of Property 20531 remains largely intact. Given the longevity of the Hawk program at LC-32, the launch pads probably were used into the 1980s. However, at the time of the current inventory the pad was not in use.

7.4.2.2 Property 20545

Property 20545 is an at-grade concrete pad constructed atop an underground bunker. The concrete pad maintains a rectangular plan, oriented north-south and measures 50 feet by 30 feet. Eight square steel access panels are inset and evenly spaced across the pad in two, north-south oriented rows. Three Crouse-Hinds Co. explosion proof 120/208 volt outlets are evenly spaced along the east edge of the pad. It is likely that the west edge of the pad is also fitted with outlets; however, the west edge of the pad is overgrown with dense vegetation and not visible. A subterranean cable chase (Property 20544) and a stairwell abut the southwest corner of the pad. The cable chase extends to the south from the pad and the concrete stairwell descends from ground level providing access to the bunker below the pad. Two large yellow-painted ventilation ducts extend from the ground set in concrete immediately west of the stairwell. The east-west oriented stairwell is ringed by a yellow-painted safety rail at ground level and includes a yellow-painted mounted handrail and inset steel traction plates. The vacant concrete bunker measures 10

Figure 66. Property 20545 Launch Pad, view to the north.

Figure 67. Faint “BLUE ROOM” lettering on door lentil of entry into vault portion of Property 20545.

feet by 15 feet and is fitted with a steel blast door situated at the bottom of the stairwell. The concrete lentil above the entryway is stenciled “BLUE ROOM.”

Figure 68. The interior of the Blue Room with boarded over east portion, view to the east.

History of Use

Property 20545 was constructed in 1958 as a concrete launching slab and underground control room for the Hawk program at LC-32, and was among the original facilities constructed at the complex. Aerial imagery entitled “Hawk Prototype under Construction” and dating to 1958 indicates that the construction and configuration of Property 20545 remains largely intact. Little documentation exists for its usage in the years following its construction, but given the longevity of the Hawk program at LC-32 it was probably used into the 1980s by the program. However, at the time of the current inventory the building was vacant and no longer in use.

7.4.3 LC-32 East Assembly and Maintenance Facilities

Two assembly and maintenance facilities were identified at LC-32 East, Properties 20540 and 20541. Property 20540 is a pre-manufactured steel building while Property 20541 is of CMU construction. Property 20540 is located at the south end of the original Hawk area at LC-32 East, while Property 20541 is located opposite the Property 20542 blockhouse.

7.4.3.1 Property 20540

Figure 69. Property 20540, north and west elevations, view to the southeast.

This property consists of a pre-manufactured Butler steel building constructed on an at-grade concrete foundation. The gable roof of the building is clad in the same sheet metal panels as the walls, with eaves on the east and west elevations. Four round static globe vents are spaced along the roof ridge and the roof is also equipped with red warning lights, lightning rods, and grounding wires.

The west elevation of the building has five steel frame windows spaced along its length. Each of the windows has nine lights and awning type operation of the upper six light panel. All the windows on this elevation are painted over and are equipped with exterior steel mesh security grilles. Two entrances are located on this elevation, one at either end of the wall, and both have concrete entry slabs and explosion proof light fixtures mounted over the doorway. The doors are both of the steel panel variety with four lights in their upper half. Like the windows, the door lights are painted over and equipped with exterior steel mesh security grilles.

Figure 70. Property 20540, west elevation, view to the east.

The north and south elevations of the building are identical in form. Both elevations have a set of large double sliding "barn" type doors in the center of the wall. On both sides of these doorways are vertical pairings of the steel frame, nine light windows seen on the east and west elevations. Large louvered vent panels are located in the gable portion of each wall, and these vents are also equipped with steel mesh security grilles. On both elevations are two large, sealed explosion-proof floodlights mounted to the walls at the roof line. A cargo container is parked just outside the south elevation which has an asphalt surfaced parking area. A faded, hand painted sign with the explosive and personnel limits of the building is attached to the east side of the south elevation.

Figure 71. Property 20540, south and east elevations, view to the northwest.

The east elevation of the building has seven of the same nine light windows spaced along its length, although the northern three of these windows are partially covered by ductwork and an attached storage shed. Like the west elevation, all of these windows are painted over and protected by steel mesh security grilles. A large HVAC unit is mounted on a concrete slab along this elevation, and ductwork from this unit enters the east wall just above the windows. At the north end of the east elevation is a storage shed addition that has been attached to the wall. The shed is a small, steel gable roof building of Armco manufacture with a steel slab personnel door in its east gable end elevation.

History of Use

Property 20540 was constructed in 1958 as the Missile Checkout Building for the Hawk program at LC-32, one of the original facilities constructed at the complex. Glenn Moore identified this building as one of the assembly buildings used by the government Hawk program (Glenn Moore personal communication 2015). According to the property's record, the shed addition on the east elevation was added in 1963. Little documentation exists for its usage in the years following its construction, but given the longevity of the Hawk program at LC-32, it was likely used by this program into the 1980s. The building underwent extensive renovations in 2000 which included HVAC and electrical upgrades, the addition of a 3-ton monorail hoist, and refinishing the roof and exterior. It was not clear at the time of the current inventory if the property remained in use.

7.4.3.2 Property 20541

Property 20541 is a split-level, rectangular-plan, concrete post and lintel building with CMU infill walls. The pillars are of CMU construction while the lintels are of poured concrete. It is built on an above-grade concrete foundation and is painted tan with brown doors. The west half of the building consists of a high bay, while the east half is a single story of standard height. The flat, split-level roof of the building is sealed with tar and gravel material and covered in flashing along its edges. The roof is equipped with rain gutters and downspouts, and a series of

Figure 72. Property 20541, north and east elevations, view to the southwest.

lightning rods and ground wires. A large HVAC unit is mounted to the eastern portion of the roof. A large fenced storage yard is located to the south and east of the building, and the chain link fence abuts the east elevation and southwest corner of the building. A fenced electrical substation, signed as "GROUND BANK STATION NO. 44", is located just to the east of the building.

Figure 73. Property 20541, south and west elevations, view to the northeast.

Figure 74. Property 20541, window detail on the west elevation.

The concrete post supports of the building divide each elevation of the building into two bays. The north elevation of the building has a single steel personnel door with one wire-glass light, and the doorway is illuminated by a globe light fixture. To the west of this entrance are two small windows with protruding sills. These steel frame windows are equipped with interior steel security bars and pebbled glass. A sidewalk along this elevation connects to the entrance on the east elevation of the building.

The east elevation of the building has a single steel personnel door with one wire-glass light located at its northern end. A globe light fixture is affixed to the wall above the door, and a network server cabinet and water cooler are discarded near this entrance. Spaced along the remainder of this elevation are three steel frame windows with four lights, which appear to have awning openings. These windows have protruding sills and are also equipped with interior rebar security bars. The west elevation lacks any entrances but does have three large windows set high along the wall. Each of these steel-frame windows has eight lights, the central four of which are hinged with a hopper opening. The hopper (inward) opening is hampered by an interior grid of rebar security bars that are common to all the building windows. The south elevation has a large overhead rolling door set into the (west) high bay portion of the wall, above which is a globe light fixture. A short concrete entry ramp leads up to the rolling door, obviously the primary access for large equipment into the building. The east portion of this elevation is plain. The building appears to be in overall good condition.

History of Use

Property 20541 was originally built in 1958 as a Maintenance Laboratory Building for the Hawk program, part of the original LC-32 Hawk facilities. Little documentation exists for its usage in the years following its construction, but given the longevity of the Hawk program at LC-32, it was likely used by this program into the 1980s. However, at the time of the current inventory the building appeared to be vacant and no longer in use.

7.4.4 LC-32 East Blast Barricades

Two blast barricade structures were identified at LC-32 East, Properties 20533 and 20537. Property 20533 includes both timber and earthen portions, while Property 20537 is entirely wood sheathed. Property 20533 surrounds the Hawk launch pads (Properties 20530 and 20531) at the north end of LC-32 East, while Property 20537 is located outside Property 20540.

7.4.4.1 Property 20533

Figure 75. Property 20533, south and east sides, view to the northwest.

Property 20533 is a blast barricade located within the LC-32 Hawk launch area. The barricade was originally constructed in an "E" shaped configuration. The barricade encompasses two launch pads (Properties 20530 and 20531) and is open to the north with the long axis oriented east-west. The east half of the blast barricade structure is constructed of milled timbers and filled with compacted earth. The east half of the barricade is framed with 8 by 6 inch timbers and clad with 3-inch by 12-inch boards, with 4-inch by 4-inch timbers as additional vertical supports on the wall ends. The frame is held together with ½-inch diameter bolts and nuts. Tar paper roofing material, or "felt", is applied to the interior of the frame to prevent any of the earthen fill from spilling out between gaps in the boards. The barricade walls are approximately 8 feet wide near the base, and taper to a width of 4 feet at the top. The top of the barricade is capped by additional 3-inch by 12-inch boards and 2-inch by 4-inch spacers and trimmed with metal flashing. The top of the east half of the barricade is fitted with electrical conduit and ground wires. The west half of the blast barricade is of earthen construction with an asphalt mantle. The asphalt mantle is severely degraded with intact portions on the top and north facing slope of the barricade. Two portions of the west half of the barricade are constructed of plywood-formed, undressed concrete. One portion serves as a north facing retaining wall, while the other is incorporated into the south side of the earthen blast barricade serving as a shelter for conduit and infrastructure associated with Property

Figure 76. A 1958 aerial photograph of the Hawk area at LC-32 East under construction, Property 20533 at center.

20531. This later concrete blast barricade includes an 8-inch thick north wall and 12-inch thick wing walls.

History of Use

Property 20533 was constructed in 1958 as a Wood Sheathed Barricade associated with the LC-32 Hawk Launch Site. Aerial imagery entitled "Hawk Prototype under Construction" and dating to 1958 indicates that the construction and configuration of Property 20533 remains largely intact, with the exception of an earthen extension to the west of the barricades back wall. Given the longevity of the Hawk program at LC-32, the barricade and launch pads were probably used into the 1980s. However, at the time of the current inventory the barricade and associated pads were not in use.

7.4.4.2 Property 20537

Property 20537 is a large blast barricade structure constructed of milled timbers and filled with compacted earth, located southeast of Property 20540. The linear barricade is oriented on a southwest-northeast alignment. The barricade is framed with 4 by 8-inch timbers and clad with 3 by 12-inch boards, and fastened with ½ inch diameter bolts and nuts. Some portions of the barricade are trimmed with 2 by 4-inch boards. Tar paper roofing material, or "felt", is applied to the interior of the frame to prevent any of the earthen fill from spilling out between gaps in the boards. The barricade is approximately nine feet wide at its base and tapers to a width of four feet at its top. The top of the barricade is capped by additional 3 by 12-inch boards and trimmed with metal flashing. A rough concrete slab runs parallel to the south elevation for a portion of its length and appears to be a crudely smoothed dump of surplus concrete. Several metal signs painted "1" are located near the west end of the barricade, as is a "NO SMOKING" sign. It remains in good overall condition.

Figure 77. Property 20537, north and west sides, view to the east.

History of Use

Property 20537 was constructed in 1958 as a blast barricade associated with Property 20540, and was among the original Hawk facilities at LC-32. The barricade provided blast protection for areas outside Property 20540, which was used as an assembly building for the Hawk missile.

7.4.5 LC-32 East Miscellaneous Facilities

Two miscellaneous facilities were identified at LC-32 East, Properties H5103 and WS00910/HS052C. Both of the resources are small, pre-manufactured steel buildings built on skid foundations, rendering them easily transportable. Portable buildings of this type are the most common type of miscellaneous facility found at LC-32. In the case of these two properties, both are associated with more substantial buildings; H5013 is west of Property 20542 and WS00910/HS052C is just east of Property 20541.

7.4.5.1 Property H5103

Property H5103 is a portable metal-panel clad building with a rectangular floor plan oriented on a north-south long axis. The white-painted structure is mounted on wood skids and consists of metal wall panels with a flat roof of standing seam metal construction that includes overhanging eaves on all elevations. Fenestration of the south elevation consists of a white-painted, single panel steel door, serving as the only entryway to the building. Additionally, the south elevation includes building signage, a light fixture, a mounted aluminum log book shelter, and electrical conduit extending above the roofline. The east elevation

Figure 78. Property H5103, south and west elevations, view to the northeast.

includes a wall mounted HVAC unit set on a yellow-painted angle iron frame and associated electrical conduit. The north elevation includes building signage mounted below the roofline and a rectangular metal patch centered on the façade several inches above ground level. The west elevation is unfitted with the exception of stenciled signage that reads, "WSMR TSN." A metal electrical box abuts the building's north elevation in addition to a subterranean cable vault offset approximately four feet from the facade. The concrete vault includes two steel hinged access panels and is flanked to the north, east and west by timber posts.

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building's history could be located among the various archival sources available at the range. As such, the use history and age of the portable building remain unknown. At the time of the present recording, the building was vacant and no longer appears to be in use.

7.4.5.2 Property WS00910/ HS052C

This property is a pre-manufactured Armco steel building constructed on a wooden skid foundation for easy transport. The building is located just east of Property 20541. The walls of this single-room building are clad in flat sheet metal panels while the low-pitch gable roof is clad with standing-seam sheet metal panels. The roof has a slight eave on the north and south elevations and its gable ends have embossed "ARMCO" end caps.

Figure 79. Property WS00910/HS052C, north and west elevations, view to the southeast.

The building's only entrance is on the west elevation and consists of a steel slab personnel door. An air conditioning unit is installed with a cantilevered steel mount next to the doorway. A wood entry deck, built on extensions of the wood skid foundation, runs the full length of this elevation. A faded facilities ID tag is mounted to the wall next to the door and identifies the property as "HAWK PROJECT MTD MA." An electrical meter is mounted on the wall near the ID tag. The interior of the building is empty and finished in what appear to be asbestos tiles. The north and south elevations of the building both have steel frame, four light windows with awning openings and are otherwise plain. The east elevation of the building is entirely plain with the exception of a sheet metal vent housing and vent flue pipe. Located on the ground near the northwest corner of the building are an overturned wood deck and steps, and discarded pallets are located nearby. Outside the west elevation is a discarded, faded sign that appears to bear the WSMR TMDE logo, but is otherwise illegible.

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building's history could be located among the various archival sources available at the range. As such, the use history and age of the portable building remain unknown. Given the reference to the Hawk program on the Property's ID tag, it was used in support of this program, possibly as an adjunct facility to Property 20541. At the time of the present recording, the building was vacant and no longer appears to be in use.

7.5 Hawk Fixed Battery Properties

The portion of LC-32 known as the Hawk Fixed Battery was constructed in 1959 east of the original Hawk Launch Area (Figure 80). This location consisted of a bermed series of launch pads arrayed around a central missile service building (Property 20555). Supporting these

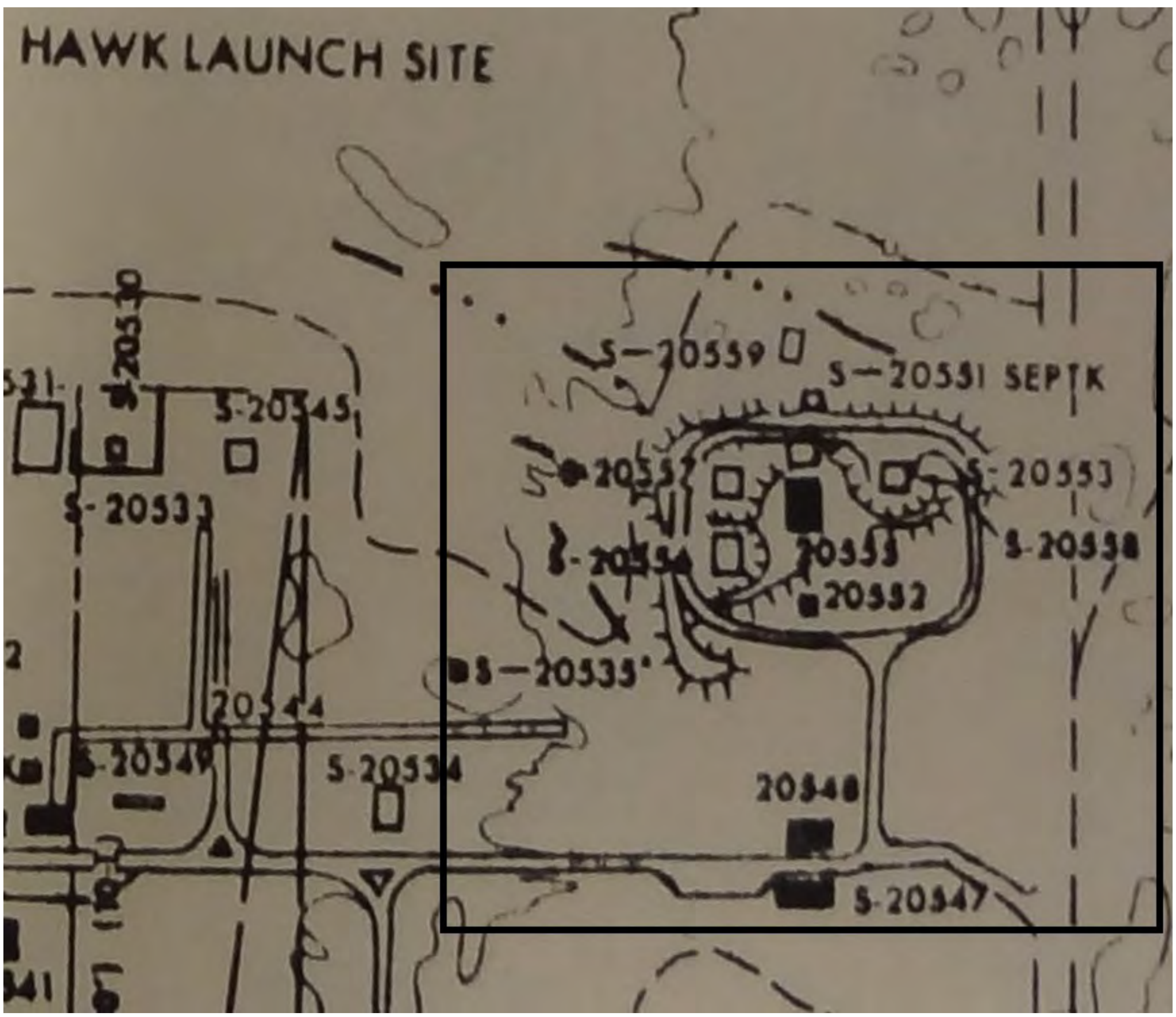

Figure 80. Excerpt from the 1982 WSMR Master Plan of the Hawk Fixed Battery at LC-32.

facilities was the Generator Building (Property 20548) and the Operations Building (Property 20547), which were connected to Property 20555 via a cable trench. A large radar tower for the support of the various Hawk targeting and guidance radars was planned for the installation, but was apparently never built. A Converter Building (Property 20552) was also located north of Property 20548, but has been demolished. Several other of the Fixed Battery launch facilities have also been removed, including two launch pads, the interior blast berms, and the cable trench. Identified property types at the Hawk Fixed Battery include launch control facilities, launch facilities, assembly and maintenance facilities, and miscellaneous facilities.

7.5.1 Hawk Fixed Battery Launch Control Facilities

Only one property within the Hawk Fixed Battery can be considered as a launch control facility, Property 20547. Known as the Operations Building, it appears to have served more as an administrative hub than a typical launch control center. However, the electrical connections routed through the cable trench to the firing area suggest that it may also have housed launch control functions. It is located directly south across an access road from Property 20548.

7.5.1.1 Property 20547

This property is a pre-manufactured, steel frame building clad in standing seam sheet panels. The building has a rectangular footprint and is constructed on an at-grade concrete foundation. No manufacturer's logo or identification was visible on the building. The building's medium pitch gable roof is clad in standing seam sheet metal panels and features three static globe vent assemblies spaced along its peak.

Figure 81. Property 20547, north and west elevations, view to the southeast.

The primary elevation of the building is the south, along which are two separate personnel door entrances. The western of these entrances is a steel personnel door with two vertical upper lights of wire glass. A small Hawk missile logo sticker is affixed to one of the door lights. This entryway is flanked by two aluminum frame windows, each with three horizontal lights. These windows, like all the building windows, have awning openings that are operated by an interior crank mechanism. However, sheet metal screws have been installed into the frames to seal the windows closed. The east half of the building's north elevation has another steel personnel door, this one with two horizontal upper lights with wire glass. Two stickers are affixed to the glass of this door; one is another Hawk missile logo sticker and the other is labeled "Team EFOGM" with an illustration of a drone and service truck. Two smaller aluminum frame windows with three lights and crank operated awning openings are located along this portion of the building. These windows have frosted glass panes and have also been fixed shut with the addition of sheet metal screws.

Figure 82. Cable trench that connects Properties 20547 and 20548, view to the south.

The south elevation of the building lacks any entrances, but has several windows and a large, crudely cut opening that appears to have been for the routing of a large HVAC unit. The HVAC unit and its housing have been removed from the wall, leaving behind the rectangular cut opening and some remnant flashing. The opening has been incompletely sealed from the interior with plywood. The west half of the south elevation has two windows with three horizontal lights, identical to those on the north elevation. A duct extends from the upper wall between these two windows, another remnant from a removed HVAC system. Beneath the abandoned duct is a concrete slab and some remnant wiring left behind from the HVAC removal. The east half of the south elevation features a three-light, frosted glass window identical to that of the north elevation. At the southeast corner of the building is a square concrete electrical pullbox, which appears to be an extension of the cable trench that runs beneath the east end of the building and connects to the adjacent Property 20548.

The east elevation, on the gable end of the building, has a central entryway with a steel personnel door with two vertical upper lights of wire glass. The entryway is surrounded by the legs of an evaporative cooler stand, which is attached to the upper wall above the doorway. An exterior HVAC ventilator unit is mounted on a concrete slab just south of this doorway. The interior room accessed by this entrance appears to be independent, with no interior conveyance to the rest of the building interior. The opposite gable end of the building, the west elevation, is entirely plain.

History of Use

Property 20547 was constructed in 1959 as the Operations Building for the Hawk Fixed Battery. The Hawk Fixed Battery was a prototype of the fixed Hawk installation that would have been similar to a Nike Ajax or Nike Hercules battery. Disposition data indicate that a portable steel building was formerly joined to Property 20547 to add space for additional personnel. Disposition forms dating from 1986 indicate that the property was used by the Hawk Phase III program during this period (Moore 1986). The current WSMR realty data identifies the property as an “outside latrine”, an obvious error that probably stems from an associated latrine facility that was added during the 1980s and subsequently removed. At the time of the present recording, the building was vacant and no longer appears to be in use.

7.5.2 Hawk Fixed Battery Launch Facilities

One remaining launch facility was identified at the Hawk Fixed Battery; Property 20558. This launch pad was originally one of three, the other two pads being Properties 20556 and 20557. However, both of these properties have been demolished and a launch services pad from the Orion LAS testing now occupies the former location of Property 20557. Property 20558 is a relatively simple launch pad with basic anchoring hardware and imbedded electrical conduits.

7.5.2.1 Property 20558

Property 20558 is a former Hawk launch pad located just east of Property 20555. It consists of a square concrete slab foundation, 30 feet per side, with a slightly elevated circular center. This portion of the launch pad is three inches higher than the surrounding slab and is 20 feet in diameter. The central raised portion of the pad is enclosed by a steel ring. Three electrical conduits and one nine inch diameter steel pipe are cast into the concrete of the pad. Four torch-cut steel anchors define a rectangular pattern that is seven feet, six inches long by five feet, two inches in width. Architectural plans indicate that these steel anchor points were launcher supports. According to Raytheon Hawk engineer Steven Lowery, the steel ring around the center of the pad once supported a launcher shelter (Steven Lowery personal communication 2015).

Figure 83. Property 20558 Launch Pad, view to the west.

History of Use

Constructed in 1959, Property 20558 was formerly a Hawk launch pad located within the Hawk Fixed Battery at LC-32. Two additional launch pads were also originally included in the installation and were isolated from the Property 20555 Missile Service Building by blast berms. The entire launch area was partially surrounded by the Property 20553 blast berm. The interior blast berms and other launch pads have been demolished, leaving only Property 20555 and 20558.

During the 1960s, Glenn Moore and Bill Jones recall that the Hawk Fixed Battery area was used for pre-launch systems checks of the Hawk missile and guidance equipment (Glenn Moore and Bill Jones personnel communication 2015). Moore also believed that at least a few Hawk launches were conducted from the Fixed Battery (Glenn Moore personal communication 2015). As of the mid-1970s, Property 20558 and the other launch pads were used as outdoor storage areas and Property 20555 was used for Hawk electronic chassis repair (Stephen Lowery personal communication 2015). Other buildings (Property 20547) in the Hawk Fixed Battery area were used during the Hawk Phase III improvement testing in the mid-1980s, but it is unknown if Property 20558 was also still in use at that time. As of the current inventory, the launch pad was no longer in use.

7.5.3 Hawk Fixed Battery Assembly and Maintenance Facilities

One assembly and maintenance facility was identified at the Hawk Fixed Battery area; Property 20555. Referred to as a Missile Service Building, it is of CMU construction and is located in the launch area contained within the Property 20553 blast berm. In its original configuration, an interior berm isolated the building from the surrounding launch pads, but this interior berm has been removed. The cable trench from Property 20548 also originally connected to this building, but has been demolished.

7.5.3.1 Property 20555

This building is of CMU construction with a rectangular footprint, constructed on an at-grade concrete foundation. The building's flat roof is of built-up construction and surfaced with asphalt and gravel. The roof has an eave on all elevations with an attached gutter and downspouts, along with lightning rods and ground wires affixed at the roof corners. The property is located in the former Hawk Fixed Battery area within the interior of the Property 20553 blast berm.

Figure 84. Property 20555, south and west elevations, view to the southeast.

The primary elevation of the building is the north, which features an overhead rolling door and double personnel door entrance. A metal sign bearing a missile logo and the lettering "PATRIOT" is mounted on the wall between the two doorways. Two sealed floodlights are mounted on the upper part of this wall, and a concrete parking slab extends north from this elevation.

The east elevation is mostly plain with the exception of one wood frame, double-hung window with 1/1 glazing. A security grille of flat steel bars is affixed to the exterior of this window.

Two concrete slabs are located outside this elevation, one of which supports an HVAC unit with ductwork routed through the central portion of the wall. The second concrete slab is unoccupied but an empty HVAC housing is discarded nearby. The west elevation is mostly plain with only one louvered vent panel set high in the wall near its north end. Like the other building windows and vents it is equipped with an exterior steel security grille of flat steel bars. A sealed floodlight and several electrical boxes and conduits are also attached to this wall.

Figure 85. Property 20555, south and east elevations, view to the northwest.

The south elevation of the building has one steel slab personnel door entrance with a concrete entry slab. A louvered vent panel is set high in the wall on its west side, and is equipped with a security grille of flat steel bars. Attached to the central portion of the wall are a rooftop access ladder and another sealed floodlight. A few meters south of this wall is a transformer bank of recent construction.

Figure 86. Property 20555, Patriot Missile sign on north elevation, view to the south.

History of Use

Property 20555 was constructed in 1959 as the Missile Service Building for the Hawk Fixed Battery. The Hawk Fixed Battery was a prototype of fixed Hawk installation that would have been similar to a Nike Ajax or Nike Hercules battery. This building was centrally located among several Hawk launch pads and protected by blast berms. Most of the launch pads, except for Property 20558, have been removed, as have the blast berms. The Hawk Fixed Battery prototype development was halted by 1962, but the facilities continued to be used for Hawk testing. During the 1960s, the Hawk Fixed Battery area was used for pre-launch systems checks of the Hawk missile and guidance equipment (Glenn Moore and Bill Jones personnel communication 2015). Moore also believed that at least a few Hawk launches were conducted from the Fixed Battery (Glenn Moore personal communication 2015). As of the mid-1970s, the Hawk Fixed Battery launch pads were used as outdoor storage areas and Property 20555 was used for Hawk electronic chassis repair (Stephen Lowery personal communication 2015). Little information exists for the later use of the building, but the nearby Property 20547 was still being used for Hawk as of 1986. The Patriot missile sign on the north elevation indicates that the building was used in support of this program, but the majority of

Patriot testing is known to have been conducted at LC-38. At the time of the current inventory, the building still had electrical power but otherwise did not appear to be in use.

7.5.5 Hawk Fixed Battery Miscellaneous Facilities

Two miscellaneous facilities were identified in the Hawk Fixed Battery area, Properties 20548 and Unknown Portable Building Number 1. Property 20548 is a permanent facility of CMU construction while Unknown Portable Building 1 is a small pre-manufactured building that abuts its east elevation. Property 20548 originally housed generators for the Hawk Fixed Battery, and the adjacent portable building was apparently added at a later date to provide supplemental space.

7.5.5.1 Property 20548

This building is of CMU construction with a rectangular footprint, built on an at-grade concrete slab foundation. It is located across the road from Property 20547, and a cable trench connects the east ends of both buildings. The roof of the building is clad in corrugated sheet metal panels

Figure 87. Property 20548 Generator Building, south and east elevations, view to the northwest.

Figure 88. Property 20548 interior, view to the west.

Figure 89. Articulated wood mannequins piled along west interior wall of Property 20548.

and has a low pitch towards the north to facilitate drainage to the gutter and downspouts located along that elevation. Two static globe vents are located along the centerline of the roof, each of which is equipped with a lightning rod and grounding wire. A large evaporative cooler is also mounted to the center of the roof. The roof features a flashing clad eave along all elevations of the building.

The south elevation of the building is the primary elevation and features two overhead rolling doors at its west end and one personnel door entrance at its east end. The personnel entrance's wood slab door has detached from its hinges and rests on the ground outside the building. Immediately east of the doorway is a steel frame window with 16 lights and double-hung operation. The window has a protruding concrete sill and several Hawk missile stickers are affixed to the window's interior. Near the center of the south elevation wall is a painted Hawk logo. The west elevation of the building has two double-hung, 16-light windows identical to that of the south elevation. The east elevation of the building is entirely plain; it is obscured by an abutting sheet metal storage building that is described separately. The north elevation of the building has three windows and a personnel door entry at the west end of the elevation. The entry door is a steel slab door with a large upper light, but the light has been boarded over with a sheet of plywood. The three windows are the 16-light, double-hung variety present in the south and west elevations of the building. A single concrete slab is located near the center of the north elevation, and two sealed openings in the adjacent portion of the wall suggest that an HVAC unit was formerly located on the slab with ductwork routed through the wall.

At the northeast corner of the building, a portion of the underground cable trench that connects the building to the adjacent Property 20547 is visible. The cable trench originally extended north beyond Property 20548 into the former Hawk Fixed Battery Area, but this section has been removed. At the time of the current inventory, the building remained structurally sound but was in somewhat dilapidated condition. The interior has been subjected to the elements due to the detached personnel door and an incompletely closed overhead door on the south elevation.

