Environmental Assessment

Stuart Mesa West Training and Conversion

Marine Corps Base
Camp Pendleton, California

January 2018

DEPARTMENT OF DEFENSE
UNITED STATES MARINE CORPS

FINDING OF NO SIGNIFICANT IMPACT FOR STUART MESA WEST TRAINING AND CONVERSION ABOARD MARINE CORPS BASE CAMP PENDLETON, SAN DIEGO COUNTY, CALIFORNIA

Pursuant to the National Environmental Policy Act (NEPA) (42 United States Code §§ 4321-4370h); the Council on Environmental Quality Regulations implementing procedural provisions of NEPA (40 Code of Federal Regulations Parts 1500-1508); and the Marine Corps Environmental Compliance and Protection Manual (Marine Corps Order P5090.2A, Change 3, Chapter 12), the Marine Corps gives notice that an Environmental Assessment (EA) has been prepared and an Environmental Impact Statement (EIS) will not be prepared for a proposal to convert the former Stuart Mesa West Agricultural Field into a multipurpose training area on Marine Corps Base (MCB) Camp Pendleton, California. I find that the proposed action, including adherence to the impact avoidance, minimization, and mitigation measures set forth in detail in the EA, will not have a significant impact on the human environment. Therefore, an EIS is not required.

Proposed Action: The proposed action is the conversion of the former Stuart Mesa West Agricultural Field into a multipurpose training area on MCB Camp Pendleton that would accommodate combined land, air, and sea training (amphibious landing operations). The proposed action would support integrated amphibious operations, infantry movements, air support (rotary wing and tilt-rotor aircraft), and logistics support training as well as United States Marine Corps (USMC) amphibious operations training requirements.

Purpose and Need for the Proposed Action: The purpose of the proposed action is to develop a multipurpose training area at the former Stuart Mesa West Agricultural Field on MCB Camp Pendleton that would accommodate combined land, air, and sea training (amphibious landing operations). A multipurpose training area is needed in support of Marine Air Ground Task Forces exercises to meet USMC mission requirements under 10 United States Code § 5063 because MCB Camp Pendleton currently lacks sufficient training area that can accommodate all three types of training operations. Although MCB Camp Pendleton provides approximately 93,200 acres (37,717 hectares) of training space, including approximately 12,700 acres (5,140 hectares) of impact areas, it currently lacks sufficient dedicated training area that meets requirements identified in the *Operational Training Ranges and Required Capabilities Document* (Marine Corps Reference Publication 3-OC), which defines the spatial area necessary for capabilities training for each of the Marine Air Ground Task Forces, specifically the

Ground Combat Element and the Logistics Combat Element. For example, Marine Corps Reference Publication 3-OC requires 24-hour maneuver and Military Operations on Urbanized Terrain training for all Marine Air Ground Task Force elements. The proposed multipurpose training area would address this deficiency at MCB Camp Pendleton. In addition, the multipurpose training area would meet the need for a dedicated amphibious operations exercise training area at MCB Camp Pendleton that can accommodate large-scale amphibious operations.

Alternatives: The EA analyzed the potential effects of two alternatives: 1) Alternative A (Preferred Alternative); and 2) the No-Action Alternative. No other location alternatives were determined feasible and carried forward for analysis for reasons set forth in the EA. Alternative A would convert the 273-acre (110-hectare) project site into a multipurpose training area that would accommodate combined land, air, and sea training (amphibious landing operations). The former agricultural field is located on Stuart Mesa between Cockleburr Canyon to the northwest and the Santa Margarita River to the southeast. Under the No-Action Alternative, the 273-acre (110-hectare) project site would not be converted into a multipurpose training area, but would be left in its current state. The project site would be minimally maintained (i.e., periodically mowed) under the No-Action Alternative.

Selected Alternative: Based on the analysis in the EA, I have selected the Preferred Alternative for implementation.

Summary of Environmental Effects: The EA analyzes the potential environmental impacts resulting from implementation of the Selected Alternative. The resources most likely to be affected by this action are aesthetics; airspace; air quality and greenhouse gases; biological resources; cultural resources; land use and coastal zone management; noise; public health and safety; utilities; and water resources. The potential environmental impacts of the alternatives on these resources were analyzed. Conversely, impacts to the following resources were considered to be negligible or non-existent and were not further analyzed in the EA: environmental justice; geology; public services; socioeconomics; and transportation. The alternatives will have negligible direct, indirect, or cumulative impacts on the quality of the local environment and will comply with all regulatory requirements. With incorporation of the Special Conservation Measures, impacts to all resources would not be significant for the Selected Alternative. Air quality impacts from the Selected Alternative will not exceed any conformity de minimis threshold for the San Diego Air Basin.

A Record of Non-Applicability for Clean Air Act General Conformity requirement has been prepared and approved for this project. There are no significant cumulative effects associated with the Selected Alternative when combined with other projects considered in the cumulative impact analysis.

Findings: There will not be any disproportionately high and adverse human health or environmental effects from the Selected Alternative on minority or low-income populations. Nor will there be any impacts associated with the protection of children from environmental health and safety risks.

The EA and FONSI addressing the proposed action are on file and may be reviewed at the place of origin: Marine Corps Base, Camp Pendleton (Attn: Environmental Security), Box 555008 Bldg. 22165, Camp Pendleton, California 92055-5010, telephone (760) 725-4512

11 OCT 19

Signature **Date**

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Brigadier General, U.S. Marine Corps
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Abstract

Environmental Assessment for the Stuart Mesa West Training and Conversion, MCB Camp Pendleton

Lead Agency for the EA: United States Marine Corps

Title of Proposed Action: Stuart Mesa West Training and Conversion

Location of the Proposed Action: San Diego County, California

Document Type: Environmental Assessment

The United States Marine Corps has prepared this Environmental Assessment in accordance with the National Environmental Policy Act of 1969, 42 United States Code §§4321–4370h, as implemented by the Council on Environmental Quality regulations, 40 Code of Federal Regulations Parts 1500–1508, and Marine Corps Order 5090.2A, Change 3, Chapter 12, dated 26 August 2013, *Environmental Compliance and Protection Manual*, which establishes procedures for implementing the National Environmental Policy Act. The proposed action is the conversion of the former Stuart Mesa West Agricultural Field into a multipurpose training area on Marine Corps Base (MCB) Camp Pendleton that would accommodate combined land, air, and sea training operations (amphibious landing operations). The proposed action would change the land use of the former Stuart Mesa West Agricultural Field to military training, and would include construction and maintenance of two beach access routes and a dirt access road in the main training area, general site maintenance (e.g., mowing/discing, grading, erosion control, digging, and fill), and combined (land, air, and sea) training operations. A multipurpose training area is needed in support of Marine Air Ground Task Force exercises to support United States Marine Corps mission requirements under 10 United States Code §5063 because MCB Camp Pendleton currently lacks sufficient training area that can accommodate combined (land, air, and sea) training operations. This Environmental Assessment describes the potential environmental consequences resulting from a change in land use and the No-Action Alternative on the following resource areas: Aesthetics; Airspace; Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources; Land Use and Coastal Zone Management; Noise; Public Health and Safety; Utilities; and Water Resources.

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January 2018

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Acronyms

I MEF	First Marine Expeditionary Force
3D MAW	Third Marine Aircraft Wing
AAS	Assault Amphibian School
AAV	Amphibious Assault Vehicle
AICUZ	Air Installations Compatible Use Zone
APE	Area of Potential Effects
AR	Army Regulation
ARB	(California) Air Resources Board
B.P.	Before Present
BAT	best available technology
BCT	best conventional pollutant control technology
BEQ	bachelor enlisted quarters
BMP	best management practice
BO	Biological Opinion
C4I	Command, Control, Communications, Computers, and Intelligence
CAA	Clean Air Act
CAAQS	California Ambient Air Quality Standards
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH_4	methane
CNEL	Community Noise Equivalent Level
$CNEL_{mr}$	Onset-Rate Adjusted Monthly variant of CNEL
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	CO_2 equivalent
CRPR	California Rare Plant Rank
CSC	California Special Concern Species
CZMA	Coastal Zone Management Act
dB	decibel
dBA	A-weighted decibel
DoD	Department of Defense
EA	Environmental Assessment
EISA	Energy Independence Security Act
ESA	Endangered Species Act
ESQD	Explosive Safety Quantity Distance
FAA	Federal Aviation Administration
FR	*Federal Register*
GHG	greenhouse gas
GIS	geographic information system
GWP	global warming potential
HERF	Hazards of Electromagnetic Radiation to Fuel
HERO	Hazards of Electromagnetic Radiation to Ordnance
HERP	Hazards of Electromagnetic Radiation to Personnel
HHERA	human health and ecological risk assessment
I	Interstate
INRMP	Integrated Natural Resources Management Plan
IR	Installation Restoration
L_{dnmr}	time-averaged noise levels

L_{max}	Maximum noise levels
LAV	light armored vehicle
LEED	Leadership in Energy and Environmental Design
LID	Low Impact Development
$\mu g/m^3$	micrograms per cubic meter
MAG	Marine Air Group
MAGTF	Marine Air Ground Task Forces
MBTA	Migratory Bird Treaty Act
MCB	Marine Corps Base
MCIWEST	Marine Corps Installations West
MCO	Marine Corps Order
MCTSSA	Marine Corps Tactical Systems Support Activity
MEF	Marine Expeditionary Force
mg/L	milligrams per liter
MLG	Marine Logistic Group
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
National Register	National Register of Historic Places
NAVFAC	Naval Facilities Engineering Command
NAVFAC SW	Naval Facilities Engineering Command Southwest
NCO	non-commissioned officer
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NOISEMAP	noise modeling software program
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
O_3	ozone
OSHA	Occupational Safety and Health Administration
PK 15(met)	peak noise level, without any frequency weighting, expected to be exceeded by 15 percent of all firing events
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
PM_{10}	particulate matter less than 10 microns in diameter
ppm	parts per million
PSD	Prevention of Significant Deterioration
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RNM	Rotorcraft Noise Model
ROI	region of influence
RWQCB	Regional Water Quality Control Board
SAIC	Science Applications International Corporation
SDAB	San Diego Air Basin
SDCAPCD	San Diego County Air Pollution Control District
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SO_2	sulfur dioxide
TAC	toxic air contaminants
TACAN	Tactical Air Navigation
U.S.	United States
UFC	Unified Facilities Criteria

USACE	United States Army Corps of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USMC	United States Marine Corps
VHF	Very High Frequency
VMU-1	Unmanned Aerial Vehicle Squadron 1
VOC	volatile organic compound
VOR	Very High Frequency Omni-directional Range
VORTAC	Very High Frequency Omni-directional Range Tactical Aircraft Control

Executive Summary

The United States Marine Corps (USMC) has prepared this Environmental Assessment (EA) in accordance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [USC] §§ 4321-4370h, as amended) as implemented by the Council on Environmental Quality (CEQ) *Regulations for Implementing the Procedural Provisions of NEPA* (40 Code of Federal Regulations [CFR] 1500-1508), Department of the Navy *Procedures for Implementing NEPA* (32 CFR Part 775), and USMC *Environmental Compliance and Protection Manual* (Marine Corps Order [MCO] 5090.2A, change 3). This EA describes the potential environmental consequences resulting from a proposal to convert the former Stuart Mesa West Agricultural Field into a multipurpose training area on Marine Corps Base (MCB) Camp Pendleton, California, that would accommodate combined land, air, and sea training operations (amphibious landing operations). The USMC has developed one action alternative to implement the proposed action.

