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Explosives Safety Submission

Munitions Response Action

Western Magazine Area

Former Mare Island Naval Shipyard Vallejo, California

September 2005

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TABLE OF CONTENTS

1. Project Summary 1-1
2. Maps/Figures 2-1
   - 2.1 Regional Map 2-1
   - 2.2 Site Map 2-1
   - 2.3 Munitions Response Area Map 2-1
   - 2.4 Proposed Open Area Geophysical Prove-Out Area 2-1
   - 2.5 Proposed Building Footprint Geophysical Prove-Out Area 2-1
3. Amount and Type of MEC 3-1
4. Project Start Date 4-1
5. Frost Line 5-1
6. Response Techniques 6-1
7. Quantity-Distance 7-1
8. Off-Site Disposal 8-1
9. Environmental Considerations 9-1
10. Technical Support 10-1
11. Land Use Restrictions 11-1
12. Public Involvement 12-1
13. References 13-1

LIST OF FIGURES

Figure 2-1 Mare Island and Western Magazine Area Location Map 2-2

Figure 2-2 Western Magazine Area Site Map 2-3

Figure 2-3 Western Magazine Area Munitions Response Areas 2-4

Figure 2-4 Proposed Open Area Geophysical Prove-Out Area 2-5

Figure 2-5 Proposed Building Footprint Geophysical Prove-Out Area 2-6

LIST OF TABLES

Table 3-1 Recovered MEC (1997-98 Intrusive Investigation) 3-1

Table 6-1 Open Area GPO Seed Items 6-4

Table 6-2 Building Footprint GPO Seed Items 6-5

Table 7-1 MGFD Exclusion Zone Summary 7-4

1. PROJECT SUMMARY

The Western Magazine Area (WMA) is located on the former Mare Island Naval Shipyard located in Vallejo, California as shown in Figure 2-1. The WMA is situated on the southern portion of Mare Island between a hilly upland area to the east and the San Pablo Bay wetlands to the west. The area is approximately 1,000 feet wide, 4,500 feet long, and covers 108 acres. The primary purpose of the WMA was to store medium and large caliber gun ammunition for use aboard Navy ships between its creation in 1938 and closure of the ammunition facility in 1975. There are 22 aboveground magazines in the complex; eight set into the hillside to the east and fourteen constructed on fill material to the west. The location of the site-approved munitions storage facility for discarded munitions recovered at Mare Island (Magazine A180) is shown in Figure 2-2.

The WMA was identified as a munitions area of concern by the Ordnance Preliminary Assessment (PA) completed in 1995 by PRC Environmental, Inc. (PRC, 1995). The PA described the history of munitions activities at Mare Island, including the construction of ammunition storage magazines in the WMA between 1931 and 1939. The PA concluded that the site was an area of potential concern and recommended further investigation to determine if buried munitions were present.

A geophysical survey of the area was subsequently completed during the 1995-96 Unexploded Ordnance (UXO) Site Investigation (SI) completed by Mare Island Naval Shipyard/Superintendent of Shipbuilding, Conversion, and Repair, Portsmouth, Virginia (SSPORTS) Environmental Detachment Vallejo. The SI survey was performed using a combination of handheld MK 26 magnetometers and a Geometrics G-858 Gradiometer. MK 29 metal detectors were also used to supplement the magnetometers in specific areas where non-ferrous munitions constituents (gun ammunition primers) had been observed on the surface. A total of 1,065 discrete anomalies were identified by the SI survey at estimated depths ranging from one to six feet.

SSPORTS was subsequently tasked by the Navy to complete the munitions intrusive investigation of the WMA. All anomalies documented by the SI were relocated, excavated, and evaluated during the 1997-1998 intrusive investigation to determine if they posed a munitions

hazard. DDESB approval of the project was obtained in August 1997 (NOC, 1997b). The removal of buried munitions during the intrusive investigation was intended to satisfy the minimum clearance requirements of the Department of Defense Explosives Safety Board (DDESB) as outlined in Section 2.1.14 of NAVSEA OP 5 (Ammunition and Explosives Ashore) for the planned reuses of the site. “Public Access” (recreational) and “Limited Public Access” (wildlife preserve) reuses are planned for the site as described in the Mare Island Final Reuse Plan (City of Vallejo, 1995). The minimum clearance depths specified by the DDESB in the intrusive investigation explosives safety submission approval letter of April 1997 (NOC, 1997b) were 4 feet overall and 10 feet in the vicinity of used or maintained utilities. Clearance depths were based on the planned reuse of the site in order to maintain public safety in accordance with Chapter 12 of Department of Defense Standard 6055.9 (Ammunition and Explosives Safety Standards; DOD, 1999).

The WMA as defined for the current project by the Mare Island Remediation Agreement includes a small area within the adjacent South Shore munitions response area. The same munitions removal philosophy and criteria (including minimum clearance depths and removal techniques) were applied to this additional area during previous munitions actions.

All 1,065 anomalies documented by the UXO SI geophysical survey were investigated, evaluated, and removed during the intrusive investigation completed between September 1997 and June 1998,. A total of 156 *munitions and explosives of concern* (MEC) items were recovered, including 20 mm anti-aircraft rounds/projectiles (132 items), 40 mm anti-aircraft rounds/projectiles (9 items), 1.1 inch anti-aircraft rounds/projectiles (1 item), projectile nose fuze (1 item), and MK 15 gun ammunition primers (13 ea). Most of the recovered MEC gun ammunition consisted of an integrated cartridge case and projectile assembly. Those few separate projectiles that were recovered were unfired (i.e., they had no rifling marks on their rotating bands or other indication of having been fired). They are believed to have been separated from their associated cartridge cases because of the deteriorated condition of the cases and by handling received during their disposal, deposition, and subsequent recovery. Various scrap metal objects, primarily remnants (rail spikes and plates, pieces of broken switches, etc.) of the rail system removed as interference prior to the initial geophysical survey, accounted for the remainder of the anomalies investigated.

No discernable evidence of explosives contamination in soil or groundwater was noted during the intrusive investigation. The recovered MEC items were substantially intact and no bulk explosives materials were encountered or suspected. Because the approved investigation work plan required sampling only where contamination was known or suspected to exist, no sampling of soil or groundwater for explosives was performed. Since all anomalies identified by the SI were removed by the intrusive investigation, no additional MEC is known to remain at the site. Details of the investigation are described in the Final Summary Report for the Unexploded Ordnance Intrusive Investigation of the Western Magazine Area at Mare Island (SSPORTS, 1998b).

All munitions response actions have been planned in consultation with regulatory agency representatives to effectively address the various environmental concerns (including the presence of buried munitions) posed by the closure of Mare Island Naval Shipyard. The response actions have been performed utilizing the best available technology and techniques to meet existing Department of Defense (DOD), Navy, and regulatory agency requirements to support the ultimate transfer and reuse of the property.