History of Use

Property 20548 was constructed in 1959 as the Generator Building for the Hawk Fixed Battery. The Hawk Fixed Battery was a prototype of fixed Hawk installation that would have been similar to a Nike Ajax or Nike Hercules battery. This building housed large diesel generators that powered the Fixed Battery installation (Stephen Lowery personal communication 2015). According to a 1962 WSMR memo, the building housed three Hollingsworth 400 cycle 30 KW electrical "converters" (generators) that were no longer in use; these were requested for transfer to an Army project in the Pacific (Jordan 1962). The memo also notes that these generators were originally Nike units that were modified for use with the Hawk installation. The generators were removed in August 1962, suggesting that the Hawk Fixed Battery Prototype was no longer in operation at this point. The property continued to support the Hawk program, as a 1965 disposition form notes that the building was re-assigned for use by the Hawk Test Branch and Raytheon following the completion of the generator removal process (Kaiser 1965). Little additional information is available regarding the use of the property, but the neighboring Property 20547 was used by the Hawk Phase III program during the mid-1980s (Moore 1986). It is likely that Property 20548 was also being used by the Hawk Phase III improvement program during this period as well. At the time of the present recording, the building was vacant and no longer used or maintained.

Figure 90. OPSEC sticker on electrical cabinet within interior of Property 20548.

Figure 91. Stenciled Hawk emblem on south exterior wall of Property 20548.

7.5.5.2 Unknown Portable Building 1

This building is a steel frame sheet metal clad portable building constructed on wood skids that directly abuts the east elevation of Property 20548. No indication of the building's manufacturer is visible. The low-pitch gable roof is clad in the same sheet metal as the building's walls. The building's only entrance is on the south elevation and consists of steel slab personnel door with a weathered wood entry deck. The east and west sides of the building are plain and lack any windows or doors. A cantilevered evaporative cooler mount and wall opening are centrally located high in the north elevation of the building. A rebar security grill is located on the interior of the opening.

Figure 92. Unknown Portable Building 1 adjacent to the east elevation of Property 20548, south elevation.

The interior of the building is finished with paneling on three walls and sound proof tiles along the north wall. The building is also equipped with fluorescent lighting along its ceiling. The rear (north) interior wall has two paper tags posted; one on the east side labeled "GOV'T" and one on the west side labeled "RAYTHEON."

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building's history could be located among the various archival sources available at the range. As such, the use history and age of the portable building remain unknown. Despite its location, it is unknown if it was related to the Hawk Fixed Battery program or was a later addition to the area. Its position suggests that it was used as supplemental space for Property 20548, but in what capacity is unknown. At the time of the present recording, the building was vacant and no longer appears to be in use.

7.6 LC-32 West Properties

The portion of LC-32 referred to here as LC-32 West consists of the original Sergeant Launch Area established in 1958 (Figure 93). This area, opposite the Hawk area to the east, was the primary flight test area at WSMR for the Sergeant missile testing during the late 1950s and early 1960s. The location also supported Sergeant ASP firings through the early 1970s. Following the conclusion of the Sergeant testing, this portion of LC-32 supported a series of test programs into the 1990s and currently hosts the Japanese Chu-SAM program. The location is bounded by the original range access road to the east and mostly undeveloped desert to the north, south, and west. Identified property types at LC-32 West include launch control facilities, launch facilities, assembly and maintenance facilities, blast barricades, magazines, and miscellaneous facilities.

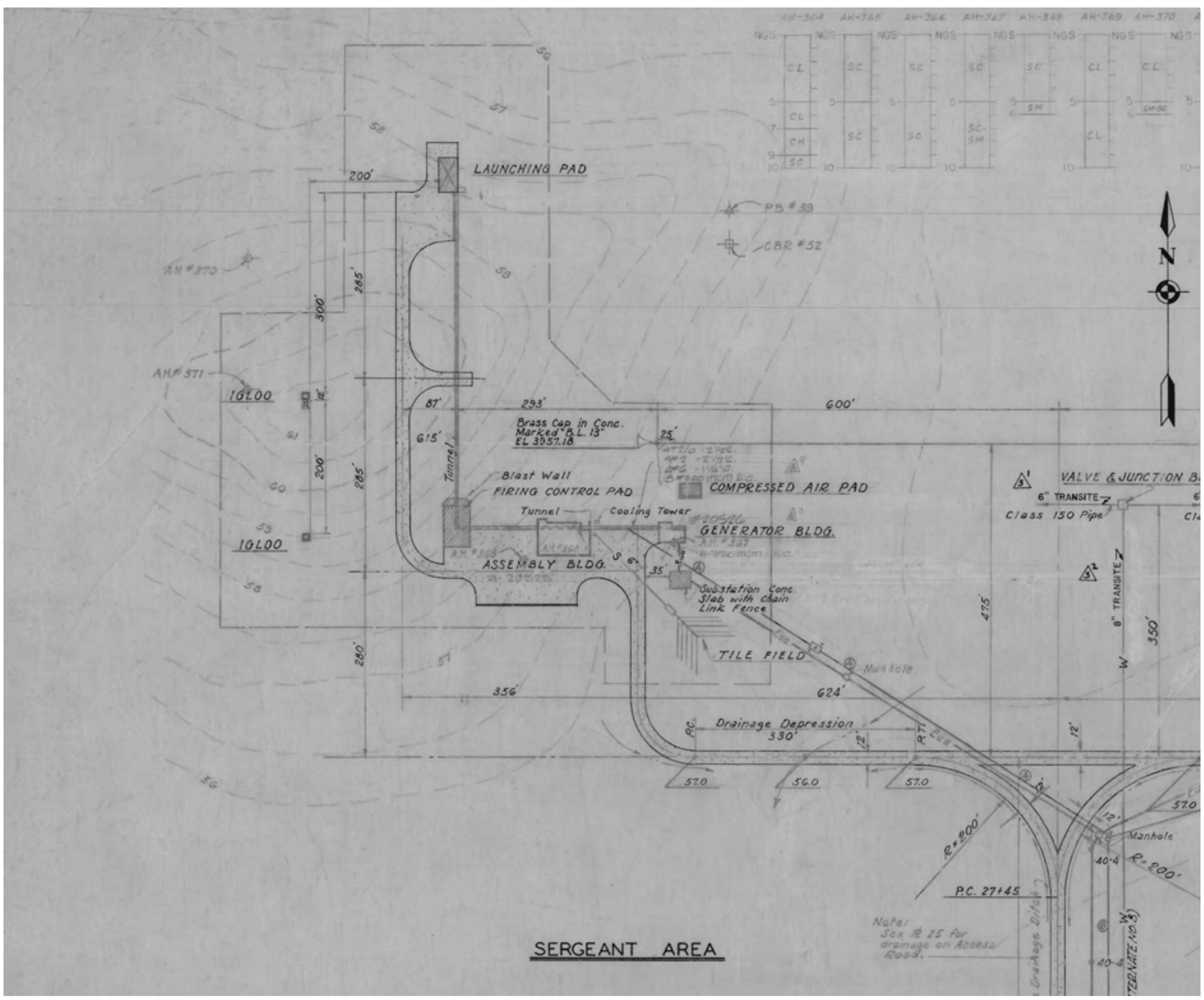

Figure 93. Excerpt from 1958 WS-FT Drawings showing the LC-32 West Sergeant Test area.

7.6.1 LC-32 West Launch Control Facilities

Two launch control facilities are found at LC-32 West, although the primary one is incorporated into Property 20525. This concrete blockhouse is built into the north side of Missile Assembly Building 17, a somewhat unique arrangement. As the building is primarily identified as an assembly facility, it is discussed under the section covering LC-32 West Assembly and Maintenance Facilities. Property 20521 is the other identified launch control facility at LC-32 West, and is a subterranean cable trench that routed control and electrical wiring from Property 20525 to Property 20520. It is similar to the cable trench found at LC-32 East, but is of greater depth, essentially a full size, underground corridor along its entire length.

7.6.1.1 Property 20521

This property is a subterranean vault and cable trench that connects Properties 20520 and 20525. The property includes an above-ground stairwell shelter at the southeast corner of the Property 20520 Launch Pad. This structure is constructed of reinforced, poured concrete with six-inch thick walls and roof. The structure's west elevation slopes down from the concrete slab roof at 45-degree angle that adjoins the adjacent Property 20520 Launch Pad. Two large electrical lockers and several smaller switch and terminal boxes are affixed to the stairwell shelter's south elevation above a shallow cable trench. The east elevation entrance has an inset steel personnel door with a central louvered vent panel, beyond which is a concrete stairwell that leads down to the subterranean vault. A steel plate blast door is located at the bottom of the stairs. Along the north of the stairwell is a louvered vent panel that connects to a ventilator system within the vault room.

Figure 94. Property 20521 above ground entrance shelter, north and east elevations, view to the southwest.

Inside the small vault room, multiple electrical boxes are mounted to the walls and a large ventilator assembly is built into the east interior wall. The subterranean cable trench branches off from the south interior wall. Most of the electrical conduits and wiring are mounted with brackets to the east wall of the cable trench. The walls and floor of the trench are of poured concrete and the trench appears to remain weather-proof. Unlike many cable trenches at WSMR, this one is approximately seven feet in height, allowing personnel to walk along its entire length. Its subterranean access is also unique. Many cable trenches, including the one at the neighboring Hawk launch area at LC-32, are shallow (two or three feet deep) and accessed primarily from the surface via steel deck plates. The top of the cable trench is protected by a poured concrete slab resembling a sidewalk. The cable trench runs due south to Property 20524, then makes a right angle turn to the east to connect with the west elevation of Property 20525. This end of the tunnel is accessible from the interior of Property 20525. A bollard-and-chain handrail runs along the east edge of the concrete surface slab of the cable trench and a parking curb is incorporated into its west edge.

History of Use

Property 20521 was constructed in 1958 as a Vault and Cable Trench for the Sergeant Missile program. It routed power and control wiring to the adjacent Property 20520 Sergeant Launch Pad from the Property 20524 Firing Control Pad/Blast Barrier and the Property 20525 Assembly Building and Blockhouse. It is unknown if the property continued to be used with later programs. The 20521 property number was later re-assigned to the Hera Launch Pad and Environmental Shelter. The rationale behind this re-use of the property number is unknown.

Figure 95. Property 20521, view south down cable tunnel from the electrical vault room.

7.6.2 LC-32 West Launch Facilities

Two launch facilities were identified at LC-32 West, Properties 20520 and Property 20521. Not to be confused with the identically numbered cable trench, Property 20521 is a high bay rail- mounted conditioning shelter and launch pad for the Hera Target Missile. The rationale behind the reuse of an existing property number in this case is unknown. Property 20520 is the original Sergeant Launch Pad, and is closely associated with the Property 20521 cable trench and electrical vault. Both of the launch facilities are located immediately adjacent to one another at the north end of LC-32 West.

7.6.2.1 Property 20520

Property 20520 is a rectangular concrete launch pad located at LC-32 West. The launch pad consists of four individually poured concrete slabs separated by expansion joints with overall dimensions of 51 feet north-south by 30 feet east-west. The stairway shelter of Property 20521 adjoins the southeast corner of the launch pad.

Explosion-proof steel electrical ports manufactured by the Crouse-Hinds are built into the pad along its perimeter. These ports have both 120 and 220 volt recessed receptacles and are designed to withstand vehicular loads. The ports were originally equipped with threaded aluminum caps, but these are missing from some of the receptacles. Eight small square electrical pullboxes protected by steel plates are also built into the pad; within each is a three-way junction of electrical conduit. The pad has been modified by the addition of two steel plates that were bolted to the pad, one of which has broken loose. These plates were probably added as blast shields to protect the concrete from the blast and heat of missile launches. Two geodetic survey datums are installed into the pad and are stamped "WHITE SANDS PROVING GROUND / GEODETIC CONTROL F.D.L. / REFERENCE MARK" and "1" and "2."

Figure 96. Property 20520 Launch Pad, view to the south.

Figure 97. Property 20520, Crouse-Hinds explosion-proof electrical ports in pad, plan view.

History of Use

Property 20520 was constructed in 1958 as the primary launch pad for the Sergeant Missile program. The adjacent Property 20520 Vault and Cable Trench provided power and control wiring to the Property 20524 Firing Control Pad/ Blast Barrier and the Property 20525 Assembly Building and Blockhouse. The Sergeant Launch Pad was surrounded by a series of asphalt surfaced instrumentation locations. These locations were assigned WSMR property numbers (20511, 20512, 20513, 20514, 20517, 20518, 20519, 20522, and 20523) but lacked any standing structures. Rather they appear to have consisted simply of power supply boxes and paved, level slabs for the positioning of mobile instrumentation. After the completion of the Sergeant RDT&E, this location was likely also used for Annual Service Practice (ASP) firings by Army units equipped with the Sergeant. The Sergeant ASP firings were required of Army units equipped with the missile to maintain proficiency and readiness with the system (Missile Ranger 1971:1, 5).

Disposition data indicates that the former Sergeant Launch Pad was also assigned for use with the Little John Laser Guided program for a short period beginning in 1970. It was also used for firings of the Roland missile during the latter part of the 1970s and early 1980s. During the mid-1990s, the Hera Target Missile launch pad and shelter were constructed immediately to the east of the launch pad and many of the old Sergeant missile facilities (including 20525 and 20521) were reused for this program. Today the Japanese Chu-SAM program uses Property

20525 for missile assembly but it is unknown if Property 20520 is utilized as a launch location for testing of this system.

7.6.2.2 Property 20521

Figure 98. Property 20521 Hera Environmental Shelter, west elevation, view to the east.

This property is a steel frame high bay assembly and conditioning building located at LC-32 West adjacent to the old Sergeant Launch Pad. The building is clad in white sheet metal panels and the roof is clad in the same material. Exterior I-beam support frameworks brace the south and north elevations and large bay doors are located on the east and west elevations. The entire building is constructed on four large rails and retracts to the east to expose the missile and launch pad for firing. Along the outer edges of the rails are a series of square concrete pullboxes, a few of which have attached grounding wires from the building. Large electric winches mounted to the steel frameworks on the south and north elevations of the building provide the pulling power needed to retract the building. An electrical cable spool is mounted on the south elevation of the building manages the winch power supply cables as the building moves. The cable anchors are attached to buried I-beam posts and connected via 1 1/8 inch diameter turnbuckles. Stacked on the exterior steel frameworks on the north and south elevations are hollow-core concrete panels. Four sealed floodlights are spaced along the upper walls of the north and south elevations and three large HVAC units are mounted to the central part of the south elevation wall.

The west elevation bay doors extend nearly the height of the wall and are of sliding bi-fold operation, with each door hinged along its center. The south door of the pair has a steel slab personnel door built into its lower left hand corner. Above the personnel door is a sign reading "RESTRICTED AREA / MISSION ESSENTIAL PERSONNEL ONLY." Two sealed floodlights are mounted to the middle portion of the wall along this elevation. The east elevation has smaller bay doors of identical operation, the north of which also has a steel slab personnel door built into its lower half. Adjacent to this doorway is a sign reading "EXPLOSIVE AREA / DEPOSIT ALL FLAME PRODUCING ITEMS HERE" with an arrow indicating a sheet metal collection box mounted on the wall. A red warning light is mounted to the upper wall on both the east and west elevations.

History of Use

Property 20521 was constructed as the Hera Target Missile Launch Pad and Shelter in 1995. It is also referred to as the Hera Launch Pad and Rails in WSMR realty data. The building allowed final assembly and pre-launch preparation of the missile in a vertical position, and maintained the completed missile within its required temperature range prior to launch. A similar building was constructed at Fort Wingate for the Hera Target Missile launches from that location (Larry Carreras personal communication 2015). The property is currently used as storage space for the Japanese Chu-SAM program (Larry Carreras personal communication 2015).

Figure 99. Property 20521 Hera Environmental Shelter, north and east elevations, view to the southwest.

7.6.3 LC-32 West Assembly and Maintenance Facilities

Three assembly and maintenance facilities were identified at LC-32 West, Property 20525, Property 2052A, and a Hera Assembly Stand. Property 20525 is a pre-manufactured steel building that is combined with a concrete blockhouse on its north elevation. Also known as Missile Assembly Building 17 (MAB 17), it was an important facility at LC-32 that hosted a variety of programs beginning with the Sergeant tactical missile in 1958. Property 2052A is pre-manufactured steel maintenance building added to the complex in 1994 as part of the Hera Target Missile program. Contemporaneous with Property 2052A, the Hera Missile Assembly Stand is a steel framework located outside of Property 20525 that was used to support components of the Hera during assembly (Larry Carreras personal communication 2015).

7.6.3.1 Property 20525

Property 20525 is a two-story pre-manufactured steel-frame Butler building with an irregular footprint oriented on an east-west axis on an above-grade concrete slab foundation. The medium pitch, gabled roof includes a white elastomeric coating, a short eave, and the peak of

Figure 100. Property 20525, north and west elevations, view to the southeast.

the roof is fitted with seven globe vents and five lightning rods. The building consists of three integrated structural blocks: a reinforced concrete block house of plywood-formed reinforced concrete construction, a storage area of post and lintel concrete construction with CMU infill, and the Butler building. The north elevation of the building is a composite of these three blocks, where the blockhouse and storage area form a continuous one-story wall, and the pre-manufactured block serves as an adjoining second story, extending above the roof line of the former block. The blockhouse includes undressed concrete walls, a reinforced concrete shed roof topped with a half-inch steel plate, slightly overhanging eaves, and five fixed, slightly recessed, single pane, blast resistant windows. The windows are set in protruding green-painted steel frames, three of which are sealed with steel plates. A ladder extends from the roof of the blockhouse which leads to a catwalk mounted atop the Butler building, running parallel to the peak of the roof. The storage area extends to the east from the block house, and includes a recessed single steel slab personnel door entry, a storage room accessed by east-facing double hung slab steel doors, and a flat graveled roof finished in galvanized metal trim with a wood-frame observation deck. A detached green-painted steel stairway provides access to the deck mounted atop a concrete apron that also houses an HVAC unit. A white LP tank set atop a concrete pad is offset from the wall and encircled by six yellow bollards. The CMU section extends to the buildings' northeast corner and includes one steel frame window with a CMU protruding lug sill and a 3/2 glazing pattern fitted with a security grate. The pre-manufactured

Figure 101. Property 20525, north elevation, view to the southeast.

Figure 102. Property 20525, south and west elevations, view to the northeast.

Figure 103. Property 20525, northeast corner with observation deck, view to the southwest.

block is clad in tan-painted metal vertical panels, the north elevation of which includes a row of 11 identical casement windows with a 3/3 glazing pattern and fitted with security grates. Fenestration of the west elevation consists of bi-parting horizontal sliding service bay doors, one blast-resistant window associated with the block house component, and two metal casement windows each with a 3/3 glazing pattern, and fitted with a security grate. Signage in both English and Japanese is mounted on the wall as well as the bay doors. Two Crouse-Hinds Co. explosion proof flood lights are mounted on the wall, flanking the bay doors, in addition to a red dome light extending above the roofline from the gable. The east elevation is identical to the west, with the exception of the blast resistant window and only one casement window. The fenestration of the south elevation consists of three rows of metal casement windows, each with a 3/3 glazing pattern and fitted with security grates, and one steel slab personnel door. The top two rows consist of seven windows, while the bottom row consists of six. Two HVAC units are offset from the wall and mounted on concrete pads with paired bollards. Duct work extends from the units and is mounted vertically on the elevation, partially obscuring pairs of windows. A small tan-painted entryway porch clad in 16-inch wide metal panels extends from the center of the south elevation, obscuring the entryway. Additional signage in both English and Japanese, two electrical boxes and electrical conduit are mounted on this wall as well. The building is surrounded on all but the north side by an asphalt parking lot. Tall timber poles stabilized by guy wires are offset from each of the buildings corners. Each pole is topped with a lightning rod and the four poles are interconnected with grounding cables suspended above and around the perimeter of the building.

History of Use

Property 20525 was constructed in 1958 as a Missile Assembly Building as part of the original Sergeant facilities at LC-32. It served in this capacity through the early 1960s. In July of 1964, Property 20525 was transferred to the Mauler Test Branch for use as office space, missile assembly area, parts storage, and equipment storage space. The neighboring Property 20526 was also transferred to the Mauler program so that it could be used for office and equipment storage (Boyes 1964).

After the cancellation of the Mauler program in 1965, Property 20525 was used in support of the Hawk Missile program. The property also supported the bi-annual Sergeant ASP firings, two in June and two in December, from 1966 to 1972 (Carpenter 1966). The property was also briefly assigned to the Little John Laser Guided program beginning in 1970.

The disposition data indicates that the building was used by Raytheon as shop space for the overhaul of two Hawk Program diesel generators in early 1971. Following this use, Property 20525 was assigned to the Navy in support of Project Hi-Star as a vehicle and payload preparation facility through 1972 (Brown 1971; Ferdig 1971). The disposition records relate that the blockhouse portion of the building remained available for use by Army programs during this period, and probably continued to be used for the bi-annual Sergeant ASP firings until 1972. In 1973, the property was transferred back to the Army Test and Evaluation (TE) Directorate.

By the mid-1970s, the building was used to support the Roland Missile development. Property 20525 served as a launcher checkout, assembly, and repair area for the Roland Missile program (Giesey 1975), and it likely served in this capacity through the early 1980s. During the mid-1990s, Property 20525 served as an assembly and launch control facility for the HERA Target

Missile program. The building was modified for use with the Hera program, with the addition of steel plate to the block house windows, improvements to the wiring and HVAC systems, and additions of required instrumentation and control equipment into the blockhouse interior (US Army Space and Strategic Defense Command 1994:25). At the time of the current recording, the building was well-maintained and in use by the Japanese for Chu-SAM program (Larry Carreras personal communication 2015).

7.6.3.2 Hera Missile Assembly Stand

The Hera Missile Assembly Stand is a blue-colored structure of I-beam construction with a rectangular footprint. The stand is oriented on an east-west axis, measuring 20 feet in length by 9 feet wide by 5½ feet in height. The structure is mounted on rectangular pad, measuring 43 feet by 10 feet, within a paved lot situated between Properties 20525 and 20526. The stand includes a steel grate deck or personnel catwalk and removable aluminum safety rails set atop the robust I-beam superstructure. A central service platform is recessed approximately one foot below the personnel catwalks and flanked by I-beams capped with a rail system. Braided grounding cables run the length of the structure's interior extending to the ground at the southwest corner. The structure includes three pairs of legs, each bolted to the underlying concrete pad. The western half of the concrete pad is presently vacant; however, observed bolt patterns suggest that an additional structure of similar configuration was once mounted in this location. A laminated plywood support was observed approximately 50 feet to the west of the structure and identified as a possible Hera missile support (Larry Carreras personal communication 2015).

Figure 104. Hera Missile Assembly Stand, view to the northwest.

Figure 105. Hera Missile support block, assembly stand in background, view to the east.

History of Use

No realty or disposition data is available for the Hera Missile Assembly Stand; however, Larry Carreras, Property 20525 Facility Manager, identified the structure as one of the missile assembly stands associated with the Hera Target Missile system during the mid-1990s (Larry Carreras personal communication 2015). According to Mr. Carreras, similar structures are housed within Property 20521.

7.6.4 LC-32 West Blast Barricades

Two blast barricade structures were identified at LC-32 West, Properties 20524 and 20527, both of which are located near Property 20525. Property 20524 is a concrete slab that supports a large concrete blast barricade. The Property 20521 Cable Trench is incorporated into the concrete slab on its route into Property 20525. Property 20527 is a similar barricade structure that was originally constructed to shelter an industrial air compressor.

7.6.4.1 Property 20524

Property 20524 is an at-grade concrete pad with a concrete blast barricade. The 40 feet north-south by 12 feet east-west pad consists of nine sections and maintains a hexagonal footprint, terminating at a blast barrier on the north end. The blast barricade consists of three courses of plywood-formed, undressed concrete construction with facility signage, cabling, conduit and electrical boxes mounted on the south-facing wall. Four electrical boxes are mounted to the north-facing wall, in addition to two lengths of conduit extending above the height of the barricade. A subterranean cable tunnel (Property 20521) bisects the pad, extending northward to Property 20520, and dog-legging to the east at the south end of the pad and continuing to Property 20525. Two inset steel, Crouse-Hinds Co. explosion proof 120/208 Volt electrical outlets flank the cable tunnel, immediately south of the barricade. A metal clad electrical cabinet with communications equipment is also present and tied into the cable tunnel below via electrical conduit. A tangle of electrical cables extends from

Figure 106. Hera Missile mock-up on Property 20524 pad, view to the northeast.

Figure 107. Property 20524 Blast Barricade, north side, view to the south.

two, four-inch conduit risers adjacent to the cabinet. To the south of the cabinet, a rectangular, steel trap door provides access to the subterranean cable tunnel. The north end of the pad is currently occupied by an angle iron framework supporting a full-size mock-up of a HERA missile, labeled “WSMR HERA.” A stack of olive drab green, steel fork lift pallets is situated along the east edge of the southern half of the pad. A timber pole and mounted electrical panel are offset from the northwest corner of the pad in addition to a pair of yellow electrical boxes mounted on an I-beam post.

History of Use

Property 20524 was constructed in 1958 as an Explosive Barricade as part of the original Sergeant facilities at LC-32. In the original (WS-FT) drawings for the property, it is labeled as the “Firing Control Pad.” A 1963 WSMR facilities summary simply refers to it as a “Blast Barricade.” Little information exists for its use in the years following the end of the Sergeant program at LC-32, but it was briefly assigned to the Little John Laser Guided program beginning in 1970. The presence of the Hera missile mock-up and pallets on the pad during the current inventory suggest that it may have been used as a staging/assembly area for the Hera Target Missile program.

7.6.4.2 Property 20527

Property 20527 is an “L” shaped concrete blast barricade structure located northeast of Property 20525. The blast barricade is constructed on an at-grade concrete slab foundation with concrete walls along its south and west sides and open to the northeast. It is constructed of board-formed, reinforced concrete with walls that taper from 14 inches at the base to 10 inches at the top.

Figure 108. Property 20527, north side view to the southwest.

The barricade has been modified for use as a storage area for oxygen and acetylene tanks, with a wood-framed shed roof constructed over the eastern portion of the barricade interior. Beneath the roofed area is a chain link fence paddock for securing the tanks. In addition to the tanks, an office table and a filing cabinet are located within the enclosure. Outside the fenced area but still within the barricade interior is a work bench and several discarded office chairs. An axle from a heavy truck rests on the north edge of the barricade foundation slab outside the fenced paddock. Square portals have been cut into the central part of the west barricade wall and lower portion of the south barricade wall for purposes unknown. An overhead hoist is mounted to the south elevation exterior, the boom of which overhangs the roofed portion of the magazine. An electrical switch box is also affixed to the south exterior wall. Outside the south elevation, a sheet metal panel and what appear to be heavy truck suspension parts rest on the ground outside the south elevation.

Figure 109. Property 20527, south side, view to the northwest.

Outside the west barricade wall on an extension of the barricade's slab foundation is a steel storage container, possibly used as a fuze storage magazine. The container is of welded steel plate and has lift points installed at its upper corners, a door on its north side, and several ports and vents. It is currently empty.

History of Use

Property 20527 was constructed in 1958 as a Compressed Air Pad as part of the original Sergeant facilities at LC-32. Also referred to as the Compressed Air Pad and Blast Wall, the structure was a sheltered outdoor installation for an industrial air compressor for pneumatic supply to Property 20525.

7.6.5 LC-32 West Magazine Facilities

Two magazine structures were identified at LC-32 West, Properties 20515 and 20516. Both of the resources are typical concrete box magazines located along the west margin of LC-32 West. They are the largest box magazines identified at LC-32, with the other magazines found near the MTLC being substantially smaller.

7.6.5.1 Property 20515

Figure 110. Property 20515, west and south elevations, view to the northeast.

Property 20515 is a small, one-story, high explosive magazine consisting of two vaults. The building is of plywood-formed reinforced concrete construction and includes a square floor plan, with undressed concrete walls on a raised grade concrete slab foundation. The shed style roof is of concrete construction with slightly overhanging eaves. The corners of the roofline are fitted with lightning rods with braided grounding cables running along the perimeter of the roof and extending to ground level. The fenestration of the west elevation consists of two individual, slab steel, hinged doors, each leading to a separate internal vault. Each door includes grounding straps affixed to the hinges that extend between the door frames and splice into grounding cable extending from the roof line. A narrow stoop runs the length of the west elevation. The board formed concrete stoop is separated from the wall, likely due to settling. With the exception of building signage on the east and west elevations and electrical conduit mounted on the south elevation, the building is completely unfitted. Two timber light posts are placed nearby, offset from the southwest and northwest corners of the magazine by approximately 20 feet.

History of Use

Property 20515 was constructed in 1958 as a "Fuse Det" magazine as part of the original Sergeant facilities at LC-32. According to Disposition data, the building served as a magazine for the Sergeant program through the 1960s. In 1970, the building was re-assigned in support of the Little John-Laser Guided program. In 1975, the property was assigned for support of the Roland missile program. As of the 2001 HSR recording, the use of the building was unknown. It appeared to be vacant at the time of the current inventory.

7.6.5.2 Property 20516

Figure 111. Property 20516, west and south elevations, view to the northeast.

Property 20516 is a small, one-story, high explosive magazine consisting of two vaults. The building is of plywood-formed reinforced concrete construction and includes a square floor plan, with undressed concrete walls on a raised grade concrete slab foundation. The shed style roof is of concrete construction with slightly overhanging eaves. The corners of the roofline are fitted with lightning rods with braided grounding cables running along the perimeter of the roof and extending to ground level. The fenestration of the west elevation consists of two individual, slab steel, hinged doors, each leading to a separate internal vault. Each door includes grounding straps affixed to the hinges that extend between the door frames and splice into grounding cable extending from the roof line. A narrow, board formed concrete stoop runs the length of the west elevation. Aside from the lightning rods and ground wires, the building is mostly unfitted except for building signage present on the east elevation and electrical conduit mounted on the north elevation. The magazine is encircled by a chain link security fence with timber light posts present at the southeast and northwest corners of the paddock.

History of Use

Property 20516 was constructed in 1958 as a "Fuse Det" Magazine as part of the original Sergeant facilities at LC-32. According to WSMR disposition data, the building served as a magazine in support of Sergeant Missile testing through the 1960s. In 1975, the magazine was used by the Aequare drone program, and was also co-used by the Roland program around this time. As of the 2001 HSR recording, the use of the building is unknown; however, the building was vacant at the time of the present recording.

Figure 112. Property 20516, east and north elevations, view to the southwest.

7.6.6 LC-32 West Miscellaneous Facilities

Two miscellaneous facilities were identified at LC-32 West, Properties 20506 and 20526. Both are permanent facilities and supported activities at the nearby Property 20525. Property 20526 was a heat plant for the neighboring assembly building and Property 20506 provided supplemental latrine facilities required by the influx of personnel during the 1970s Roland program.