The purpose of the proposed action is to develop a multipurpose training area at the former Stuart Mesa West Agricultural Field on MCB Camp Pendleton that would accommodate combined land, air, and sea training (amphibious landing operations). A multipurpose training area is needed in support of Marine Air Ground Task Forces exercises to support USMC mission requirements under 10 USC § 5063 because MCB Camp Pendleton currently lacks sufficient training area that can accommodate all three types of training operations. Although MCB Camp Pendleton provides approximately 93,200 acres (37,717 hectares) of training space, including approximately 12,700 acres (5,140 hectares) of impact areas, it currently lacks sufficient dedicated training area that meets requirements identified in the *Operational Training Ranges and Required Capabilities Document* (Marine Corps Reference Publication 3-OC), which defines the spatial area necessary for capabilities training for each of the Marine Air Ground Task Forces, specifically the Ground Combat Element and the Logistics Combat Element (MCB Camp Pendleton 2017). For example, Marine Corps Reference Publication 3-OC requires 24-hour maneuver[1] and Military Operations on Urbanized Terrain training for all Marine Air Ground Task Force elements. The proposed multipurpose training area would address this deficiency at MCB Camp Pendleton. In addition, the multipurpose training area would meet the need for a dedicated amphibious operations exercise training area at MCB Camp Pendleton that can accommodate large-scale amphibious operations.

The following resource areas were evaluated for potential environmental consequences: Aesthetics; Air Quality and Greenhouse Gases; Airspace; Biological Resources; Cultural Resources; Land Use and Coastal Zone Management; Noise; Public Health and Safety; Utilities; and Water Resources. The potential environmental consequences associated with a change in land use (Alternative A) and the No-Action Alternative are summarized in Table ES-1. Alternative A would convert the 273-acre (110-hectare) project site into a multipurpose training area to support combined land, air, and sea training operations. Alternative A would include construction and maintenance of two new beach access routes and a dirt access road in the main training area and general site maintenance (e.g., mowing/discing, grading, erosion control, digging, and fill). Proposed improvements would support integrated amphibious operations, infantry movements, air support, and logistics support training as well as USMC amphibious operations training requirements.

As shown in Table ES-1, no significant impacts to any resource area would occur with implementation of Alternative A with the inclusion of Special Conservation Measures or with the implementation of the No-Action Alternative. Based on the analysis presented in this EA, the USMC has identified Alternative A as the Preferred Alternative.

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1 Maneuver training refers to exercises involving the movements of infantry and mechanized assets.

Table ES-1. Summary of Potential Environmental Consequences

Resource	*Alternative A*	*No-Action Alternative*
Aesthetics	The presence of construction equipment would be short-term (6 months), occur within an area only accessible to military personnel, and be visually compatible with existing military activity in the project vicinity. Construction of two new beach access routes and a dirt road in the main training area would not obstruct expansive views of undeveloped agricultural land, coastal bluffs, and the Pacific Ocean from vehicles traveling along Interstate (I)-5. Alternative A would not alter the overall visual character of the project site. The installation of lighting fixtures would not be required to support proposed training operations. All construction activities would occur during the daytime; therefore, lighting fixtures would not be required to illuminate construction areas. Proposed nighttime training activities (e.g., military vehicles headlights) would generate nighttime glare. However, nighttime lighting would be minimal. Due to the proximity of the proposed training area to I-5, fugitive dust generated during maneuver training and aircraft operations would obscure views of motorists traveling on I-5. Existing signage along the I-5 corridor indicates the possibility of dust clouds, and dust generated from training operations is anticipated to be intermittent and consistent with similar military training activities that occur along I-5 within MCB Camp Pendleton. In addition, all operations would be conducted in accordance with the requirements stipulated in the range regulations. Therefore, no significant impacts on aesthetics would occur.	For the No-Action Alternative, the proposed action would not occur, and there would be no change in existing conditions. No impacts on aesthetics would occur.
Airspace	Alternative A would not require changes or additions to the existing airspace structure. All aviation training activities would occur on land managed by the USMC within general aviation, unrestricted (Class G) airspace. Training operations would be consistent with existing non-restricted airspace operations, and restricted airspace would not be activated to support proposed aircraft training activities. Proposed operations would have minimal effects on other airspace users in the Region of Influence. In addition, aircraft operations would be consistent with current activities conducted within the MCB Camp Pendleton airspace complex. Therefore, no significant impacts on airspace would occur.	For the No-Action Alternative, the proposed action would not occur, and there would be no change in existing conditions. No impacts on airspace would occur.

Table ES-1. Summary of Potential Environmental Consequences

Resource	***Alternative A***	***No-Action Alternative***
Air Quality and Greenhouse Gases	Emissions generated by Alternative A would be below the conformity *de minimis* levels or the United States Environmental Protection Agency Prevention of Significant Deterioration threshold. Implementation of Special Conservation Measure 1 (*Fugitive Dust Control for Construction*) and Special Conservation Measure 2 (*Construction Equipment Emission Control Measures*) would minimize fugitive dust and equipment combustion emissions from construction activities. In addition, Special Conservation Measure 3 (*Procurement of Operational Equipment*) would further minimize combustive emissions from proposed training and maintenance operations. Because the project site is adjacent to I-5, fugitive dust generated by proposed operations could impact this transportation corridor. Existing signage along the I-5 corridor indicates the possibility of dust clouds, and dust generated from training operations is anticipated to be intermittent and consistent with similar military training activities that occur along I-5 within MCB Camp Pendleton. In addition, all operations would be conducted in accordance with the requirements stipulated in the range regulations. Therefore, no significant impacts on air quality would occur.	For the No-Action Alternative, the proposed action would not occur, and there would be no change in existing conditions. No impacts on air quality would occur.
Biological Resources	All activities associated within Alternative A would adhere to the requirements for Class II activities under the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian Biological Opinion (1-6-95-F-02). Construction of the two new beach access routes would result in the permanent removal of approximately 2.6 acres (1.05 hectares) of coastal bluff scrub, foredune, riparian scrub, and beach communities. Construction of the dirt access road in the main training area would result in the removal of approximately 1.8 acres (0.73 hectare) of disturbed, ruderal plant communities. Losses to riparian plant communities on MCB Camp Pendleton are managed through the *Riparian and Estuarine Programmatic Conservation Plan* and associated Biological Opinion (1-6-95-F-02). The permanent loss of dune habitat would be offset by the 2.1 acres (0.85 hectares) of dune habitat that was created between 2013 and 2016 adjacent to the project site and the creation of an additional 0.5 acres (0.20 hectares) of dune habitat at a location approved by MCB Camp Pendleton Environmental Security and the United States Fish and Wildlife Service (USFWS) before construction of the two new beach access routes at a 1:1 mitigation ratio according to Marine Corps/ USFWS project consultation precedent. Special Conservation Measure 4 (*Seasonal Avoidance for Federally Listed and*	For the No-Action Alternative, the proposed action would not occur, and there would be no change in existing conditions. No impacts on biological resources would occur.

Table ES-1. Summary of Potential Environmental Consequences

Resource	*Alternative A*	*No-Action Alternative*
	MBTA-protected Bird Species) and Special Conservation Measure 5 (*Riparian Vegetation Removal Compensation*) would ensure that construction of the new access routes would occur outside the breeding season for most species, and that the loss of riparian habitat is compensated for in accordance with the ratios identified in the Riparian Biological Opinion. Construction-related noise associated with development of the two new beach access routes and dirt access road in the main training area would occur temporarily and intermittently over the 6-month construction period. However, construction of the new access routes would not impact federally listed species or Migratory Bird Treaty Act (MBTA)-protected species nests because construction of the proposed access routes would be scheduled between 1 September and 14 February as described in Special Conservation Measure 4 (*Seasonal Avoidance for Federally Listed and MBTA-protected Bird Species*). Implementation of Special Conservation Measure 5 (*Riparian Vegetation Removal Compensation*) would also minimize impacts to MBTA-protected species and federally listed species. In addition, the habitat and associated wildlife exposed to temporary construction noise levels are routinely exposed to continuous noise levels associated with the I-5 corridor and existing military training activities. Temporary construction-related noise levels would be within the type and magnitude of activities that currently occur within the project vicinity. No construction activities are proposed within or adjacent to the jurisdictional wetlands that occur along the western edge of the project site adjacent to the existing drainage system. Fill associated with construction of the two beach access routes would be placed above the mean high water line and high tide line. The United States Army Corps of Engineers (USACE) is reviewing the jurisdictional status of the wetlands along the beach and coastal bluffs and, if necessary, an individual permit may be required. Mitigation would be completed as deemed necessary by the USACE. Amphibious vehicle landings at White Beach during the breeding season for the western snowy plover and California least tern would potentially affect these federally listed species. Proposed aircraft operations and the use of non-live fire munitions and sound-simulating training aids would potentially induce a startle response and cause possible injury to federally listed beach nesting species. However, all proposed training that has the potential to impact riparian and	