The property is currently in the Remedial Investigation (RI) phase of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process. A second survey and clearance of the site, termed a ***"munitions confirmation survey"*** is required by regulatory agencies to support completion of the RI and the ultimate transfer of the property. The confirmation survey will also provide an opportunity to utilize advances in quality control (QC) methodology and available new techniques to address perceived shortcomings in past survey efforts. Specifically, the confirmation survey will focus on the following areas:

- *Dredge Outfall*—A previously unknown dredge outfall site containing discarded munitions was identified and removed during the intrusive investigation. Further analysis of historical aerial photographs suggests that a second outfall may exist at the edge of a wetland area not previously surveyed. Dredge outfall locations at Mare Island have typically been found to contain small caliber (20 mm, 40 mm, and 1.1 inch) anti-aircraft munitions discarded overboard after the end of World War II.

- *Magazine Footprints*—The lack of a survey under the magazines was noted by regulatory agencies as a concern during their review of the initial munitions SI summary report in 1997. No technology available at that time could effectively discriminate buried munitions from reinforcing steel in the building floor and support pilings. Survey technologies and data processing techniques able to locate anomalies under the magazine footprints are available today. Surface and near-surface anomalies deposited after construction of the magazines are the primary concern since the magazines were built on clean upland fill material.
- *Quality Control Measures*—Although the QC measures implemented during the previous survey and investigation activities were adequate, documentation supporting the measures is not available. Current data processing techniques can effectively validate the adequacy of previous geophysical data collection and removal activities by analyzing available SI electronic survey data to corroborate the selection of applicable anomalies and verify their removal.
- *Use of "Real-Time" Survey Instruments*—Portions of the WMA, were surveyed during the original SI using handheld "real-time" survey instruments (MK 26 Ordnance Locators) that did not provide a permanent data record of anomaly parameters or verification of adequate search coverage. This lack of verifiable survey data prevents effective QC confirmation of the previous search results and necessitates resurvey of the areas.

The current munitions confirmation survey will resurvey those areas of the site where SI electronic survey data is not available or is considered unreliable. The resurvey will also include those areas previously surveyed using only MK 26 instruments and other areas, such as the building footprints and potential outfall site, that were not previously surveyed. Anomalies identified by the data reassessment and resurvey will be excavated and removed to a minimum depth of 4 feet overall and 10 feet in the vicinity of used or maintained utilities.

The site has been divided into the five discrete Munitions Response Sites (MRSs) shown on Figure 2-3, based on their history and potential mode of munitions placement:

- Roads/Rail Lines/Vicinity of Magazines (MRS 1)—The 38-acre area includes the land along the roads and rail lines and surrounding the munitions storage magazines; typically begins at the edge of the roadway pavement and extends approximately 15 feet down the sloped embankment to the edge of the wetlands.
- Magazine Footprint Area (MRS 2)—The 4-acre area is defined as the soil underneath the aboveground magazine structures.
- Open Storage Areas (MRS 3)—The area includes 8 acres used as open storage areas for munitions-related items between 1945 and 1947.
- Dredge Outfall (MRS 4)—Approximately 1-acre located at the site of a possible dredge pond outfall identified from historical photographs. One other nearby outfall located during the intrusive investigation yielded numerous MEC items discarded overboard following World War II.
- Wetland Area (MRS 5)—The area covers approximately 57 acres; no previous surveys were performed because of its status as endangered species habitat and a low probability of containing discarded munitions.

2. MAPS/FIGURES

2.1 REGIONAL MAP

Figure 2-1 shows the location of Mare Island relative to the San Francisco Bay Area and the WMA in relation to Mare Island.

2.2 SITE MAP

Figure 2-2 shows the 200 foot exclusion zone distance from all potential WMA excavation sites and the nearest inhabited buildings. A 200 foot exclusion zone around each work area will be invoked, as described in Section 7, during all site work that may involve the excavation, handling, or evaluation of recovered MEC.

The figure also shows the 1,250-foot Inhabited Building Distance (IBD) arc from the MEC storage site (Magazine A180) and the 1,250-foot exclusion zone established around the MEC treatment site (Disposal Range #2) during MEC treatment events.

2.3 MUNITIONS RESPONSE AREA MAP

Figure 2-3 shows the five Munitions Response Areas located within the WMA.