7.6.6.1 Property 20506

Property 20506 is a small rectangular building with CMU walls constructed on an above grade concrete foundation. The flat roof of the building is of built-up construction and surfaced in asphalt and gravel. The upper edge of the roof is clad in galvanized sheet metal flashing and a gutter and downspout are located along the north elevation. Two steel slab personnel doors are located at both ends of the south elevation, each with a small concrete entry slab. The east entrance is protected by a steel frame and sheet metal windbreak. Parking curbs are located outside the entry slabs on this elevation. Both the east and west elevations have centrally located two light aluminum frame windows with horizontal sliding openings. These windows have slightly protruding sills of concrete block. The north elevation is entirely plain with the exception of two circular vent housings and a gutter and downspout.

Figure 113. Property 20506, south and east elevations, view to the northwest.

The interior of the building is divided into two lavatory rooms. Although few personnel appeared to be active at the adjacent Property 20525 at the time of the recording, the building appeared to be well-maintained and functional.

Figure 114. Property 20506, north and west elevations, view to the southeast.

History of Use

Property 20506 was constructed in 1977 as a standalone Public Toilet Facility in support of the Roland testing at LC-32. The latrine facility was necessitated by the influx of personnel into the area and the lack of sufficient existing restroom facilities in Properties 20525 and 20526. It is probably the only permanent building added to LC-32 as part of the Roland program, which otherwise re-used existing facilities or used mobile office trailers and buildings. Architectural plans indicate that other properties associated with the program were temporary installations that consisted of two portable skid mounted buildings, two contractor trailers, and one metal shed. None of these temporarily installed properties remain at the site. Property 20506 appears to remain maintained and operational and likely continues to be used by personnel from the Japanese Chu-SAM program at the neighboring Property 20525.

7.6.6.2 Property 20526

Property 20526 is a pre-manufactured steel Butler building constructed on an above-grade concrete foundation. The building is located east of Property 20525 and a concrete sidewalk connects the two properties. The building is clad in tan-painted corrugated sheet metal panels as is the medium-pitch gable roof. The roof has eaves on the north and south elevations and embossed "BUTLER" caps on the gable ends of the roof. A shed roof block of identical materials extends from the north elevation of the building.

Figure 115. Property 20526, south and west elevations, view to the northwest.

The west elevation of the building has sliding barn-type bay doors that have been sealed shut with riveted galvanized flashing and caulking. A personnel door entry is inset into the north bay door and consists of a steel panel door with four upper lights. An explosion-proof globe light fixture is located above the sealed bay doors which also have a short concrete entry slab. The west elevation of the shed roof extension has a steel frame window with nine lights and awning operation.

Figure 116. Property 20526, north and east elevations, view to the southwest.

The south elevation has two of the nine-light windows seen on the west elevation located at the east and west end of the wall, beneath which are smaller six-light windows. Centrally located in the upper portion of this wall are two additional six-light windows. All but the western-most pair of windows on this elevation have been painted over with the same tan paint as the building exterior. Like all the building windows, those along this wall have steel frames and awning type openings. A large HVAC unit and ventilator are mounted on a concrete slab at the base of the wall and ductwork from these units is routed through the middle portion of the wall beneath the central pair of six-light windows. Beneath the ductwork two electrical switch panels are mounted to the wall near a sign that reads “NO PARKING WITHIN 15 FEET OF BUILDING.”

Figure 117. Property 20526 interior, view to the southeast.

The building’s east elevation is generally similar to the west but the sliding bay doors remain operational. A steel personnel door identical to that of the west elevation is located in the south portion of this elevation. An explosion-proof dome light fixture is mounted to the wall above the bay door.

The west half of the building’s north elevation is occupied by a shed roof extension which has a double door entrance on its north side. This entrance consists of double steel panel doors each with four upper lights. The western door has oxidized extensively and the lower portion of the door has completely detached. A louvered vent panel and an electrical terminal box are also fitted to the exterior of this wall. The interior of this portion of the building does not connect to the rest of the building; in effect the shed roof extension is a stand-alone room attached to the north side of the building. This room housed a boiler and supporting equipment and was probably isolated from the rest of the building for safety purposes. The east facing wall of the boiler room has a nine light steel frame window and a louvered vent panel.

The portion of the north elevation not occupied by the shed roof extension houses two window pairings identical to those of the south elevation; a nine light window above a smaller six light window. These windows are identical to those used on the south elevation and have the same steel frames and awning openings. The muntins and glass of the eastern six light window have been knocked out, exposing the building interior to the elements. The visible portions of the interior are in poor condition.

History of Use

Property 20526 was constructed in 1958 as part of the original Sergeant facilities at LC-32. Referred to as the Boiler House or Heat Plant, the building housed boiler equipment and supported work at the adjacent Property 20525. The south half of the building supported assembly and maintenance work on the Sergeant Missile. Disposition data indicates that it was later used in support of the Roland program beginning in 1975, with the south half of the building used as an electrical checkout and shop area (Giesey 1975). Glenn Moore recalled that the building was also used briefly by the Hawk program prior to the initiation of the Sergeant missile testing (Glenn Moore personal communication 2015). During the mid-1990s the building was used for minor maintenance activities and storage by the Hera Target Missile program. At the time of the current inventory it was no longer used or maintained.

7.7 LC-32 MTLC Properties

The portion of LC-32 referred to here as the MTLC is a series of drone launch complexes that are arrayed near the east boundary of the complex. This area consists of two nearly identical aerial target drone launch complexes, each with two launch pads, a control building, and an air compressor shelter. An additional drone launch complex is also located further east, but appears to be decommissioned and lacks any associated buildings. The MTLC area is located to the east of the Hawk Fixed Battery area, across an access road. It occupies an area labeled as the “Hawk Annex” on the 1982 WSMR Master Plan map of LC-32. According to Glenn Moore, this area was used for launches of the Government Hawk program, while the main Hawk area at LC-32 East was used by Raytheon. Beginning in 1974, the Hawk Annex was converted into the MTLC, with additional facilities added in 1977. Identified property types at the MTLC include launch control facilities, launch facilities, instrumentation support facilities, assembly and maintenance facilities, magazines, and miscellaneous facilities.

7.7.1 LC-32 East Launch Control Facilities

Two launch control facilities were identified at the LC-32 MTLC, Properties 20754 and 20758. Both are essentially identical concrete blockhouse buildings that were constructed specifically for the MTLC during its installation in the 1970s. Each is located just south of paired drone launch pads.

Figure 118. Overview of the MTLC area in the eastern portion of LC-32.

7.7.1.1 Property 20754

Property 20754 is a small, one-story, launch control building. The building is of plywood-formed reinforced concrete construction and includes a hexagonal floor plan, with undressed concrete walls on a raised grade concrete slab foundation. The flat roof is also of reinforced concrete construction with an elastomeric coating. The perimeter of the roofline is fitted with four lightning rods and braided grounding cables that extend to ground level. A red dome light and two conduit penetrations are visible extending above the roofline. The northwest and northeast elevations are identical; each is unfitted and oriented to view their respective drone launch pads. Fenestration of these elevations consists of one fixed, single pane, blast resistant window. Each window is slightly recessed in a protruding steel frame that is fitted with a grounding strap. Fenestration of the south elevation includes two slab-type steel personnel doors, each leading to a separate internal control room. Access to the entryways is provided by two sets of concrete steps separated by a HVAC unit and associated duct work mounted on an offset concrete pad. A dome light is mounted above each entryway and each brown-painted door includes grounding straps affixed to the hinges and mounted signage. The north, east and west elevations of the building are completely unfitted with the exception of signage present on the west elevation and electrical conduit mounted on the north and east elevations. A portable steel frame observation stand is present to the north of the building and a wood pallet rests against the buildings' west elevation. The facility number is stenciled on the south and west elevations, offset from the building's southwest corner.

History of Use

Property 20754 was constructed in 1977 as the Launch Control Building associated with the MTLC. The building is part of a drone launch complex associated with Properties 20753, 20755 and 20756. The pad and associated facilities continue to be maintained and used in support of target drone launches at LC-32.

Figure 119. Property 20754, north and west elevations, view to the southeast.

7.7.1.2 Property 20758

This property is a small one-story building of reinforced poured concrete construction with an irregular, hexagonal floor plan. The undressed concrete walls are constructed on an elevated concrete slab foundation. The flat roof is also of reinforced concrete construction with an elastomeric coating. The perimeter of the roofline is fitted with four lightning rods and braided grounding cables that extend to ground level. A red dome light and two conduit penetrations are visible extending above the roofline. The northwest and northeast elevations are identical; each is unadorned and oriented to view their respective drone launch pads. Fenestration of these elevations consists of one fixed, single pane, blast resistant window. Each window is slightly recessed in a protruding steel frame that is fitted with a grounding strap. Fenestration of the south elevation includes two slab single panel steel personnel doors, each leading to a separate internal control room. Access to the entryways is provided by two sets of concrete steps separated by a HVAC unit and associated duct work mounted on an offset concrete pad. A dome light is mounted above each entryway and each brown door includes grounding straps affixed to the hinges and mounted signage. The north, east and west elevations of the building are completely unadorned with the exception of signage present on the west elevation and electrical conduit mounted on the north and east elevations. The facility number is stenciled on the south and west elevations, offset from the buildings southwest corner.

Figure 120. Property 20758, north and east elevations, view to the southwest.

Figure 121. Property 20758, south and east elevations, view to the northwest.

A portable steel container, designed to be carried by a 2 ½ ton flatbed truck, rests on the ground immediately outside the north elevation. A decal on the container reads "STRICOM / PM ITTS / Targets Management Office." The Simulation, Training, and Instrumentation Command (STRICOM) was the predecessor organization to the current Program Executive Office for Simulation, Training, and Instrumentation (PEO-STRI), and the Project Manager Instrumentation, Targets, and Threat Simulators (PM ITTS) is a division within PEO-STRI (formerly STRICOM). A telescoping radio tower is located approximately 15 meters to the east of the building and a transformer mounted on a concrete slab foundation is located to the southeast of the building.

History of Use

Property 20758 was constructed in 1975 as the Launch Control Building associated with the MTLC. The building is part of a drone launch complex associated with Properties 20757, 20759 and 20760. The pad and associated facilities continue to be maintained and used in support of target drone launches at LC-32.

7.7.2 MTLC Launch Facilities

Six launch facilities were identified at the LC-32 MTLC, Properties 20755, 20756, 20759, 20760, 20769, and 20770. These launch pads are co-located in consecutively numbered pairs, each of which is equipped with an overhead gantry crane. The westernmost pair consists of Properties 20755 and 20756, and Properties 20759 and 20760 are the next pair to the east. Both are still actively used by the PEO-STRI targets group at WSMR. The easternmost pair is Properties 20769 and 20770, which do not appear to have been recently used.

7.7.2.1 Property 20755

Property 20755 is a concrete drone launch pad consisting of two staggered launch bays constructed atop an above grade gravel mound. The pad measures approximately 86 feet E-W by 62 feet N-S with an irregular footprint. The two launch bays are identical in configuration, each consisting of a drone launcher spanned by a 3,000 pound gantry crane of I-beam construction. The launchers are oriented toward the north/northeast and flanked by service platforms accessed by two metal stairways. Each launcher is painted silver and includes Crouse-Hinds Co. explosion-proof electrical fittings. A trapezoid shaped, 2½ inch thick steel blast plate is bolted to the concrete pad rearward of each launcher. The tan-painted gantry cranes are each fitted with two floodlights and an electric hoist. The cross member of each crane is stenciled “L-542” and “L-543,” respectively, moving from west to east. Square, steel access panels are inset on the east and west sides of the launch bays providing access to conduit and electrical infrastructure. Additional electrical infrastructure is situated between the two launch bays, inclusive of an electrical cabinet mounted atop a wheeled, steel frame cart and an electrical box mounted atop a concrete pedestal. Various electrical conduits extend between the launch pad, electrical boxes, launchers and the gantry cranes.

Figure 122. Property 20755, view to the southeast.

Figure 123. Property 20755 launcher rail detail view to the southeast.

History of Use

Property 20755 was constructed in 1977 as the West Launch Pad addition to MTLC. The structure is part of a drone launch complex associated with Properties 20753, 20754 and 20756. Archival photography and comparison of the launch support structure indicate that the pad was constructed for launches of the MQM-34D (Firebee) drone. The pad and associated facilities continue to be maintained and used in support of aerial target drone launches at LC-32.

7.7.2.2 Property 20756

Property 20756 is a concrete drone launch pad consisting of two staggered launch bays constructed atop an above grade gravel mound. The pad measures approximately 86 feet east-west by 62 feet north-south with an irregular footprint. The two launch bays are identical in configuration, each consisting of a drone launcher, spanned by a 3,000 pound gantry crane of I-beam construction. The launchers are oriented toward the north/northeast and flanked by service platforms accessed by metal stairways. Each launcher is painted silver and includes Crouse-Hinds Co. explosion-proof electrical fittings. A trapezoid shaped, 2½ inch thick steel blast plate is bolted to the concrete pad rearward of each launcher. The tan-painted gantry cranes are each fitted with two flood lights and an electric hoist. The cross member of each crane is stenciled “L-544” and “L-545,” respectively moving from west to east. Square, steel access panels are inset on the east and west sides of the launch bays providing access to conduit and electrical infrastructure. Additional electrical infrastructure is situated between the two launch bays,

Figure 124. Property 20756 launch pad, view to the southeast.

inclusive of an electrical cabinet mounted atop a wheeled, steel frame cart and an electrical box mounted atop a concrete pedestal. Various electrical conduits extend between the launch pad, electrical boxes, launchers and the gantry cranes.

History of Use

Property 20756 was constructed in 1977 as the East Launch Pad addition to the MTLC. The structure is part of a drone launch complex associated with Properties 20753, 20754 and 20755. Archival photography and comparison of the launch support structure indicate that this pad, and the adjacent Property 20755 pad, were constructed for launches of the MQM-34D (Firebee) drone. The pad and associated facilities continue to be maintained and used in support of target drone launches at LC-32.

7.7.2.3 Property 20759

Property 20759 is a concrete drone launch pad consisting of two staggered launch bays constructed atop an above grade gravel mound. The pad measures approximately 86 feet east-west by 74 feet north-south with an irregular footprint. The two launch bays are identical in configuration, each consisting of a drone launcher, spanned by a two-ton Yale gantry crane of I-beam construction with a concrete blast deflector (20 feet by 3 feet by 2 feet high) located to the rear of each bay. The yellow-painted steel frame launchers are oriented toward the northeast, and mounted atop 2½ inch thick steel blast plates. The trapezoidal blast plates are bolted to the concrete pad and extend rearward of each launcher. It is apparent that the launchers and associated blast plates have been relocated on the pad, as evidenced by trapezoidal torch cut bolt patterns oriented north/south. The tan-painted gantry cranes are each fitted with two speakers, electrical boxes, conduit, one flood light and an electric hoist. Square, steel access panels are inset on the east and west sides of the launch bays providing access to conduit and electrical infrastructure. Additional electrical infrastructure is situated between the two launch bays, inclusive of shielded electrical conduit extending between the launch pad, electrical boxes, launchers and the gantry cranes. One additional electrical box mounted on a post is present on the west edge of

Figure 125. Property 20759 launch pads, view to the northeast.

the pad adjacent to the gantry crane. The structure is part of a drone launch complex associated with Properties 20757, 20758 and 20760.

History of Use

Property 20759 was constructed in 1975 as the MTLC I, Launch Pad West. The structure is part of a drone launch complex associated with Properties 20757, 20758, and 20760. Archival photography and comparison of the launch support structure indicate that this pad and the adjacent Property 20760 were constructed for launches of the MQM-107 (Streaker) drone. The pad and associated facilities continue to be maintained and used in support of target drone launches at LC-32.

7.7.2.4 Property 20760

Figure 126. Property 20760 launch pads, view to the northeast.

Property 20760 is a concrete drone launch pad consisting of two staggered launch bays constructed atop an above grade gravel mound. The pad measures approximately 86 feet east-west by 74 feet north-south with an irregular footprint. The two launch bays are identical in configuration, each consisting of a drone launcher, spanned by a two ton Yale gantry crane of I-beam construction with a concrete blast deflector (20 feet by 3 feet by 2 feet high) located to the rear of each bay. The yellow-painted steel frame launchers are oriented toward the northeast. The launchers have been relocated from their original orientation, as evidenced by offset, 2½ inch-thick steel trapezoidal blast plates bolted to the concrete pad. Launches subsequent to the relocation have resulted in scorching and scouring of the unprotected concrete pad. The tan-painted gantry cranes are each fitted with two speakers, electrical boxes, conduit, one flood light and an electric hoist. Square, steel access panels are inset on the east and west sides of the launch bays providing access to conduit and electrical infrastructure. Additional electrical infrastructure is situated between the two launch bays, inclusive of shielded electrical conduit extending between the launch pad, a yellow-painted air compressor, electrical boxes, launchers and the gantry cranes. One additional electrical box mounted on a post is present on the west edge of the pad adjacent to the gantry crane. The structure is part of a drone launch complex associated with Properties 20757, 20758 and 20759. The concrete pad was extended in 1983 resulting in a squared, continuous north edge of the pad.

History of Use

Property 20760 was constructed in 1975 as the MTLC I, Launch Pad East. The structure is part of a drone launch complex associated with Properties 20757, 20758, and 20759. Archival photography and comparison of the launch support structure indicate that this pad and the adjacent Property 20759 were constructed for launches of the MQM-107 (Streaker) drone. The pad and associated facilities continue to be maintained and used in support of target drone launches at LC-32.

Figure 127. Property 20760 launcher hardware, view to the southeast.

7.7.2.5 Property 20769

Property 20769 is an aerial target drone launch pad located at the far eastern margin of LC-32. It is the west launcher of an identical pair; the adjacent drone launch pad to the east is Property 20770. The launch pads consist of two adjoining concrete slab foundations, each equipped with an assembly gantry. The gantry tower is constructed of tubular steel support columns and an upper I-beam. Affixed to each upper beam are the letters “FLY NAVY” bracketed by the Navy anchor symbol. The gantry is equipped with lightning rods and grounding wires, as well as climbing stirrups. The gantry has an attached 2-ton electric hoist for the lifting of the aerial drone onto the launcher rail or frame. Centered beneath each gantry is a rectangular steel plate bolted to the concrete slab, which measures 14 feet north-south by 6 feet east-west. This plate acts as a blast shield during the drone launch to prevent erosion of the concrete foundation. On the east side of the blast plate is a yellow sheet metal housing with enclosed electrical connectors on its south side. It appears that it may serve as a step or access platform during the drone launch preparation. Anchor points are embedded in the concrete on each side of the steel blast plate. A trash can and electrical conduit access box are located at the center of the launch pad and the primary electrical main switch for both Properties 20669 and 20770 is mounted to the east column of the west gantry. An extensive cleared area extends to the north of the two launcher pads.

History of Use

This launch pad is clearly identified in WSMR GIS mapping as Property 20769; however, this identification might be in error. The description of Property 20769 in WSMR realty data is a “Concrete Pad for MQM-34D Boosters”, which does not fit with the identified property’s physical characteristics. This suggests that the WSMR GIS layer is likely in error in its identification of this property. Unfortunately, a more appropriate property number or label was not identified for this launch pad during the current inventory. Archival photography suggests that the location of Property 20769 and 20770 was formerly occupied by a drone catapult launcher system that used a Navy aircraft carrier catapult system to launch MQM-34D drones without the use of JATO booster. This catapult system was damaged in 1979, which may have resulted in the removal of the system and its replacement with the current drone launch pads. The catapult system required an extended concrete apron for its operation, which is consistent with the cleared strip of desert that stretches northeast of the launch pad. An inspection sticker indicates that both of the extant launcher pads were last inspected as of 2005, and it appears that this launch complex has not been used in recent years.

7.7.2.6 Property 20770

Property 20770 is an aerial target drone launch pad located at the far eastern margin of LC-32. It is the east launcher of an identical pair; the adjacent drone launch pad to the west is Property 20769. The launch pads consist of two adjoining concrete slab foundations, each equipped with an assembly gantry. The gantry tower is constructed of tubular steel support columns and an upper I-beam. Affixed to each upper beam are the letters "FLY NAVY" bracketed by the Navy anchor symbol. The gantry is equipped with lightning rods and grounding wires, as well as climbing stirrups. The gantry has an attached 2-ton electric hoist for the lifting of the aerial drone onto the launcher rail or frame. Centered beneath each gantry is a rectangular steel plate bolted to the concrete slab, which measures 14 feet north-south by 6 feet east-west. This plate acts as a blast shield during the drone launch to prevent erosion of the concrete foundation.

Figure 128. Properties 20769 and 20770 launch pads, view to the northeast.

On the east side of the blast plate is a yellow sheet metal housing with enclosed electrical connectors on its south side. It appears that it may serve as a step or access platform during the drone launch preparation. Anchor points are embedded in the concrete on each side of the steel blast plate. A trash can and electrical conduit access box are located at the center of the launch pad and the primary electrical main switch for both Properties 20669 and 20770 is mounted to the east column of the west gantry. An extensive cleared area extends to the north of the two launcher pads.

History of Use

This launch pad is clearly identified in WSMR GIS mapping as Property 20770; however, this identification might be in error. The description of Property 20770 in WSMR realty data is a "Concrete Pad for MQM-34D Boosters", which does not fit with the identified property's physical characteristics. This suggests that the WSMR GIS layer is likely in error in its identification of this property. The same situation exists for Property 20669, which is identified as the neighboring launch pad in the WSMR GIS layer. Unfortunately, a more appropriate property number or label was not identified for this launch pad during the current inventory. Additionally, a 1979 disposition form requested Property 20770 be removed from the ARMTE property inventory, hinting that the actual 20770 physical property may have been retired or demolished.

Archival photography suggests that the location of Property 20769 and 20770 was formerly occupied by a drone catapult launcher system that used a Navy aircraft carrier catapult system to launch MQM-34D drones without the use of JATO booster. This catapult system was damaged in 1979, which may have resulted in the removal of the system and its replacement with the current drone launch pads. The catapult system required an extended concrete apron for its operation, which is consistent with the cleared strip of desert that stretches northeast of the launch pad. An inspection sticker indicates that both of the extant launcher pads were last inspected as of 2005, and it appears that this launch complex has not been used in recent years.

7.7.3 MTLC Instrumentation Support Facilities

One property specific to instrumentation support was identified at the MTLC area of LC-32 during the current inventory. Located northwest of Property 20746, Unknown Instrument Platform 1 likely pre-dates the MTLC and is a remnant of the area's former role as the LC-32 Hawk Annex. The elevated instrument platform is typical of platforms used for general range support or for the targeting and guidance radars used with the Hawk missile system.

7.7.3.1 Unknown Instrument Platform 1

This property consists of an elevated earth and gravel mound topped by a rectangular concrete slab foundation located northwest of Property 20746. The concrete slab foundation measures approximately 35 feet east-west by 15 feet north-south. The mound is ramped on its east and west sides, allowing vehicle access to the concrete foundation. The mound is unusual in that it has concrete steps and railings on its north and south sides. The steps are of expedient construction, consisting of concrete blocks surfaced with poured concrete. The accompanying railings are anchored into the poured concrete and appear to be metal tubing recycled from another location.

History of Use

Although indicated on an HSR map as Property 20749, this property number assignment appears to be in error when compared to historic maps of the LC-32 Hawk Annex. The actual property number is unknown. The site is consistent with a decommissioned Hawk radar platform or a range instrumentation site, a remnant of the Hawk testing conducted prior to the establishment of the MTLC in this portion of LC-32. Due to the lack of a known WSMR property number, no information regarding the structure's history could be located among the various archival sources available at the range. As such, the use history and age of the platform cannot be verified. At the time of the present recording, the mound appeared to have been unused for quite some time.

Figure 129. Unknown Instrument Platform 1, concrete foundation on top of mound, view to the southeast.

Figure 130. Concrete stairway on north side of mound, view to the southeast.

7.7.4 MTLC Assembly and Maintenance Facilities

Two assembly and maintenance facilities were identified at MTLC, Properties 20540 and 20546. Property 20540 is a pre-manufactured steel building while Property 20546 is of CMU construction; both serve as drone repair and weight and balance facilities. Property 20546 was originally built as a missile maintenance facility for the Hawk program, but was converted for use with the MTLC. Property 20540 was constructed specifically for the MTLC in 1975.

7.7.4.1 Property 20740

Figure 131. Property 20740, south and east elevations, view to the northwest.

Figure 132. Property 20740, north and east elevations, view to the southwest.

This property is a pre-manufactured steel building produced by Kirby Building Systems, as identified by manufacturer's logos on the gable ends of the roof. The building is constructed on an elevated concrete slab foundation with a split-level layout; it has a northern high bay portion and a standard height one story block at its south end. The building is clad in sheet metal panels as is the low-pitch gable roof. The roof is equipped with gutters and downspouts on its east and west elevations, but does not have eaves. A series of lightning rods and ground wires are positioned along the edges of the roof. The roof of the south portion of the building supports HVAC equipment and associated ductwork.

The west elevation of the building has one entrance and two windows in the south portion of the wall. The entrance is accessed by two concrete steps and consists of a steel personnel door with one upper light equipped with security bars. An explosion-proof dome light fixture is mounted near the door. The two steel frame windows both have 6/6 patterns of vertical rectangular lights, and the hinged lower panels have inward opening hopper operations. A louvered vent panel is located near the north end of the wall. The east elevation of the building is mostly plain, with one steel personnel door positioned at the north end of the wall. The door is accessed by a two-step concrete entry slab and an explosion-proof dome light fixture is mounted to the wall near the door. A louvered vent panel is located just south of the doorway, and another small louvered vent is located in the southern portion of the wall. A round, aluminum vent housing is also located in the southern portion of this elevation. Various warning signs, including "FLAMMABLE", "NO SMOKING", and personnel and explosives limits, are attached to this wall as well. The north elevation of the building has an overhead rolling door flanked by two explosion-proof flood lights. A concrete entry ramp with safety bollards extends from the base of this wall, allowing easy vehicle access into the building. The building's south elevation has one entrance and one window. The entrance is accessed by a two-step concrete entry slab and consists of a steel personnel door with one upper light with security bars. An explosion-proof dome light is affixed to the wall near the door. Adjacent to the door is a window similar to those on the west elevation; however, this smaller version has a 3/3 pattern of small rectangular lights. A round, aluminum vent housing is located near the east end of this wall.

History of Use

Property 20740 was constructed in 1975 as a Weight and Balance Building, part of the support facilities for the MTLC. It has continued to serve as a support facility for the MTLC since its construction, and little additional data is available regarding its use and function.

7.7.4.2 Property 20746

Property 20746 is a split-level, rectangular-plan, concrete post and lintel building with CMU infill walls. The building is of the same basic plan and design as Property 20541, but differs from that building in its fenestration. The wall pillars are of CMU construction while the lintels are of poured concrete. It is built on an at-grade concrete foundation and is painted tan with the exception of the concrete lintels, which are unpainted. Window frames and doors are painted an olive drab color which has faded substantially. The east half of the building consists of a high bay, while the west half is a single story of standard height. The flat, split-level roof of the building is sealed with tar and gravel material and covered in flashing along its edges. The roof is equipped with rain gutters and downspouts, and a series of lightning rods and ground wires. A septic tank is located just off the southeast corner of the building and a telescoping radio tower is located across the gravel lot to the northeast of the property.

Figure 133. Property 20746, west and south elevations, view to the northeast.

Figure 134. Property 20746, north and west elevations, view to the southeast.

The concrete post supports of the building divide each elevation of the building into two bays. The north elevation of the building has a large overhead rolling door set into the (east) high bay portion of the wall, above which is globe light fixture. This door is obviously the primary access for moving large equipment into the building. The west half of the north elevation is plain, with the exception of a series of electrical breaker and switch boxes. The south elevation of the building has two personnel doors and one window in the high bay portion of the wall. One door is a steel slab type, while the other has three horizontal upper lights with wire glass. A security grille of flat steel bars is affixed to the interior of the door. This entrance is further distinguished by a heavy, poured concrete lintel above the door and an overhead explosion-proof light fixture. The other entrance lacks the structural lintel above the doorway, suggesting that this entrance was likely added to the wall after the building's original construction. Set into the wall between the two doors is a large, circular aluminum vent housing. Near the east edge of the wall is a small steel frame window with two lights and a protruding sill. The west half of the elevation is plain. The west elevation of the building has three windows and a personnel door entrance at its south end. The steel frame windows each have four lights, protruding sills, and awning type operation. The interior of each window is fitted with flat steel security grilles and are boarded over from the inside. The steel personnel door at the south end of the elevation has three horizontal lights of wire glass and interior steel bar security grille. Various warning signs describing the personnel and explosive limits of the building are affixed to the wall near the entrance and an explosion-proof light fixture is located above the doorway. The east elevation of the building has a single steel slab personnel door and one window set high in the wall. The window is fitted with an exterior security grille of flat steel bars, and screen over the central portion of the window. The steel frame window appears to have eight lights, the central four of which are hinged with an inward hopper opening. As with the other building windows, this one has a protruding concrete sill. The same style of window was identified at Property 20541. The remainder of the elevation is plain, with only a hand-painted sign reading "DANGER / NO SMOKING WITHIN 60 FT" affixed to the wall.

History of Use

Property 20746 was constructed as a Missile Maintenance Building at the Hawk Annex in 1959. As of 1961, disposition data indicates that it was being used for storage and was therefore requested for use by the Raytheon Hawk program. As of 1973, the building was again vacant and it was assigned as a support facility for the upcoming MTLC. In 1975, the building was modified by the Army Corps of Engineers for use as a drone repair and weight and balance building in support of the MTLC. It has continued to serve as a support facility for the MTLC since 1975, and little additional data is available regarding its use and function.

7.7.5 MTLC Magazine Facilities

Four magazine structures were identified at the LC-32 MTLC area, Properties 20743, 20752, 34932, and 34933. All of these resources are typical concrete box magazines located along the southern portion of the MTLC. Several have been recycled from other locations at WSMR for use at the MTLC.

7.7.5.1 Property 20743

This structure is a small concrete box magazine with an attached foundation slab. The magazine is essentially a concrete cube that measures four feet per side. Small double steel doors set into a steel frame are located on the magazine's west side. Lift points are built into the flat concrete roof of the magazine and is equipped with the typical lightning rods and grounding wires.

Figure 135. Property 20743 Magazine, north and west elevations, view to the southeast.

History of Use

This property number is no longer maintained in WSMR realty records, suggesting that it was retired from the system. This magazine is associated with the nearby Property 20765 Engine Run-up Test Pad and is likely used in association with drone launch activities at the MTLC.

7.7.5.2 Property 20752

This structure is a small concrete box magazine constructed on an above-grade concrete slab foundation. This magazine is larger than other magazines in the same general area and proportioned large enough to allow walk-in access. The flat concrete roof of the magazine is equipped with the typical lightning rods and grounding wires. A steel slab personnel door is located on the south elevation of the structure and has a series of drilled vent holes in its lower extent. A "NO SMOKING" sign and facility ID placard are affixed to the door. A concrete entry slab extends from the base of the doorway. An electrical terminal box and associated conduit are mounted on the west elevation of the structure. Additional warning and explosive limit signage is affixed to a nearby double sign post.