Table ES-1. Summary of Potential Environmental Consequences

Resource	*Alternative A*	*No-Action Alternative*
	estuarine/beach ecosystems and species would comply with programmatic avoidance measures, range regulations, and programmatic instructions stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian Biological Opinion (USFWS 1995). In addition, Special Use Areas would be designated at the northern and southern portions of the project site to buffer training activity from adjacent native habitats. During the breeding season, only foot mobile patrols (i.e., no motorized vehicle activity) would be authorized in the Special Use Areas which would ensure a minimum 500-foot (152-meter) buffer between noise-producing training activities and native habitats. In addition, if general site maintenance activities (e.g., mowing/discing, grading, erosion control, digging, and fill) are required within the special use areas, these activities will occur outside of the breeding season as identified in Special Conservation Measure 4 (*Seasonal Avoidance for Federally Listed and MBTA-protected Bird Species).* Therefore, no significant impacts on biological resources would occur.	
Cultural Resources	Under Alternative A, one archeological site, recommended eligible for listing in the National Register, is located within the buffer area for the project site but is not expected to be directly or indirectly affected by proposed construction or operations. Although highly unlikely based on the findings of the Phase II archeological testing, it is possible that subsurface archeological material could be encountered during construction activities. The potential to impact previously unrecorded cultural resources during ground-disturbing activities would be reduced by implementing Special Conservation Measure 6 (*Construction Monitoring for the Beach Access Routes*) and Special Conservation Measure 7 *(Post-Review Discovery Procedures*). Therefore, the proposed undertaking would have no adverse effect on any historic properties, and no significant impacts on cultural resources would occur. The USMC has determined that effective protection measures would be employed to avoid adverse effects to any historic properties, per Stipulation III.D.(3) of the *Programmatic Agreement Among the USMC, the Advisory Council on Historic Preservation (ACHP), and the California State Historic Preservation Officer (SHPO) Regarding the Process for Compliance with Section 106 of the National Historic Preservation Act for Undertakings on Marine Corps Base Joseph H. Pendleton* (August 2014). Therefore, no review or consultation with the SHPO or ACHP is required before implementing the undertaking.	For the No-Action Alternative, the proposed action would not occur, and there would be no change in existing conditions. No impacts on cultural resources would occur.

Table ES-1. Summary of Potential Environmental Consequences

Resource	***Alternative A***	***No-Action Alternative***
Land Use and Coastal Zone Management	Alternative A would not result in significant impacts to land use compatibility because it would be consistent with the existing land use designations in the project vicinity, and would be compatible with surrounding land uses. In addition, conversion of the project site from former agricultural lands (Prime Farmland) to training would not result in significant land use impacts because acquisition or use of farmland by a federal agency for national defense purposes is exempt from Farmland Protection Policy Act requirements. In addition, the project site is recommended as a potential expansion area in the MCB *Camp Pendleton 2030 Base Master Plan*. Significant impacts on long-use management plans would not occur because the project would be sited, designed, and constructed consistent with the guidelines presented in the MCB Camp Pendleton 2030 Base Master Plan for future development. Furthermore, Alternative A would have no effect on coastal zone uses or resources, thus it is consistent to the maximum extent practicable with the enforceable policies of *California's Coastal Management Plan*. The California Coastal Commission issued a concurrence letter stating that Alternative A would not affect the coastal zone and, therefore, does not require a consistency determination. Finally, no impacts to surrounding communities would occur because the proposed development would be contained within existing military designations at MCB Camp Pendleton. Therefore, no significant impacts on land use and coastal zone management would occur.	For the No-Action Alternative, the proposed action would not occur, and there would be no change in existing conditions. No impacts on land use and coastal zone management would occur.
Noise	Construction activities would temporarily increase noise in the project vicinity. However, short-term construction-related noise would not be expected to be overly disruptive and would not be a substantial change from current conditions. Operations-related surface vehicle noise as well as aircraft noise may be audible at nearby noise-sensitive locations (e.g., military family housing) at certain times. However, the noise would not be expected to be overly disruptive and would not be a substantial change from current conditions. Expected project-related noise levels would be largely masked by current noise levels generated from the I-5 corridor and other ongoing military aircraft overflights. The one exception would be munitions noise generated by small arms, such as M-16 (5.56 mm blank rounds), M-60 (7.62 mm blank rounds), and M-2 (.50 caliber blank rounds), used during training. The use of non-live fire munitions could result in a moderate risk of noise complaints from noise-sensitive locations (e.g., military family housing). However, munitions noise would likely occur only during six training exercises per year and would be consistent with noise from other non-live fire training that occurs on Base. Overall, no impacts to auditory health would be expected to occur	For the No-Action Alternative, the proposed action would not occur, and there would be no change in existing conditions. No impacts on noise would occur.

Table ES-1. Summary of Potential Environmental Consequences

Resource	***Alternative A***	***No-Action Alternative***
	from proposed construction or operational activities, and noise impacts would not be expected to be perceived as significant in nature. Therefore, no significant impacts on noise would occur.	
Public Health and Safety	No children would be exposed to environmental conditions or military activities at the project site or in the project vicinity. Six subsites within active Installation Restoration (IR) Site 1120 underlie the project site. Residual concentrations of petroleum hydrocarbons, organochlorine pesticides, and chlorinated herbicides associated with IR Site 1120 have been detected in soils at the project site. However, because the timing of soil sampling and remediation activities at subsites within the project site is unknown, these areas would be identified as "avoidance areas" until all necessary remediation activities are completed. Fencing will be installed around the IR Site 1120 subsites within the project site. Avoiding the IR Site 1120 subsites would eliminate risks associated with soil contamination to construction workers, operational personnel, and trainees. After all required remediation activities are completed for the IR Site 1120 subsites, these areas would be used to support training operations. Safety arcs around the adjacent Marine Corps Tactical Systems Support Activity (MCTSSA) radars (i.e., the Hazards of Electromagnetic Radiation to Ordnance [HERO] restriction zone) cover approximately 5.5 acres (2.2 hectares) of the project site. The use of non-live fire munitions and refueling operations would not occur within this zone when radar activities are being conducted in the MCTSSA expansion area. All construction and operational activities conducted within the HERO restriction zone would be coordinated in advance with MCTSSA personnel to ensure consistency with HERO program regulations and prevent electromagnetic interference with MCTSSA's transmission sources (i.e., radars, radio, and beacon emissions). In addition, communications used during proposed training activities, such as very high frequency communications used by combat units and ultra-high frequency communications (e.g., aircraft and satellite communications), would not generate large amounts of electromagnetic radiation. The project site is partially located within the Explosives Safety Quantity-Distance arc from the Stuart Mesa Ammunition Handling Pad. However, this site was never developed and is unlikely to be used in the future to support the transfer of ammunition and explosives from MCB Camp Pendleton to naval ships for training operations. However, in the event the Stuart Mesa Ammunition Handling Pad is	For the No-Action Alternative, the proposed action would not occur, and there would be no change in existing conditions. No impacts on public health and safety would occur.

Table ES-1. Summary of Potential Environmental Consequences

Resource	*Alternative A*	*No-Action Alternative*
	used in the future, personnel would be required to evacuate this portion of the project site during explosives handling operations at the pad. Therefore, no significant impacts on public health and safety would occur.	
Utilities	Alternative A would increase demands on solid waste disposal. However, sufficient capacity exists within the San Onofre Landfill to accommodate the small volume of solid waste expected to be generated by Alternative A. Therefore, no significant impacts on utilities would occur.	For the No-Action Alternative, the proposed action would not occur, and there would be no change in existing conditions. No impacts on utilities would occur.
Water Resources	Proposed construction activities could contribute to increased runoff, increased erosion, off-site sedimentation, nutrients, and pesticides into the adjacent Santa Margarita Lagoon and Pacific Ocean. Alternative A would incorporate Best Management Practices (BMPs) for erosion and sedimentation control, as identified in Order No. 2009-0009-DWQ (General Construction Permit) and as specified in a site-specific Storm Water Pollution Prevention Plan (SWPPP) to mitigate the adverse effects of construction-related activity on water quality. Potential surface water and/or shallow groundwater quality impacts associated with the inadvertent dispersion of contaminants during construction would be minimized by implementation of a Spill Prevention, Control and Countermeasures Plan and by compliance with Order No. 2009-0009-DWQ. In the event that shallow groundwater is encountered during construction, dewatering would be completed in compliance with appropriate requirements, depending upon the method of disposal. Land disposal requires compliance with the San Diego Basin Plan Waivers, Stormwater system or receiving water disposal requires compliance with the Groundwater Discharge Permit, and sanitary sewer system disposal requires approval from the Camp Pendleton Wastewater Department. Alternative A would result in a change in the level of operational activities within the project site. However, there would be a negligible difference in stormwater runoff between current conditions and post-project implementation. Alternative A is expected to provide a significant long-term improvement in water quality in the Santa Margarita Lagoon. The conversion from agricultural fields to military training eliminates a major source of nutrients and pesticides to Santa Margarita Lagoon.	For the No-Action Alternative, the proposed action would not occur, and there would be no change in existing conditions. No impacts on water resources would occur.

1 Purpose and Need

1.1 Introduction

This Environmental Assessment (EA) has been prepared by the United States Marine Corps (USMC or Marine Corps) in accordance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [USC] 4321–4347, as amended), the Council on Environmental Quality (CEQ) *Regulations for Implementing the Procedural Provisions of NEPA* (40 Code of Federal Regulations [CFR] 1500–1508), Department of the Navy *Procedures for Implementing NEPA* (32 CFR Part 775), and USMC *Environmental Compliance and Protection Manual* (Marine Corps Order [MCO] 5090.2A, change 3). NEPA encourages public involvement in the environmental review process, and a description of the public involvement process for the proposed action is provided in Appendix A (*Public Participation Process*).

This EA describes the potential environmental consequences resulting from a proposal to develop a multipurpose training area at the former Stuart Mesa West Agricultural Field on Marine Corps Base (MCB) Camp Pendleton, California, that would accommodate combined land, air, and sea training (amphibious landing operations) (Figure 1.1-1).