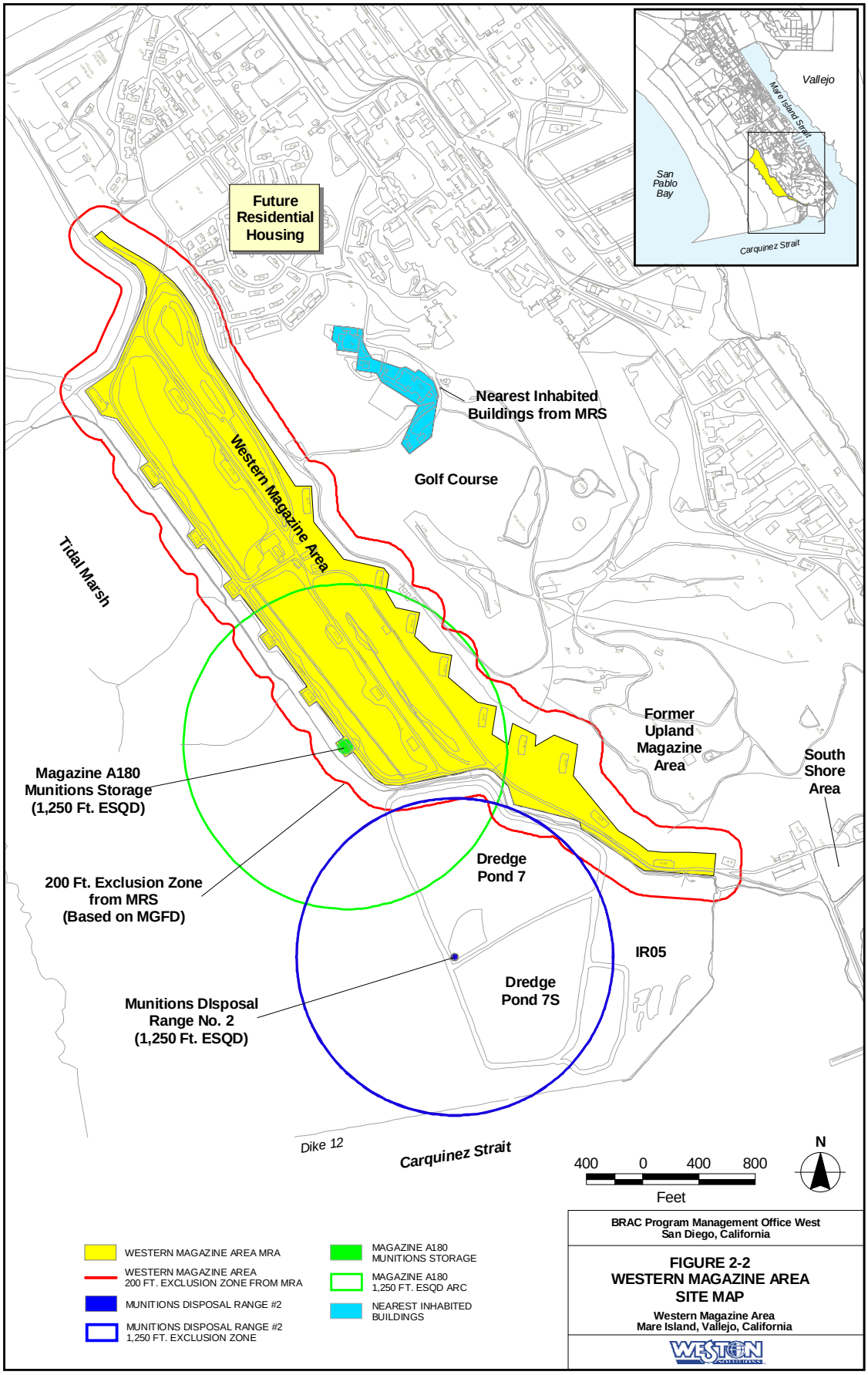
2.4 PROPOSED OPEN AREA GEOPHYSICAL PROVE-OUT AREA

Figure 2-4 shows the layout of the proposed open area Geophysical Prove-Out (GPO) area applicable to the four open area Munitions Response Areas (MRS 1, 3, 4, and 5) located within the WMA.

2.5 PROPOSED BUILDING FOOTPRINT GEOPHYSICAL PROVE-OUT AREA

Figure 2-5 shows the layout of the proposed building footprint GPO area applicable to the building footprint Munitions Response Area (MRS 2) located within the WMA.

Figure 2-1 Mare Island and Western Magazine Area Location Map


Future Residential Housing
Vallejo
Mare Island Strait
San Pablo Bay
Carquinez Strait
Nearest Inhabited Buildings from MRS
Golf Course
Western Magazine Area
Tidal Marsh
Former Upland Magazine Area
South Shore Area
Magazine A180 Munitions Storage (1,250 Ft. ESQD)
200 Ft. Exclusion Zone from MRS (Based on MGFD)
Dredge Pond 7
IR05
Dredge Pond 7S
Munitions DIsposal Range No. 2 (1,250 Ft. ESQD)
Dike 12
Carquinez Strait
400 0 400 800
Feet
N
WESTERN MAGAZINE AREA MRA
WESTERN MAGAZINE AREA 200 FT. EXCLUSION ZONE FROM MRA
MUNITIONS DISPOSAL RANGE #2
MUNITIONS DISPOSAL RANGE #2 1,250 FT. EXCLUSION ZONE
MAGAZINE A180 MUNITIONS STORAGE
MAGAZINE A180 1,250 FT. ESQD ARC
NEAREST INHABITED BUILDINGS
BRAC Program Management Office West
San Diego, California
FIGURE 2-2
WESTERN MAGAZINE AREA
SITE MAP
Western Magazine Area
Mare Island, Vallejo, California