Figure 136. Property 27052, south and west elevations, view to the northeast.

History of Use

This property number is no longer maintained in WSMR realty records, suggesting that it was retired from the system. This magazine is associated with the nearby Property 20765 Engine Run-up Test Pad and is likely used in association with drone launch activities at the MTLC.

7.7.5.3 Property 34932

This structure is a small concrete box magazine with an attached foundation slab. The magazine is essentially a concrete cube that measures four feet per side. The attached foundation slab is substantial and measures roughly 8 feet by 8 feet, and is approximately 18 inches thick. The condition of the foundation slab, and the discontinuous property number, suggest that this magazine was removed from another location and re-used at LC-32. Small double steel doors set into a steel frame are located on the magazine's east side. The flat concrete roof of the magazine is equipped with the typical lightning rods and grounding wires. Associated warning and explosives limits signs are mounted on nearby double sign posts.

Figure 137. Property 34932, east and south elevations, view to the northwest.

History of Use

Property 34932 was constructed in 1959; however, this property number is no longer maintained in WSMR realty records, suggesting that it was retired from the system. Other property numbers in this range are located at WSMR's Zeus Up Range Facility (ZURF) Site, suggesting that the magazine was removed and re-used at LC-32, which is consistent with its condition. This magazine is associated with the nearby Property 20765 Engine Run-up Test Pad and is likely used in association with drone launch activities at the MTLC.

7.7.5.4 Property 34933

This structure is a small concrete box magazine with an attached foundation slab. The magazine is essentially a concrete cube that measures 4 ½ by 4 by 4 feet. The attached foundation slab is substantial and measures roughly 8 feet by 8 feet, and is approximately 22 inches thick. The condition of the foundation slab, and the discontinuous property number, suggest that this magazine was removed from another location and re-used at LC-32. Small double steel doors set into a steel frame are located on the magazine's west side. The flat concrete roof of the magazine is equipped with the typical lightning rods and grounding wires. Associated warning and explosives limits signs are mounted on nearby double sign posts.

History of Use

Property 34933 was constructed in 1959; however, this property number is no longer maintained in WSMR realty records, suggesting that it was retired from the system. Other property numbers in this range are located at WSMR's ZURF Site, suggesting that the magazine was removed and re-used at LC-32, which is consistent with its condition. This magazine is associated with the nearby Property 20765 Engine Run-up Test Pad and is likely used in association with drone launch activities at the MTLC.

Figure 138. Property 34933, south and west elevations, view to the northeast.

7.7.6 MTLC Miscellaneous Facilities

Five miscellaneous facilities were identified at LC-32 East; Properties 20753, 20757, 20765, 20767, and H3220. These resources consist of an assortment of support facilities related to the MTLC, and include air compressor shelters, an engine run-up slab, a fueling station, and a portable building.

7.7.6.1 Property 20753

Property 20753 is a small, one-story, air compressor shelter located immediately to the south of Property 20754. The building is of plywood-formed reinforced concrete construction and includes a rectangular floor plan, with undressed concrete walls with a flat reinforced concrete roof on a raised grade concrete slab foundation measuring 4 feet 4 inches by 9 feet 6 inches. The north elevation provides the only access to the building via slightly recessed, double hung, two panel metal doors, where the upper door panel consists of louvered vents. The south elevation is unfitted with the exception of a square louvered vent centered high on the façade. The east and west elevations of the building

Figure 139. Property 20753, north elevation, view to the southeast.

are completely unfitted. The facility number “20757” is incorrectly labeled on facility signage mounted on the south and west elevations, offset from the buildings southwest corner.

History of Use

Property 20753 was constructed in 1977 as the Compressor Air Plant Building associated with the Multiple Target Launcher. The building is part of a drone launch complex associated with Properties 20754, 20755 and 20756. As constructed, the building serves to shelter an air compressor in support of target drone launches at LC-32.

7.7.6.2 Property 20757

Property 20757 is a small, one-story, air compressor shelter located immediately to the south of Property 20758. The building is of plywood-formed reinforced concrete construction and includes a rectangular floor plan, with undressed concrete walls with a flat reinforced concrete roof on a raised grade concrete slab foundation measuring 4 feet 4 inches by 7 feet 6 inches. The north elevation provides the only access to the building via slightly recessed, double hung, two panel metal doors, where the upper door panel consists of louvered vents. The south elevation is unfitted with the exception of a square louvered vent centered high on the façade. The east and west elevations of the building are completely unfitted. The property number “20753” is incorrectly labeled on facility signage mounted on the south and west elevations, offset from the buildings’ southwest corner.

Figure 140. Property 20757, north and west elevations, view to the southeast.

History of Use

Property 20757 was constructed in 1975 as the Compressor Air Plant Building associated with the Multiple Target Launcher. The building is part of a drone launch complex associated with Properties 20758, 20759 and 20760. As constructed, the building serves to shelter an air compressor in support of target drone launches at LC-32.

7.7.6.3 Property 20765

This property is an at-grade concrete slab foundation that measures approximately 35 by 35 feet, with overhead light poles centrally positioned at its east and west ends. The area around the concrete pad is cleared and surfaced with asphalt and gravel. Both overhead light poles are mounted with a variety of electrical switches, terminal boxes, and outlets. No mounting hardware was observed on the foundation, but an oxidation stain at the center of the pad suggests that a steel framework of some kind was formerly located there. An unmarked brass datum is set into the concrete at the west edge of the pad. Several small box magazines are located around the pad and are described separately.

Figure 141. Property 20765, view to the north.

History of Use

Property 20765 was constructed in 1977 as an Engine Run-up Test Facility at the MTLC. The facility apparently serves as a location for the testing of drone jet engines prior to launch and is associated with a series of small concrete box magazines. The facility appears to still be used in support of drone launches at the MTLC, but little additional data is available regarding its use and function.

7.7.6.4 Property 20767

This property is an isolated fueling station that consists of a large steel fuel tank mounted on concrete supports situated within a concrete enclosure. The concrete enclosure surrounds the fuel tank with a low concrete wall and serves as a catchment basin for any potential spills or leaks from the tank. Stenciled labels on the enclosure walls read “SCS 9-13 I. OHM”, while the tank itself is stenciled “JP-8.” The tank is equipped with a ladder at its east side and an access deck at its top. Concrete slabs extend from the north and south sides of the station. The north slab has four steel and concrete bollards and a “NO SMOKING” sign. An additional concrete slab supporting an emergency wash station is located on the east side of the tank enclosure. Electrical switches, tank valves, and a transfer pump are located at the south end of the tank. The fueling station is situated within a large graveled lot within which Property H3220 is also located, and several pole-mounted flood lights illuminate the lot.

History of Use

Property 20767 was constructed in 1977 as an aboveground jet fuel storage facility at the MTLC. The facility serves as a pre-launch fueling location for the aerial target drones launched at the MTLC. The facility appears to still be used in support of drone launches at the MTLC, but little additional data is available regarding its use and function.

Figure 142. Property 20767, south and east elevations, view to the northwest.

7.7.6.5 Property H3220

Figure 143. Property H3220, north and west elevations, view to the southeast.

This property is a pre-manufactured steel Butler building constructed on a wooden skid foundation for easy transport. The walls of this single-room building are clad in corrugated sheet metal panels and the low-pitch gable roof is clad in the same material. The roof has eaves on the east and west elevations and its gable ends have embossed “BUTLER” end caps.

The building’s only entrance is on the north elevation and consists of a steel slab personnel door, to which a facility ID tag is affixed. A wood step, built on extensions of the wood skid foundation, runs the full length of this elevation. The west elevation of the building has one steel frame window with four lights and awning operation. A “NO SMOKING WITHIN 50 FT” sign is mounted to the wall next to the window. The east and south elevations of the building are entirely plain.

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building’s history could be located among the various archival sources available at the range. As such, the use history and age of the portable building remain unknown. The building is located at the southeast corner of the gravel lot associated with the Property 20767 fueling station and therefore likely supports aerial drone fueling activities at the MTLC.

7.8 LC-32 South Properties

The portion of LC-32 referred to here as LC-32 South is located south of the main LC-32 complex on the opposite side of Nike Avenue. The original facilities in this area were constructed in support of the LC-32 Hawk program in 1959, and the location was referenced as LC-32 South in several period photographs and documents. It is also identified as the Hawk Engineering and Contractor Facility Area in the 1982 WSMR Master Plan map of the area. This area includes Property 21759, home of the Raytheon Hawk program and known as the Hawk Hangar, and Property 21756, another large assembly building constructed for the Hawk program. Each of these buildings is located within a discrete fenced compound that includes various associated facilities. Property 21756 was also used in support of the Raytheon Mauler program before its cancellation in 1965. Although Raytheon relocated away from Property 21759 during the 1970s as the SAM-D/Patriot program at LC-38 expanded, Property 21756 and surrounding properties continue to be used by the contractor in support of the Hawk and Stinger missile programs. As LC-32 South served as an assembly hub for the complex, the identified property types in this area consist entirely of assembly and maintenance properties and miscellaneous facilities.

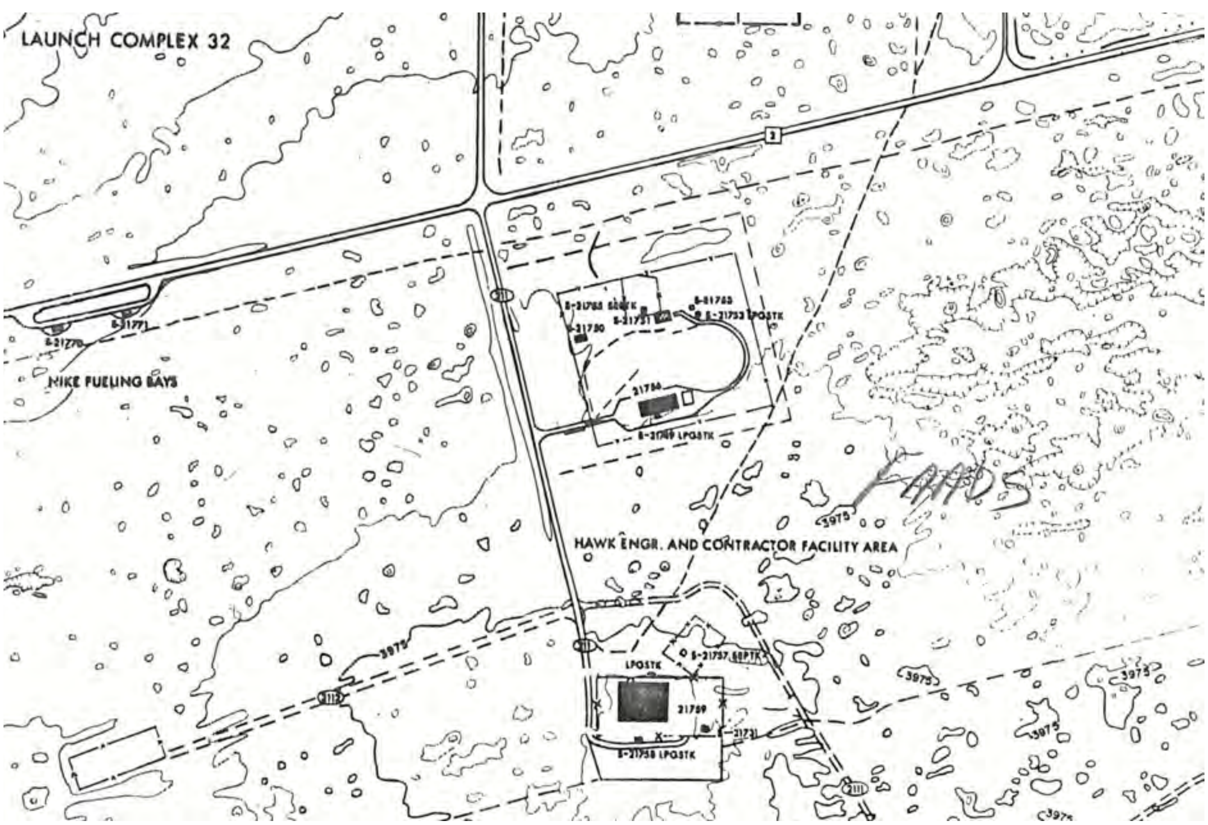

Figure 144. Excerpt from the 1982 WSMR Master Plan of the LC-32 South area.

7.8.1 LC-32 South Assembly and Maintenance Facilities

Five assembly and maintenance facilities were identified at LC-32 South; Properties 21731, 21750, 21751, 21756, and 21759. Properties 21756 and 21759 are substantial buildings with CMU construction, and the other assembly and maintenance properties are of pre-manufactured steel construction. Property 21756 and Property 21759 are the primary facilities in each of their respective sub-areas at LC-32 South, and are surrounded by various satellite properties.

7.8.1.1 Property 21731

Figure 145. Property 21731, north and west elevations, view to the southeast.

Figure 146. Property 21731, west and south elevations, view to the northwest.

Property 21731 consists of two abutting one-story, pre-manufactured steel buildings set on an above ground concrete slab foundation with a rectangular floor plan oriented on an east-west axis. Concrete aprons of variable length extend to the north from the foundation providing access to each of the buildings. The eastern building is a Butler building with a galvanized metal clad superstructure and a medium pitch, gabled roof with a white elastomeric coating. The roof includes a short eave clad in metal flashing on the north and south elevations an overhanging eave on the west elevation. The eave of the east elevation is truncated to allow for a flush abutment with the adjoining building. The peak of the roof is fitted with two static globe vents. Fenestration of the north elevation consists of one white-painted, off center, rolling metal door set in a metal frame. The building number is stenciled at the northwest corner on the north elevation. The west elevation includes two four–pane, metal casement windows in addition to mounted conduit and an electrical box offset from the northwest corner. The south elevation is unfitted with the exception of mounted conduit running the length of the façade. The eastern building also maintains a rectangular footprint; however, the long axis orientation is east-west as opposed to north-south. The eastern building is slightly taller than the west, and is clad in corrugated metal panels with the facility number stenciled on the southeast corner. The medium pitch gabled roof includes a short eave clad in metal flashing on the east and west elevations and an open, slightly overhanging eave on the north and south elevations. The roof is finished with a white elastomeric coating and includes two penetrations situated above the roofline on the south elevation. Fenestration of the north elevation consists of two, white-painted rolling metal, full-height bay doors. The south elevation includes two HVAC units and associated electrical conduit mounted on the façade atop angle iron frameworks. The south elevation also includes a vertical length of gas pipe with a regulator extending below the roofline to the ground as well as an offset water spigot and six white-painted corrugated metal patches. The east elevation is completely unfitted.

History of Use

Property 21731 was constructed in 1965 as a Motor Repair Shop. According to Disposition data the buildings were constructed concurrently at the request and expense of Raytheon as a maintenance facility in support of the Hawk and Mauler programs. Utilities were connected to Property 21731 in 1966. At the time of the present recording, Property 21731 remains in use as a repair shop.

7.8.1.2 Property 21750

Figure 147. Property 21750, south and east elevations, view to the northwest.

Property 21750 is a pre-manufactured steel Armco-style building with a rectangular floor plan oriented on an east-west axis on an above grade concrete slab foundation. The superstructure is tan-colored with brown trim and includes 16-inch wide, vertically-oriented metal panels, and a medium pitch, gabled roof with a white elastomeric coating. The roof includes a short eave clad in metal flashing on all elevations. The peak of the roof is fitted with four static globe vents each capped with a lightning rod, with two additional lightning rods and grounding cables situated it either end of the roof line. Fenestration of the east elevation consists of two, rolling metal, full-height bay doors. One of the doors is unpainted and appears to be a motorized replacement. The east elevation includes a gable vent fitted with a security grate in addition to two Crouse-Hinds Co. explosion-proof flood lights mounted below the gable. The bay doors are flanked by paired bollards that are offset from the building wall. A large concrete pad extends from the east elevation on which are mounted four angle iron gas cylinder racks that line the pads north edge. A tan-colored shipping container and a truck trailer lie to the east of the concrete pad. Fenestration of the south elevation of Property 21750 includes a two-panel steel personnel door with a painted glass upper panel and one boarded window. Both the window and the upper door panel are fitted with rebar security grates. The south elevation also includes a globe light above the entryway, electrical conduit, four electrical boxes, signage and an additional light above the entryway. An offset concrete walkway extends the length of the elevation terminating at the entryway. The property number for the building is stenciled in black paint offset from the building's southwest corner on both the west and south elevations. The west elevation includes a gable vent fitted with a security grate in addition to mounted electrical conduit and signage. A small tan-colored pre-manufactured addition extends from the center of the west elevation. The addition is clad in 16-inch wide panels, with a flat metal standing seam roof. A two-panel steel door with a rebar security grate fitted over the upper glass panel is placed on the addition's southern wall. Fenestration of the north elevation includes one two-panel steel door with a painted glass upper panel fitted with a rebar security grate. A concrete landing extends from the entryway and a globe light is mounted above the doorway. Additional signage and electrical conduit flank the entryway. An offset angle iron framework supports an HVAC unit centered on the wall. The tan-painted framework includes four concrete footers, a ladder and safety rail. Duct work extends from two penetrations and an additional light is mounted adjacent to the HVAC system.

Figure 148. Property 21750, north and west elevations, view to the southeast.

History of Use

Property 21750 was constructed in 1959 as a Storage Building in support of the Hawk missile program. Realty records from 1963 identify it as a "Missile Paint Shop." In 1963, the building, along with Properties 21756, 21751, and 21752 were transferred to the General Dynamics Pomona Division for use with the Mauler testing program (Wilson 1963). These facilities were transferred to General Dynamics in the anticipation that the Hawk workload would be replaced by the Mauler effort, but the Hawk program continued to use the facilities. Disposition data from 1965 relates that following the cancellation of the Mauler program, Properties 21750, 21751, and 21756 were requested for support of the Redeye and Chaparral programs. It is unknown for what duration the properties were used in support of these programs. At the time of the 2000 HSR recording, the building was used for storage. At the time of the current inventory, the property is used in support of the Stinger Missile program (Personal Communication Steven Lowery 2015).

7.8.1.3 Property 21751

This property consists of a pre-manufactured Armco-style steel building with a rectangular footprint constructed on an at-grade concrete foundation. The building is clad in flat sheet metal panels as is the medium-pitch gable roof, which has been coated in white elastomeric sealant. Although the building is typical of the buildings produced by Armco, no manufacturer's logo or identification was visible. The roof has an eave along the north and south elevations and is equipped with lightning rods and ground wires.

Figure 149. Property 21751, south and east elevations, view to the northwest.

The south elevation of the building has two steel slab personnel entrances at the ends of the wall, which are connected by a concrete sidewalk. A series of electrical conduits and boxes are mounted to the west half of this wall. Bilingual warning signs and a sign bearing "4" (indicating the flammable solids class) are mounted to the central portion of the wall. A sign bearing the explosive and personnel limits of the property is mounted on double posts outside the east entry. A centrally located sealed floodlight is mounted high on the wall.

Figure 150. Property 21751, north and west elevations, view to the southeast.

The north elevation of the building has a single steel slab personnel door at its east end, which has a concrete entry slab. The same warning signs seen on the other elevations are affixed to the middle portion of this wall, above which a sealed floodlight is mounted. A shed roof addition modifies the west end of this elevation. This addition is constructed of the same materials as the main building and has a double steel slab entrance in its north elevation. A large ventilator housing from its shed roof and two HVAC units are mounted to a concrete slab at the base of the addition's east wall. An electrical breaker and switch box are mounted to the addition's west elevation. At the west end of the north elevation is another single steel slab door personnel entrance, whose concrete entry slab abuts the foundation of the adjacent addition.

The east and west elevations of the building are the gable end elevations and both feature large bay doors. The east elevation has a large overhead rolling door illuminated by sealed floodlight; bilingual warning and explosive class signs are affixed to the wall next to the door. The west elevation of the building has two large bay doors with barn type openings. These doors have been fixed shut with riveted sheet metal. A short concrete entry slab extends from the base of the door and incorporates two concrete and steel safety bollards. A sealed overhead floodlight illuminates this elevation and the standard warning signage is affixed to this wall as well.

History of Use

Property 21751 was constructed in 1959 as a General Maintenance Building in support of the Hawk missile program. Realty records from 1963 identify it as a "Hazardous Operations Building." In 1963, the building, along with Properties 21750, 21752, and 21756, were transferred to the General Dynamics Pomona Division for use with the Mauler testing program (Wilson 1963). These facilities were transferred to General Dynamics in the anticipation that the Hawk workload would be replaced by the Mauler effort, but the Hawk program continued to use the facilities. Disposition data from 1965 relates that following the cancellation of the Mauler program, Properties 21750, 21751, and 21756 were requested for support of the Redeye and Chaparral programs. It is unknown for what duration the properties were used in support of these programs. At the time of the current inventory, the use of the property was unknown but it was well-maintained and appeared to be in regular use.

7.8.1.4 Property 21756

This building is a long, rectangular one-story building of CMU construction whose long axis is oriented east-west. It is constructed on an at-grade concrete foundation with slab extensions on the east and west sides of the building. The building's flat roof is of built-up construction that is surfaced in asphalt and gravel. The roof edges are covered in aluminum flashing and are equipped with gutters and down spouts. Several HVAC units and ventilators are mounted across the roof.

The west elevation of the building faces the road and parking lot, and therefore acts as the principal elevation of the building. The west elevation has a central recessed portion, a feature also found on the opposite east elevation. According to Steven Lowery, a principal engineer of the Raytheon Hawk program that currently occupies the building, these recessed areas on the west and east elevations were originally the location of bay doors that allowed vehicles to be pulled into the central gallery of the building. The gallery ran the entire length of the building to an opposite bay door on the east elevation. The building in its original format was somewhat akin to a hangar and bore functional similarities to the nearby Property 21759. The bay doors were later removed and the openings infilled with CMU block (Steven Lowery personnel communication 2015). The central gallery of the building remains in place and is flanked on either side by office and shop space.

The west elevation has a single personnel door entrance within the recessed portion of the wall, which is protected by a windbreak structure of steel and sheet metal construction. In the adjacent portion of the wall, outside the recessed portion, is a doorway that has been sealed with CMU blocks. A Hawk logo is stenciled onto this portion of the wall. On the north end of the west elevation is an aluminum frame window with a fixed central pane and horizontal sliding

Figure 151. Property 27156, north and east elevations, view to the southeast.

sidelights. Like most of the building windows, this window has a protruding concrete sill. A red warning light and frequency hazard sign is affixed to the north edge of the west elevation. Sealed floodlights are attached to the upper corners of the wall at its north and south sides.

The north elevation of the building has three aluminum frame windows identical to that of the west elevation and one centrally located steel slab personnel door. The personnel door has an upper light of safety glass and a concrete entry slab. Near the west end of this elevation are two smaller steel frame fixed windows with 1/1 lights of frosted glass. These windows are probably associated with the building restrooms. An antenna is mounted to a mast above the west corner of this elevation.

The east elevation has the same central recessed portion as the west elevation, although on this elevation an overhead rolling door is incorporated into this part of the wall. Adjacent to this door is a steel slab personnel door with a safety glass upper light. Electrical breaker and switch boxes are mounted on the wall next to the doorway. Hazardous material disposal containers, a pallet with discarded batteries, and a basketball hoop are located outside this elevation. Sealed floodlights are attached to the upper corners of the wall at its north and south sides.

The south elevation of the building has a double door entrance near its west end. This doorway

Figure 152. Property 21756, south elevation, view to the northeast.

Figure 153. Property 21756, east elevation, view to the southwest.

has a concrete entry slab and an electrical box mounted west of the door. Two louvered vent panels are set into the wall east of this doorway. Spaced along the remainder of this elevation are four of the same aluminum frame windows seen on the west and north elevations of the building. One of these windows, located near the center of the elevation, is protected by a steel mesh security grille, the only building window so equipped. A rooftop access ladder is mounted to the wall near its west end. A wood utility pole supporting an antenna is also located along this elevation. Opposite this side of the building a line of surplus trucks is parked along the edge of the parking lot.

History of Use

Property 21756 was constructed in 1959 as a Flight Test Building for the Hawk program at LC-32. In 1963, the building, along with Properties 21750, 21751 and 21752, were transferred to the General Dynamics Pomona Division for use with the Mauler testing program (Wilson 1963). Disposition data from 1965 relates that following the cancellation of the Mauler program, Property 21756, as well as Properties 21750 and 21751, were used for support of the Redeye and Chaparral programs (Kaiser 1965). It is unknown for what duration Property 21756 was used in support of these programs. Glenn Moore related that the government Hawk program was re-located to a portion of Property 21759 when it was assigned for use by the Mauler program. The Raytheon Hawk program later moved back into the building, probably during the 1970s when the program moved out of Property 21759. At the time of the current inventory, the building continues to be used in support of the Raytheon Hawk System.

The sealed bay doors at each end of the building were used to bring Hawk missiles and launcher equipment into the building for maintenance and service. They served the same purpose when the building supported the Mauler development. It is not clear from the property records when the bay doors were sealed.

A large crane bridge was constructed at the east end of the building, between the west elevation and the adjacent Property WS28, in 1963. A 1972 photograph of the crane bridge demonstrates that it was still extant at that time, but it was removed in 1978 according to the building's real property record.

Figure 154. A 1972 photograph of the crane bridge formerly located off the east elevation of property 21756.

7.8.1.5 Property 21759

Figure 155. Property 21759, west elevation, view to the northeast.

Property 21759 is a large hanger building with a central high bay gallery flanked by one-story wings on its north and south elevations that house office and shop space. Including the two office and shop wings, the building has 32 interior rooms. The property and adjacent lots on its east and west sides are surrounded by a chain link fence. The building has a rectangular footprint and is constructed on an at grade concrete foundation. The hanger building is of steel frame construction and clad in tan-painted corrugated metal, while the office wings are of tan-painted CMU construction. The roof of the hangar portion of the building is a low-pitch gable, while the north and south one-story wings have built-up shed roofs surfaced in asphalt and gravel. Various HVAC and ventilator units are mounted to the roofs of the one-story wings. The main hanger roof has nine large ventilators spaced along the ridgeline of the roof. Rooftop access ladders are mounted at the southeast and northwest corners of the building.

The hangar portion of the building has double rows of clerestory windows on the upper walls of the north and south elevations. Each row of the steel frame clerestory windows alternates between a fixed 12 light panel and a paired eight light casement opening. This arrangement includes 412 panes of glass per clerestory window. With four of these windows, two per elevation, the clerestory windows are composed of an impressive 1,648 individual panes of

Figure 156. Property 27159, north and west elevations, view to the southeast.

glass. Of course, some of the clerestory window panels have been replaced with sheet metal or transparent fiberglass panels, altering the total number of panes.

The west elevation of the building is dominated by a pair of large horizontal sliding service bay doors. Like the building itself, the bay doors are constructed of steel frames and clad in corrugated metal. Steel slab personnel doors are located in the hanger wall on either side of the bay doors; the south door appears to be the most used and is protected by a sheet metal windbreak structure. The adjacent west elevations of the CMU office wings are mostly plain, lacking windows or doors. The west elevation of the north office wing has a louvered vent panel and a HVAC unit mounted to the wall. The vent panel is protected by a security grille of welded rebar.

The north elevation of the CMU office wing has one fixed plate glass window protected by a rebar security grille. A double door entry is located near the center of this elevation which appears to be seldom used. Adjacent to the entry is a large HVAC unit mounted on a concrete slab foundation, with associated ductwork routed through the north elevation wall. A fenced power sub-station is located along the north elevation near its western end. Near the northwest corner of the building is a central tall pole braced by three shorter supporting poles. The purpose and use of this pole structure is unknown.

The south elevation of the building is more formalized and includes access sidewalks and facility signage. A double door entry is enclosed within a gable roof entry block on the south elevation of the office wing. Another double door entrance on this elevation lacks the entry block, but does have a concrete entry slab. Several louvered panels are associated with this entrance. Like all the building doors, these entrances are composed of simple steel slab doors. This elevation is surrounded by a chain link fence and an exterior sign is labeled PEO STRI / TMO Liaison Office WSMR/Ft. Bliss." The Targets Management Office (TMO) is a division of the Program Executive Office for Simulation, Training, and Instrumentation (PEO STRI).

The east elevation mirrors the west and includes a large pair of horizontal sliding service bay doors, with single personnel door entrances on the north and south ends of the hangar walls. Two small louvered vent panels are built into the south CMU wing wall. Outside the east end of the building is a large fenced lot with several portable pre-manufactured steel buildings, which are described separately.

Figure 157. Sign associated with the south elevation entrance of Property 21759.

Figure 158. Property 21759, east elevation with drone loading in progress, view to the northwest.

History of Use

Property 21759 was constructed in 1959 as the Missile Assembly Building for the Raytheon Hawk program at LC-32, and is identified in some realty records as the Hawk Contractor Test and Assembly Building. It soon became known as the Hawk Hangar and was the primary home of the Raytheon Hawk program through the 1970s.