1.2 Background

As directed by law (10 USC § 5063), the USMC must be able to field, on virtually immediate notice, a self-sufficient, combined arms combat force that can operate in three dimensions (land, air, and sea) under a single command. The USMC organizes its combat divisions and air wings into *Marine Air Ground Task Forces* (MAGTF), which form the fundamental cornerstones of modern USMC combat doctrine. They are one of the first front-line combat forces that the nation turns to in times of crisis. MAGTFs are scalable in size and can be tailored for specific missions (e.g., humanitarian assistance, emergency response, peacekeeping, specific regional threat, and major war abroad). This ability provides the flexibility to address the full spectrum of possible military operations by sizing and tailoring MAGTFs to fit the situation and optimize forces as needed for forward presence, engagement, crisis response, antiterrorism, and war fighting. Regardless of their size, all MAGTFs are composed of common organizational elements that include command, ground combat, air combat, and logistics. A *Marine Expeditionary Force* (MEF) is a type of MAGTF that consists of 20,000 to 90,000 personnel and is built around a division, an aircraft wing, and a logistics group.

MCB Camp Pendleton is currently home to the First Marine Expeditionary Force (I MEF), which is the largest MAGTF in the USMC. I MEF is composed of the following combat elements: 1st Marine Division (*Ground Combat Element*), 3rd Marine Aircraft Wing (3D MAW) (*Air Combat Element*), and 1st Marine Logistic Group (MLG) (*Logistics Combat Element*). Although the training operations addressed under the proposed action would primarily be conducted by these I MEF combat elements, occasional training may be conducted from visiting organizations based elsewhere.

1.3 Project Location

The proposed action would be implemented at the Stuart Mesa West Agricultural Field on MCB Camp Pendleton, the USMC's major amphibious training center for the west coast (Figure 1.1-1). MCB Camp Pendleton is a 200-square mile (518-square kilometer) area located primarily within the northern portion of San Diego County, 40 miles (64 kilometers) north of downtown San Diego. The Orange County line is contiguous with the northwest boundary of MCB Camp Pendleton, and Riverside County is to the north but not adjacent to the boundary of MCB Camp Pendleton. The City of San Clemente and the Cleveland

Project Vicinity Map

FIGURE 1.1-1

National Forest border MCB Camp Pendleton to the north and east, with the community of Fallbrook and the Naval Weapons Station – Seal Beach/Fallbrook Annex to the east, and the City of Oceanside to the south. The Base is primarily accessed by Interstate (I)-5 and State Route 76. The former agricultural field is located on Stuart Mesa between Cockleburr Canyon to the northwest and the Santa Margarita River to the southeast.

1.4 Purpose and Need for the Proposed Action

The purpose of the proposed action is to develop a multipurpose training area at the former Stuart Mesa West Agricultural Field on MCB Camp Pendleton that would accommodate combined land, air, and sea training (amphibious landing operations). A multipurpose training area is needed in support of MAGTF exercises to support USMC mission requirements under 10 USC § 5063 because MCB Camp Pendleton currently lacks sufficient training area that can accommodate all three types of training operations. Although MCB Camp Pendleton provides approximately 93,200 acres (37,717 hectares) of training space, including approximately 12,700 acres (5,140 hectares) of impact areas, it currently lacks sufficient dedicated training area that meets requirements identified in the *Operational Training Ranges and Required Capabilities Document* (Marine Corps Reference Publication 3-OC), which defines the spatial area necessary for capabilities training for each of the Marine Air Ground Task Forces, specifically the Ground Combat Element and the Logistics Combat Element (MCB Camp Pendleton 2017). For example, Marine Corps Reference Publication 3-OC requires 24-hour maneuver[2] and Military Operations on Urbanized Terrain training for all MAGTF elements. The proposed multipurpose training area would address this deficiency at MCB Camp Pendleton. In addition, the multipurpose training area would meet the need for a dedicated amphibious operations exercise training area at MCB Camp Pendleton which can accommodate large-scale amphibious operations.

1.5 Regulatory Setting

This EA discusses reasonable alternatives for meeting the purpose and need for the proposed action; existing environmental conditions in the vicinity of the proposed action; direct, indirect, and cumulative impacts that might result from the proposed action; and measures to avoid or minimize potential adverse impacts. The decision to be made by the MCB Camp Pendleton Commanding General is whether or not to establish a multipurpose training area on-Base for combined land, air, and sea training operations and, if so, which alternative best fulfills the purpose and need for the proposed action while avoiding or minimizing adverse environmental impacts.

This EA has been prepared in accordance with applicable federal regulations, instructions, and public laws including, but not limited to, those identified in Appendix B (*Applicable Federal Regulations, Instructions, and Public Law*). NEPA requires consideration of potential impacts to the environment in the decision-making process for federal actions. CEQ regulations represent the "action forcing" provisions of NEPA to ensure that federal agencies comply with NEPA. MCO 5090.2A provides specific guidance for the Marine Corps in preparing environmental documentation for proposed actions subject to NEPA.

[2] Maneuver training refers to exercises involving the movements of infantry and mechanized assets.

The proposed action would require the following permits, certifications, and/or determinations:

- Consultation with the United States Fish and Wildlife Service (USFWS) pursuant to Section 7 of the Endangered Species Act (ESA)[3];
- Concurrence from the California Coastal Commission of a Negative Determination pursuant to the Coastal Zone Management Act (CZMA);
- Approval by the State Water Resources Control Board of a California Construction General Permit (2009-0009-DWQ) for construction-related discharges
- Clean Air Act (CAA), as amended, General Conformity Rule Analysis; and
- Consultation with the United States Army Corps of Engineers (USACE) pursuant to Section 404 of the Clean Water Act and Regional Water Quality Control Board (RWQCB) for the Water Quality Certification pursuant to Section 401 of the Clean Water Act.

[3] MCB Camp Pendleton informally coordinated with USFWS regarding the proposed action during field visits and following MCB Camp Pendleton received technical advice, guidance, and feedback identifying Alternative A as a Class II activity under the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian Biological Opinion (1-6-95-F-02).

2 Description of the Proposed Action and Alternatives

The proposed action addressed in this EA is a proposal to develop a multipurpose training area at the former Stuart Mesa West Agricultural Field on MCB Camp Pendleton that would accommodate combined land, air, and sea training (amphibious landing operations). The proposed action would support integrated amphibious operations, infantry movements, air support, and logistics support training as well as USMC amphibious operations training requirements. This chapter describes the reasonable alternatives for accomplishing the proposed action. The CEQ *Regulations for Implementing the Procedural Provisions of NEPA* (40 CFR Parts 1500–1508) establish a number of policies for federal agencies, including "using the NEPA process to identify and assess reasonable alternatives to the proposed action that will avoid or minimize adverse effects on the quality of the human environment" (40 CFR § 1500.2 [e]). Therefore, the EA only addresses those alternatives that could reasonably meet the purpose and need for the proposed action as well as a no-action alternative. The USMC identified several selection criteria to develop reasonable alternatives that meet the purpose and need for the proposed action. These criteria include the following:

- Sufficient land area near the ocean that could accommodate combined land, air, and sea training operations with the following attributes:
    - Beach access for landing amphibious vehicles from off-shore;
    - Access to interior main training areas from the coast;
    - Unobstructed and flat terrain for landing aircraft;
    - Appropriate terrain for the movement of infantry and mechanized assets (i.e., tracked and wheeled vehicles); and
    - Available viewpoints that allow instructors to view tactical formations from a vantage point at least as high as the ground level of the troops involved in training;
- Compatibility of proposed training with adjacent land uses;
- Current site conditions (vegetation, soils, and topography) that would reduce the need for new grading, construction, infrastructure improvements, and maintenance; and
- Minimize impacts to environmentally sensitive areas (e.g., archeological and biological resources).

Based on a review of available sites on MCB Camp Pendleton, the USMC determined that the former Stuart Mesa West Agricultural Field represents the only reasonable location for the proposed action (refer to Section 2.4, *Alternatives Considered but Eliminated*, for more details).

2.1 Alternative A

Alternative A would convert the 273-acre (110-hectare) project site into a multipurpose training area that would accommodate combined land, air, and sea training (amphibious landing operations) (Figure 2.1-1). The former agricultural field is located on Stuart Mesa between Cockleburr Canyon to the northwest and the Santa Margarita River to the southeast.

Alternative A Conceptual Site Plan

FIGURE 2.1-1

The USMC outleased the former agricultural field to Singh and Sons, who grew tomatoes until their lease expired in January 2011. Subsequently, the project site was disked and mowed in accordance with Categorical Exclusions 20110062 (25 July 2011), 20110062A (1 September 2011), and 20110062C (7 November 2011) to allow for soil sampling, repair, and maintenance. The former agricultural field had been designated as "Prime Farmland"; however, the field is considered exempt under the Farmland Protection Policy Act (refer to Section 3.6, *Land Use and Coastal Zone Management*, for more details).

2.1.1 Proposed Training Operations

Proposed training operations would be conducted in accordance with the Marine Corps Installations West (MCIWEST) - MCB Camp Pendleton Range and Training Area Standard Operating Procedures (MCIWEST_MCB CAMPENO 3500.1 CH 1) (USMC 2013c). All activities associated within Alternative A would adhere to the requirements for Class II activities under the *Riparian and Estuarine Programmatic Conservation Plan* and associated *Biological Opinion (1-6-95-F-02) Programmatic Activities and Conservation Plans in Riparian and Estuarine/Beach Ecosystems on Marine Corps Base, Camp Pendleton* (hereinafter referred to as "Riparian BO") (1-6-95-F-02) (USFWS 1995). Proposed training operations would support the full spectrum of I MEF and amphibious operations training elements, including the following:

1st Marine Division (Ground Combat Element). The 1st Marine Division mission is to function as the Ground Combat Element of I MEF. It also provides task-organized forces for assault operations and such operations as may be directed. The 1st Marine Division must be able to provide the ground amphibious forcible entry capability to the naval expeditionary force and to conduct subsequent land operations in any operational environment. The 1st Marine Division is comprised of Headquarters Battalion; the 1st, 5th, 7th, and 11th Marine Regiments; 1st Reconnaissance Battalion; 1st and 3rd Light Armored Reconnaissance Battalions; 1st Tank Battalion; and 3rd Assault Amphibian Battalion. These units represent a combat-ready force of more than 22,000 Marines and Sailors.

3D MAW (Air Combat Element). The 3D MAW mission is to provide combat-ready, expeditionary aviation forces capable of short-notice worldwide deployment to MAGTF, fleet, and unified commanders. Currently, 3D MAW operates 19 squadrons (about 330 aircraft) of rotary wing and tilt-rotor aircraft under two Marine Air Groups (MAGs), including MAG 16 stationed at MCAS Miramar and MAG 39 stationed at MCAS Camp Pendleton. Also, 3D MAW operates fixed wing aviation squadrons under MAG 11 and MAG 13 (Hornet - FA-18D/E, Harrier - AV-8B, and Hercules - KC-130), but these fixed wing squadrons are not part of the proposed action.