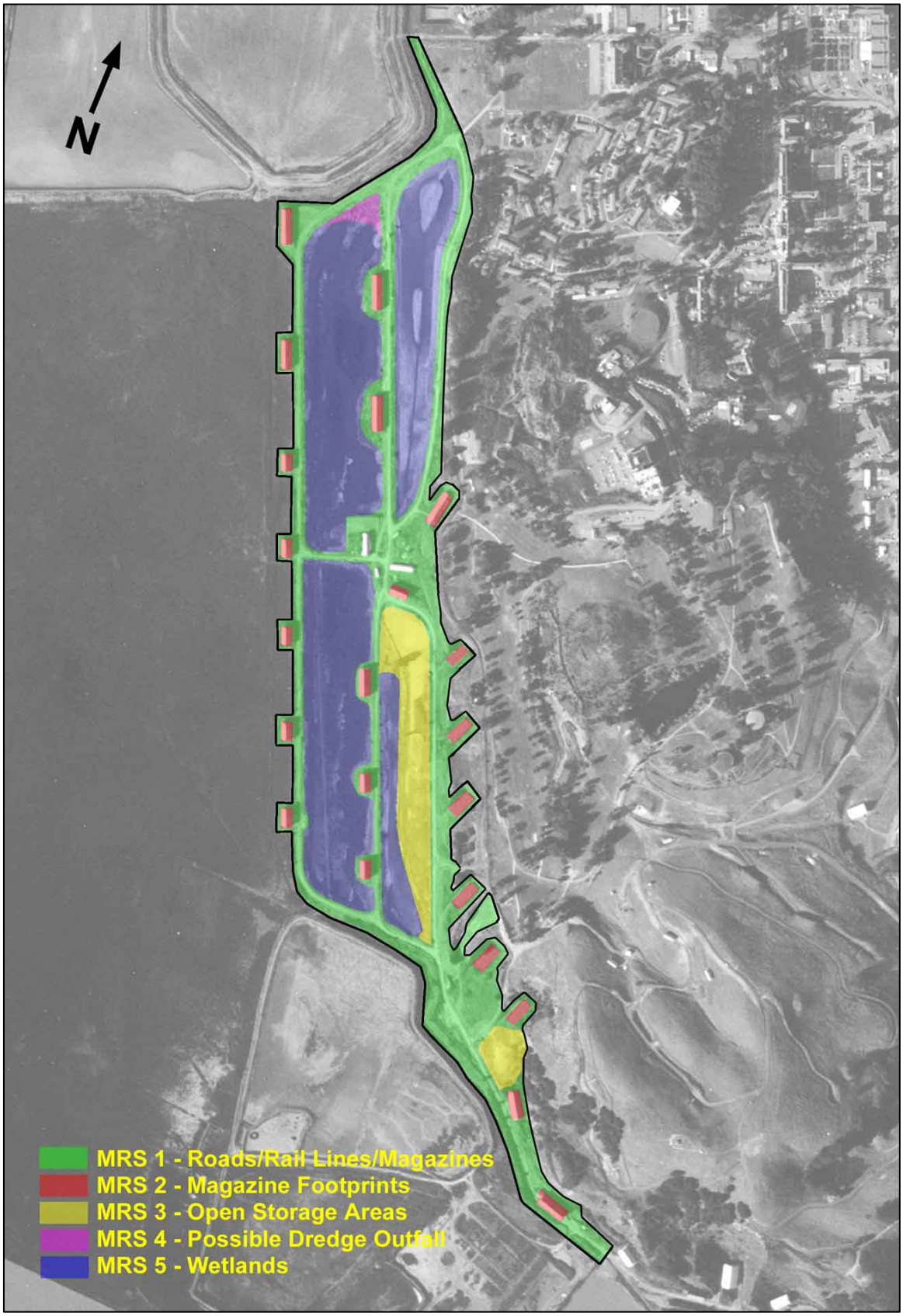


Figure 2-3 Western Magazine Area Munitions Response Areas

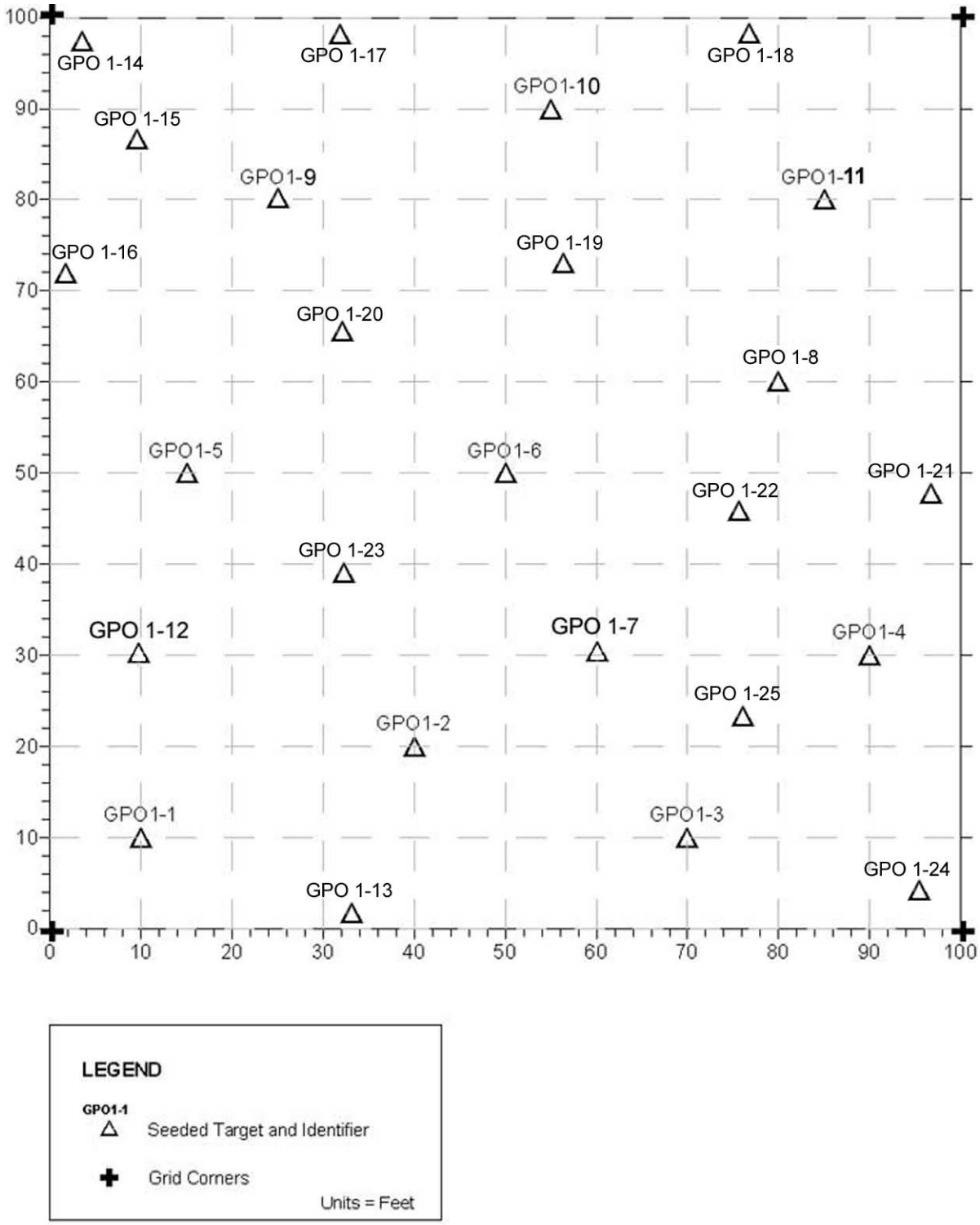


Figure 2-4 Proposed Open Area Geophysical Prove-Out Area

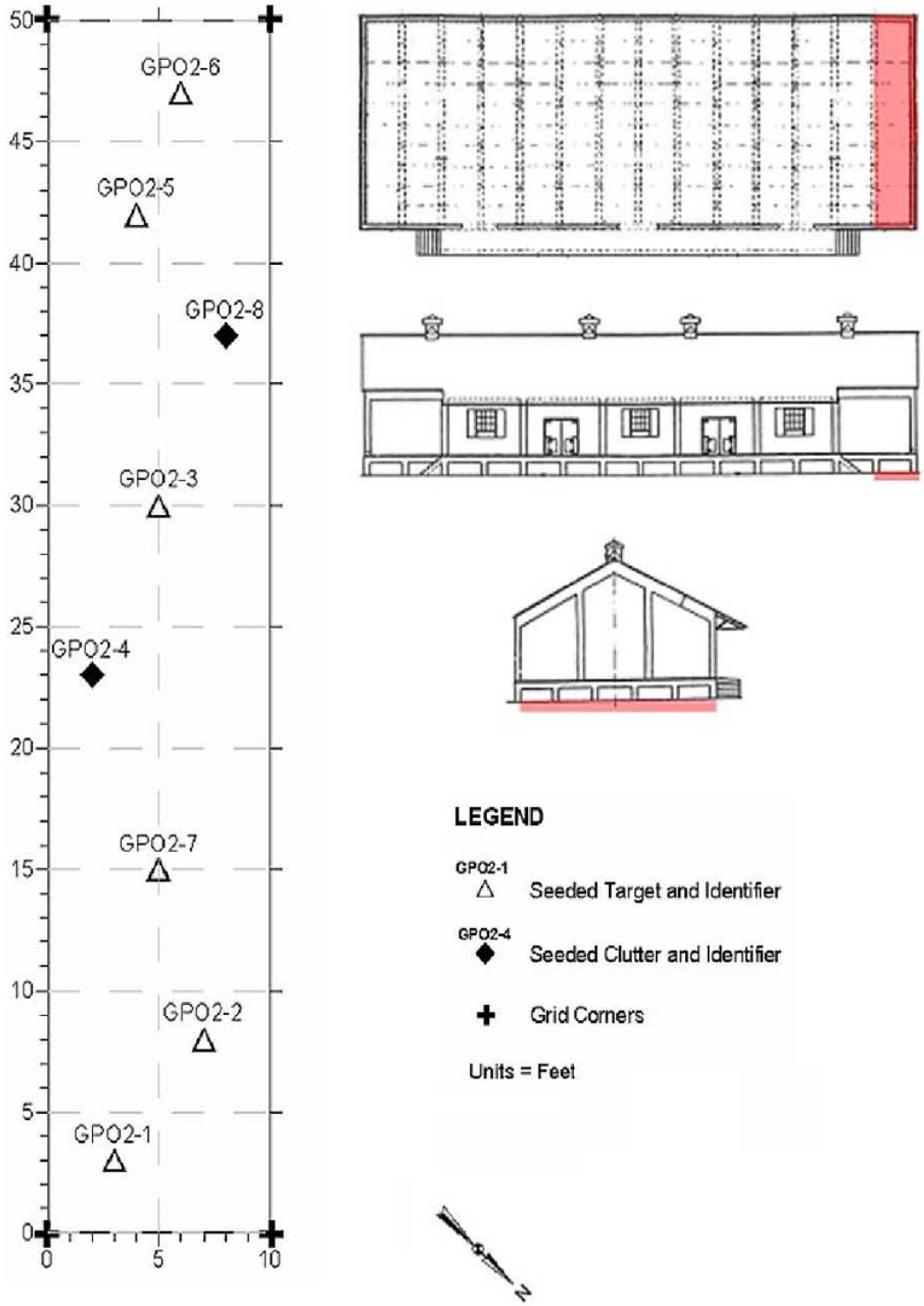


Figure 2-5 Proposed Building Footprint Geophysical Prove-Out Area

3. AMOUNT AND TYPE OF MEC

Numerous MEC items were recovered from the site during the prior investigation and removal of geophysical anomalies (as shown in Table 3-1) and none are known to remain. The prevalent munitions types encountered during previous actions are 40 mm, 20 mm, and 1.1 inch high explosive anti-aircraft rounds dating to the World War II era. Based on the MEC items already recovered from the site, the most probable *munition with the greatest fragmentation distance* (MGFD) is the 40 mm MK 2 high explosive anti-aircraft round.

Table 3-1
Recovered MEC (1997-98 Intrusive Investigation)

MEC Item	Quantity
MK 15 primer	13
#253 projectile nose fuze	1
20 mm high explosive projectile	36
20 mm high explosive round	49
20 mm round (no fuze)	47
40 mm MK 2 high explosive projectile	8
40 mm cartridge case (projectile base and propellant only)	1
1.1 inch high explosive projectile	1

No explosive-contaminated soil or buildings are known to exist at the site. There are no occupied structures located at or near the site and access into the area is restricted by fencing and locked gates maintained by the Navy.

The WMA is located adjacent to three other Mare Island MRAs as shown in Figure 2-2:

- The former Upland Magazine Area to the east was initially identified as a potential munitions area of concern but subsequent geophysical survey and investigation actions revealed no evidence of discarded munitions (SSPORTS, 1997b).
- The South Shore Area was a former munitions storage and handling area where munitions were discarded by dumping/burial along the historic shoreline. This area has

also been previously surveyed and all anomalies removed; a munitions confirmation survey will likely be required to facilitate transfer (Weston, 2003).

- Installation Restoration Site 05 was the location of a former munitions disposal area operated from 1948 through 1975. All detectable munitions material was removed from the site during a 1995-97 removal action; a munitions confirmation survey will likely be required to facilitate transfer (SSPORTS, 1998a).

4. PROJECT START DATE

Project work, including surveys and anomaly investigation, is scheduled to begin in October 2005.

5. FROST LINE

There are no known potential phenomena that would cause movement of MEC. Mare Island is located in a temperate region where frost heave is not a concern. The site is predominantly flat and vegetated such that erosion is not a realistic concern.

6. RESPONSE TECHNIQUES

The proposed munitions confirmation survey consists of a preliminary visual surface search (to remove metallic surface debris), a geophysical survey, and a removal of all identified anomalies. The five MRSs within the WMA referred to in this section are shown on Figure 2-3.

Since MEC items comprised of both ferrous and non-ferrous materials were recovered during previous actions, systems utilizing both EM and magnetometer sensors will be utilized to perform the surveys. A magnetometer can reliably locate ferrous items at deeper depths than an EM system and is more effective at minimizing interference in high clutter situations (such as the magazine footprint areas). An EM system is capable of locating non-ferrous as well as ferrous targets. Three separate systems, all of which provide geo-referenced data via an integrated GPS receiver, will be used to perform the survey:

- A Geonics EM-61 inductive time domain electro-magnetic (TDEM) instrument will be used to survey the Open Storage Area (MRS 3 in Figure 2-3) since non-ferrous MEC items have been encountered near the surface in this area
- A Geometrics G-858 cesium vertical gradiometer will be used to survey the Roads, Rail Lines, and Magazine Area (MRS 1 in Figure 2-3) and the Dredge Outfall Area (MRS 4 on Figure 2-3), since expected MEC includes small to medium caliber gun ammunition and other munitions items constructed largely of ferrous materials. Possible anomalies also include dredge outfall debris that may be buried at depths exceeding 10 feet.
- The GeoVizor system will be utilized to locate anomalies in the Magazine Footprint Area (MRS 2 in Figure 2-3). The system, developed by Gifford Integrated Sciences, incorporates a Geometrics G-858 magnetometer sensor and laser/ultrasonic positioning system with a laptop computer that enables dynamic real-time data processing and visualization of anomalies. Preliminary trials indicate the system is capable of discriminating anomalies from interferences caused by the steel reinforced magazine floor and support pilings. The ability of the integrated GeoVizor system to present a visual representation of the spatial location of anomalies in real time will also be

implemented as a QC tool to verify that detected anomalies have been completely removed.

The proposed survey instruments were evaluated by the Naval Surface Warfare Center at Dahlgren Virginia (NOSSA, 2005) with regard to Hazards of Electromagnetic Radiation to Ordnance (HERO). The G858, and the GeoVizor system utilizing an G858 sensor/electronics unit, will not produce measurable electromagnetic radiation during normal operation and therefore poses no HERO concerns. The EM-61 system operating at an average power level will necessitate a safe separation distance of 1 foot (0.3 meters) be maintained between the coils and the soil surface. HERO warning labels will be affixed to the EM-61 indicating the required standoff distance.

Although included within the WMA munitions response area, the Wetland Area (MRS 5 in Figure 2-3) is not believed to represent a munitions concern for the following reasons (SSPORTS, 1997a):

- There is no historical evidence of munitions being discarded there.
- No munitions had ever been encountered in the wetland areas.
- Due to its present and future classification as endangered species habitat.

Search instruments were selected to represent the best available technology to locate the expected anomalies at depths characteristic for each of the areas. Capabilities of the EM-61 and G-858 systems will be verified at a nearby 100 x 100 foot open area GPO test area established in representative soil conditions (Figure 2-4). A second GPO test area will be established under one of the WMA magazines to verify capabilities of the GeoVizor system to locate anomalies in a building footprint environment (Figure 2-5). Blind seeding of test plot targets representing the range of potential MEC items will be utilized to verify the combined capabilities of the system and operator. The proposed seed items are listed in Tables 6-1 and 6-2.