As Raytheon increasingly began to focus on the SAM-D/Patriot system during the 1970s, the building began to be used for maintenance and pre-flight preparation of the MQM-34D and other drone systems. Around this time, the building is also referred to as the "Teledyne-Ryan Building", in reference to the manufacturer of the popular Ryan Firebee MQM-34D aerial target drone. A 1976 disposition memo refers to the building as the "Ryan Building 21759, (old Hawk Hanger)." This memo requests that a 20 by 20 foot portable building be located outside of 21759 for use with the Drone Formation Control System (DFCS). The DFCS was a project

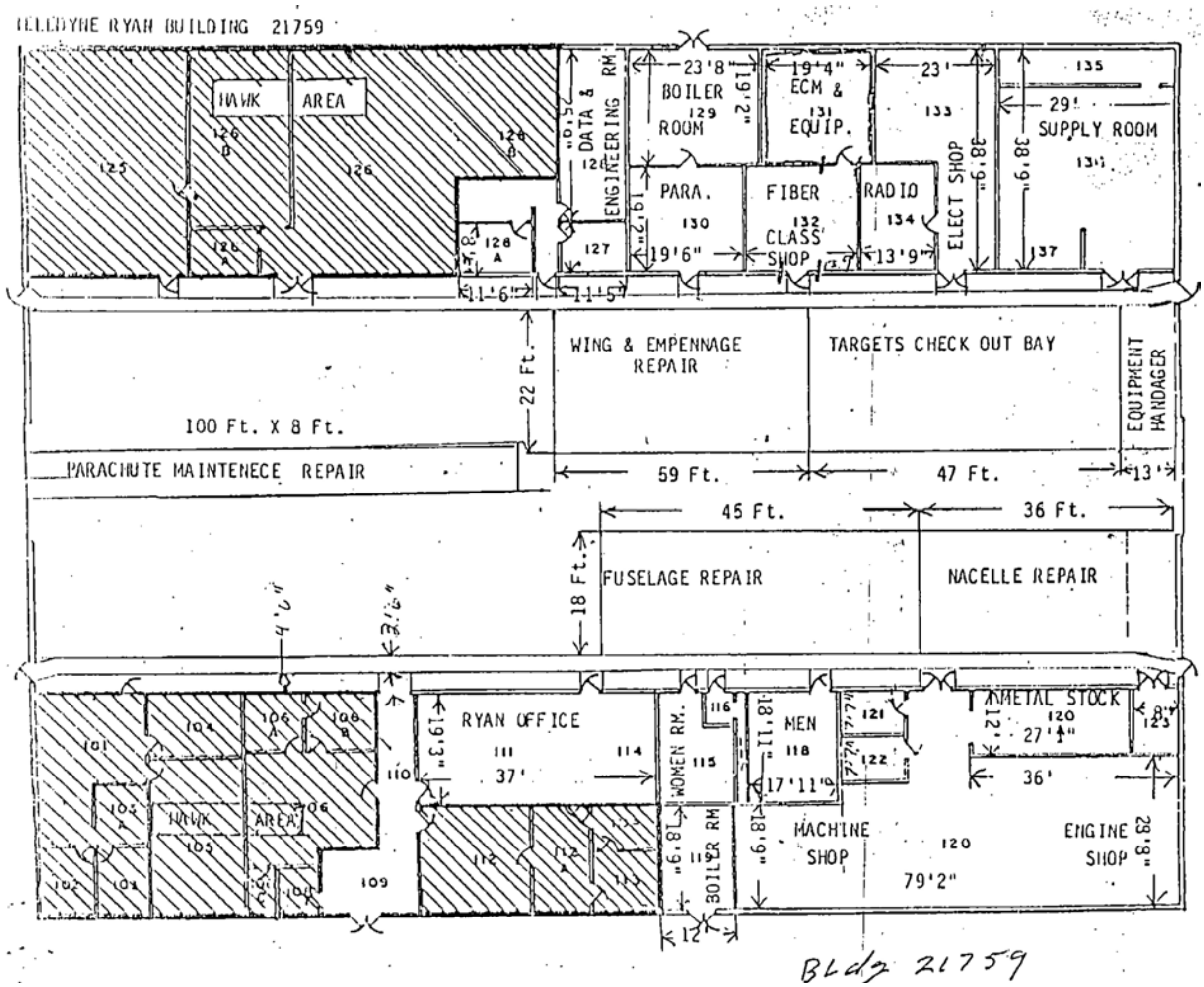

Figure 159. Floor plan and usage of Property 21759 circa late-1970s (*WSMR realty files)*.

in direct support of the Raytheon SAM-D/Patriot testing (Cranford 1976).

Despite the increasing usage by other programs, Hawk activities continued in the building's west half during the 1970s. As of 1976, Raytheon had requested nearly 4,000 square feet of space within Property 21759 for use with the I-Hawk program. The northwest corner of the building was dedicated to Hawk telemetry, and the telemetry antennas were mounted on the large pole structure located outside the northwest corner of the building (Glenn Moore personal communication 2015).

In 1983, the US Navy High Energy Laser Project, also known as the Sea Lite Program, used approximately 1,500 square feet of the high bay area within Property 21759 on a shared basis with the Army MQM-34D drone program. The records do not indicate how long this shared use agreement lasted, but the Sea Lite Beam Director was eventually re-located to HELSTF, which attained initial operational status in 1985.

A 1997 WSMR memo relates that the building was "used by the Japanese Patriot Project as well as the Kuwaitis for the past several years." The memo describes that the building was

Figure 160. A 1983 photograph of Property 21759, north and west elevations (*WSMR realty files)*.

co-used by Lockheed-Martin for work with Navy drones (McKeel 1997). As of the time of the current inventory, the building was used by contractors with the Army PEO-STRI / PM ITTS TMO for flight preparation and maintenance of MQM-34D and MQM-107 aerial target drones.

Various modifications have been made to the building over the years; a foyer addition was made to the building by Raytheon in 1960 and cooling system improvements were made in 1963 to aid in the temperature control of sensitive electronic systems. Despite these minor changes, the building remains largely intact and consistent with its original design.

7.8.2 LC-32 South Miscellaneous Facilities

Ten miscellaneous facilities were documented at LC-32 South, Properties 21752, H3057, WS28, WS30, WS576/WS543, and five additional unidentified buildings. All of these properties are pre-manufactured steel buildings typical of the Armco and Butler varieties, but several are of unknown manufacture. Many of these buildings are built on skid foundations, rendering them easily transportable. Portable buildings of this type are the most common type of miscellaneous facility found at LC-32. In most cases, these portable buildings are associated with more substantial buildings and are likely used as needed to provide supplemental shop or storage space.

7.8.2.1 Property 21752

Property 21752 is a pre-manufactured steel building with a rectangular floor plan oriented on a north-south axis on an above grade concrete slab foundation. The building is tan-colored with brown trim and includes 16-inch wide metal panels, and a medium pitch, gabled roof with a white elastomeric coating. The roof includes a short eave clad in metal flashing on all elevations. The roof is fitted with two lightning rods and associated grounding cables along the peak in addition to three ventilation penetrations, one of which is capped with a third lightning rod. The west elevation provides the only access to the building via double-hung, two panel metal doors, where the upper door panel consists of windows sealed with sheet metal. Drip line flashing runs the width of the entry above the entryway, and the doors are flanked by rectangular vents near ground level. Additional adornments on the west elevation include building signage, one light fixture and mounted grounding cables. Similar paired vents are present on the north and south elevations, while a single vent extends below the roofline on the east elevation. Fenestration of the east, north and south elevations is identical, consisting of a centered, metal awning window with four lights; however,

Figure 161. Property 21752, north and east elevations, view to the southwest.

Figure 162. Property 21752, south and east elevations, view to the northwest.

the window is sealed with plywood and sheet metal on the north elevation. Additional fixtures present on the south elevation includes mounted electrical conduit with associated grounding cabling that extends to the east elevation.

History of Use

Property 21752 was constructed in 1959 as a Heating Plant Building, a support facility for the Hawk Flight Test Building (Property 27156). In 1963, this building, along with Properties 21750, 21751, and 21756, were transferred to the General Dynamics Pomona Division for use with the Mauler testing program (Wilson 1963). Disposition data from 1965 relates that following the cancellation of the Mauler program, the neighboring Properties 21750, 21751, and 21756 were requested for support of the Redeye and Chaparral programs. Property 21752 was also likely used in support of these programs as well. At the time of the current inventory, the use of the property was unknown and it was in somewhat dilapidated condition.

7.8.2.2 Property H3057

This property is a pre-manufactured Butler steel building constructed on a wooden skid foundation for easy transport. This portable building is located in the storage yard east of Property 21756 adjacent to Property WS0028. The building walls are clad in corrugated metal panels and the low-pitch gable roof is clad in the same material. The roof has a slight eave on the north and south elevations and its gable ends have embossed "BUTLER" end caps. Two large round vent assemblies are spaced along the ridgeline of the roof.

Figure 163. Property H3057, east and south elevations, view to the northwest.

The building's only entrance is on the east elevation and consists of a steel slab personnel door. An electrical switch box is mounted on the wall next to the doorway, as is a sign reading "NO PARKING WITHIN 15 FT. OF BUILDING." The south elevation of the building has two steel frame windows with four lights and awning operations. The north elevation had two windows of identical size and position, but these have been sealed with sheet metal panels. The west elevation has one window identical to those of the south elevation, above which is an evaporative cooler unit supported by a cantilevered steel bracket.

Located nearby the building is a variety of surplus Hawk support equipment. Four Hawk launcher trailers, one small general purpose trailer, Hawk trailer mounted radar units, a generator trailer, and a radar receiver/transmitter trailer were parked in the storage along with Property H3057. Along with these trailers are a number of small miscellaneous parts, tools, and other equipment.

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building's history could be located among the various archival sources available at the range. As such, the use history and age of the portable building remain unknown. At the time of the present recording, the building was vacant and no longer appears to be in use.

Figure 164. Property H3057, west and south elevations, view to the northeast.

7.8.2.3 Property WS28

Property WS28 is a pre-manufactured steel Butler-type building in poor condition that is located just east of Property 21756. It is labeled "CONDEMNED" and appears to have been damaged by a fire. No wood or steel skids are visible under the building and it therefore does not appear to have been constructed as a portable unit. Rather, it rests directly on the concrete slab foundation that extends from Property 21756. The building is clad in corrugated metal panels and the medium pitch gable roof of the building is clad in the same material.

Figure 165. Property WS28, south and west elevations, view to the northeast.

The west elevation of the building has one personnel doorway and six windows. The door has been removed from the entrance. Above the doorway is a stenciled sign that reads "CHAPARRAL MAINT. SHOP." The wood frame windows have replacement single panes, although only the frame remains of the southern two windows on this wall. Like all the building windows, these are equipped with interior security bars of welded rebar. A flammable materials storage cabinet, rolling access stairs, pallets, and storage containers are located outside this elevation. The east elevation of the building has five of the wood frame windows seen on the other building elevations, several of which are missing their glass. These windows also have interior rebar security bars. A portion of the east elevation wall has been damaged by the removal of a doorway; this doorway is incompletely sealed by weathered lumber. An evaporative cooler unit is affixed to the eastern roof slope.

The north and south elevations are the gable ends of the building and include the same windows seen on the east and west elevations. The north elevation includes a bay door opening with weathered plywood replacement doors and one window. The sheet metal panels on the northwest corner of the building have detached from the buildings frame. The south elevation of the building has two windows, one of which lacks glass.

Figure 166. Property WS28, north and east elevations, view to the southwest.

A carport shelter and table are located near the south end of the building, but are unrelated to it. The storage yard around the building includes multiple pieces of Hawk support equipment and Property H3057, which is described separately.

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building's history could be located among the various archival sources available at the range. According to Glenn Moore, the building has occupied the same location for a number of years and was used as a storage building for Property 21756 (Glenn Moore personnel communication 2015). It is visible in a 1972 photograph of the bridge crane installation at the east end of Property 27156, indicating that it has been in place at its current location at least since that time. At the time of the present recording, the building was vacant and no longer appears to be in use.

7.8.2.4 Property WS30

This property is a pre-manufactured steel building produced by SteelCon of El Paso, Texas. The portable building is constructed on an I-beam foundation, and is located in the lot at the east end of Property 21759. The walls of the building are clad in corrugated sheet metal panels and the low pitch gable roof of the building is covered in the same material. The roof has a slight eave on the east and west elevations and a galvanized metal cap on the north and south elevations. The south elevation of the building has a central rolling overhead door, next to which is

Figure 167. Property WS30, south and west elevations, view to the northwest.

the manufacturers ID tag which reads "STEELCON / BUILDINGS-FENCES / EL PASO-TEXAS." The east and west elevations both have two 1/1 pattern horizontal sliding aluminum frame windows. The north elevation has single personnel door entry with a steel slab door. A second manufacturer's tag is affixed to the wall near this door.

Figure 168. Property WS28 manufacturer's ID tag, "STEELCON."

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building's history could be located among the various archival sources available at the range. As such, the use history and age of the portable building remain unknown. A drone fuselage and other parts are visible within the building interior indicating that it is used as supplemental maintenance or storage space for the adjacent Property 21759.

7.8.2.5 Property WS576/WS00543

Property WS576/WS00543 is a portable pre-manufactured steel building with a rectangular floor plan oriented on an east-west axis. The building is mounted on wood skids and includes 16-inch wide galvanized metal wall panels, and a medium pitch, gabled roof of standing seam metal construction with a short eave over the east and west elevations. Fenestration of the west elevation consists of a galvanized metal, two panel door, where the upper door panel consists of two horizontal reinforced glass panes. The door includes Armco hardware and serves as the only entryway to the building. Additionally, the west elevation includes stenciled building signage that reads, "WS 576" and "WS00543." Fenestration of the north elevation consists of a centered, metal awning window with four lights. The south and east elevations are completely unfitted.

Figure 169. Property WS576/WS543, south and west elevations, view to the northeast.

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building's history could be located among the various archival sources available at the range. As such, the use history and age of the portable building remain unknown. At the time of the present recording, the building was vacant and no longer appears to be in use.

7.8.2.6 Unknown Portable Building 2

This property is a small pre-manufactured Armco-style steel building constructed on an I-beam foundation for easy transport. Despite similarities to Armco buildings, no manufacturer's logo or identification was visible on the building. Along with another portable building (Unknown Portable Building 3), this building is located just north of Property WS30 within the storage yard east of Property 21759. The walls of this single-room building are clad in flat metal panels while the medium-pitch gable roof is clad in standing seam metal panels. The roof has a slight eave on the north and south elevations and small vents in the gable ends of the roof. A single central lightning rod is mounted to the center of the roof ridgeline.

Figure 170. Unknown Portable Building 2, west and south elevations, view to the northeast.

The building's only entrance is on the west elevation and consists of a steel panel personnel door. Vent panels are present on the lower portions of the north and south elevation walls, but these elevations are otherwise nondescript. The west elevation is likewise entirely plain.

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building's history could be located among the various archival sources available at the range. As such, the use history and age of this portable building remain unknown. At the time of the present recording, the building was vacant and no longer appears to be in use.

7.8.2.7 Unknown Portable Building 3

This property is a pre-manufactured Armco steel building constructed on a wooden skid foundation for easy transport. Along with another portable building (Unknown Portable Building 2), this building is located just north of Property WS30 within the storage yard east of Property 21759. The walls of this single-room building are clad in flat sheet metal panels while the low-pitch gable roof is clad with standing-seam sheet metal panels. The roof has a slight eave on the north and south elevations and its gable ends have embossed "ARMCO" end caps. A vent housing is attached to the ridgeline of the roof along with two lightning rods.

Figure 171. Unknown Portable Building 3, west and north elevations, view to the southeast.

The building's only entrance is on the west elevation and consists of a steel slab personnel door. Although no property number was visible on the building, "B2" is painted on the west wall and door. The other building elevations are entirely plain and lack any windows or doors.

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building's history could be located among the various archival sources available at the range. As such, the use history and age of the portable building remain unknown. At the time of the present recording, the building was vacant and no longer appears to be in use.

7.8.2.8 Unknown Portable Building 4

This property is a pre-manufactured Armco-style steel building constructed on an I-beam skid foundation for easy transport. Despite similarities to Armco buildings, no manufacturer's logo or identification was visible on the building. This building is located in a vacant lot north of Property 21759. The walls of this single-room building are clad in flat metal panels while the medium-pitch gable roof is clad in standing seam metal panels, all of which have been whitewashed. The roof has a slight eave on the north and south elevations and one central vent housing along the roof ridgeline.

The building doors are located on the gable-end east and west elevations. The wide doorway on east elevation is equipped with bi-fold doors, with the door composed of four hinged panels. The west elevation has a single personnel door entry with a steel panel door. A door bears an attached facility ID tag, but no facility number or name was legible on the tag. Electrical wiring is routed through the west wall of the building from an adjacent overhead utility pole.

The north and south elevations both have two steel frame windows. These windows have six lights each and awning operations and have interior steel security bars. A patched ductwork opening is located in the upper central part of the north elevation. The "shadow" of an attached shed roof addition, probably a removed hot water tank or air compressor enclosure, is visible in the whitewash paint of the south elevation.

Figure 172. Unknown Portable Building 4, east and south elevations, view to the northwest.

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building's history could be located among the various archival sources available at the range. As such, the use history and age of the portable building remain unknown. At the time of the present recording, the building was vacant and no longer appears to be in use.

7.8.2.9 Unknown Pre-manufactured Building 1

This property is a pre-manufactured steel building located to the southeast of Property 21756. The steel frame building has a rectangular footprint and is constructed on an above grade concrete foundation. The walls and low pitch gable roof of the building are clad in ridged metal panels. The gable end caps identify the building manufacturer as A&M Building Systems of Clovis, NM. The building appears to be of relatively recent construction, but no WSMR property number was visible.

Figure 173. Unknown Pre-manufactured Building 1, north and west elevations, view to the southeast.

The west elevation of the building has a large overhead rolling bay door and a concrete entry ramp extends out from this doorway. A sealed flood light is mounted to the wall above this door. The building's south elevation has a single personnel entry with a steel slab door. A sealed floodlight is also positioned above this doorway and an electrical meter is located at the west end of the wall. A WSMR facility ID tag is affixed to this door, but was illegible. A raised concrete slab extends from the east end of this elevation and supports a large HVAC unit with ductwork that is routed through the upper part of the wall. The remainder of the concrete slab is used as outdoor storage space and is occupied by numerous wiring spools, equipment containers, electrical panels, and other miscellaneous parts and equipment.

Figure 175. Unknown Pre-manufactured Building 1, east and south elevations, view to the southwest.

The east elevation has a single centrally located steel slab personnel door and is otherwise plain. What appears to be the cradle from a Hawk missile transporter/launcher rests on the ground outside this door. The south elevation of the building is entirely plain and lacks any doors, windows, or other features.

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building's history could be located among the various archival sources available at the range. The property appears to be used in conjunction with the nearby Property 21756 and is a relatively recent addition to LC-32 South (Glenn Moore personal communication 2015).

7.8.2.10 Unknown Pre-manufactured Building 2

Figure 174. Unknown Pre-manufactured Building 2, south and west elevations, view to the northeast.

Unknown Pre-manufactured Building 2 is a dilapidated, one-story, pre-manufactured steel building set on an above grade concrete slab foundation. The building maintains an "L" shaped floor plan clad in 16-inch wide galvanized metal panels and a standing seam roof with a short eave clad in metal flashing on the north and south elevations and an open, overhanging eave on the west and east elevations. The core of the building is oriented north-south and includes a medium-pitch, gabled roof. A similarly clad addition on the west side of the building includes a shed roof. Fenestration of the south elevation consists of one white-painted, two-panel, steel personnel door, one awning window set in a metal frame with four lights, and one boarded window associated with the addition. The

Figure 176. Unknown Pre-manufactured Building 2, east and north elevations, view to the southwest.

south elevation also includes two square gable vents and a horizontal electrical conduit adjacent to the entryway that terminates at a flood light below the peak of the roof. Fenestration of the east elevation consists of two awning windows set in metal frames, each with four lights. Fenestration of the north elevation consists of one awning window set in a metal frame with four lights, one boarded window, and one sliding replacement window with two lights set in an aluminum frame and associated with the addition. The north elevation also includes one hinged gable access panel, two square gable vents, a vertical length of gas pipe with a regulator extending below the roofline to the ground, and horizontal and vertical lengths of electrical conduit mounted to the wall. Fenestration of the west elevation consist of one awning window set in a metal frame with four lights, and two replacement, two-light sliding aluminum frame windows associated with the addition. A utility pole and associated electrical panel are offset from the northwest corner of the building.

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building's history could be located among the various archival sources available at the range. As such, the use history and age of the portable building remain unknown. At the time of the present recording, the building was vacant and no longer appears to be in use.

7.9 Uncle Site Properties

The portion of LC-32 referred to here as the Uncle Site is a small cluster of facilities located south of LC-32 East along Range Road 200, the eastern access road into the complex (Figure 177). The Uncle Site is encompassed by the current boundaries of LC-32 and has been used as an extension of the complex in recent years; for these reasons it was included in the current inventory effort. However, the Uncle Site location actually pre-dates the establishment of LC-32 and was not related to the formation of the launch complex. Rather, it was established as part of the WSMR timing network in 1952. Documentary evidence suggests that the primary building at Uncle Site, Property 20710, was one of the four range timing signal generator stations that were in operation as of the early 1960s. Identified property types at Uncle Site include instrumentation support facilities and miscellaneous facilities.

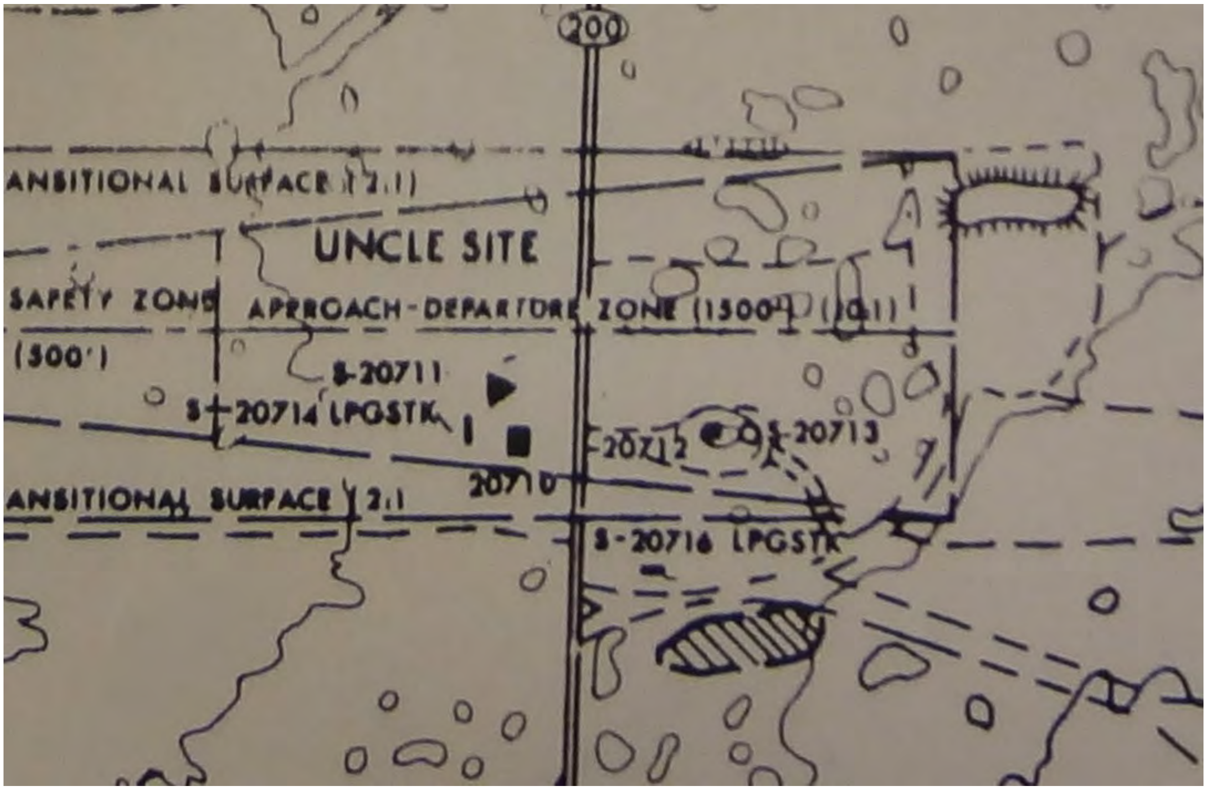

Figure 177. Excerpt from 1982 WSMR Master Plan of Uncle Site Area of LC-32.

7.9.1.1 Property 20710

Property 20710 is the principal building at the Uncle Site and is of tan stucco clad, CMU construction with an irregular footprint. The building is constructed on an at-grade concrete slab foundation. The building has a flat roof of built-up construction that is clad in asphalt and gravel and surrounded by a low flashing-capped parapet. Typical of most range buildings, this building is equipped with a lightning rod and ground wire system. A warning light is attached to the northeast corner of the roof.

The east elevation of the building faces the road and therefore acts as the principal elevation of the property. This elevation presents an uneven profile as the southeast corner of the building has a substantial setback from the rest of the wall, suggesting an addition. When viewed from the roof, it is apparent that original building footprint was an “L” shape with long axis oriented north-south and the short axis oriented east-west. The roof lines indicate that an addition was built within the corner of the original “L” on the building’s west side, and another addition was constructed on the building’s east side, creating the setback along this elevation. On the east elevation, a single personnel door entrance is located near the center of the wall and this steel slab door has a large upper light protected by a steel mesh security screen. On the north end of the wall is a double steel door entry that enters an equipment room. The steel slab doors of this entrance have basal vent panels. A concrete entry slab extends across both of these entrances. In the south facing portion of the addition block, there is a small two light casement window,

Figure 178. Property 20710, east and south elevations, view to the northwest.

probably a restroom window. A vent housing embossed with "NUTONE" is located in the wall around the corner from this window. On the remaining original portion of the east elevation there is a 3/3 vertical pattern steel casement window. Both of these windows are equipped with steel mesh security screens. A bracket of indeterminate purpose and an electrical conduit are mounted to the south extent of this wall.

The most prominent feature of the south elevation is a glass block window panel that consists of 17 columns of five blocks. The linear texturing of each individual glass block is alternated between vertical and horizontal orientations throughout the window. On the east side of this elevation is a horizontal pairing of 3/3 pattern steel casement windows, the same window noted on the east elevation. The casement windows are protected by a steel mesh security grille, while the glass block window lacks this feature.

The west elevation has a smaller glass block window, this one with 12 columns of four blocks. The same alternating pattern of blocks seen on the south elevation is also used here. Near the central portion of this elevation is a double door entry consisting of heavy steel slab doors. A metal sign affixed to the north door reads "WHITE SANDS MISSILE RANGE / MOBILE CLOCK FACILITY / PRECISION TIME/TIME INTERVAL." A concrete entry slab is located outside this entrance. To the north of the entrance is another 3/3 pattern steel casement window with security screen, identical to those on the east and south elevations. Between the glass block window and the double door entrance is a rubber and aluminum expansion joint cover affixed to the wall. The expansion joint cover, the “Expand-O-Flash” manufactured by Johns Manville, patches a substantial crack in the wall caused by differential settling of the addition on this elevation.

The north elevation lacks any doors but has three windows. The east and west windows are the same 3/3 pattern steel casement windows with security screens used elsewhere in the building. The central window was a larger casement window that appears to have originally consisted of a central fixed six light panel with flanking casement opening three light panels. However, most of the window was removed and replaced with a single large plate glass pane. Only the east three light panel remains intact. An unoccupied concrete slab at the base of the wall below the window suggests that an HVAC unit and ductwork was once routed through the window, necessitating the observed modifications. This window is also fitted with an exterior steel mesh security screen. Two large HVAC units are mounted on concrete slabs near the northeast corner of the building, and a rooftop access ladder is affixed to the wall at this corner of the building as well.

History of Use

Property 20710 was constructed in 1952 as an Instrument Building. It is also referred to as an Electrical Equipment Facility in its Real Property Record, and the architectural schematic for the

Figure 179. Property 20710, sign on west elevation door, view to the east.

Figure 180. Property 20710, south and west elevations, view to the northeast.

Figure 181. Property 20710, north elevation, view to the south.

building indicates it as the "U-Station Central Timing Building." As indicated by the sign on the west elevation, the building housed equipment for coordinating the WSMR range-wide timing network, a fact corroborated by Glenn Moore (Glenn Moore personal communication 2015).

The WSMR timing network provides a common base reference for range users and range instrumentation systems (WSMR 1977). A 1963 instrumentation summary describes the timing network as consisting of four signal generating stations and five signal distribution stations. The signal was communicated from the generator stations to each distribution station via FM radio, and the signal carried from the distribution stations to the local area via open wire and cable (WSMR 1962; 1963). The timing signals were transmitted at one-half or one millisecond intervals on a continuous basis. The range timing signal was synchronized to Greenwich Mean Time, as maintained by the Bureau of Standards, to within a half millisecond (WSMR 1962;1963).

Although the timing generator stations are not specifically identified in the various instrumentation summaries discussing the range timing network, the low-resolution maps that accompany these documents indicate a generator station in the vicinity of LC-32. It is therefore likely that Property 20710 at the Uncle Site was one of the four timing signal generator stations that comprised the core of the WSMR timing network as of 1963.

The real property record shows that the addition to the building was constructed in 1963, around the same time that the WSMR timing network was improved with new equipment that conformed to Inter-Range Instrumentation Group (IRIG) standards. These improvements also included inter-range synchronization of timing signals between the National Ranges and the various service branch ranges (WSMR 1962). At the time of the current inventory, the building was in need of maintenance and appeared to be vacant. It is not clear from the records when the building fell out of use or what technological changes to the WSMR timing network occurred that made the facility obsolete.

7.9.1.2 Property 20711

Property 20711 is a steel lattice radio tower constructed of angle steel, painted in an alternating pattern of red and white. According the WSMR realty records, the tower is 120 feet in height. It is located to the northwest of Property 20710 at the Uncle Site. The tower is free-standing, or Eiffelized, and as such tapers along its height. The angle steel used in the tower is primarily 6 by 6 inch and 5 by 3 ½ inch material. An access ladder runs along the west side of the tower and several maintenance decks for antenna installation or repair are spaced along its height. A small platform is also located at the top of the tower. A cluster of electrical panels and boxes are located at the southwest corner of the tower base.

History of Use

Property 20711 was constructed in 1952 as an antenna tower at the Uncle Site. Although records regarding the use and function of the property are minimal, its location and contemporaneous construction with the nearby Property 20710 indicate that it was involved in the WSMR timing network. Supporting this conclusion is the fact that radio signals were critical to the operation of the WSMR Cold War-era timing signal distribution. Timing signals were transmitted from the primary timing generation stations via the "FM radio time division multiplex system" to timing distribution centers and mobile instrumentation sites across the range (WSMR 1962). Further, the WSMR timing signal was correlated to actual time by receiving the National Bureau of Standards radio station signal (WSMR 1962). Both the reception and broadcast of timing signals would have required a tower like Property 20711 for the mounting of the appropriate antennas. The tower, like Property 20710, appears to be no longer used.

Figure 182. Property 20711 Radio Tower, view to the west.

7.9.1.3 Property 20712

Property 20712 is a Bowen-Knapp Camera Building constructed atop the west side of a leveled gravel mound. The single-story, one room building is set on an above-grade concrete foundation with a rectangular floor plan and flat roof. The superstructure is of undressed CMU construction with two independent courses of board-formed concrete. The board-formed concrete courses include a low parapet wall. Lentils are located above the buildings' two windows and doorway. The partially collapsed roof is constructed of a gravel and asphalt membrane set atop milled lumber joists. A two panel steel personnel door present on the north elevation serves as the only entryway for the property. The

Figure 183. Property 20712, south and west elevations, view to the northeast.

Figure 184. Property 20712, north and east elevations, view to the southwest.

lower panel of the green-painted door is missing and a wood pallet serves as a small stoop. Mounted electrical conduit flanks the doorway, terminating at an electrical terminal mounted below the parapet wall. The north elevation also includes two sheetmetal vents, one with protruding duct work, and a single metal canale penetrating the wall below the parapet. A concrete pad that is slightly offset from the north elevation previously housed an evaporative cooler unit that is no longer present. An elevated rusted steel pipe framework supported a 150 gallon tank that provided water for the removed evaporative cooling unit. A series of yellow-painted 3½-inch by 3½-inch wood posts delineate the north edge of the mound running parallel to the building's northern wall.

The east elevation includes a pair of hinged green-painted steel shutters centered on the wall, and each shutter consists of three horizontal steel panels. The east elevation includes tandem recessed casement windows with a protruding continuous concrete lug sill. Only one of the six horizontal lights remains in place. The south elevation includes a capped square exhaust vent, electrical conduit, and facility signage.

The interior of the building includes a single concrete camera pedestal sheltered by the steel shutters on the east elevation and a wood work bench running the length of the interior of the west elevation. The building has been left open to the elements, providing a convenient home for a pair of barn owls, and it is in generally poor condition.