1st MLG (Logistics Combat Element). The 1st MLG mission is to provide direct support to the MEF Ground Combat Element and sustained tactical logistics to each element of the MEF in the functional areas of logistics beyond the organic capabilities of supported units. For example, the 1st MLG can establish beach support areas, landing zone support areas, Logistics Combat Element areas, and Force Logistics Combat Element areas commensurate with the level of operations to ensure responsive, timely support for the sustainment of the MEF.

Assault Amphibian School (AAS) Battalion. The AAS Battalion is the formal school for Amphibious Assault Vehicle[4] (AAV) training in the Marine Corps. It is chartered to conduct eight formal courses of instruction per fiscal year. The *Officer Course* provides 54 days of training for officers to become assault amphibian platoon commanders. The *Assault Amphibian Crewman Course* presents entry-level instruction in basic crewman operations of an AAV, which requires 46 days of training. The *Assault*

[4] AAVs are defined as any USMC vehicles that can be put on a ship and roll off onto shore and include Abrahams tanks, light armored vehicles (LAVs), medium tactical vehicle replacements, and high-mobility multipurpose wheeled vehicles.

Amphibian Intermediate Maintenance Course is a repairman skills progression course for non-commissioned officers (NCOs) and Staff NCOs lasting 63 days. The 70-day *Basic Repairman Course* is an entry-level training course, producing repairman capable of performing 1st- and 2nd-echlon maintenance on the AAV. The 60-day *Assault Amphibian Unit Leader Course* provides selected NCOs and Staff NCOs with advanced leadership and tactical skills necessary to become a Section Leader.

Establishing and maintaining tactical formations and standard operating procedures is critical for combat, and changing formations are required depending on factors such as the mission objective, the number of Marines involved, and their available equipment. Depending on the specific mission, training in the new area could range from a single company commander conducting maneuvers with three infantry platoons (up to approximately 250 personnel) to full battalion training (up to approximately 1,000 personnel), with integrated amphibious operations, infantry movements, air support, and logistics support. Approximately 2,000 vehicles per year would be used to support training activities. Once this foundational element of tactical formations is mastered, additional formation movement training can continue elsewhere on MCB Camp Pendleton.

Specific training elements proposed for the multipurpose training area include the following:

- *Amphibious Landings*. Up to six large-scale training exercises are anticipated each year with a duration of 10 days each, for 60 total training days. AAVs (Table 2.1-1) would cross the tidal zone and come ashore at the beach directly west of the main training area (Figure 2.1-1). Offloaded Marines and tracked or wheeled vehicles would proceed to the main training area via two new beach access routes. A logistics/Command Post Operations would be set up in the beachhead area, and maneuvers and firing (non-live fire) could be conducted off of the beachhead. Non-live fire munitions would be used to increase combat-realism of training events. Small arms that could be used during training include M-16 (5.56 mm blank rounds), M-60 (7.62 mm blank rounds), and M-2 (.50 caliber blank rounds). Smoke could also be used, but would only be authorized when wind conditions are favorable. The use of pyrotechnics and pop-ups would not be authorized. The logistics/Command Post Operations could be located anywhere within the project site and may change from training session to training session. Conceptually, the training would allow Marines to simulate a beach assault/landing, secure the beach, and then move the units off the beach to establish a beachhead for logistical supply and Command Post Operations.

- *Land-based Maneuvers*. Once in the main training area, infantry and mechanized formation training would occur. Training would include trenching to dig fighting positions, burying communication wire (about 12 inches [30 centimeters] in depth), and creating percolation ponds (about 2 feet [0.6 meters] in depth). The heaviest equipment proposed for use is an Abrams tank that weighs 70 tons (refer to Table 2.1-1 for a list of typical equipment). The proposed training area provides adequate vantage for instructors to view tactical formations so they can evaluate Marines in training and provide appropriate guidance.

- *Air Support*. Rotary wing (AH-1Z, UH-1Y, and CH-53) and tilt-rotor aircraft (MV-22) (Table 2.1-1) would be used to support amphibious, convoy, and medical evacuation operations. There would be no designated landing zone in the training area. Aircraft crew members would make the decision as to where to land in the training area to best support units. Air support would usually consist of two aircraft, and it is estimated that about 180 aircraft landings would occur per year. Aircraft would generally approach the project site from the east and conduct operations on suitable landing areas that are free from obstacles (i.e., Marine Corps Tactical Systems Support Activity [MCTSSA] buildings, antenna, and RADOME) in the north-central portion of the project site. Flight activities would be conducted in conformance with Federal Aviation Administration (FAA)-mandated restrictions (FAA Regulation § 91.119 [Minimum Safe Altitudes]) and Naval Air Training and Operating Procedures Standardization flight instructions (e.g., Chief of Naval Operations Instruction 3710.7U). Per these regulations all aviation operations would occur at least

500 feet (152 meters) above the MCTSSA cantonment area, 200 feet (61 meters) above all vehicles or structures, including I-5, and 200 feet (61 meter) from all structures. Aircraft operations within the Very High Frequency (VHF) Omni-directional Range (VOR) Tactical Aircraft Control (VORTAC) buffer area would be conducted in accordance with FAA regulations. All ground and aviation training activities would occur on land managed by the USMC within general aviation, unrestricted (Class G) airspace. Training operations would be consistent with existing non-restricted airspace operations. Restricted airspace (R-2503A[5]), which overlies the northern portion of the project site, would not be activated to support proposed aircraft training activities. Additional details regarding aircraft restriction areas within the project site are provided in Appendix K (*Operational Constraints*). FAA regulations and correspondence are included in Appendix I (*FAA Regulations and Correspondence*).

Aviation operations are based on supporting amphibious assaults for six large-scale exercises each year with a duration of 10 days each, for 60 total training days. During the first two days of the training events, there would be an estimated three sorties per day flown by rotary-wing and tilt-rotor aircraft. The UH-1Y, CH-53, and MV-22 aircraft would fly three sorties per day on about half of the subsequent days of the 10-day training event. AH-Z aircraft would be less likely to participate in training after the first two days. Roughly 40 percent of total aircraft training sorties would occur between 7:00 p.m. and 10:00 p.m. while training events after 10:00 p.m. would be infrequent.

Aircraft operations by UH-1Y, CH-53, and MV-22 aircraft would consist primarily of the aircraft approaching the main training area from either MCAS Camp Pendleton or the sea, landing in the training area to load/unload materials and/or personnel, and then departing. These aircraft would spend approximately 20 minutes above the main training area per sortie. AH-1Z aircraft would conduct reconnaissance and close-air support, spending approximately 90 minutes per training sortie over the main training area.

- *Logistics Support*. A wide range of logistics support may be provided during proposed training operations, depending on mission objectives, such as refueling motorized and mechanized equipment, setting up food and shower facilities, and constructing a temporary ammunition dump (i.e., setting up the tents, barbed wire, security check points, and conducting immediate reaction drills) within the proposed training area. No ammunition would be stored or disposed of at the temporary facility. No vehicle storage areas would be located within the project site. Temporary vehicle maintenance areas would be established, as necessary, to support training operations. Table 2.1-1 provides a list of potential logistical vehicles and engineering equipment that may be used in the proposed training area.

Table 2.1-1. Typical Equipment Associated with I MEF Training Operations[2]

Name	*Vehicle Type*
AAVP-7A1 armored personnel carrier	amphibious assault vehicle
AAVC-7A1 armored command and control	amphibious assault vehicle
AAVR-7A1 armored recovery vehicle	amphibious assault vehicle
Amphibious Combat Vehicle	amphibious assault vehicle
Improved Navy Lighterage Systems	amphibious assault vehicle
Landing Craft Air Cushioned	amphibious assault vehicle
M1A1 Abrams Main Battle Tank	heavy armored vehicle
M88 Armored Recovery Vehicle	heavy armored vehicle
M1165 troop/cargo/MRC radio truck	high-mobility, multipurpose wheeled vehicle

[5] R-2503A overlies MCB Camp Pendleton's coastal area and extends offshore one nautical mile from the surface to 2,000 feet (610 meters) mean sea level.

Table 2.1-1. Typical Equipment Associated with I MEF Training Operations[2]

Name	Vehicle Type
M1152 (A1) heavy cargo truck	high-mobility, multipurpose wheeled vehicle
M1114 armament carrier	high-mobility, multipurpose wheeled vehicle
M1151 armament carrier M1167A1 TOW carrier	high-mobility, multipurpose wheeled vehicle
LAV-25 armament-reconnaissance vehicle	light armored vehicle
LAV-AT anti-tank TOW carrier	light armored vehicle
LAV-M mortar carrier	light armored vehicle
LAV-R recovery	light armored vehicle
LAV-C2 command and control	light armored vehicle
LAV-L logistics cargo carrier	light armored vehicle
High Mobility Artillery Rocket System	medium tactical vehicle
MK23 Cargo, standard wheelbase, without self-recovery winch	medium tactical vehicle replacement
MK25 Cargo, standard wheelbase with self-recovery winch	medium tactical vehicle replacement
MK27 Cargo, extra-long wheelbase without self-recovery winch	medium tactical vehicle replacement
MK28 Cargo, extra-long wheelbase with self-recovery winch	medium tactical vehicle replacement
MK29 Dump, standard wheelbase without self-recovery winch	medium tactical vehicle replacement
MK30 Dump, standard wheelbase with self-recovery winch	medium tactical vehicle replacement
MK31 Tractor, standard wheelbase with all-wheel steering	medium tactical vehicle replacement
MK36 Wrecker, extra-long wheelbase	medium tactical vehicle replacement
MK37 high-mobility artillery rocket system	medium tactical vehicle replacement
MK48 Front Power Unit	logistical vehicle
MK14 flatbed trailer	logistical vehicle
MK15 wrecker	logistical vehicle
MK16 tractor	logistical vehicle
MK17 dropside with crane (flatbed with troop seats)	logistical vehicle
MK18 self-loader (containers, ribbon bridges, and river boats)	logistical vehicle
A/S32P-19A firefighting truck	support engineering equipment
Airfield refueler truck	support engineering equipment
M970 semi-trailer refueler	support engineering equipment
M93 Fox Nuclear, Biological, and Chemical reconnaissance vehicle	support engineering equipment
Z-Backscatter imaging reconnaissance van	support engineering equipment
M9 ACE Combat Excavator	support engineering equipment
Kalmar Rough Terrain Container Handler	support engineering equipment
Terex MAC-50 50-Ton crane	support engineering equipment
LRT Crane	support engineering equipment
130-G Grader	support engineering equipment
621-B Scraper-Tractor	support engineering equipment
Runway Crosswind-J 1067602 Sweeper	support engineering equipment
MC1150E/MC1155E Tractor	support engineering equipment
D9 bulldozer	support engineering equipment
John Deere 850J Medium Crawler Tractor	support engineering equipment
CAT420DIT Loader Backhoe	support engineering equipment
Extended Boom MMV Container Forklift	support engineering equipment
TX51-19M and D Rough Terrain Forklift	support engineering equipment
John Deere TRAM 624KR Tractor	support engineering equipment
M60A1 AVLB Armored Vehicle Launched Bridge	support engineering equipment
Assault Breacher Vehicles	support engineering equipment
CAT 277B/C MTL Multi-Terrain Loader w/attachments	support engineering equipment
Sea Knight (CH-46E)[1]	medium lift helicopter
Super Stallion (CH-53E)	heavy lift helicopter
Super Cobra (AH-1W)	light attack helicopter