The GPO test areas will be developed to duplicate, as closely as possible, the conditions under which the geophysical surveys will be conducted. Representative inert ordnance will be used as seed items for burial in the GPOs. If inert ordnance items are not available, surrogates of approximately the same composition, size, and shape will be utilized.

The GPO process will ensure that the following DQOs are satisfied:

- Instrument Latency DQO: Instrument latency will be corrected based on the lags or time differences observed in anomaly peak positions. Corrections will be applied using an appropriate correction routine that accounts for instrument latency time and sensor velocity. “Zig-zag” or “chevron” effects should not be visible in the data maps when plotted at the scales used to detect the smallest amplitude signal for a given MEC item.
- Magnetic heading DQO: For proper heading correction there should be no ‘striping’ visible in vertical gradient data above a 0.2 nanoTeslas per foot (nT/ft) level between lines and no ‘striping’ visible in total field data above a 0.4 nT/ft level between lines.”
- Diurnal data DQO statement: The base station data should exhibit normal characteristics for such data. Background variations of less than 1 nt are typical between measurements during periods without magnetic storms.
- EM leveling DQO statement: For any given dataset of EM data, all data channels will be leveled using the same routines and parameters.
- Processing DQO statement: All leveling and/or filtering routines that are applied to datasets will be evaluated, on a dataset by dataset basis, to confirm that those routines do not alter the nature of the original measured response.
- Sampling density/velocity DQOs: Along-track sampling densities should not exceed 0.5 feet. For EM and magnetometer data, the across-track line spacing will not exceed 3.5 feet. Average sampling velocity will not exceed 2.5 miles per hour.
- Anomaly Selection DQO: The senior geophysicist, or one of his/her designees, will certify that all anomaly selections have been performed or reviewed by them, and that they accept the anomaly selection as reasonable for the intended purpose of this project.
- Navigation DQO: The sum of all data positioning errors in the final datasets will not exceed +/- 2.0 foot. This DQO is specific to the reported positions of the state-plane coordinates for each data point in the final version of geophysical data. Many factors affect DGPS accuracies, including PDOP, SNRs, base-station geodetic coordinate accuracies, carrier-phase ambiguity resolution, etc.

Table 6-1
Open Area GPO Seed Items

Item Identification	X (feet)	Y (feet)	Target Type	Depth (inches)	Orientation (degrees from horizontal)	Azimuth
GPO 1-1	10	10	3 inch projo	30	60	E-W
GPO 1-2	40	20	5 inch projo	24	45	E-W
GPO 1-3	70	10	4 inch projo	36	60	N-S
GPO 1-4	90	30	40 mm	24	90	--
GPO 1-5	15	50	5 inch projo	48	45	N-S
GPO 1-6	50	50	8 inch projo	36	45	N-S
GPO 1-7	60	30	Projo fuze	12	90	--
GPO 1-8	80	60	20 mm	6	0	N-S
GPO 1-9	25	80	20 mm	24	0	E-W
GPO 1-10	55	90	4 inch projo	24	90	--
GPO 1-11	85	80	8 inch projo	48	30	E-W
GPO 1-12	10	30	40 mm	18	90	--
GPO 1-13	33	2	8 inch projo	48	90	--
GPO 1-14	4	97	40 mm	30	60	E-W
GPO 1-15	10	86	20 mm	12	90	--
GPO 1-16	2	72	4 inch projo	12	60	N-S
GPO 1-17	32	97	6 inch projo	24	30	N-S
GPO 1-18	77	98	40 mm	6	45	N-S
GPO 1-19	56	73	6 inch projo	36	90	--
GPO 1-20	32	46	3 inch projo	12	45	E-W
GPO 1-21	96	48	Projo fuze	6	90	--
GPO 1-22	76	46	3 inch projo	24	90	--
GPO 1-23	32	48	20 mm	18	45	N-S
GPO 1-24	95	5	5 inch projo	36	90	--
GPO 1-25	76	24	20 mm	0	45	N-S

Table 6-2
Building Footprint GPO Seed Items

Item Identification	X (feet)	Y (feet)	Target Type	Depth (feet)	Orientation (degrees from horizontal)	Azimuth
GPO 2-1	3	3	20 mm	1	60	E-W
GPO 2-2	7	8	40 mm	2	90	--
GPO 2-3	5	30	20 mm	2	45	N-S
GPO 2-4	2	23	Clutter	1.5	--	--
GPO 2-5	4	42	40 mm	0.5	60	N-S
GPO 2-6	6	47	20 mm	1.5	90	--
GPO 2-7	5	15	40 mm	1	45	E-W
GPO 2-8	8	37	Clutter	0.5	--	--

Oasis Montaj data analysis software will be utilized to select anomalies for investigation. The effectiveness of anomaly discrimination techniques will be evaluated by comparing data from anomaly "dig sheets" with predicted anomaly characteristics.

QC measures relating to the geophysical survey will include the following:

- Initial equipment calibration "prove-out" surveys will be performed prior to the start of survey activities. Inert munitions items representative of those recovered in the WMA will be planted at a 100 x 100 ft test area adjacent to Dredge Pond 7 at depths that will demonstrate the detection capability of the EM-61 and G-858 survey systems. An additional test area will be similarly established under one of the magazines in the WMA to evaluate the effectiveness of the GeoVizor system for the magazine footprint surveys. Results of the calibration surveys will establish operational baselines for equipment use and data processing, including lane spacing, baseline equipment calibration data, and anomaly identification.
- Prior to the start of each survey activity, equipment operators will divest themselves of all metallic objects (i.e., keys, steel-toed shoes, pocket knives) to eliminate any potential for

interference. Cellular phones, radio transceivers, and other sources of electromagnetic noise will not be permitted in close proximity of the coils due to the potential for interference. The operator will then move away from and back toward the energized search instrument to verify that there is no variation in instrument output.

- Prior to each initialization of the survey instruments (at a minimum once daily or more frequently based on varying survey or site conditions), the equipment will be calibrated in accordance with the manufacturer's specifications. Satisfactory operation will be verified by reacquiring the same fixed test target for each check to ensure that the instrument output remains consistent within 20%. Instrument battery levels will be within specified parameters (>10.6 volts for the EM-61; >65% for the G-858). A one minute static check of instrument response at rest will indicate acceptable instrument drift (1.5 mV for the EM-61; 1.5 nT/ft for the G-858).
- Prior to each use of the Differential Global Positioning System (DGPS) and ultrasonic positioning systems (at a minimum once prior to and following each survey session or more often based on varying survey or site conditions), accuracy of the equipment will be verified. Satisfactory operation of the DGPS receiver will be verified by locating a known point in the survey area to within 1 meter accuracy and by observing that the position threshold (Percent Dilution of Position or PDOP) during the survey remains less than 6.0. Satisfactory operation of the ultrasonic positioning system will be verified by observing that the location of a fixed point in the survey area remains consistent to within 1 foot accuracy.
- Random duplicate transects of the areas already surveyed will be conducted to demonstrate the repeatability of the measurements. A minimum number of transects required to meet the Verification Level III requirements of MIL-STD-1916 (DOD, 1996) will be completed. Any anomalies noted after data processing of the original data should also be mirrored in the data from the duplicate transects.
- Survey data stored in the data loggers at the completion of each day's fieldwork will be downloaded to a computer and reviewed by the project geophysicist. Data will be available for review by regulatory agencies upon request.