History of Use

Property 20712 was constructed in 1950 as a shelter for a Bowen-Knapp camera, but is referred to as a "General Storehouse" or "Storage Building" in WSMR realty records. It pre-dates the Uncle Site by two years, the primary facilities of which were constructed in 1952. Blueprints consistent with the buildings' present configuration are dated 1958 and entitled "U-Station Bowen-Knapp Camera Building, Building Number 20712." According to disposition data, Property 20712 was listed as vacant by 1975. Little information exists for its use in the years following construction; however, at the time of the current inventory the dilapidated building was not in use and the instrumentation had long since been removed.

7.9.1.4 Property 20713

Property 20713 is an at-grade concrete instrument pad constructed atop the east half of a leveled gravel mound. The pad maintains a square footprint, measuring 16 feet by 16 feet. A four inch concrete pedestal capped with a stainless steel three foot diameter ring mount with six mounting bolts is centered on the pad. Three Russell & Stoll Co. electrical outlets with flush cover plates are inset in the pad and oriented around the pedestal. A 10 foot diameter astrodome mounting ring encircling the instrumentation pedestal has been removed. Two electrical conduit risers are present on the north side of the central mounting plate within the astrodome mounting ring. Two inset square access panels with diamond plate steel covers are situated between the risers. A steel I-beam that once housed electrical boxes is offset from the northwest corner of the pad. Various electrical boxes and other debris are strewn about the pad. Property 20713 is immediately east of the Property 20712 Bowen-Knapp Camera Building.

Figure 185. Property 20713 Instrument Pad, view to the southwest.

Figure 186. Property 20713, instrument mount detail, plan view.

History of Use

Property 20713 was constructed in 1961 as an Instrument Pad located at the Uncle Site. According to disposition data, Property 20713 housed a fixed camera within a 10-foot diameter Astrodome Type “A.” Little information exists for its use in the years following construction; however, at the time of the current inventory the pad was not in use and the astrodome and instrumentation had long since been removed.

7.9.2 Uncle Site Miscellaneous Facilities

Two miscellaneous facilities were identified at Uncle Site, Properties 20710A and 25991. Both of the resources are expedient structures for housing electrical equipment; Property 20710A is a generator shelter and Property 25991 is an instrument shelter converted to house electrical boxes and controls. Both properties are located near Property 20710 and 20711 and likely provided a back-up power supply to these facilities.

7.9.2.1 Property 20710A

This property is a portable electric generator trailer that is semi-permanently mounted on steel skids north of Property 20711. The trailer is clad in sheet metal panels with a flat roof of the same material. An exhaust muffler is mounted to the roof of the trailer. The entrance into the trailer is on its north elevation and consists of a steel slab door with an affixed hand painted "NO SMOKING WITHIN 50 FT" sign. A sheet metal awning covers the doorway. A variety of debris is associated with this elevation, including pieces of steel plate, a large wire spool, several wood pallets, a tripod stand, PVC pipe, and the remnants of an emergency eyewash station. A panel on the eyewash station is embossed with the lettering "PUSH TO OPERATE / Haws / BERKELEY, CALIF." The Haws Corporation is a major manufacturer of workplace water and safety equipment, including emergency showers, drinking fountains, and eyewash stations. A vent panel with awning hood is also installed on the north elevation.

Figure 187. Property 20710A, north and east elevations, view to the southwest.

The remaining elevations include various types of ventilation equipment and vents. An HVAC unit is mounted to the upper portion of the west elevation via a cantilevered mount. On the central portion of the south elevation, another HVAC unit is mounted to a concrete slab with ductwork routed through the wall. A large louvered vent panel is located in the east half of the south elevation. A large louvered vent panel with a screen cover is the major feature on the east elevation of the trailer. A utility pole is located at the southeast corner of the trailer.

History of Use

Property 20710A is a semi-permanently mounted generator trailer located at Uncle Site. The property number, derived from the nearby Property 20710, is not listed in WSMR realty records and therefore no information regarding the history and use of the building could be found in WSMR records. It appears to have provided auxiliary power to the Uncle Site timing facility when it was still in operation.

7.9.2.2 Property 25991

This property is a small steel frame and sheet metal structure bolted to an at-grade concrete slab foundation. Essentially a sheet metal cube with double slab doors on its east side, the structure appears to be a re-purposed retractable instrument shelter. The sheet metal enclosure has the remnants of a lever operated roller mechanism on its north and south sides. With the shelter doors open, these rollers would have been lowered onto rails to enable the shelter to roll backwards and expose the instrument for operation. In its current installation it is permanently fixed in place to the concrete foundation. A vent panel has been added to the lower part of the north side. The interior of the shelter contains a series of electrical panels and switches mounted to the south wall and assorted lumber is stacked on the floor. A sheet metal vent assembly is attached to the roof of the structure.

Figure 188. Property 25991, east and north elevations, view to the southwest.

Figure 189. Property 25991, roller mechanism on north side, view to the south.

History of Use

WSMR realty records indicate Property 25991 as a “camera pad” at the Largo Site that was constructed in 1960. This strongly indicates that the structure was originally a camera shelter that was removed from the Largo Site and re-purposed at Uncle Site. Its purpose and use at its current location were not found in archival records, but it appears to have been re-used as a shelter for electrical equipment, possibly a transformer.

7.10 LC-32 Dispersed Properties

A series of support properties are located outside the primary concentration of facilities at LC-32 and are not specifically related to any of the identified sub-areas at the complex. As such they occupy a diverse set of locations across the complex and generally were not constructed or used exclusively for any particular program. These dispersed properties, as they are referred to here, consist of instrumentation and miscellaneous properties.

7.10.1 LC-32 Dispersed Instrumentation Support Facilities

Four properties specific to instrumentation support were identified among the dispersed facilities at LC-32. All of these properties were ribbon frame camera sites positioned around the margins of the complex in order to capture on film the first few thousand feet of missile flight. These cameras were all housed within astrodome shelters located atop elevated mounds. The astrodomes and instruments have all long since been removed, leaving only the concrete pads and installation hardware behind.

7.10.1.1 Property 20502

Figure 190. Property 20502, view to the north.

This property consists of a concrete slab astrodome foundation situated atop an elevated, gravel-surfaced earthen mound. The concrete pad at the top of the mound measures 16 feet per side within a circular imprint at its center defined by a series of 12 anchor bolts. Three electrical conduit risers are located at the north edge of the foundation. The circular imprint and anchor bolts, remnants of the astrodome installation, has a diameter of 10 feet 4 inches. Centered within the astrodome imprint is a circular steel instrument mounting plate that is elevated three inches above the concrete slab foundation. The instrument mounting plate has a diameter of three feet and includes a circular pattern of six torch cut anchor studs. Two electrical conduit risers are located at the north edge of the instrument mount plate. Two electrical access plates on the north edge of the foundation are embossed "O.Z. ELECTRICAL MFG. CO. INC. / BROOKLYN N.Y." A WSPG brass datum stamped "WHITE SANDS PROVING GROUND / GEODETIC CONTROL F.D.L. / TRAVERSE STATION / 365" is set into the instrument pad, which is probably coincident with the site's construction. FDL stands for Flight Determination Laboratory, the WSPG organization responsible for the early geodetic control system at the range. Three geodetic survey datums stamped "DMA-WSMR", which generally date from 1980s to 1990s elsewhere on the range, are also associated with the pad. These datums are stamped "ELSSE-X" with sub-designations of "ANT. D", "ANT. E", and "S-0531."

An electrical terminal box mounted on a wood post is located at the northwest corner of the mound. Along the southern exposure of the elevated mound is a series of cobble alignments that probably spelled out the site's name when viewed from above, a common embellishment at WSMR instrumentation sites. However, while the cobble alignments are visible the letters they represented are no longer legible.

Figure 191. Property 20502 mound, view to the northeast.

History of Use

Property 20502 was constructed in 1959 as an Instrument Pad, part of the original LC-32 facilities for the Hawk and Sergeant programs. According to the 1982 WSMR Master Plan, this instrument site was identified as the Lara Site. The original architectural drawings (set WS-GT) for the location indicate that the site was a Ribbon Frame Camera Station (Number Two at LC-32), and the foundation slab supported a Houston Fearless Astrodome Model 10F-A, Serial Number 3. A portable instrumentation shelter, with no assigned WSMR property number, is also specified as part of the camera station installation; the drawings indicate these shelters as pre-manufactured steel frame, sheet metal clad Armco-style (although no specific manufacturer is identified) buildings constructed on 4 by 12 inch skids. These small portable buildings measured 12 feet by 10 feet 8 inches. None of these portable shelters remain at the LC-32 Ribbon Frame Camera sites.

7.10.1.2 Property 20505

This property consists of a concrete slab astrodome foundation situated atop an elevated, gravel-surfaced earthen mound. The mound is ramped on its north and south sides to allow vehicle access. The concrete pad at the top of the mound measures 16 feet per side within a circular imprint at its center defined by a series of 12 anchor bolts. Three electrical conduit risers are located at the west edge of the astrodome imprint. The circular imprint and anchor bolts, remnants of the astrodome installation, has a diameter of 10 feet 4 inches. Centered within the astrodome imprint is a circular steel instrument mounting plate that is elevated three inches above the concrete slab foundation. The instrument mounting plate has a diameter of three feet and includes a circular pattern of six anchor studs. Two electrical conduit risers are located at the west edge of the instrument mount plate. A WSPG brass datum stamped "WHITE SANDS PROVING GROUND / GEODETIC CONTROL F.D.L. / TRAVERSE STATION / T.S. 368" is set into the instrument pad, which is probably coincident with the site's construction.

An electrical conduit riser and panel are mounted on a wood post near the northwest corner of the mound and several wood pallets are discarded near the southwestern base of the mound. Along the southwestern slope of the elevated mound is a series of cobble alignments that probably spelled out the site's name when viewed from above, a common embellishment at WSMR instrumentation sites. However, while the cobble alignments are visible the letters they represented are no longer legible.

Figure 192. Property 20505, instrument pad atop mound, view to the west.

History of Use

Property 20505 was constructed in 1959 as an instrument pad, part of the original LC-32 facilities for the Hawk and Sergeant programs. According to the 1982 WSMR Master Plan, this instrument site was identified as the Son Site. The original architectural drawings (set WS-GT) for the location indicate that the site was a Ribbon Frame Camera Station (Number Five at LC-32), and the foundation slab supported a Houston Fearless Astrodome Model 10F-A, Serial Number 6. A portable instrumentation shelter, with no assigned WSMR property number, is also specified as part of the camera station installation; the drawings indicate these shelters as pre-manufactured steel frame, sheet metal clad Armco-style (although no specific manufacturer is identified) buildings constructed on 4 by 12 inch wood skids. These small portable buildings measured 12 feet by 10 feet 8 inches. None of these portable shelters remain at the LC-32 Ribbon Frame Camera sites.

Figure 193. Property 20505, instrument mount detail, view to the west.

Figure 194. Property 20505, WSPG datum, plan view.

7.10.1.3 Property 20701

This property consists of a concrete slab astrodome foundation situated atop an elevated, gravel-surfaced earthen mound. The mound is leveled with sloping sides and its east and west slopes of the mound include graded ramps for vehicular access. The concrete pad at the top of the mound measures 16 feet per side within a circular imprint at its center defined by a series of 10 anchor bolts. The circular imprint is further defined by an interior concrete lip, and remnants of white, square linoleum tiling are glued directly to the concrete pad within the area demarcated by the circular imprint. Three electrical conduit risers are located at the north edge of the foundation. The circular imprint and anchor bolts, remnants of the astrodome installation, has a diameter of 10 feet 4 inches. Centered within the astrodome imprint is a circular steel instrument mounting plate that is elevated three inches above the concrete slab foundation. The instrument mounting plate has a diameter of three feet and includes a circular pattern of six torch cut anchor studs. Two electrical conduit risers are located at the north edge of the instrument mount plate. An illegible cobble alignment that likely once spelled "BOWL" is present on the south slope of the mound. Three conduit risers, a terminal box and a timber post are present at the base of the northwest corner of the mound, in addition to three calibration target poles offset to the east.

Figure 195. Property 20701, overview of instrument mound, view to the northeast.

Figure 196. Property 20701, instrument mount detail, plan view.

History of Use

Property 20701 was constructed in 1959 as an instrument pad, part of the original LC-32 facilities for the Hawk and Sergeant programs. According to the 1982 WSMR Master Plan, this instrument site was identified as the Bowl Site. The original architectural drawings (set WS-GT) for the location indicate that the site was a Ribbon Frame Camera Station (Number One at LC-32), and the foundation slab supported a Houston Fearless Astrodome Model 10F-A, Serial Number 8. Disposition data indicates that the astrodome was transferred to another location in 1961. A portable instrumentation shelter, with no assigned WSMR property number, is also specified as part of the camera station installation. The drawings indicate these shelters as pre-manufactured steel frame, sheet metal clad Armco-style (although no specific manufacturer is identified) buildings constructed on 4 by 12 inch wood skids. These small portable buildings measured 12 feet by 10 feet 8 inches. None of these portable shelters remain at the LC-32 Ribbon Frame Camera sites. Little information exists for its use in the years following construction; however, at the time of the current inventory the pad was not in use and the astrodome and instrumentation had long since been removed.

7.10.1.4 Property 20706

Figure 197. Property 20706, instrument platform, view to the north.

This property consists of a concrete slab astrodome foundation situated atop an elevated, gravel-surfaced earthen mound. The elevated mound incorporates vehicle access ramps on its east and west sides. The concrete pad at the top of the mound measures 16 feet per side within a circular imprint at its center defined by a series of 12 anchor bolts. Three electrical conduit risers are located at the north edge of the foundation. The circular imprint and anchor bolts, remnants of the astrodome installation, has a diameter of 10 feet 4 inches. Centered within the astrodome imprint is a circular steel instrument mounting plate that is elevated three inches above the concrete slab foundation. The instrument mounting plate has a diameter of three feet and includes a circular pattern of six torch cut anchor studs. Two electrical conduit risers are located at the north edge of the instrument mount plate. A WSPG brass datum stamped “WHITE SANDS PROVING GROUND / GEODETIC CONTROL F.D.L. / TRAVERSE STATION / T.S. 369” is set into the instrument pad, which is probably coincident with the site’s construction.

A steel box or locker of heavy gauge steel is located near the east edge of the instrument pad. Two electrical features, two conduit risers and a terminal box mounted on a wood post, are located at the northwest corner of the mound. Along the southern exposure of the elevated mound is a series of cobble alignments that probably spelled out the site’s name when viewed from above, a common embellishment at WSMR instrumentation sites. However, while the cobble alignments are visible the letters they represented are no longer legible.

History of Use

Property 20706 was constructed in 1959 as an instrument pad, part of the original LC-32 facilities for the Hawk and Sergeant programs. According to the 1982 WSMR Master Plan, this instrument site was identified as the Noe Site. The original architectural drawings for the location indicate that the site was a Ribbon Frame Camera Station (Number Six at LC-32), and the foundation slab supported a Houston Fearless Astrodome Model 10F-A, Serial Number 5. A portable instrumentation shelter, with no assigned WSMR property number, is also specified as part of the camera station installation. The drawings indicate these shelters as pre-manufactured steel frame, sheet metal clad Armco-style (although no specific manufacturer is identified) buildings constructed on 4 by 12 inch skids. These small portable buildings measured 12 feet by 10 feet 8 inches. None of these portable shelters remain at the LC-32 Ribbon Frame Camera sites. Little information exists for its use in the years following construction; however, at the time of the current inventory the pad was not in use and the astrodome and instrumentation had long since been removed.

7.10.2 LC-32 Dispersed Miscellaneous Facilities

Three miscellaneous facilities were identified among the LC-32 Dispersed Facilities; Properties 20510, 20560, and 20562. These properties consist of a guard house on the original entry road into the complex, a helipad, and an observation stand constructed for the 1963 visit by President Kennedy.

7.10.2.1 Property 20510

This building is a small pre-manufactured Butler steel building constructed on an above-grade concrete slab foundation along the east side of the original LC-32 access road. The building is situated in an asphalt paved pullout area alongside the roadway. The building is clad in white-painted, sheet metal panels and the low pitch gable roof of the building is clad with the same material. The roof includes an eave along its east and west elevations and central lightning rod along its peak. The gable ends of the roof have the usual embossed "BUTLER" end caps. A red warning light, labeled "THE LIGHT FROM MARS / SKYBOLT", is affixed to the southwest corner of the roof. Outside the north elevation of the building is a dismantled road closure gate.

Figure 198. Property 20510 Guard House, south and east elevations, view to the northwest.

The primary elevation of the small building is the west elevation, which contains a metal-panel personnel door with four upper lights. A short concrete entry slab extends from the entryway. Steel frame windows are located in the north and south elevations of the building, each with six lights. The upper four light panels of these windows are hinged with an awning operation.

The building's east elevation is entirely plain.

The interior of the small building was finished but has been left open to the elements and is in poor condition. A small desk, office chair, broom, wall heater, and electrical box are found inside the building.


Figure 199. Property 20510, view of interior, view to the north.

History of Use

Property 20510 was constructed in 1959 as a Sentry House as part of the original Hawk and Sergeant facilities at LC-32. The small building served as a guard and gate house that supervised entry along the primary access road into the complex. Disposition data indicates that the building was still being used in this capacity by the Hawk Program as late as 1986. During the current inventory, the building appeared to have been vacant for some time. However, closer inspection of the interior revealed 2014 Las Cruces Sun newspapers and a roll of toilet paper, suggesting that the building may have recently been temporarily used as a guard house.

7.10.2.2 Property 20560

This property is an asphalt surfaced helicopter landing pad located in the south central portion of LC-32. Although partially overgrown with vegetation, the pad retains a visible landing zone demarcated by whitewashed corner marks and a central hourglass pattern. The square paved area of the helipad measures approximately 175 feet per side. A large cleared area, which appears to have been chip-sealed but is now overgrown, is located on the west side of the helipad and appears to be associated with it. A short paved road segment connects the two areas. This rectangular area measures approximately 450 feet north-south by 265 feet east-west.

History of Use

Property 20560 was constructed in 1963 as a helipad at LC-32. The 1982 WSMR Master Plan indicates it as the "Launch Complex 32 Helipad" and indicates takeoff safety zones extending from the pad in each cardinal direction. The helipad is located just east of the Property 20562 Observation Building and bleachers that were built expressly for the 1963 visit by President Kennedy. Glenn Moore and Bill Jones recollect that this helipad was constructed around the same time as the 1963 Presidential visit and was specifically built in support of the visit (Glenn

Moore and Bill Jones personnel communication 2015). However, the Kennedy entourage flew via helicopter from Holloman AFB to the WSMR cantonment and then proceeded by car to LC-32.

While the President did not land on the LC-32 helipad, film footage of the visit to LC-32 shows that it was used as a landing zone for the demonstration of the Little John missile. The Little John was flown into LC-32 by helicopter, emplaced, and fired to demonstrate its mobility and rapid deployment capability (John F. Kennedy Museum 2015). The large cleared lot adjacent to the helipad and east of the observation building and bleachers was used as a staging and maneuvering area for the missiles that were fired during the presidential demonstration at LC-32 which included the Honest John, Little John, Sergeant, and Hawk missiles (Eckles 2013:292). According to Glenn Moore, the helipad was later used for a series of lift tests of Hawk equipment using a Chinook helicopter. These tests were conducted in the late 1970s to early 1980s period (Glenn Moore personal communication 2015).

7.10.2.3 Property 20562

Property 20562 is a two-story observation building. The wood frame building has a rectangular footprint that is constructed on an at-grade concrete foundation, measuring 14 feet, 4 inches by 16 feet, 4 inches. The building includes a shed roof clad in galvanized metal with overhanging eaves on all elevations and a yellow and black-painted metal safety rail ringing the perimeter of the roofline. The collapsed roof is constructed of wood joists with a composite role membrane. The wood frame superstructure is trimmed with white-painted plywood clapboard; however, the majority of the clapboard is no longer in place. The west elevation includes the building's only entryway. Two wooden steps lead up to the entryway where a stairway extends from the single panel wood door providing direct access to the observation room on the second floor. In addition to facility signage and two mounted electrical boxes, the west elevation includes one fixed frame, wood window with four lights offset from the northwest corner, below the roof line. The east elevation includes an identical window to that of the west; however, a wood HVAC platform is mounted to the wall at the sill of the window. The

Figure 200. Property 20562, north and east elevations, view to the southwest.

north elevation includes an alignment of four wood-framed, picture windows situated below the roofline. One electrical box and electrical conduit are also mounted on the wall. Loudspeakers are mounted on the northwest and northeast corners of the building just below the window level. The south elevation includes a wood, fixed-frame window offset from the southeast corner below the roofline. A yellow-painted, steel ladder extends from the ground to the roofline at the southeast corner of the south elevation. Bleacher seating constructed of green-painted angle iron with fiberglass bench seating is offset from the northeast corner of the building. Downed signage to the south of the building reads, "REPRESENTING THE ARMY MATERIEL TEST AND EVALUATION DIRECTORATE, WSMR NM."

Figure 201. Property 20562 and associated bleachers, view to the southwest.

Figure 202. Army Materiel Test and Evaluation Directorate sign located off south elevation of building, plan view.

History of Use

Property 20562 was constructed in 1963 as an Observation Building. Blueprints consistent with the buildings' present configuration are dated 1962 and entitled "Demonstration Control Stand at A.L.A. 2." Property 20562 and similar range support buildings were built in support of the June 5, 1963 visit of President John F. Kennedy (Personal Communication Glenn Moore and Bill Jones 2015). Footage of the presidential visit shows Kennedy observing a Hawk Missile launch from a wooden grandstand situated in front of Property 20562 (JFK Museum Library 2015). The current bleachers positioned outside the building are substantially different than the wood grandstand visible in the film footage and are obviously a later addition to the location. According to disposition data dated 1986, Property 20562 was still in use as an observation building at that time. Little additional information exists for its use in the years following construction; however, at the time of the current inventory the dilapidated building was not in use and the grandstand and related electrical equipment had long since been removed.

8. NRHP Eligibility Recommendations

In evaluating the recorded properties for individual eligibility, the LC-32 resources were assessed in terms of the applicable National Register Criteria. The four eligibility criteria are:

> (a) that are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> (b) that are associated with the lives of persons significant in our past; or
>
> (c) that embody distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> (d) that have yielded, or may be likely to yield, information important in prehistory or history.

Special Criteria Considerations are also applied in specific circumstances. One of these criteria considerations is applicable to the LC-32 resources: Criterion Consideration G. This consideration allows the NRHP nomination of properties that are younger than 50 years old, provided that they are of exceptional importance. Criterion Consideration G and how it applies to the recorded resources is discussed in further detail in the Period of Significance section below.

Throughout the resource evaluation process, the historic context of LC-32 was consulted in order to determine events that might constitute significance, facts about the people who were important to the history of the range, and attributes of design in the various periods of construction. Of the evaluation criteria, Criterion B appears to be the least applicable to the buildings, structures, and objects at the complex. Generally, any such associations are taken into account under the historical trends treated under Criterion A. Criterion D is not particularly applicable in this case as additional information about the resources would be garnered from archival resources rather than from the study of the resources themselves. Criteria B and D were considered in evaluation of the LC-32 resources wherever possible; however, the more systematic application was made with respect to Criteria A and C.

During the current inventory, a total of 75 resources were recorded, which were grouped into seven different property types. The property types are Launch Control Facilities, Missile Launch Facilities, Assembly and Maintenance Facilities, Instrumentation Facilities, Blast Barriers, Magazines, and Miscellaneous Facilities. The NRHP eligibility of the individual LC-32 properties is discussed in detail within the HCPI forms included in Appendix C. The property eligibility is also summarized in Table 10 below. As individual resources, most of the inventoried properties at LC-32 were not recommended for individual eligibility to the NRHP for the reasons summarized below.

In addition to the 75 recorded properties, 336 features were also recorded at LC-32. As these features are by definition insubstantial manifestations that cannot be categorized as buildings, structures, or objects, they do not possess any significant associations with historic events or

Table 10. Eligibility Recommendations of Properties Recorded During the Current Inventory

Property	Property Function	Build Date	HCPI #	Eligible?
20502	Instrument Mound	1959	40283	No
20505	Instrument Mound	1959	40284	No
20506	Latrine	1977	40285	No
20510	Guard House	1959	33866	No
20515	Magazine	1958	33867	No
20516	Magazine	1958	33868	No
20520	Launch Pad	1958	40286	No
20521	Vault and Cable Trench	1958	40288	No
20521	Hera Shelter	1995	40287	No
20524	Blast Barricade and Pad	1958	40289	No
20525	Assembly Bldg and Blockhouse	1958	33869	No
20526	Boiler House	1958	33871	No
20527	Blast Barricade	1958	40290	No
20530	Launch Pad	1958	40291	No
20531	Launch Pad	1958	40292	No
20533	Blast Barricade	1958	40293	No
20537	Blast Barricade	1958	40294	No
20540	Assembly Bldg	1958	40295	No
20541	Maintenance Bldg	1958	33874	No
20542	Blockhouse	1958	33875	No
20544	Cable Trench	1958	40296	No
20545	Launch Pad	1958	33876	No
20547	Operations Bldg	1959	33879	No
20548	Generator Bldg	1959	33880	No
20555	Maintenance Bldg	1959	33882	No
20558	Launch Pad	1959	40297	No
20560	Helipad	1963	40298	No

Table 10. Eligibility Recommendations, Cont.

Property	Property Function	Build Date	HCPI #	Eligible?
20562	Observation Bldg	1963	33883	No
20701	Instrument Mound	1959	40299	No
20706	Instrument Mound	1959	40300	No
20710	Timing Facility	1952	40301	No
20710A	Generator Trailer	Unknown	40302	No
20711	Radio Tower	1952	40303	No
20712	Camera Shelter	1950	40304	No
20713	Instrument Pad	1961	40305	No
20740	Maintenance Bldg	1975	40306	No
20743	Magazine	Unknown	40307	No
20746	Maintenance Bldg	1959	33884	No
20752	Magazine	Unknown	40325	No
20753	Compressor Bldg	1977	40308	No
20754	Launch Control Bldg	1977	40309	No
20755	Launch Pad	1977	40310	No
20756	Launch Pad	1977	40311	No
20757	Compressor Bldg	1975	40312	No
20758	Launch Control Bldg	1975	40313	No
20759	Launch Pad	1975	40314	No
20760	Launch Pad	1975	40315	No
20765	Engine Test Stand	1977	40316	No
20767	Fuel Station	1977	40317	No
20769	Launch Pad	1977	40318	No
20770	Launch Pad	1977	40319	No
21731	Motor Repair Shop	1965	40320	No
21750	Maintenance Bldg	1959	33986	No
21751	Assembly Bldg	1959	40321	No

Table 10. Eligibility Recommendations, Cont.

Property	Property Function	Build Date	HCPI #	Eligible?
21752	Heating Plant	1959	40322	No
21756	Maintenance Bldg	1959	40323	No
21759	Assembly Bldg	1959	33987	Yes; A
25991	Electrical Shelter	1960	40324	No
34932	Magazine	1959	40326	No
34933	Magazine	1959	40327	No
H3057	Portable Bldg	Unknown	40328	No
H3220	Portable Bldg	Unknown	40329	No
H5103	Portable Bldg	Unknown	40330	No
WS28	Maintenance Bldg	Unknown	40342	No
WS30	Portable Bldg	Unknown	40331	No
WS576/WS543	Portable Bldg	Unknown	40332	No
WS910/HS052C	Portable Bldg	Unknown	40333	No
Hera Assembly Stand	Assembly Stand	Unknown	40334	No
Unknown Instrument Platform 1	Instrument Mound	Unknown	40335	No
Unknown Portable Bldg 1	Portable Bldg	Unknown	40336	No
Unknown Portable Bldg 2	Portable Bldg	Unknown	40337	No
Unknown Portable Bldg 3	Portable Bldg	Unknown	40338	No
Unknown Portable Bldg 4	Portable Bldg	Unknown	40339	No
Unknown Pre-manufactured Bldg 1	Unknown	Unknown	40340	No
Unknown Pre-manufactured Bldg 2	Unknown	Unknown	40341	No

people, lack any distinction of architectural form or method of construction, and do not possess additional information relevant to LC-32 or WSMR. As such, they cannot be recommended for eligibility to the NRHP, either individually or as contributing elements to any possible district.

8.1 Eligibility Criterion A

Under Criterion A, the LC-32 properties are associated with the Cold War and Army missile development. Based on the guidance provided by the US Department of the Army (Lavin 1998), Cold War era properties considered as eligible under the four criteria must be related to a specific historic theme related to the Cold War. Per the guidance offered in Lavin (1998), two specific themes are applicable to LC-32: Materiel Development; and Air Defense, Ballistic Missile Defense, and Army Missiles. This discussion will first explore in greater detail the relevant historic themes under which the resources were evaluated. This is followed by a discussion of the historic significance and eligibility of the LC-32 properties under Criterion A.

8.1.1 Historic Themes

Specific guidance for the evaluation of US Army Cold War era military-industrial properties is provided by the Army (Lavin 1998). This guidance is relevant to the evaluation of LC-32 as it played an active role in the Army's military-industrial complex during the Cold War. As a significant launch complex for the testing of anti-aircraft and tactical missiles, LC-32 operated within the nexus of collaboration between the military, federal legislation, and the private defense industry, coined as the "military-industrial complex" by President Dwight Eisenhower in 1961. This collaboration was physically expressed in the semi-independent LC-32 facilities established for the parallel Raytheon and military Hawk test programs. Additionally, LC-32 was active throughout most of the Cold War period, generally defined as beginning with Winston Churchill's "Iron Curtain" speech in 1946 and ending with the fall of the Berlin Wall in 1989. From its establishment in 1958, LC-32 remained an active launch site at WSMR throughout the end of the Cold War and into the new millennium.

Based on the guidance provided by the US Department of the Army (Lavin 1998), Cold War era properties considered as eligible under the four criteria must be related to a specific historic theme related to the Cold War. Lavin (1998) defines nine such Cold War themes, some with specific sub-themes or facilities, for Army military-industrial properties. Two specific themes are applicable to LC-32: Materiel Development; and Air Defense, Ballistic Missile Defense, and Army Missiles.

The theme of Material Development is defined by Lavin (1998:66) as "the process of transforming a concept into an actual weapon or piece of equipment… [in order to]…use superior technology to gain an advantage over the Warsaw Pact Forces." Materiel development activities were carried out at Army designated Research, Development, and Engineering centers and proving grounds, where WSMR is identified as a significant Army Proving Ground (Lavin 1998:69). As one of the major launch complexes active in material development activities at WSMR during the Cold War, LC-32 qualifies for consideration under this historic theme.

The theme of Air Defense, Ballistic Missile Defense, and Army Missiles is also relevant to LC-32, as several Army tactical and air defense missile systems were developed and tested at the complex. Lavin outlines three subcategories under this broader theme: air defense, ballistic missile defense, and research and development.