Table 2.1-1. Typical Equipment Associated with I MEF Training Operations[2]

Name	*Vehicle Type*
Viper (AH-1Z)	light attack helicopter
Huey (UH-1N)	light attack helicopter
Venom (UH-1Y)	light attack helicopter
Osprey (MV-22B)	tilt-rotor aircraft

Notes:
[1] The CH-46E is approaching the end of its service life and is currently being replaced by the MV-22B. The transition between CH-46E and MV-22B is expected to be completed by 2017, based on the current Marine Aviation Plan (USMC 2010a).
[2] This table provides a list of equipment typically used during I MEF operations. However, newer equipment may be used in the future as technology improves/changes.

Communications during training would include VHF communications, such as those used by combat units to communicate to higher, adjacent, and subordinate commanders, as well as ultra-high-frequency communications, such as aircraft and satellite communications used by senior commands. This amount of waveband is not expected to produce large amounts of electromagnetic radiation.

The FAA VORTAC facility is located within the south-central portion of the project site and would not be moved as a result of the proposed action (Figure 2.1-1). The facility provides three individual services for aircraft operations: VOR azimuth, tactical air navigation (TACAN) azimuth, and TACAN distance. Transmitted signals of VOR and TACAN are identified by a three-letter code transmission and are interlocked, so that pilots using a VOR azimuth with a TACAN distance know that both signals are from the same ground station. The frequency channels of the VOR and the TACAN at each VORTAC facility are “paired” in accordance with a national plan to simplify airborne operations. Construction within a 1,000-foot (304-meter) radius around the VORTAC facility is severely limited to prevent radio wave interference between the VORTAC site and using aircraft (FAA 1986) (Figure 2.1-1). In addition, all activities would adhere to the posted parking restrictions (i.e., no parking within 75 feet [23 meters] of the VORTAC). FAA would continue to have uncontrolled access to the VORTAC to ensure they can rapidly respond to unscheduled outages. FAA has reviewed the proposed action and concurred that the proposed land use change and associated training operations comply with all VORTAC operational restrictions (Appendix I, *FAA Regulations and Correspondence*).

2.1.2 Proposed Training Restrictions

The proposed multipurpose training area would be available for operations 24 hours per day and year-round. However, training activities (i.e., amphibious landings, ashore laydown areas, vehicle and foot traffic training, and use of new beach access routes) within the multipurpose training area would be restricted per below (refer to Appendix K, *Operational Constraints*, for details). All training restrictions will be communicated to Range Control to ensure operational compliance and implementation.

On the sandy beach areas within the project site, or anywhere species protected under the Riparian BO are present, training operations would be per the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995) as follows:

- All activities would be subject to the requirements for Class II activities under the *Riparian and Estuarine Programmatic Conservation Plan* and associated BO (1-6-95-F-02).
- During the breeding season (15 February through 30 August), all activities involving smoke, loud noises, blowing sand, and large groupings of personnel (14 or more) would be kept at least 1,000 feet (305 meters) away from fenced or posted nesting areas. All other activities would be kept at least 15 feet (5 meters) from these areas;

- All training foot traffic within the Santa Margarita River Management Zone , or anywhere species protected under the Riparian BO are present, would be prohibited within 15 feet (5 meters) of posted nesting areas during the breeding season with the exception of MCB Camp Pendleton Environmental Security, animal damage control, law enforcement, research, and life guard personnel;

- Motorized vehicles would remain at least 15 feet (5 meters) from nesting areas during the breeding season, with the exception of amphibious tracked vehicles. Vehicle traffic within the Santa Margarita River Management Zone during the breeding season would be kept to a minimum. Vehicles would remain on hard-packed sand unless parked, outside posted (signed) areas during the breeding season and as much as possible at other times, and would avoid the dune system at the base of the bluffs, as well as coastal wetlands. Travel speeds would not exceed 25 miles per hour;

- Amphibious tracked vehicles would traverse the Santa Margarita River Management Zone while maintaining both tracks in water at all times. During the breeding season, amphibious tracked vehicles would not traverse the Santa Margarita River Management Zone in excess of a monthly average of 20 traverses per day;

- If a snowy plover nest is in or near the new beach access routes or route across White Beach, or anywhere nests have been established, individual nests and any young produced would be afforded protection by posting and fencing around the immediate vicinity of the nest(s);

- During the breeding season, aircraft would not land within 98 feet (30 meters) of fenced nesting areas as identified on the Camp Pendleton Special Training Map; and

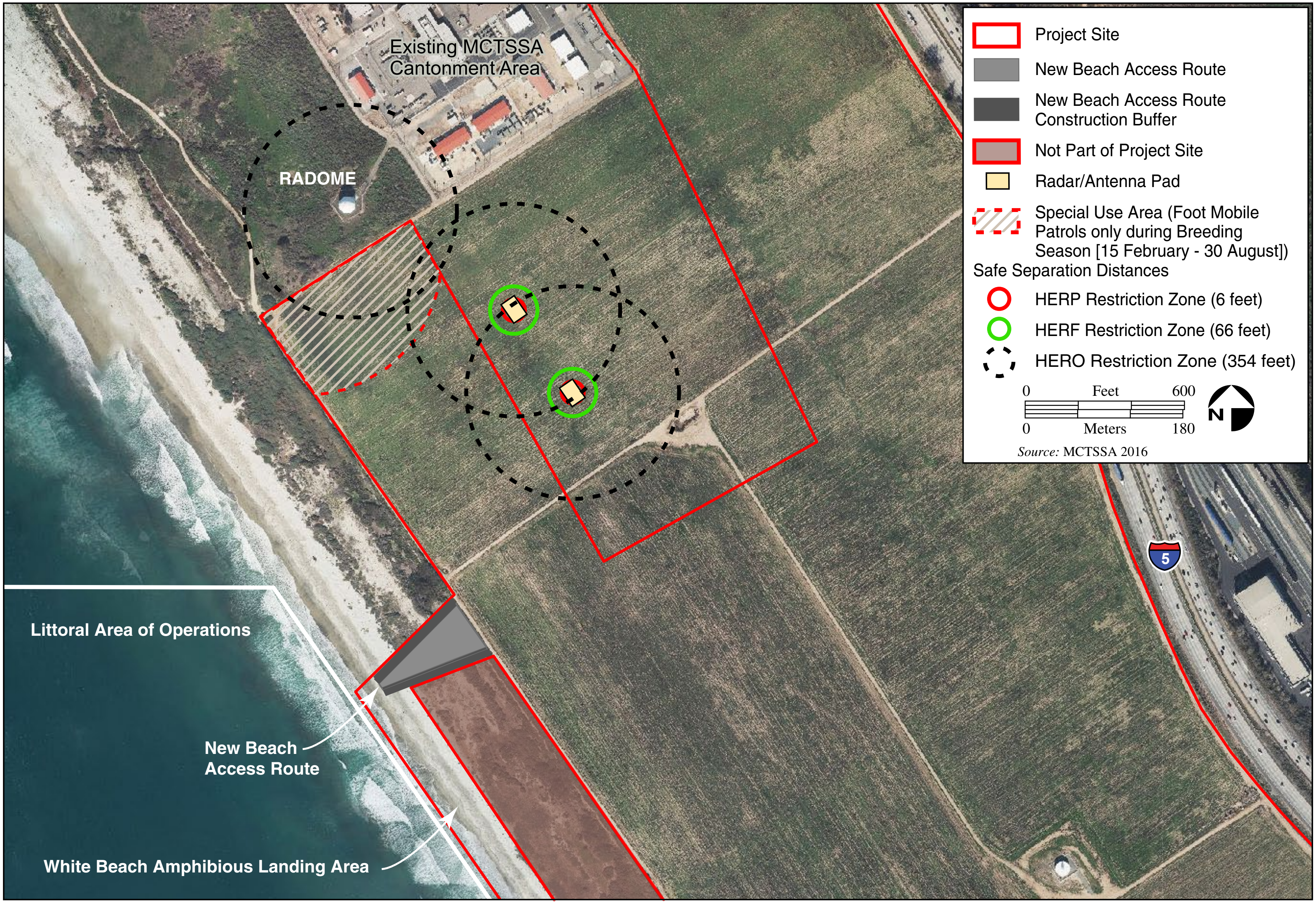
- Aircraft would maintain an altitude of 300 feet (91 meters) above ground level or more above nesting areas.

In addition, the following restrictions would be implemented during operations:

- Training activities would be limited on the southern and northern portions of the project site during the breeding season for nearby sensitive bird species (i.e., Coastal California Gnatcatcher and light-footed Ridgway's rail) (Figure 2.1-1). During 15 February through 30 August, training activities within the designated special use areas would be restricted to foot mobile patrols only, and no motorized vehicle activity would be permitted. In addition, general site maintenance activities (e.g., mowing/discing, grading, erosion control, digging, and fill) would not occur within the special use areas during the breeding season (15 February through 30 August).