- All collected data will be reviewed daily for completeness, accuracy, and comprehensive DGPS coverage. Areas with incomplete survey data coverage ("data gaps") will be resurveyed at the earliest opportunity.
- A second geophysicist will examine the collected geophysical data for each grid to verify that all appropriate anomalies were selected for investigation.

QC measures relating to the relocation, excavation, and evaluation of selected survey anomalies will include the following:

- Satisfactory operation of the MK 26 magnetometers will be verified daily by reacquiring a buried test target established at the site. The MK 26 instruments will undergo factory calibration within 12 months of use.
- Satisfactory operation of the AN-19/2 metal detectors will be verified daily by establishing their ability to satisfactorily acquire the test item supplied by the manufacturer.
- Operation of radiological monitoring instruments will be verified using a known radiological source. Manufacturer calibration of radiological instruments will have been performed within 12 months of use. To validate the anomaly tracking and relocation processes, the positions of each relocated survey anomaly will be verified using MK 26 and/or AN-19/2 instruments prior to excavation.
- The boundary of each anomaly excavation will be searched using both the MK 26 and AN-19/2 instruments to ensure that all metallic objects are removed or evaluated and determined not to represent a munitions hazard prior to backfilling.
- All disturbed soil will also be surveyed with the search instruments to ensure that all hazardous items have been removed.
- Disturbed soil will be returned and the excavation area restored only after the excavation and soil have both been verified to be free of additional munitions as well as any suspected chemical contaminants.
- Information from the investigation of each anomaly will be compared with the geophysical data to ensure that the dig results match the expected targets.

- The GeoVizor real-time geophysical system, exploiting its ability to visualize the spatial location of anomalies in real time will be used to verify satisfactory anomaly clearance of a minimum of 10% of the anomalies selected for investigation.

Additional periodic monitoring of munitions cleared areas will be accomplished independent of the anomaly investigation process using visual and geophysical search methods. The random independent search will ensure that the quality of the removal process is maintained throughout the operation.

Qualification requirements for project personnel include the following:

- Sweep personnel performing the visual surface search and assisting with the anomaly investigation and removal will receive training consisting of a general munitions safety briefing and familiarization with typical MEC items encountered in the WMA. Sweep personnel will also be required to demonstrate proficiency at performing assigned tasks while under the oversight of a qualified UXO Technician.
- Survey personnel will be required to demonstrate their proficiency using each specific survey instrument by locating typical anomalies at the appropriate test plot. Survey personnel will also be trained in general munitions safety and recognition of typical MEC items encountered in the WMA.
- The project Senior UXO Specialist (SUXOS) must be qualified U.S. Army Corps of Engineers (USACE) Tech III level with the requisite field experience. Other UXO Technicians may be qualified at the U.S. Army Corps of Engineers (USACE) Tech II or Tech III level and must be familiar with the typical MEC items encountered in the WMA. The UXO Technicians will evaluate and handle all suspected munitions items.

Recovered MEC items will be packaged and transported to Magazine A180 for temporary storage pending on-site treatment. All small arms ammunition and inert ordnance scrap will be controlled from discovery through disposal. Items identified as ordnance scrap will be inspected, containerized, and kept in a secure storage area until they are certified and verified to be inert, demilitarized in accordance with DOD Instructions 4160.21-M and 4160.21-M-1 (DOD, 1995)

(if necessary), and transferred to an approved processing facility (recycler). Small arms ammunition will be handled, transported, and treated with other MEC items.

7. QUANTITY-DISTANCE

The site MGFD is the World War II era 40 mm Bofors anti-aircraft round incorporating a Mk 2 High Explosive (HE) or High Explosive Incendiary (HEI) projectile loaded with approximately 0.15 lbs of TNT and incorporating a Mk 27 point detonating fuze. A summary of exclusion zone requirements relating to the MGFD is presented in Table-7-1.

The location and corresponding Inhabited Building Distance (IBD) Explosives Safety Quantity-Distance (ESQD) footprint of the existing DDESB site approved storage magazine (Magazine A180) is shown on Figure 2-2. The storage site, with an established 1,250 foot ESQD footprint (IBD) and a limit of 1,000 lbs Net Explosive Weight (NEW), was site-approved for the storage of recovered MEC in 1997 (NOC, 1997a). Access into the ESQD is controlled by the Navy and is restricted by a series of fences and locked gates.

The location and corresponding exclusion zone footprint of the existing DDESB approved treatment range (Disposal Range #2) is also shown on Figure 2-2. The range was site-approved for the disposal of recovered MEC in 1994, (NOC, 1994), with an established 1,250 foot exclusion zone that is controlled by the Navy and is restricted by fencing and gates. Since an established demolition area exists, no in-grid consolidated shots will be required. Table 13-1 of NAVSEA OP 5 indicates that the maximum fragment range for the intentional detonation of a 2 inch diameter projectile (the next larger diameter from the 1.57 inch equivalent diameter of the site MGFD) is 1,626 feet. However the use of earth cover, as discussed in Section 6 of DDESB Technical Paper 16 (DDESB, 2003) and quantified in the associated Buried Explosion Module (DDESB, 2004), can effectively reduce fragment range and size of the required exclusion zone. Based on data for a 40 mm MK 2 projectile, the BEM indicates that a dramatic reduction in fragment range can be obtained when earth cover is used to mitigate fragmentation. The current site-approved 1,250 foot exclusion zone is therefore considered adequate for the MGFD (within the established range limit of 25 lbs NEW), provided that a minimum of 1 foot of dry sand cover is used to mitigate fragmentation.

Recovered MEC placed into storage during this project will be managed and treated by the Navy under separate contract. MEC storage and disposal will be in accordance with the requirements of the *Engineering Evaluation/Cost Analysis and Removal Action Workplan (EECA/RAW) for the Operation of Mare Island Ordnance Storage and Treatment Facilities* (Weston, 2004). As described in the EECA/RAW, contained detonation technology will be utilized to treat recovered MEC when significant quantities of appropriately sized MEC are to be treated; otherwise treatment may be performed by open detonation at the established MEC treatment facility (Disposal Range #2) shown on Figure 2-2.