Specific to the air defense sub-theme, the Hawk program tested at LC-32 was one of the most successful and long-lived anti-aircraft missile systems ever developed. The testing requirements of the Hawk program influenced the layout of LC-32, with the entire east portion of the original complex dedicated to the Hawk program in 1958. The Hawk provided a low-to-medium altitude air defense system that could intercept aircraft very close to ground level. It was a portable system, which made it more versatile than fixed point-defense anti-aircraft systems like the Nike Ajax and Hercules. Hawk units were established in southern Florida during and after the Cuban missile crisis to bolster the existing Nike Hercules installations. When located in conjunction with the Nike Hercules, the two systems provided a potent two-tier air defense network. The I-Hawk version of the system was developed in the latter 1960s and made improvements that included solid-state electronics, ECCM technology, and higher performance missiles. The Hawk was widely distributed amongst allied nations, where in many cases it served as the primary line of air-defense.

Other air defense systems were also tested at LC-32. Beginning in the late 1950s, the protection of front-line forces against low-flying assaults by high-speed jet aircraft, attack helicopters, and strikes by short and medium range ballistic missiles became a significant strategic concern, referred to as FAAD. Although the Hawk was mobile, it was not designed to keep pace with troop movements in the field and self-contained, vehicle-based FAAD concepts were engineered during the 1960s. These systems encountered significant technological and packaging problems as they required the various system radars and the missile launcher to be fitted into a single all-terrain vehicle. The Army's first attempt was the Mauler, which was canceled in 1965, and a mobile version of the Hawk known as the SP-Hawk was experimented with during the 1960s. Finally, the Sidewinder-based Chaparral FAAD system entered Army service in the early 1970s, but it too possessed limitations. The shortcomings of the Chaparral led the Army to develop an American version of the French-German Roland anti-aircraft system, which was essentially an evolved version of the old Mauler concept. The Roland was tested, in part, at LC-32 beginning in the mid-1970s.

Activities at LC-32 also played a role in the development of BMD systems, and the Hawk program at LC-32 experimented with anti-missile versions of the missile. On January 29, 1960, a Hawk successfully intercepted an Honest John missile flying over WSMR (Wind and Sand 1960). An anti-missile capability was originally a component of the HIP, but was dropped from the final I-Hawk configuration. However, during the late 1980s updated versions of the Hawk were modified to receive Patriot radar targeting data in order to engage short range ballistic missiles. LC-32 was also peripherally involved in the testing of the THAAD and Patriot PAC-3 next generation kinetic interceptors. The Hera Target Missile was one of the primary targets used in the testing of these systems, and several demonstration firings of the Hera were conducted from the old Sergeant facilities at LC-32 in the mid-1990s.

Other Army missile systems were also tested at LC-32, furthering the complex's association with the historic theme of Army missiles. The complex was the primary location for testing of the Sergeant tactical missile, and the west portion of the complex was established exclusively for the program. The Sergeant was a significant advance in solid-propellant motor technology, offering comparable range and payload to the existing liquid-propellant Corporal missile without the time intensive and hazardous fueling procedures required of that system. The Sergeant was the Army's primary nuclear capable, short-range tactical missile from 1962 to 1977.

Specific to the Research and Development subtheme of Army missiles, LC-32 played an important role in the testing and development of new technologies, as seen in the continual improvements to the Hawk missile that maintained its effectiveness for nearly 40 years. Additionally, LC-32 became home to one of WSMR's primary drone launch complexes during the 1970s. The aerial target drones, primary the MQM-107 and MQM-34D models, launched from the complex were a vital support component to RDT&E testing of anti-aircraft systems such as the Hawk and Roland.

8.1.2 Significance under Criterion A

Under Criterion A, RDT&E work at LC-32 is closely tied to two historic Cold War programs; the Hawk anti-aircraft missile and the Sergeant tactical missile. In the latter portion of the Cold War, the complex became a major center for the launches of drone aerial targets, and was also a location used for testing of the Roland anti-aircraft system. While all of these programs are of interest historically, not all can be considered significant to the identified Cold War historic themes.

Of the major Cold War programs at LC-32, the Hawk missile was the most significant and successful. It is therefore relevant for its association with the themes of Materiel Development; and Air Defense, Ballistic Missile Defense, and Army Missiles (Lavin 1998). The Hawk missile remained in service with US forces for nearly a half century, being the Marine Corps' primary anti-aircraft system even after it was retired by the Army. The Hawk missile proved to be such a reliable and effective system that it was also adopted by many allied NATO countries as a primary air defense weapon (Federation of American Scientists 2015). Unlike many missile systems, the Hawk is also combat proven; it was first used by Israeli forces during the Six Day War in 1967. Kuwaiti air defense forces armed with the Hawk shot down 23 Iraqi aircraft during the 1990 invasion (Federation of American Scientists 2015). The final version of the Hawk possessed ATBM capabilities and sophisticated multi-plexing capabilities, as shown during a 1996 demonstration at WSMR when Hawk missiles achieved a simultaneous intercept of two Lance missiles and three aerial drone targets (Glenn Moore personal communication 2015). Although largely retired by American forces, it continues to serve several allied nations. Maintaining the technological parity of the Hawk missile was an ongoing effort from the mid-1960s through the 1990s, and much of this work was tested at LC-32. Therefore, not only was the Hawk an influential system at the national and international level, it also was significant to the local history of WSMR. The series of improvements made to the Hawk system over the years was an important source of revenue to the range and created numerous jobs for contractors and government employees alike at WSMR (Eckles 2013).

The other historic programs tested at LC-32 were not as significant to the history of WSMR or the Cold War. The Sergeant missile was a significant advance in solid-propellant missilery and was the first vehicle of its size and payload to rely solely on a solid propellant motor.

However, it was an intermediate development in the succession of Army tactical missiles. It was a significant improvement to its predecessor the Corporal, but was still a large system with fairly limited range. By the end of the 1970s, it was replaced by the Lance missile, which had returned to a liquid propellant motor. The more advanced and accurate Pershing II also entered Army inventories during the 1980s and was much more influential in Cold War politics. Tactical missiles like the Sergeant and Lance were most effective as short range delivery vehicles for tactical nuclear warheads, and as such could only be deployed in certain extreme scenarios (McKenney 2007:242). As a result, they were never fired in combat; for general fire support up to ranges of 20 miles conventional artillery was just as effective as tactical missiles, and most importantly, substantially cheaper (McKenney 2007:242). The era of the tactical missile as a supplement to conventional artillery ended with the signing of the Intermediate-Range Nuclear Forces Treaty (INF) of 1987 which imposed strict limits on nuclear capable systems such as the Lance and Pershing. The MLRS and the Army Tactical Missile System (ATACMS), supplemented by inter-service cruise missiles, replaced these systems as tactical field systems. Therefore, the association of LC-32 with the development of the Sergeant missile is not considered to be of particular significance to the identified historic themes, the history of WSMR, or the Cold War.

As the Hawk program is the most significant of the Cold War RDT&E programs at LC-32, the properties that were directly associated with the program require a careful consideration of their eligibility under Criterion A. However, as various developmental aspects of the Hawk missile and its improved variants were conducted at a number of facilities across LC-32 and elsewhere at WSMR, it is difficult to assign special significance to its association with any single property. Over the several decades of Hawk testing, multiple properties were involved in the development of the missile and as such identification of any individual property for its singular association with the program is difficult. This is particularly true as the mobile Hawk system did not require custom designed support facilities, such as specialized gantries or launch towers, for its testing. As a result, the prosaic Hawk support facilities at LC-32 do not convey information about the Hawk missile or its significance to WSMR and Cold War history. The ability of any individual LC-32 property to convey its historic associations has also been hampered by various cycles of adaptive reuse and modification, some of which post date the Cold War period of significance. Therefore, the historic associations of nearly all the LC-32 properties are not compelling enough to merit consideration for individual eligibility under Criterion A.

However, the exception is Property 21759 at the LC-32 South Assembly Area. This building was the primary facility for the Raytheon Hawk program from its construction in 1959 through the 1970s, when Raytheon began to focus on the SAM-D (Patriot) program at LC-38. This building was known as the “Hawk Hangar” and referred to as “a landmark south of Nike Avenue” during this period (Missile Ranger 1971:1). Of all the LC-32 properties it likely has the most compelling association with the Hawk program, an association that was recognized during the heyday of the program. In 1967, a reporter at WSMR wrote:

> Perhaps, then, it is not one voice, but many, which speak out of the past to anyone who stops under a special sign posted over an office door at the “Hawk hangar,” the main building at the launch complex. Mounted with a jagged fragment from the airframe of a recovered drone, the sign reads: ‘Remains of Q2C

> Target Drone slain by a marauding Hawk - February 13, 1962.' Not only an epitaph to the drone, but also a fitting ode to the Hawk and the men who test her [Frost 1967:8].

In recognition of this special association, the New Mexico HPD (Log No. 059829) found the property to be eligible under Criterion A, as well as Criteria C and D, in a letter dated June 28, 2000 (Hanks and Oster 2000). Epsilon Systems agrees with the recommendation of Property 21759 as individually eligible under Criterion A; however, the recommendation of this property's eligibility under Criteria C and D is reassessed under the relevant headings below.

Other RDT&E activities continued at LC-32 from the mid-1960s until as recently as 2010. As these associations are less than 50 years old, they are discussed within the section on Criterion Consideration G. The late Cold War and post-Cold War reuse and adaptation of the original Hawk and Sergeant properties are also considered within this section. The consideration of the LC-32 properties as contributing elements to a possible district is discussed in the section on military landscapes and districts.

8.2 Eligibility Criterion B

In regards to Criterion B, the majority of the recorded LC-32 properties were not found to be associated with specific individuals important to local, state, or national history or the history of WSMR. The historic associations of the properties are generally more appropriately considered under the broader scope of Criterion A. However, Property 20562 is a special case that merits additional analysis due to its association with President John F. Kennedy during the 1963 Presidential visit to WSMR.

Property 20562 was especially constructed as an observation building for the visit and was originally associated with a wood grandstand (since removed) that abutted its north elevation. In film footage of the visit, President Kennedy is only seen at the grandstand, not within the building itself. Nonetheless, the property was associated with the President's visit, but the strength of the association is not particularly strong. President Kennedy's visit was scheduled for 139 minutes; the actual time on the ground ran a little longer than scheduled, but nonetheless the President was at WSMR for no more than three hours. Of that time, only a portion of was spent at LC-32. After arriving by helicopter at the main cantonment, the Presidential party traveled by car to LC-32. Glenn Moore and Bill Jones recall that they stood on the roof of Property 21756 and waved at the Presidential motorcade as it passed by on Nike Avenue (Glenn Moore and Bill Jones personal communication 2015). The President viewed demonstrations of the Honest John, Little John, Sergeant, and Hawk missiles at LC-32 before moving over to LC-37 for demonstrations of Nike Hercules, Talos, and Nike Zeus missiles (Eckles 2013:292-293).

According to guidance in *National Register Bulletin 32*, Criterion B is not meant to nominate properties whose association with persons significant to history is based on a single visit, or other types of brief relationships. Rather, for a property to be nominated based on association with an individual significant to history, it must possess meaningful association with that person's life or works during the period when they achieved significance. The ephemeral association of Property 20562, and LC-32 in general, with President John F. Kennedy therefore does not qualify as a meaningful association with his life and works. Thus, Property 20562 is not recommended for eligibility based on its association with the 1963 Presidential visit.

8.3 Eligibility Criterion C

The major historic Cold War test programs at LC-32, the Hawk and Sergeant, were mobile systems that did not require specialized support structures for testing and development. Accordingly, most of the buildings and structures at LC-32 are utilitarian types that are commonplace at DOD test ranges. The launch control buildings at the complex, Properties 20542 and 20525, are simple, robust concrete blockhouses that are commonplace at launch complexes. Property 20525 is somewhat notable as it is incorporated into a larger assembly building. However, assembly and control buildings are typical launch complex support facilities and combining the two functions is not particularly compelling as a technological or stylistic breakthrough. Other assembly and maintenance buildings at the range are of CMU or pre-manufactured construction that are standardized, ubiquitous types found at DOD facilities. These include Properties 20540, 20541, 20555, and 20746. Other buildings and structures at the range, such as magazines, instrument pads, launch pads and underground cable runs, are also typical, utilitarian properties that are not of any architectural interest.

One LC-32 building, Property 21759, was previously recommended by HPD in 2000 (HPD Log No. 059829) to be eligible under Criterion C as "it embodies the distinctive characteristics of missile buildings used from 1960 through the 1990s" (Hanks and Oster 2000:1). Although Epsilon Systems recommends the building as eligible under Criterion A due to its close association with the Hawk Missile program, the recommendation of eligibility under Criterion C is more problematic. The term "missile buildings" most closely equates to the building type of Assembly and Maintenance buildings as used in the current inventory. As previously discussed, missile assembly and maintenance properties are highly variable depending on the type of missile system and scope of activities the building is designed to support. As such, it is generally difficult for any particular building to be representative of the type as the buildings are so widely varied in design, materials, and physical characteristics. As a large, steel frame and sheet metal clad hanger building with CMU wings, the building is not representative of a distinctive type, period, or method of construction. Hangar buildings and CMU buildings are common across DOD facilities and other airfields across the nation, and the combination of the two construction methods is not rare or otherwise notable on a technological level. Finally, the building cannot be considered as the work of a master or to possess high artistic value. Therefore, counter to the 2000 HPD recommendation, Epsilon Systems does not recommend Property 27159 as individually eligible under Criterion C.

None of the LC-32 properties represent any particular technological advances or innovations in its actual construction. The buildings' construction includes CMU walls, reinforced concrete, and pre-manufactured steel buildings that were used across WSMR and other military installations nationwide during the Cold War and beyond. Overall, the LC-32 properties are utilitarian buildings driven by function rather than form. As such, the buildings lack distinction in their type, period, or method of construction. Nor do they represent the work of a master or possess high artistic value. For these reasons, none of the recorded LC-32 properties are recommended for individual eligibility under Criterion C.

The final clause of Criterion C, "…a significant and distinguishable entity whose components may lack individual distinction" (NPS 1995:2), refers to districts. The district considerations for the LC-32 properties are discussed in a separate section below.

8.4 Eligibility Criterion D

Per NRHP guidance, Criterion D is most often applied to archeological districts and sites, but can be applied to buildings, structures, and objects (NPS 1995:21). However, for buildings, structures, and objects to be eligible under Criterion D, the properties themselves must be the principal source of important information, which is usually related to design and construction details (NPS 1995:21). This is not the case with the LC-32 resources, as the design and construction details of most of the properties are already well documented and additional data is unlikely to be derived from the physical resources themselves. As such, no information potential exists in further study of the LC-32 buildings, structures, and objects. Therefore, none of the LC-32 properties are recommended as eligible under Criterion D.

Property 21759, the former Hawk Hangar building, was previously recommended as eligible under Criterion D by the New Mexico HPD in a 2000 letter (HPD Log No. 059829). The same response letter considered Property 21759 as eligible under Criteria A and C as well. Epsilon Systems recommends Property 21759 as eligible under Criterion A, but the recommendation under Criterion D is more problematic. As a relatively recent and well documented type of building, no additional information regarding Property 21759's construction and history of use can be derived from the actual physical property itself. Therefore, counter to the 2000 recommendation, Epsilon Systems recommends Property 21759 as ineligible under Criterion D.

8.5 Previous NRHP Evaluations

Nineteen properties at LC-32 have been previously recorded, which are summarized in Table 11. Seventeen of these properties (17) were submitted for formal consultation of eligibility by the New Mexico SHPO. All of these resources were updated during the current inventory, the exceptions being Properties 20539 and 20552, which were demolished. Most of these properties (16) received an eligibility recommendation from SHPO via two response letters, one dated June 28, 2000 (HPD Log No. 059829) and another dated September 23, 2002 (HPD Log No. 65537). A final response letter dated October 15, 2002 did not supply an eligibility recommendation, as requested by WSMR.

Based on the available records, the WSMR Environmental Directorate did not supply any determinations of eligibility for the four LC-32 properties submitted to SHPO for consultation in 2000. As part of the HPD response (HPD Log No. 059829) to the 2000 WSMR submittal, SHPO recommended Property 21759 as eligible. The SHPO response letter elaborated on the recommendation, and stated that Property 21759 was:

> Eligible under Criterion A for its role in missile programs associated with the Cold War, Criterion C because it embodies the distinctive characteristics of

Table 11. Summary of Previously Documented Properties and Consultations

Property Number	HCPI Number	Consultation Date	Recommendation	SHPO Concurrence
20510	33866	2002	Not Eligible	Not Eligible
20515	33867	2002	Not Eligible	Not Eligible
20516	33868	2002	Not Eligible	Not Eligible
20525	33869	2002	Eligible; A, D	None
20526	33871	2000	Not Eligible	Not Eligible
20539 (Demolished)	33872	2000	Not Eligible	Not Eligible
20541	33874	2002	Eligible; C	Not Eligible
20542	33875	2002	Eligible; C, D	Not Eligible
20545	33876	2002	Eligible; C, D	Not Eligible
20547	33879	2002	Not Eligible	Not Eligible
20548	33880	2002	Not Eligible	Not Eligible
20552 (Demolished)	33881	2002	Not Eligible	Not Eligible
20555	33882	2002	Eligible; D	Not Eligible
20562	33883	2002	Not Eligible	Not Eligible
20710	LA 116574	N/A	N/A	N/A
20712	LA 116574	N/A	N/A	N/A
20746	33884	2002	Eligible; C, D	Not Eligible
21750	33986	2000	Not Eligible	Not Eligible
21759	33987	2000	Eligible; C, D	Eligible; A, C, D

> missile buildings used from 1960 through the 1990s, and Criterion D for its potential to yield information regarding this important period in American history [Hanks and Oster 2000:1].

As part of the 2000 response letter, SHPO recommended that three other LC-32 buildings (Properties 20526, 20539, and 21750) were ineligible for listing on the NRHP, and "the proposed demolition of these properties should have no effect upon any registered or eligible properties" (Hanks and Oster 2000:2). Property 20539 was subsequently demolished and is no longer present at LC-32.

In the submittal dated July 31, 2002, the WSMR Environmental Directorate included 12 LC-32 properties for eligibility concurrence by SHPO. Six of the included resources (Properties 20525, 20541, 20542, 20545, 20555, and 20746) had been recommended as eligible by the contractor, Human Systems Research (HSR). The WSMR Environmental Directorate disagreed with the HSR eligibility recommendation for Properties 20541 and 20555, arguing that the properties were of commonplace concrete and pillar and spandrel construction which did not qualify for eligibility under Criterion C, and that neither of the properties possessed the ability to provide further information in regards to Criterion D (Ladd 2002:1).

In the response letter to the 2002 WSMR submittal (HPD Log No. 65537), SHPO stated that the submitted LC-32 properties would best be evaluated as a possible district rather than as individual properties. However, the letter went on to state that:

> This office would advise that LC-32 is not yet eligible for listing as a historic district on the National Register due to the fact it does not adequately meet Criteria Consideration G for exceptional importance. *The proposed undertaking will not, therefore, affect historic properties* [Hare 2002:2; emphasis in original].

By virtue of this statement, none of the submitted LC-32 properties included as part of the 2002 consultation received concurrence of eligibility by SHPO. No further correspondence or documentation regarding these properties was on file at WSMR. At the initiation of the current inventory project, their eligibility status was listed as “undetermined” in WSMR records.

In a separate response letter dated to October 15, 2002 (HPD Log No. 65856), SHPO provided comment on a group of submitted properties that included Property 20525 at LC-32. The letter did not address the NRHP eligibility of the building stating, “As requested, we are not supplying a determination of NR eligibility for the following buildings, but will maintain their survey files with the WSMR records at HPD pending future action” (Hare 2002b:1). No further consultation or comment was made regarding this property.

In summary, although 19 LC-32 properties have some degree of previous recording, only Property 21759 was determined to be NRHP eligible. Four other previously documented LC-32 properties (Properties 20525, 20542, 20545, and 20746) were submitted by WSMR for concurrence of NRHP eligibility by SHPO. SHPO recommended that as the properties were not yet 50 years of age, they were not eligible to the NRHP. Consequently, WSMR listed these four properties as being of undetermined eligibility status.

Although the previous inventory efforts made valuable contributions to the documentation of the LC-32 resources, none were large enough in scope to encompass all the properties present at the site. As identified by SHPO in 2002 (HPD Log No. 65537), many of the properties were not yet 50 years old at the time of these inventories, which limited the discussion of the properties’ eligibility. Additionally, these previous efforts did not identify, via a detailed historic context, the historic themes relevant to addressing the historic significance of the LC-32 properties. The current inventory and evaluation discusses the properties within the framework of an appropriate historic context, and also considers how the current condition of the resources reflects the identified periods of significance in order to properly assess the eligibility of the recorded resources.

8.6 Period of Significance and Criterion Consideration G

The primary period of significance at LC-32 encompasses the historic Cold War period at the complex from its establishment in 1958 through 1966. The term “historic”, per NRHP guidance, represents events, activities, and properties that are over 50 years old. The majority of the core infrastructure and facilities at LC-32 were established during this period, and its two major test programs, Hawk and Sergeant, also reached mature stages of development in this timeframe. Post-1966 activities and properties at LC-32 are still meaningful to recent history, but are not technically considered historic.

The post-1966 activities at LC-32, being less than 50 years of age, are considered within the framework of Criterion Consideration G. This consideration applies to both properties and events that are less than 50 years old. Additionally, per guidance in the *National Register Bulletin*, properties that are more than 50 years old but possess significant associations with events less than 50 years old must be evaluated under Criterion G (NPS 1995:43). Criterion Consideration G therefore applies to the continuing use and adaptation of the original LC-32 properties that were first constructed during the late-1950s.

The Roland mobile anti-aircraft missile program of the late 1970s and 1980s was also tested at LC-32, but was not a widely deployed or influential system. Due to significant cost overruns and gradual improvements to the already in-service Chaparral system, the Roland was only issued to one New Mexico National Guard battalion for a few years in the 1980s. Due to the minimal impact of the Roland missile to WSMR and the Cold War, the historic association of LC-32 with the program is not considered significant in regards to Criterion Consideration G.

The WSMR aerial target drone launch area was located at B-Station through the 1960s, but the launch site was relocated to LC-32 during the mid-1970s. The MTLC was constructed at LC-32 in two phases in 1975 and 1977, and was primarily used to launch MQM-107 and MQM-34D drones. The drone launch complexes at LC-32 are a slightly different consideration as they are a range support program rather than a missile program. The launch of aerial target drones is an important component of the testing of anti-aircraft systems, but is a basic range support function that can be found at test ranges nationwide. As such, the properties and activities at the LC-32 MTLC are not considered to meet the rigorous standard of exceptional importance required for eligibility under Criterion Consideration G.

Another target program that flew from LC-32 was the Hera Target Missile of the 1990s. Although the Hera was a post-Cold War development, it was developed as a target for the THAAD and Patriot PAC-3 systems rooted in the SDI of the 1980s, a hallmark initiative of the late Cold War. As a target missile, Hera is similar to the MLTC as it is a range support program rather than a major weapons development. Although the Hera was an important aspect of testing the next generation of anti-ballistic missile systems, it served only as a target and cannot be considered of the same technological caliber as the THAAD and Patriot PAC-3 systems launched against it. The Hera was in fact based around surplus Minuteman motors and was not any sort of technological breakthrough in itself. The program was based in the old Sergeant facilities in LC-32 West; the missile was launched adjacent to the old Sergeant launch pad and Property 20525 served as an assembly and launch control facility for the program. As a target missile assembled from surplus parts, a common strategy employed at test ranges, the Hera program facilities at LC-32 do not meet the rigorous standards required for eligibility under Criterion Consideration G.

A similar situation exists for the Orion LAS system tested at LC-32, the most recent major test program undertaken at the complex. The Orion space capsule was the core of the proposed NASA Constellation Program, and testing of its LAS was a major component of its development. The LAS was successfully tested at LC-32 in 2010, but the Constellation Program was defunded a year earlier and no further testing of the LAS was conducted at LC-32. The Orion capsule was retained throughout the restructuring of NASA's manned spaceflight program but as of 2015 has not yet been used in a manned flight. If the Orion is eventually used in the next phase of manned space exploration, then the Orion LAS properties will take on a new significance. However, as yet it remains to be seen if the program will be successful in its long-term goals and insufficient historical perspective exists to consider it as being of exceptional importance to recent history. Therefore, the Orion properties at LC-32 are not recommended for eligibility under Criterion Consideration G.

For these reasons, none of the LC-32 properties are recommended for eligibility based on their associations with activities or events that have occurred within the last 50 years. Per Criterion Consideration G, neither the properties themselves nor their associations can be demonstrated to meet the rigorous standard of exceptional importance required for eligibility under Criterion Consideration G.

8.7 Integrity of LC-32

Per the guidance in Lavin (1998), Cold War era Army military-industrial properties that are eligible for consideration under one or more specific Cold War themes must be judged in terms of historic integrity. This discussion primarily focuses on the integrity of the complex as a whole as a prerequisite for addressing the possibility of a NRHP district in the following section. For details regarding the integrity of individual properties, the reader is directed to the property descriptions in Chapter 7 and the HCPI forms in Appendix C.

Integrity, or the ability of the property to convey its significance via its physical attributes, is evaluated by seven qualities. These are the qualities of location, design, setting, materials, workmanship, feeling, and association. These specific qualities are derived from NRHP guidance and can be considered individually in regards to the historic character of LC-32.

The quality of location is related to, yet distinctive from, the quality of setting. The quality of location simply refers to the place where the historic events occurred, while setting refers to the "character of the place" and "how, not just where, the property is situated and its relationship to surrounding features and open space" (NPS 1996:45). NPS guidance states "The actual location of a historic property, complemented by its setting, is particularly important in recapturing the sense of historic events and persons" (NPS 1996:44). As such, it is clear that the aspect of location has remained consistent for LC-32, but the setting has been modified by the recent addition of properties and alteration of the layout of the complex.

The aspects of workmanship and materials are more applicable to individual properties, but can be applied to consideration of the general historic fabric of LC-32. Workmanship is defined as "the evidence of artisans' labor and skill in constructing or altering a building, structure, object, or site. Workmanship can apply to the property as a whole or to its individual components" (NPS 1996:45). Materials are "the physical elements that were combined or deposited…to form a historic property" (NPS 1996:45). The basic materials, concrete, CMUs, and sheet metal, of most LC-32 properties remain intact, yet the original workmanship in many cases has been altered by reuse and adaptation of the properties.

Related to setting, workmanship, and materials is the quality of design, which is defined as "the combination of elements that create the form, plan, space, structure, and style of a property" (NPS 1996:44). The quality of design is of particular note when considering the overall layout of LC-32, which was modified substantially in the last 20 years.

Modifications to the original design and setting of LC-32 were made during the 1990s Hera program, when the roads in the western portion of the complex were rerouted. This changed the formerly symmetrical layout of the complex and de-emphasized the original division of the complex between the Sergeant and Hawk programs. Many of the original Sergeant properties were modified for use with the program, including Properties 20520, 20525, and 20526, which reduced the integrity of their materials and workmanship. A support building, storage yard, and personnel trailers were also left behind from the Hera program, which further modified the setting and design of the complex. The large, high bay Hera environmental shelter erected adjacent to the original Sergeant Launch Pad (Property 20520) is a prominent addition to the area that is a very noticeable alteration to the complex. Its materials and design are also dissimilar to the original Sergeant missile facilities dating to the period of significance, which adds emphasis to the changes made to the Cold War-era design and setting of the complex.

The Hawk area has also undergone a significant series of alterations which began in the 1970s. The Hawk Annex, an eastern extension of the Hawk launch area on the east margin of LC-32, was converted into the MTLC for aerial drone launches in 1975. The MTLC was then further expanded in 1977, again altering the setting and design of LC-32 from that of the period of significance. The Hawk Fixed Battery area was also significantly altered by the removal of Property 20552, two launch pads, interior blast berms, and the cable trench connecting Properties 20555 and 20548. Various minor modifications have also been made to the blast berms associated with the original Hawk launch pad (Property 20545).

However, the most noticeable alteration to this portion of LC-32 is also the most recent; the NASA Orion LAS facilities. The Orion gantry tower is approximately seven stories in height and is the single most prominent structure at LC-32; it is an overwhelming addition to the complex that is a major distraction from the actual historic properties. Adjacent to the gantry is the Orion LAS Launch Pad, a broad concrete pad with associated electrical installations. Along with the gantry is the Final Integration and Test Facility, a large, high-bay warehouse building that dwarfs the historic assembly buildings at the main LC-32 complex. Additional Orion LAS properties include the Launch Pad Services Area, a concrete pad within the former Hawk Fixed Battery, and a fenced storage yard south of Property 20541. Not only do these properties represent a significant departure from the design and setting of the complex during its period of significance, but they are also of dissimilar design and materials from the surrounding Cold War era properties. This significantly detracts from the general integrity of the complex's workmanship and materials.

The properties at LC-32 South have undergone a lesser degree of alteration although they have been re-purposed. However, the majority of the LC-32 properties are within the main complex north of Nike Avenue and most of these have been altered for re-use with other programs. Some properties at the complex, such as the Property 20542 Hawk Blockhouse, Property 20545 Hawk Launch Pad, Property 20526 Heat Plant, and Property 20547 Operations Building are simply no longer maintained and exist in a state of disrepair. The general poor condition of many of the original properties at the complex has also diminished the integrity of design, setting, workmanship, and materials of the LC-32 complex.

Cumulatively, the impacts to LC-32's integrity of setting, design, workmanship, and materials also reduce the integrity of the more general qualities of feeling and association. According to

Figure 203. The Hawk area at LC-32 East in 1966 aerial photograph (*courtesy WSMR)*.

Figure 204. Current aerial overview of Hawk area at LC-32 East, note prominence of NASA Orion facilities.

NPS guidance feeling "is a property's expression of the aesthetic or historic sense of particular period of time" and "results from the presence of physical features that, taken together, convey the property's historic character" (NPS 1996:45). Closely related to feeling is association, which is "if it is the place where the event or activity occurred and is sufficiently intact to convey that relationship to an observer. Like feeling, association requires the presence of physical features that convey a property's historic character" (NPS 1996:45). The large facilities added to the complex by the Hera and Orion LAS programs are major deviations from the historic character of LC-32 and diminish the integrity of the qualities of feeling and association. As the most visually prominent properties at the site, they distract even the eye of trained observers away from the original Hawk and Sergeant facilities. They also confound the original design and layout of LC-32, disrupting the original Cold War era plan of the complex.

NPS guidelines are clear that not only must a property be "associated with an important historic context" but must also retain "historic integrity of those features necessary to convey its significance" in order to be eligible to the NRHP (NPS 1996:3).

The assessment of integrity, particularly in regard to eligibility under Criterion A, relies heavily on the retention of the historic features necessary to convey a property's significance. This holds true at both the individual property level and for collections of properties in historic districts. However, determination of whether a property retains sufficient integrity of its physical features to allow it to convey its historic significance can be a subjective process. Additionally, identification of what the essential historic physical features of a property are, especially in cases of properties that lack recognized architectural styles, can be also be a subjective determination.