- All Installation Restoration (IR) Site 1120 subsites would be avoided until they are cleared through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process to avoid potential exposure of on-site personnel to contaminated soil (Figure 2.1-1). The project proponent would coordinate with MCB Camp Pendleton Environmental Security to delineate the IR Site 1120 subsites boundaries of avoidance. Fencing will be installed around the IR Site 1120 subsites within the project site. After all required CERCLA remediation activities are completed for the IR 1120 subsites, these areas would be used to support training operations.

- The use of non-live fire munitions during training and refueling operations would be restricted within the project site when radar activities are being conducted in the MCTSSA expansion area (Figure 2.1-2).



MCTSSA Safe Separation Distances for Personnel, Fuel, and Ordnance

FIGURE

2.1-2

This "Hazards of Electromagnetic Radiation to Ordnance (HERO) restriction zone" provides a safe separation distance of 354 feet (108 meters) from the radar pads to minimize HERO. All activities conducted within the HERO restriction zone would be coordinated in advance with MCTSSA personnel to ensure consistency with HERO program regulations and prevent electromagnetic interference with MCTSSA's transmission sources (i.e., radars, radio, and beacon emissions). Changes requested by MCTSSA would be added in the future, at the discretion of the Range Control Officer, to the Range Facility Management Support System and the Range Regulations for the Stuart Mesa Training Area.

- The use of pyrotechnics and pop-ups would not be authorized. The use of smoke is authorized, but would be dependent on the wind direction. The use of smoke would not be authorized during westerly winds.

- All training activities within a 1,000-foot (304-meter) radius around the VORTAC facility would be coordinated in advance with FAA. All proposed aircraft operations within the VORTAC buffer area would be conducted in accordance with FAA regulations.

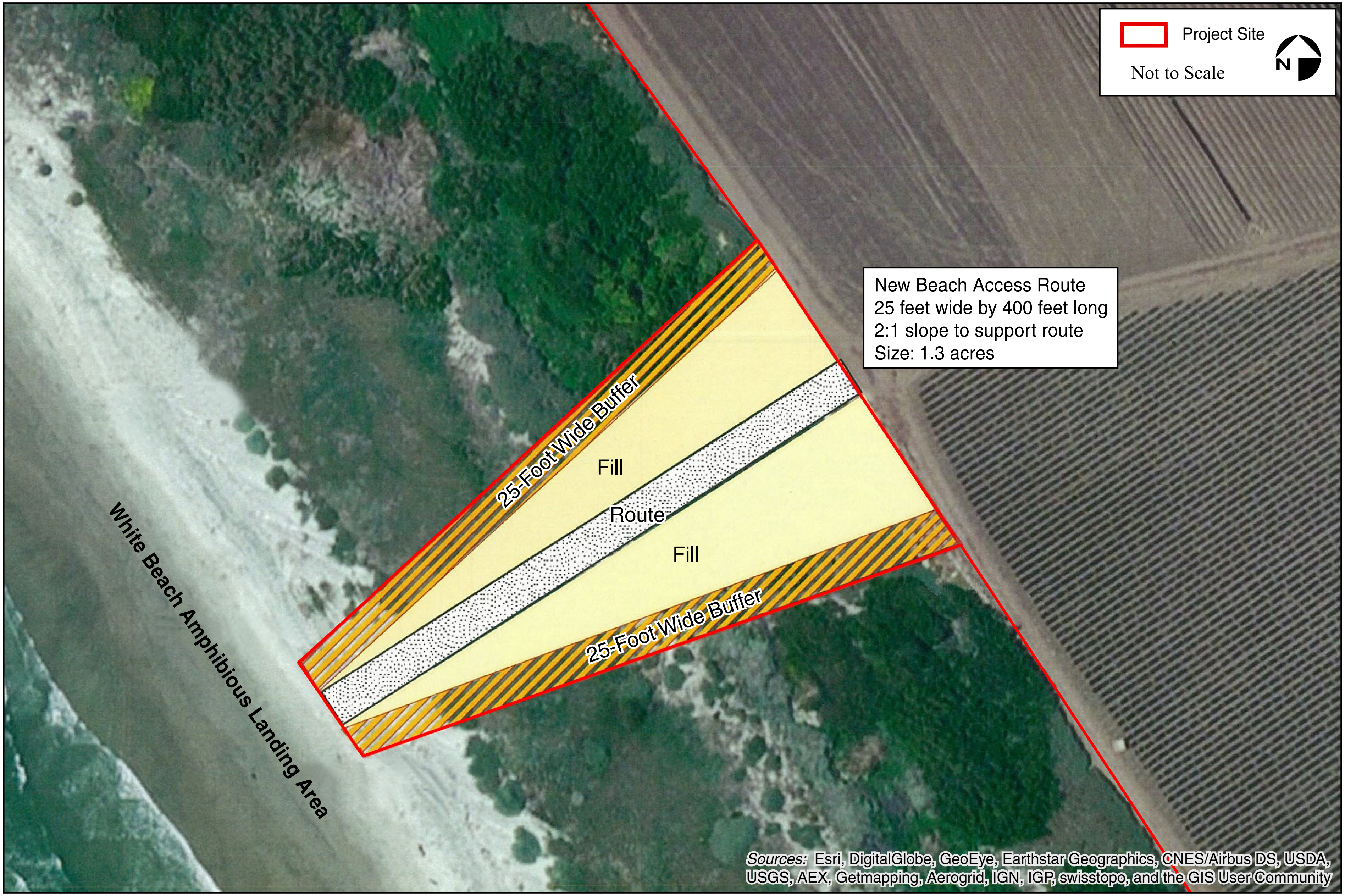
2.1.3 Proposed Site Improvements

This alternative would involve some improvements to the project site (Figure 2.1-1), including constructing and maintaining two new beach access routes and a dirt access road in the main training area and general site maintenance required to support training operations (e.g., mowing/discing, grading, erosion control, digging, and fill).

Construction would occur over a 6-month period. Construction would involve the use of diesel- and gasoline-fueled vehicles and equipment. In general, the following equipment would be used during construction: an excavator, bulldozer, dump truck, and water truck. Construction vehicles would access the project site via Stuart Mesa Road. All staging areas, construction vehicle movement and parking, and laydown of equipment would be restricted to the project boundaries shown on Figure 2.1-1 or within nearby previously developed sites (e.g., parking areas).

2.1.3.1 New Beach Access Routes

To enhance access, two dirt routes approximately 25 feet (7.6 meters) wide and 400 feet (122 meters) long would be constructed from White Beach to the main training area (Figure 2.1-3). A 25-foot (7.6-meter) wide construction buffer would be established around each new beach access route; to the maximum extent feasible, this area would be restored to dune habitat using an appropriate plant palette following construction in accordance with the Riparian BO. Approximately 120,000 cubic yards (92,000 cubic meters) of soil (fill) would be required to construct the new beach access routes. Fill would be imported on-Base from an approved vendor. Appropriate erosion control measures would be incorporated into the design of the new beach access routes. Construction of the two beach access routes would result in the permanent removal of approximately 2.6 acres (1.05 hectares) of dune habitat. The permanent loss of dune habitat would be offset by the 2.1 acres (0.85 hectares) of dune habitat that was created between 2013 and 2016 adjacent to the project site and the creation of an additional 0.5 acres (0.20 hectares) of dune habitat at a location approved by MCB Camp Pendleton Environmental Security and USFWS before construction of the two new beach access routes at a 1:1 mitigation ratio according to Marine Corps/USFWS project consultation precedent. All dune habitat restoration efforts would be coordinated with MCB Camp Pendleton Environmental Security.



New Beach Access Routes Conceptual Design

FIGURE 2.1-3

Construction (i.e., grading and vegetation removal) and maintenance of the new beach access routes would occur between 1 September through 14 February, which is outside the peak breeding season for sensitive bird species (refer to Special Conservation Measure 4, *Seasonal Avoidance for Federally Listed and MBTA-protected Bird Species*, described in Appendix C for details). The existing beach access route would be used consistent with the restrictions stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995) (Figure 2.1-1).

2.1.3.2 New Main Training Area Access Road

A new dirt access road would be constructed in the southern portion of the main training area to support proposed training activities. This road would also delineate the northern boundary of the designated special use area in the southern portion of the project site (Figure 2.1-1). The proposed access road would be approximately 25 feet (7.6 meters) wide and 3,170 linear feet (966 meters) long and rough-graded and leveled or established by repetitive use. Construction of this road would result in the permanent removal of approximately 1.8 acres (0.73 hectare) of disturbed, ruderal plant communities within the main training area. The existing southern access road would be used consistent with the restrictions stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995).

2.1.3.3 Site Grading/Maintenance

Typical maintenance activities that would be conducted as necessary to support training operations include, but are not limited to, mowing/discing, grading, erosion control, digging, and fill. Site improvements would also include maintenance of the existing and proposed access routes within the training area. Routine maintenance is expected to occur about once every 3 months.

2.2 Special Conservation Measures

Measures that would be incorporated into Alternative A to avoid, minimize, and mitigate impacts are included in the Minimization, Mitigation, Monitoring, and Reporting tracking sheet included in Appendix C (*Minimization, Mitigation, Monitoring, and Reporting Tracking Sheet*). Several non-project-specific measures that are standard requirements for construction contracts on MCB Camp Pendleton would also be implemented as part of Alternative A and are provided in Appendix D (*Standard Construction Measures*).

2.3 No-Action Alternative

Under the No-Action Alternative, the 273-acre (110-hectare) project site would not be converted into a multipurpose training area that would accommodate combined land, air, and sea training (amphibious landing operations). Rather, it would be left in its current state. Under this alternative, the project site would be minimally maintained (i.e., periodically mowed). The No-Action Alternative is not considered a reasonable alternative because it does not meet the purpose and need for the proposed action. However, it does provide a measure of the baseline conditions against which the impacts of the proposed action can be compared. In this EA, the No-Action Alternative is represented by the baseline conditions described in Chapter 3, *Affected Environment and Environmental Consequences*.

2.4 Alternatives Considered But Eliminated

As part of the USMC's decision-making process, various alternatives were considered that could potentially accomplish the proposed action purpose and need using approaches that are both similar and dissimilar to current approaches. The following alternatives were considered but eliminated as infeasible and not likely to reduce environmental impacts.