An exclusion zone extending a minimum of 200 feet around each work site will be established to prevent the entry of non-essential personnel during the excavation, evaluation, and removal of anomalies that could represent live munitions. The 200 foot arc represents the hazardous fragment distance (per Table 7-9 of NAVSEA OP 5) for the unintentional detonation of the site MGFD , the 40 mm HE/HEI anti-aircraft round. The size of the exclusion zone may be increased by the Senior UXO Supervisor based on the hazardous fragment distances in Table 7-9 of NAVSEA OP 5 for other munitions types that may be encountered. Team separation distances will correspond to the hazardous fragment distance (200 feet minimum) established for the exclusion zone.

The 200 foot exclusion zone is shown as a red boundary on Figure 2-2 extending around all potential work areas within the yellow WMA Munitions Response Area (MRA). The exclusion zone may impinge on some limited fairway and green areas of the adjacent public golf course for work areas located along the extreme eastern edge of the MRS. Access into areas of the golf course impacted by an exclusion zone will be prohibited during MEC operations and will be posted and barricaded in coordination with golf course management. Established golf course exclusion zones will be regularly monitored to ensure compliance with entry restrictions. The golf course clubhouse and other nearby structures are the nearest Inhabited Buildings to the MRA; they are well outside the exclusion zone footprint as shown in Figure 2-2. The “Future Housing Area” also shown on Figure 2-2 at the northeast corner of the MRA is currently in the grading stage; the structures visible on the photograph have been removed and construction/occupation of new structures is not expected during the time of planned work.

No “blow-in-place” operations are anticipated since munitions items recovered at Mare Island have all been discarded military munitions (DMM) and not fuzed/fired items that might pose a hazard during handling. However, should an unsafe item be encountered, the established 200 foot exclusion zone for the site is also considered adequate as a minimum evacuation distance for all potential MEC items. As discussed earlier in this section, the MGFD maximum fragment distance shown in Table 13-1 of NAVSEA OP 5, representing the minimum evacuation distance, may be reduced by the use of dry sand cover, as outlined in DDESB Technical Paper 16 (DDESB, 2003) and quantified in the associated BEM (DDESB, 2004). The maximum fragment distance of a 40 mm MK 2 projectile and 1.5 pound donor charge detonated with 3 feet of dry sand cover to mitigate fragmentation, would effectively be zero.

Since a relatively few number of MEC items are expected, recovered items will be immediately packaged and transported to the storage facility, precluding the need to establish collection points.

Table 7-1
MGFD Exclusion Zone Summary

Site	MGFD[1]		Exclusion Zones (feet)			
	Description	NEW[2]	Fragmentation Effects		Blast Overpressure Effects	
			HFD[3]	MFD[4]	K328[5]	K40[6]
Western Magazine Area	40 mm MK 2	0.150	200	1,626	959	22

NOTES:

1. Munition having the Greatest Fragmentation Distance.
2. Net Explosive Weight (in pounds) of one MGFD, from OP 1664.
3. Hazardous Fragment Distance for the 40 mm MK 2 from Table B-1 of TP-16, applicable to unintentional detonations.
4. Maximum Fragment Distance for the 40 mm MK 2 from Table B-1 of TP-16, applicable to intentional detonations.
5. Reflects detonation of multiple items and associated donor charges within range limit (25 lbs NEW).
6. Reflects detonation of a single MGFD item without donor charge.

Summary:

- ***Intentional detonation EZ for public & essential/non-essential personnel*** is K328 or MFD, whichever is greater (1,626 ft). Based on 40 mm MK 2 data in the TP-16 Buried Explosion Module (BEM), 1 ft dry sand overburden lowers MFD to 722 ft and 3 ft dry sand overburden lowers MFD to zero.
- ***Unintentional detonation EZ for public & non-essential personnel*** is greater of K40 or HFD (200 ft).
- ***Unintentional detonation EZ for essential personne***l is K40 (22 ft).

8. OFF-SITE DISPOSAL

Off-site disposal of recovered munitions (with the exception of small arms ammunition) is not a viable option since munitions recovered at Mare Island have been subjected to unknown environmental conditions for many years and cannot be considered safe to transport over public highways. No munitions of a size or type that would preclude on-site treatment are anticipated to be encountered at the site.

9. ENVIRONMENTAL CONSIDERATIONS

There are no significant environmental considerations involved with the confirmation survey. Although the site includes wetland areas (indicated in blue on Figure 2-3) classified as potential habitat for the endangered Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*), those portions of the site are not suspected to contain munitions and will not be affected by the survey. An environmental briefing will be provided to all site workers and they will be instructed to avoid the wetland areas.

The MEC storage facility (Building A180) and the MEC treatment facility (Disposal Range #2) will be operated in accordance with the requirements of the *Engineering Evaluation/Cost Analysis and Removal Action Workplan (EECA/RAW) for the Operation of Mare Island Ordnance Storage and Treatment Facilities* (Weston, 2004). Approval of the EECA/RAW document in 2004 constituted approval by State and Federal regulatory agencies (in lieu of the RCRA Part A/B permitting process) to continue use of the established MEC storage and treatment facilities until all MEC actions on Mare Island have been completed.

10. TECHNICAL SUPPORT

The evaluation and handling of suspected munitions items will be performed by Weston Solutions, Inc. UXO Technicians qualified at the USACE Tech II or Tech III level. Additional emergency support from military EOD personnel based at Travis Air Force Base is available via the Vallejo Police Department, should it be required. Note that, although a formal Memorandum of Understanding with the Air Force for responses to Mare Island is not in effect, established EOD policy is to respond to requests from municipal emergency services agencies when military munitions are involved. This process was successfully implemented in at least two recent instances when unexpected MEC items were encountered by contractors on Mare Island.

11. LAND USE RESTRICTIONS

The site is currently still under Navy control. Once all required actions have been completed to facilitate transfer of the property, restrictions appropriate for the MEC-related history of the site will be developed and implemented during the Record of Decision phase of the CERCLA process. Although no engineering controls are anticipated, institutional controls similar to those implemented for the adjoining Western Early Transfer Area may be required by regulatory agencies and may include the following:

- Deed restrictions limiting allowable reuse of the property (property is currently slated for recreational and wildlife preserve reuses)
- Restriction on excavations unless approved by regulatory agencies and performed with UXO support
- Informational signage to educate the public on the munitions hazard and to instruct them on the steps to follow should they encounter a suspected munitions item
- Periodic long-term monitoring of the site will be implemented to minimize the chance of any remaining munitions being encountered by the public

12. PUBLIC INVOLVEMENT

Public involvement has been maintained throughout all munitions response actions performed at Mare Island. Preliminary discussions concerning the planned confirmation survey with regulatory agency representatives and members of the Mare Island Restoration Advisory Board (RAB) have generated a favorable response. The public information process, following the CERCLA framework, may include:

- A presentation of planned actions and subsequent updates during monthly RAB meetings
- A public notice published in local newspapers for the remedial actions, when appropriate
- A fact sheet mailed to local concerned citizens and organizations for decision documents, when appropriate

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