The NPS recognizes this ambiguity to some extent and offers the following as a sort of litmus test in assessing historic integrity of a property considered for eligibility under Criterion A, "A basic integrity test for a property associated with an important event or person is whether a historical contemporary would recognize the property as it exists today" (NPS 1996:48). To this end, Epsilon Systems staff toured LC-32 with former Hawk technicians Glenn Moore and Bill Jones in 2015. Both men found areas of the complex difficult to navigate and many familiar buildings difficult to identify due to the recent alterations to the range layout, addition of new properties, and alterations to specific buildings (Glenn Moore and Bill Jones personal communication 2015).

These additions have made it difficult for observers, even those well acquainted with the complex, to understand how LC-32 appeared and operated during its period of significance and have substantially altered the identity of the complex as a whole. This is of particular importance in regards to the consideration of LC-32 as a possible historic district, which is discussed in the following section.

8.8 LC-32 as a Military Landscape and District

The wider perspective of a historic military landscape was considered as part of the LC-32 inventory. Military landscapes are those that have been uniquely shaped in support of military missions, and historic military landscapes are those that have significant associations with historically important persons, events, or patterns or represent significant examples of design or construction (Loechl et al. 1994:9). Per the guidance, an identified historic military landscape is typically recorded as a historic district or site. Historic military landscapes are evaluated within the framework of an appropriate historic context that allows for the associated military mission, chronological period, geographic context, and historic themes of a military landscape to be identified and understood (Loechl et al. 1994:19-20). For the purpose of the present undertaking, this historic context is provided within Chapter 6 of this report.

In addition to the historic context of a military landscape, the physical characteristics of the landscape must also be considered. Landscape characteristics are "the tangible evidence of the activities and habits of the people who occupied, developed, used, and shaped the land to serve human needs; they may reflect the beliefs, attitudes, traditions, and values of these people" (Loechl et al. 1994:36). Specific to the evaluation of historic military landscapes, nine such characteristics are identified. These characteristics are Spatial Organization and Land Use; Response to Natural Environment; Expression of Military Cultural Values; Circulation Networks; Boundary Demarcations; Vegetation; Buildings, Structures, and Objects; Clusters of Buildings, Structures, and Objects; and Archaeological Sites (Loechl et al. 1994:36-40). Each of these characteristics is discussed in relation to LC-32 below.

8.8.1 Spatial Organization and Land Use

The implementation of military missions directs the way the land of a military installation is utilized and how it is spatially organized (Loechl et al. 1994:36). During the 1950s missile testing at WSMR rapidly expanded in scope and frequency as military funding increased following the Korean War and political and social perception of the various technological "gaps" with the Soviet Union encouraged the development of new missile systems throughout the decade. Many of the WSMR launch complexes along Nike Avenue were established during this decade, including LC-32. These launch complexes are located along the north side of Nike Avenue in the southern portion of the range, leaving the vast range interior to the north available for flight paths and impact areas.

Architectural plans for the LC-32 facilities were finalized in 1958 and clearly show that the new complex was built to support the testing of two major programs; the Hawk anti-aircraft missile and the Sergeant tactical missile. The launch complex was divided into separate sub-areas for each program in an almost symmetrical fashion. A primary access road (Range Road 201) traveled north from Nike Avenue to a "Y" intersection with Range Road 2012, which branched east and west into each area, which emphasized the duality of the spatial layout of the complex. Support facilities in the Hawk and Sergeant areas largely mirrored each other, with each area possessing a launch pad (or several launch pads in the Hawk area) supported by a blockhouse and an assembly building, with a cable trench providing wiring connectivity to the launch pad. Architectural details of these properties varied, but the type and general layout of the facilities between the Sergeant and Hawk area at LC-32 were generally similar. Variations on the buildings and structures were required as the two systems varied in vehicle size and support equipment. For example, the blockhouse and assembly building were combined into a single building at the Sergeant area, but were independent properties at the Hawk area.

While the original symmetrical layout of the major LC-32 facilities was quite obvious, other facilities constructed in support of the complex were more subtle in distribution. Supporting instrumentation sites were arrayed around the margin of the complex, which consisted of six ribbon frame camera stations plotted along the north and south margins of the complex. These instrumentation sites provided high-speed film coverage of the critical early phase of flight tests and the film footage was tied into the WSMR spatial coordinate system so that accurate measurements of position, angle, pitch, and speed could be taken from the film. These instrumentation sites served to demarcate the margins of what could be considered the outer limit of the original LC-32 built environment. Within the Sergeant area of LC-32 West, additional instrumentation locations were located around the Sergeant Launch Pad. These simple instrumentation locations consisted of leveled, paved sites for the positioning of mobile instruments. Another outlying property was the sentry house (Property 20510) along Range Road 201, from which entry into the complex was monitored.

As the air defense mission of the Hawk Program expanded during the late 1950's, so did the Hawk test facilities at LC-32. Three such expansions were added to the complex in 1959. The Hawk Fixed Battery, a prototype of a permanent Hawk installation, was added just to the east of the original Hawk launch area. The launch area of the Fixed Battery was partially enclosed by a blast berm, with additional interior blast berms separating the three launch pads. Supporting buildings outside the bermed area were also part of the installation and connected to the launch pads via an underground cable trench. An additional Hawk launch area, known as the Hawk Annex or LC-32 East, was added to the east of the Hawk Fixed Battery in 1959 as well. This location included several mounds for situating Hawk radars, a maintenance building, and launch pads. These additions were an expression on the landscape of the expanding Hawk mission at LC-32, which modified the original Sergeant/ Hawk symmetry of the complex. With the 1959 additions to LC-32, the eastern portion of the complex began to sprawl to the east towards the boundary with neighboring LC-33.

By 1960, a spatially detached addition to LC-32 was added south of the main complex on the south side of Nike Avenue. Known as the Hawk Assembly Area, this location was constructed in what became known as the LC-32 South area. This area provided assembly and work space for both Raytheon and government Hawk technicians that were formerly located in the Tech Area of the main cantonment. Though separated from the main LC-32 launch area, it was closely tied to the Hawk test program and acted as an extension of the complex. A large hanger building in this area, Property 21759, was the locus of the Hawk program through the 1960s and into the 1970s and was known as the "Hawk Hangar."

Later in the Cold War, LC-32 continued to expand but de-emphasize the original programs it was built to support. Shifts in the spatial organization of the complex included the addition of the MTLC drone launch area in the east portion of the complex, which modified and replaced the Hawk Annex area. The Hawk Fixed Battery was also substantially modified by the removal of many of its buildings and structures and re-purposing of the remaining properties. More recently, the construction of the Orion LAS facility have substantially altered the spatial organization of this portion of LC-32, and added several prominent buildings and structures.

The Sergeant area of LC-32 was also substantially altered. The Sergeant Program was complete at LC-32 by the early-1970s, and the LC-32 West properties were re-purposed for other programs. During the 1990's, a large launch pad and conditioning shelter were added to LC-32 West in support of the Hera Program. Other properties were introduced to LC-32 West in support of Hera, and the original access via Range Road 2012 was re-routed to provide a more direct route to the Hera facilities. This again modified the original dual-program spatial layout of LC-32, shifting the access routes and expanding LC-32 West further to the south.

Other areas of LC-32 were devoid of built environment and helped define the spatial layout of the complex by providing undeveloped areas of natural desert vegetation. However, many of these undeveloped areas have gradually been infilled with new properties and access roads. During the early 1960s an open area south of the Hawk area at LC-32 East was cleared and paved for a helicopter landing pad and adjacent parking strip. Nearby to these paved areas, the observation stand and bleachers for the 1963 visit by President Kennedy were constructed. In recent decades, the open area north of Range Road 2012 between the Sergeant and Hawk areas has been modified with the addition of a series of blast berms, instrument pads, and associated infrastructure and access roads. This has modified the former discrete separation of the LC-32 East and West built environment into more of a continuous distribution of facilities that bridges between these two areas.

The steady shifting of the layout of LC-32 is an expression of the evolving military mission on the landscape. However, the modification to the original layout and properties of the complex and accumulation of post-Cold War properties has diminished the historic integrity of the facility, which is discussed in further detail earlier in the chapter.

8.8.2 Response to Natural Environment

Significant natural features often influence the location and organization of military installations, and climatic factors can influence the types of facilities constructed at these installations (Loechl et al. 1994:37). The natural environment was a critical factor in the selection of the Tularosa Basin as the location of WSPG in 1945. The proposed proving ground required attributes of flat and open ground, a sparse population, and predominantly clear weather. Other preferred characteristics included surrounding hills or mountains for observation sites and natural barriers, access to railroad lines and utilities, and proximity to an established military post for support. The Tularosa Basin was identified as the best choice by the Army, possessing nearly all of the desired characteristics.

More specific to LC-32 and its response to the natural environment, the location of the complex in the floor of the Tularosa Basin provided a huge extent of flat and open ground that allowed for excellent line of sight for optical instrumentation and flight lines clear of topographical barriers to the north. However, the natural environment was likely not the most important consideration in the location selection for LC-32. Rather, the complex was likely located based on logistical considerations such as proximity to the main cantonment and technical support areas. The location of LC-32 amid the established series of launch complexes along Nike Avenue consolidated launch activities in the southern portion of the range which maximized the length of flight lines available downrange.

8.8.3 Expression of Military Cultural Traditions

According to Loechl et al. (1994) military cultural traditions are expressed at military installations in both organizational and aesthetic senses. These military values include hierarchy, uniformity, discipline, utility, and patriotism (Loechl et al 1994:38). However, these values are more specific to personnel and administrative areas of military installations, while LC-32 is a technically oriented facility. As such, LC-32 expresses the technical requirements of the testing process rather than the hierarchical or patriotic values that would be displayed at military barracks or housing areas. Despite this, the value of uniformity was visible in the initial layout of the complex. The original layout of LC-32 emphasized approximately symmetrical areas with very similar facilities for both Hawk and Sergeant, a neatly organized layout that was consistent with the traditional military value of uniformity in layout and organization. As time progressed, the practical needs of the RDT&E process mandated steady expansion and modification of LC-32's facilities so the value of uniformity is no longer visible in the complex's layout.

The military value of utility is expressed in the types of buildings and structures encountered at the complex. Most of the buildings at LC-32 are of concrete and CMU construction or are steel frame, steel clad premanufactured buildings exemplified by the version produced by Butler. These buildings offer expedient construction and excellent durability, but lack recognized architectural styles or ornamentation. The utilitarian nature of the buildings and structures at LC-32 reflect the pragmatic nature of the Army testing mission, which emphasizes function rather than form in order to meet the requirements of the RDT&E process.

8.8.4 Circulation Networks

Loechl et al. (1994) defines circulation networks as roads and transportation routes that facilitate the movement of troops and supplies across military installations. These networks can include major primary and secondary roads as well as smaller local roads and access routes to specific areas (Loechl et al. 1994:38). At LC-32, circulation networks were used for the movement of equipment and materials specific to RDT&E efforts at the complex rather than the movement of Army troops and supplies.

From Nike Avenue, the complex was accessed via Range Road 201 and 2012. Range Road 201 headed north from Nike Avenue and connected with the east-west oriented 2012 at a "Y" intersection. Range Road 2012 provided access to the east (Hawk) and west (Sergeant) areas of LC-32. A sentry house and gate were located along Range Road 201, which provided access control and served as the unofficial "gateway" into the complex. Range Road 2012 connected with the Sergeant area to the west and the Hawk area to the east, and looped back onto itself within each area, providing the main transportation loop with each sub-area. This easily facilitated east-west travel between the two areas within the complex. From the Range Road 2012 loop, various minor access routes branched off to individual buildings, launch pads, and instrumentation sites. In its earliest iteration, the LC-32 circulation network did not provide connectivity to other roads and essentially dead ended at the internal loops of the Sergeant and Hawk areas, and the only way in and out of the complex was via Range Roads 201 and 2012. This further defined the discrete original layout of LC-32 on the landscape and placed an emphasis on access control into the complex.

Another north-south access route, Range Road 200, from Nike Avenue was located near the east margin of the complex, but period maps and plans indicate that it did not originally connect to LC-32. This road was primarily for access to the Uncle Site timing signal facility, which was independent of the main cluster of facilities at LC-32. However, with the establishment of the Hawk Fixed Battery and Hawk Annex on the eastern side of LC-32, Range Road 200 appears to have been extended north to connect to the Hawk Fixed Battery area, and a secondary branch added (Range Road 2001) to provide more direct access to the Hawk Annex Area. The extension of these roads was part of the general expansion of LC-32 to the east, which changed the original symmetrical layout of the complex. The construction of the MTLC during the 1970s continued this trend, which modified some of the Hawk Annex roads and added new access roads to this portion of the complex. This furthered the “sprawl” effect of LC-32 further to the east.

In its earliest iteration, the LC-32 circulation network was a significant contributor to the definition of the complex on the landscape and was designed in part to control access in and out of the complex. However, as LC-32 grew so did the road network and the accumulation of unofficial access roads and two-tracks. As time went on, the definition of the complex by the circulation network has therefore become less distinct. With the added access via Range Road 200, access control was diminished in favor of more direct access. In the last two decades, the addition of new roads and facilities has caused some portions of the original LC-32 roads to be abandoned or barricaded, and Range Road 200 has replaced Range Road 201 as the primary access route into LC-32 East.

8.8.5 Boundary Demarcations

Boundary demarcations on military installations define the limits of the overall installation as well as specific areas of land use within the larger installation, and unlike city limits, are often quite visible (Loechl et al 1994:39). However, in the case of the LC-32 the limits of the complex are not clearly indicated. As with many of the Nike Avenue launch complexes, the actual boundaries of the complex extend north far beyond the actual distribution of the complex’s built environment. The northern border of LC-32 is north of Range Road 202, while the south parallels the north edge of Nike Avenue. The west and east boundaries are limited by the neighboring LC-31 and LC-33 complexes to the east and west respectively. The extended northern area of the complex serves several purposes; it acts as a safety zone for errant vehicles and spent booster stages, provides space for future expansion, and offers locations for instrumentation. However, since the mapped limits of the ranges often include hundreds of acres of undeveloped desert, it is impractical to demarcate the boundaries of each complex with fencing. Additionally, as LC-32 is a complex located within the larger range at WSMR, the Army apparently did not consider it necessary to demarcate it in any specific manner on the ground. This lack of demarcation is typical of many areas at WSMR and reflects the notion that these sub-areas are part of the larger range at WSMR and specific demarcation is not necessary unless required by specific security or safety concerns. The only fenced areas within the complex currently are storage yards that are recent additions to the complex.

As indicated by Loechl et al. (1994:39), other delineations, such as roads and paths, can serve in place of fences or other formal boundary markers. While the LC-32 road network did not align with the complex limits, it did help define the core of the complex’s built environment.

This became less true as time progressed with the proliferation of new roads and original alignments were modified or abandoned.

8.8.6 Vegetation

Vegetation can be important to the definition of landscapes as it bears a direct relationship to long-established patterns of land use. Landscaped residential areas or intentionally cleared areas both communicate different aspects of the military mission on the land. Forests or groves of trees can be used as boundary markers or buffers against surrounding communities (Loechl et al. 1994:39). However, as a RDT&E facility situated within a larger range, LC-32 is somewhat of an exception to the patterns suggested by Loechl et al. (1994).

Vegetation typical of the area is Plains Mesa Sand Scrub (Dick-Peddie 1993). It is likely that the current vegetation community in the Tularosa Basin developed from disturbances introduced by human agency during the 19th century, allowing for the development of shrubland in lieu of established grasslands (Muldavin et al. 2000a:80). The flora within LC-32 were observed to be variable, defined by co-dominance of four-wing saltbush (*Atriplex canescens*) and honey mesquite (*Prosopis glandulosa*) with an understory of forbes and grasses including broom snakeweed (*Gutierrezia sarothrae*), and bush muhly (*Muhlenbergia porteri*).

This desert scrub vegetation was extensive enough that much of it was cleared from the interior of LC-32 when the complex was established. Photographs taken during the 1958 construction of the Hawk area show that all the vegetation within the loop road portion of LC-32 East had been cleared. The areas around each of the newly constructed Hawk buildings (Properties 20530, 20531, 20540, 20541, 20542, and 20545) had been cleared of vegetation and graded as well. Conversely, intact areas of natural vegetation around the developed areas of LC-32 helped define the spatial distribution of the facilities at the complex. In the original iteration of the complex, undeveloped areas of native vegetation between LC-32 East and West accentuated the distinction between these areas, as did the undeveloped area south of Range Road 2012. These intervening locations were also partially cleared of vegetation during later development of the complex, making the limits between the east and west portions of the complex less distinct.

While other areas within WSMR have been planted with landscaping plants, particularly within the main cantonment, no such landscaping efforts were made at LC-32. The clearing of the vegetation was in keeping with the RDT&E mission of LC-32, which was expressed in a utilitarian landscape shaped by technical requirements. Today, unmaintained or inactive portions of the complex are gradually being reclaimed by desert scrub, demonstrating the dynamic role that vegetation plays in characterizing the landscape.

8.8.7 Buildings, Structures, and Objects

Buildings, Structures, and Objects are often the most prominent features on the landscape and traditionally the focus of the NHPA compliance process. As defined by the NPS, buildings are designed to shelter some sort of human activity, while structures are designed for functions other than sheltering people and their works (NPS 1995). Objects are generally smaller and can be moveable, and are often commemorative or artistic in nature such as water fountains or statues (Loechl et al. 1994:40). The buildings, structures and objects at LC-32 are the primary expression of the military mission on the landscape and define the orientation and layout of the complex. Most of the resources were buildings, along with a relatively high number of structures; few objects were recorded. Many of the recorded structures were concrete launch pads, instrumentation foundations, or blast barricades.

The LC-32 inventory effort resulted in the recordation of 75 buildings, structures, and objects. Most of these properties were located in definable clusters or linear layouts which were an expression of the functional activities they supported. As part of the inventory methodology, less significant resources representing remnants of LC-32 supporting infrastructure were recorded as features and are described separately. A total of 336 features were recorded in association with the buildings, structures, and objects at LC-32. These less substantial manifestations of the LC-32 built environment contribute to a broader understanding of the scope and extent of activities at the complex. The recorded features generally are associated with more substantial built environment and occur at much lower frequencies in undeveloped portions of LC-32. Electrical Infrastructure was the most common feature type (n=115), accounting for approximately 34 percent, followed in decreasing frequency by Refuse Dumps (n=70, 21 percent), Instrumentation Support (n=61, 18 percent), Miscellaneous Features (n=34, 10 percent), Water/Wastewater Infrastructure (n=29, 9 percent), Launch Infrastructure (n=17, 5 percent), and LP Tanks (n=10, 3 percent).

8.8.8 Clusters of Buildings, Structures, and Objects

According to Loechl et al. (1994:40), the organizational and spatial relationships among buildings, structures, and objects at military installations is one of the most important characteristics of military landscapes. As presented in Chapter 7, six such organizational clusters of properties were identified at LC-32; LC-32 East, the Hawk Fixed Battery, LC-32 West, the MTLC, LC-32 South, and Uncle Site. Properties that were not spatially clustered at LC-32 were mostly buildings and structures that were spatially separated by plan or purpose. Examples of these dispersed properties include ribbon frame camera instrumentation sites and the Property 20510 Sentry House. Not only are these property clusters relatively well defined on the ground, they are also identified in archival records, architectural drawings, maps, and period photographs.

LC-32 East consists of the original Hawk Launch Area established in 1958. This area, opposite the Sergeant area to the west, was the primary flight test area at WSMR for Hawk missile testing for several decades. The location is bounded by the Hawk Fixed Battery to the east, Uncle Site to the south, the original range access road to the west, and mostly undeveloped desert to the north. Significant properties at LC-32 East consist of the Blockhouse (Property 20542), several launch pads (Properties 20530, 20531, and 20545), cable trench (Property 20544), blast barricades (Properties 20533 and 20537) and two assembly and maintenance buildings (Properties 20540 and 20541).

The portion of LC-32 known as the Hawk Fixed Battery was constructed in 1959 east of the original Hawk Launch Area. This location consisted of a bermed series of launch pads arrayed around a central missile service building (Property 20555). Supporting these facilities was the Generator Building (Property 20548) and the Operations Building (Property 20547), which were connected to Property 20555 via a cable trench. A large radar tower for the support of the various Hawk targeting and guidance radars was planned for the installation, but was apparently never built. A Converter Building (Property 20552) was also located north of Property

20548, but has been demolished. Several other Fixed Battery launch facilities have also been removed, including two launch pads, the interior blast berms, and the cable trench.

LC-32 West consists of the original Sergeant testing area established in 1958. This area, opposite the Hawk area to the east, was the primary flight test area at WSMR for the Sergeant missile testing during the late 1950s and early 1960s. The location also supported Sergeant ASP firings through the early 1970s. The major facilities included a combination assembly/blockhouse (Property 20525), launch pad (Property 20521), cable trench (Property 20520, blast barricade (Property 20527), and heat plant (Property 20526). Following the conclusion of the Sergeant testing, this portion of LC-32 was modified to support the Hera Target Missile program in the 1990s and currently hosts the Japanese Chu-SAM program.

The MTLC is a series of drone launch complexes that are aligned near the east boundary of the complex. This area consists of two nearly identical aerial target drone launch complexes, each with two launch pads (Properties 20755, 20756, 20759, and 20760), control building (Properties 20754 and 20758), and air compressor shelter (Properties 20753 and 20757). An additional drone launch complex is also located further east, but appears to be decommissioned and lacks any associated buildings. The MTLC area is located to the east of the Hawk Fixed Battery area, across the northern extension of Range Road 200. It supplanted the older Hawk Annex during the 1970s and continued the eastern growth of the LC-32 built environment and also altered the road network in this portion of the range.

LC-32 South is located south of the main LC-32 complex on the opposite side of Nike Avenue. The original facilities in this area were constructed in support of the LC-32 Hawk program in 1959, and the location was referenced as LC-32 South in several period photographs and documents. It is also identified as the Hawk Engineering and Contractor Facility Area in the 1982 WSMR Master Plan map of the area. This area includes Property 21759, home of the Raytheon Hawk program and known as the Hawk Hangar, and Property 21756, another large assembly building constructed for the Hawk program. Each of these buildings is located within a discrete fenced compound that includes various associated facilities. Property 21756 was also used in support of the Raytheon Mauler program before its cancellation in 1965. Although Raytheon relocated away from Property 21759 during the 1970s as the SAM-D/Patriot program at LC-38 expanded, Property 21756 and surrounding properties continue to be used by the contractor in support of the Hawk and Stinger missile programs.

The Uncle Site is a small cluster of facilities located south of LC-32 East along Range Road 200. The Uncle Site is encompassed by the current boundaries of LC-32 and has been used as an extension of the complex in recent years; for these reasons it was included in the current inventory effort. However, the Uncle Site location actually pre-dates the establishment of LC-32 and was not related to the formation of the launch complex. Rather, it was established as part of the WSMR timing network in 1952. Documentary evidence suggests that the primary building at Uncle Site, Property 20710, was one of the four range timing signal generator stations that were in operation as of the early 1960s. A steel lattice radio tower (Property 20711) located nearby was likely used to broadcast the timing signal. The Uncle Site facilities no longer appear to be in use, but several modular structures have been added to this area in support of the Orion LAS program.

A series of support properties are located outside the primary concentration of facilities at LC-

32 and are not specifically related to any of the identified sub-areas at the complex. As such they occupy a diverse set of locations across the complex and generally were not constructed or used exclusively for any particular program. These dispersed properties, as they are referred to here, mostly consist of instrumentation sites such as Properties 20502, 20505, 20701, and 20706 and miscellaneous support properties such as Properties 20510, 20560, and 20562.

8.8.9 Archaeological Sites

Military installations often include prehistoric and historic archaeological sites, but most predate the military use of the land and are unrelated to the military mission of the installation (Loechl et al. 1994:40). Accordingly, the current inventory was thematically oriented towards extant Cold War buildings, structures, and objects at LC-32. Archaeological manifestations related to this thematic approach were captured as features, which were generally associated with buildings, structures, and objects.

The perspective of historic military landscapes is thematically limited to military use of the landscape, but archaeological sites can nonetheless inform on past military missions of the installation (Loechl et al. 1994:40). Some military forts and training areas in the Southwest have long histories that began with the concession of the region to the United States by Mexico as part of the Treaty of Guadalupe Hidalgo in 1848. Fort Bliss is an excellent example, which was first established in 1849 and has steadily transitioned from a small isolated frontier outpost to a major center for Army training and maneuvers. WSMR is a different case, as the earliest significant military use of the Tularosa Basin occurred during WWII, predating the establishment of WSPG by only a few years. No prior military missions are known to have been conducted in this part of WSPG in the short interval between the founding of the proving ground in 1945 and the establishment of LC-32 in 1958. Accordingly, no historic archaeological sites related to the military use of the area prior to the establishment of LC-32 were encountered during the inventory. Prehistoric sites have been previously documented in undeveloped areas within the boundaries of LC-32 as part of prior archaeological inventory efforts. The land use of these prehistoric occupations occurred during different environmental conditions and was motivated by widely divergent factors than the 20th century military use of the landscape. As a result, the presence of these sites was not incorporated into the present landscape perspective.

8.8.10 LC-32 as a Historic District

Consideration of LC-32 within an appropriate historic context and analysis of its physical landscape characteristics show that it meets some, but not all, the physical criteria of historic military landscapes put forth by Loechl et al. (1994). As discussed above, as a military landscape LC-32 does not express military cultural traditions, lacks boundary demarcations, nor does it represent a specific response to the natural environment. However, it does have an identifiable spatial organization, possess circulation networks, include areas of modified vegetation, and is organized into recognizable clusters of buildings, structures, and objects. Many of these physical qualities were more evident in the original 1958 organization of the complex, but have been steadily diminished with the constant adaptive re-use of the complex that continues even now.

Per the guidance offered in Loechl et al. (1994), historic military landscapes are nominated as historic sites or districts. While LC-32 does represent an identifiable expression of the military mission on the land, it also possesses problems of integrity that make it an unlikely candidate for a historic district.

The language specific to historic districts is contained within the understated but very important final clause of eligibility Criterion C, which allows for properties "that represent a significant and distinguishable entity whose components may lack individual distinction" (NPS 1995:2), to be nominated to the NRHP. In essence, the district clause of Criterion C allows recognition of groups of properties whose whole is greater than the sum of their parts (King 2004:113).

According to NRHP guidelines, "A district possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development" (NPS 1995:5). The LC-32 properties represent a definable concentration of resources, subsets of which are united historically and aesthetically. Yet, as discussed in the section on integrity, LC-32 as a whole has undergone a substantial series of modifications and additions over the years that has significantly diminished the historical and physical coherence of the complex.

As a result, LC-32 has transitioned from a relatively discrete entity to more of a palimpsest accumulation of properties, many of which post-date the end of the Cold War and are unrelated to the programs the complex was established to support. The two core areas of LC-32, the Hawk area and the Sergeant area, have both undergone recent additions and reuse within the last 20 years. Due to the above identified issues of alterations and recent additions to LC-32, and the diminished integrity of many of the individual resources, a district encompassing the LC-32 properties cannot be recommended.

8.9 Summary

Although the previous inventory efforts made valuable contributions to the documentation of the LC-32 resources, these efforts did not include all the properties or address their significance within a detailed historic context. Two important Cold War Historic Themes as defined by Lavin (1998) are applicable to LC-32, which was established in support of the Hawk and Sergeant programs in 1958 and continued to serve as one of the major launch complexes at WSMR through the remainder of the Cold War. Following the end of the Cold War, additional test programs at LC-32 continued the evolution of the complex, modifying it from its original Cold War layout. As a result, the launch complex overall retains minimal integrity from its period of significance and in its current state is not united historically or functionally. As a result, LC-32 is not recommended as a historic district.

At the individual level, most of the inventoried properties lack significance under any of the four primary criteria and are not recommended for individual eligibility to the NRHP or as contributing elements to any possible district. However, the former Hawk Hangar building, Property 21759, was previously recommended as eligible under Criteria A, C, and D. Epsilon Systems concurs with the recommendation of the property as eligible under Criterion A due to its extensive association with the Hawk program, but does not recommend the property as eligible under Criteria C and D.

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Preparers' Qualifications

Nathaniel Myers, M.A. (Anthropology, Eastern New Mexico University) is a professional archaeologist with more than seven years of experience. He has performed prehistoric and historic archaeological studies throughout New Mexico and meets the SOI's Professional Qualification Standards (36 CFR Part 61) for Archaeology. Mr. Myers has worked on a broad range of Section 106 and 110 compliance projects for federal, state, municipal, and private clients. As an archaeologist, Mr. Myers has dealt with a wide range of temporal and cultural manifestations across the Southwest. He has also worked on a variety of historic preservation projects, including historic building inventories, archival research, artifact analysis, and individual and district nominations for the NRHP. Mr. Myers also has significant experience with late-nineteenth-century homestead and mining sites and Cold War-era military programs and related facilities. For the current inventory, Mr. Myers served as the primary report author, conducted fieldwork and in-field resource documentation, performed archival research, assisted with oral history interviews, and completed HCPI forms.

Brad Beacham, M.A. (Anthropology, Eastern New Mexico University) has worked as a professional archaeologist for over 12 years in the Great Basin, Southwest, and Mid-Atlantic, the last eight of which have been specific to New Mexico and Texas. He has broad experience in all phases of cultural resources management (CRM) for a wide variety of federal, state, municipal, and private clients. Mr. Beacham has managed Section 106, National Environmental Policy Act (NEPA), NEPA, and Tribal coordination projects, including the direction of fieldwork, the preparation of compliance documents, and client consultation. As an archaeologist, Mr. Beacham has dealt with a wide range of temporal and cultural manifestations across the Southwest. His demonstrated prehistoric expertise includes Ancestral Puebloan, Jornada Mogollon, Mimbres, and Apache sites. His demonstrated historic expertise includes urban landscapes, late-nineteenth-century mining, railroad and irrigation sites and districts, as well as Cold War-era military programs and related facilities. In addition to serving as co-author for the current inventory, Mr. Beacham conducted fieldwork and in-field resource documentation, compiled GPS and GIS data for the resource mapping, completed HCPI forms, and provided valuable assistance in conducting oral history interviews.

Phillip Esser, B.S. (Historic Preservation, Roger Williams University), is an architectural historian with more than 15 years of experience who meets the U.S. Secretary of the Interior's Professional Qualification Standards (as defined in 36 CFR Part 61) for architectural history and history. Mr. Esser has a wide range of historic preservation expertise, particularly historic building documentation ranging from individual buildings to large building surveys for state and National Register landmarking as well as Federal Tax Rehabilitation projects. Mr. Esser has extensive experience with Section 110 and 106 evaluations, preparation of National Register of Historic Places Determinations of Eligibility studies and preparation of nominations as well as historic building surveys. Mr. Esser acted as project manager and contributing author for the current inventory, in addition to conducting archival research and conducting oral history interviews.