2.4.1 Alternative Site Locations at MCB Camp Pendleton

Based on a review of available sites on MCB Camp Pendleton, the USMC determined that the former Stuart Mesa West Agricultural Field represents the only reasonable location for the proposed action that meets project objectives and the selection criteria. For example, two other areas at MCB Camp Pendleton with potential beach access for landing amphibious vehicles from off-shore include Green Beach and Gold Beach. However, neither of these areas has adjacent flat terrain suitable for landing aircraft and/or movement of infantry and mechanized assets. In addition, Green Beach is surrounded by recreational facilities to the north and the San Onofre State Beach to the west; these types of public/recreational uses would be incompatible with the type of proposed training under consideration in this EA.

2.4.2 Alternative Site Locations on Other Military Installations

There are no other military installations in southern California that have a sufficient land area near the ocean that also could accommodate the types of combined land, air, and sea training operations associated with the proposed action.

2.4.3 Full Conversion Alternative

An alternative was considered that would convert the entire former Stuart Mesa West Agricultural Field (about 304 acres [123 hectares]) into a multipurpose training area. This larger training footprint would allow the MCB Camp Pendleton Commanding Officer to accommodate combined land, air, and sea training to the maximum extent possible. This alternative would include the training operations required to support I MEF and AAS Battalion requirements and site improvements (e.g., construction of two new beach access routes, culvert drainage repairs, and general site grading/routine maintenance to control on-site vegetation). However, this alternative was not considered a viable alternative due to the approval of the MCTSSA Cantonment Area Expansion project.

2.4.4 Enhanced AAV Driver Course Alternative

The USMC considered an alternative that was similar to Alternative A, except it would also include construction of an enhanced AAV Driver Course in the southern portion of the project site. Implementation of this alternative would be predicated on the approval of a Military Construction Program to relocate the current AAS Battalion driver course at Camp Del Mar (MCB Camp Pendleton) to the project site. Site construction would include emplacing various obstacles and road course for students to drive AAVs to obtain Military Occupational Specialty certification. The course would include a control tower, staging area, start/stopping area, recovery pits, bivouac/bleacher area, adjustable gap, outer loop, inner loops, side slope obstacle, high-angle obstacle with drainage control berm (i.e., a large mound of dirt piled and compacted 50 feet [15 meters] high), gripping station, vertical wall, wash board, turning circle, v-shaped ditch, variable height wall, Belgium block (paving stone similar to cobblestone), bump course, angled curves, cross steering, fording station, gates, and an improved perimeter road. New utility infrastructure (e.g., electrical and communication) would be required to support the enhanced AAV Driver Course.

Under this alternative, no Special Use Areas would be established so unrestricted training would occur in the northern and southern portions of the main training area regardless of the season. In addition, training would not be restricted by the Riparian BO with respect to federally listed species and the Santa Margarita Estuary Special Management Zone. Furthermore, the existing access road on the southwestern project site boundary would be used for training, which would allow activities to occur within 50 feet (15 meters) of the fenced California least tern nesting area. Because this alternative would not implement programmatic avoidance measures, range regulations, and programmatic instructions stipulated in the Riparian BO, additional coordination with USFWS would be required to address impacts on federally listed species, including but not limited to the California least tern and western snowy plover. Also, the timing for the funding to support the Military Construction Program required to implement this alternative is unknown at this time. Therefore, this alternative is not considered a viable alternative.

2.4.5 Alternative Beach Access Route Alignments

The USMC considered alternative beach access route alignments along the bluffs within the project area. The objectives of the proposed beach route alignments were to minimize engineering constraints (i.e., reduce the need for grading and fill), minimize the loss of dune habitat, avoid existing culverts, and ensure adequate access for vehicles from White Beach to the main training area. Except for the two beach access routes carried forward for analysis in the EA, the other route alignments considered did not meet one or more alignment objectives and were not considered viable alternatives.

2.5 Resource Areas Eliminated From Detailed Consideration

Several resource areas have not been carried forward for detailed analysis in this EA because potential impacts were determined to be nonexistent or negligible. Resources not addressed further in this EA include: Environmental Justice; Geology; Public Services; Socioeconomics; and Transportation, as described below.

Environmental Justice: Proposed construction and operations would not result in disproportionate impacts to minority and low-income populations. Therefore, no impacts on environmental justice would occur.

Geology: MCB Camp Pendleton is not underlain by any active or potentially active faults, and there are no known areas of high liquefaction potential on-Base. However, active faults located within 60 miles (97 kilometers) of MCB Camp Pendleton could result in strong, seismically induced ground motion and associated ground shaking at the project site. Proposed site improvements (e.g., new access routes) would be designed and constructed to comply with the seismic design criteria identified in the Uniform Building Code, the Naval Facilities Engineering Command (NAVFAC) *P-355 Seismic Design Manual*, and the most stringent criteria identified in the latest design specifications of the Structural Engineering Association of California. Although the project site is located near the ocean, tsunamis are not considered a threat to the project site. The estimated maximum wave height for a tsunami impacting MCB Camp Pendleton is 6 feet (1.8 meters) (USMC 2010b). Combining such a wave with a maximum high tide and storm surge would create a wave run-up of 13 feet (4 meters) above the mean lower low-water level, while the project site is located at an elevation of approximately 50 feet (16 meters). Therefore, negligible impacts on geology would occur.

Public Services: There would be no additional military, government/civilian, or contractor support personnel stationed at MCB Camp Pendleton as a result of the proposed action. Therefore, no impacts on public services would occur.

Socioeconomics: There would be no additional military, government/civilian, and/or contractor support personnel stationed at MCB Camp Pendleton with implementation of the proposed action. Therefore, no impacts on socioeconomics would occur.

Transportation: Temporary increases in traffic (approximately 20 trips per day) would occur during construction activities. This represents less than 0.2 percent of the traffic at MCB Camp Pendleton

(USMC 2012) and would be within the normal flux of vehicles on the Base. The proposed action is not expected to increase traffic at MCB Camp Pendleton during proposed operations because existing traffic would be redirected to the proposed training area. Therefore, negligible impacts on transportation would occur.

2.6 Summary of Impacts

The environmental consequences associated with implementation of Alternative A and the No-Action Alternative are presented and compared in Table 2.6-1. A detailed description of the affected environment and analysis of the environmental consequences is presented in Chapter 3, *Affected Environment and Environmental Consequences*. Cumulative impacts are discussed in Chapter 4, *Cumulative Impacts*.

Table 2.6-1. Summary of Impacts

Resource Area	*Alternative A*	*No-Action Alternative*
Aesthetics	NSI	NI
Air Quality	NSI	NI
Airspace	NSI	NI
Biological Resources	NSI	NI
Cultural Resources	NSI	NI
Land Use and Coastal Zone Management	NSI	NI
Noise	NSI	NI
Public Health and Safety	NSI	NI
Utilities	NSI	NI
Water Resources	NSI	NI

Notes: NSI = no significant impact; NI = no impact.

2.7 Preferred Alternative

Alternative A is the preferred alternative because it fulfills the purpose and need for the proposed action while minimizing environmental impacts.

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3 Affected Environment and Environmental Consequences

3.1 Aesthetics

The region of influence (ROI) for consideration of the proposed action's effects on aesthetics is the portion of the project site and adjacent environment that is observed from public view corridors.

Visual Resources

Visual resources are generally defined as the natural and built features of the landscape visible from public views that contribute to an area's visual quality. This section describes the existing visual environment and changes resulting from the proposed action to characterize the aesthetic condition of the project site, including on-site structures and facilities, and assess how the condition would be potentially affected by implementation of the proposed action.

The evaluation of visual resources in the context of environmental analysis typically addresses the contrast between visible landscape elements. Collectively these elements comprise the aesthetic environment, or landscape character. The landscape character is compared to the action's visual qualities to determine the compatibility or contrast resulting from the buildout of the proposed action.

Views are defined as visual access to, or visibility of, a natural or built landscape feature from an observer viewpoint. Views may be focal (restricted in scope to a particular object), or panoramic (encompassing a large geographic area with a wide or deep [i.e., distant] field of view). Focal views can be from a number of observer viewpoints compared to the object being viewed, such as from a lower elevation, at the same level, or from an elevated vantage. Panoramic views are usually associated with an elevated observer viewpoint. Scenic views or vistas are panoramic public views that include natural features, including views of the ocean, unusual topographic features, or unique urban or historic structures.

Views are characterized by their distance from the viewer, including foreground, middleground, or background. Foreground views are those immediately perceived by the viewer and include objects at close range that tend to dominate the view. Middleground views occupy the center of the view and generally include objects that are the center of a viewer's attention if they are sufficiently large or visually contrasting with adjacent visual features. Background views include distant objects and other objects that form the horizon. Objects perceived in the background view eventually diminish in their importance with increasing distance. In the context of the background, the skyline can be an important visual context because objects above this point are highlighted against the typically blue background during daylight hours.

A viewshed, or visible area, is the total range of views experienced from an observer's viewpoint. A viewshed is defined by landscape features that define or obstruct sightlines, or the line of sight between an observer and a viewed object. Views may be partially or entirely obstructed by topography, buildings and structures, and/or vegetation. The closer an intervening obstruction is to the observer, the more it will potentially obstruct the viewshed. Accordingly, a small physical obstruction in the foreground of a view will potentially have a more substantial effect on the viewshed compared to a relatively large obstruction perceived in the middle or background.

Glare

Glare, defined as an indirectly caused phenomenon of lighting or reflection off building materials, can cause a negative impact during the day or night. Daytime glare is caused by the reflection of sunlight from highly reflective surfaces. Reflective surfaces are generally associated with buildings constructed with broad expanses of highly polished or smooth surfaces (e.g., glass or metal) or broad, light-colored paving surfaces such as concrete. Nighttime glare can include direct, intense, focused light, as well as reflected light. Glare can be caused by mobile, transitory sources such as automobiles, or from intense stationary sources such as security lighting.

3.1.1 Affected Environment

3.1.1.1 Visual Quality

MCB Camp Pendleton is located on a coastal plateau and situated between the Pacific Ocean to the west and the lower foothills of the Peninsular Range Mountains to the east. The Base is characterized by several unnamed ridges and valleys with expansive native and non-native grassland habitats. MCB Camp Pendleton includes numerous military and industrial facilities, including military training and support facilities (controlled impact areas, dedicated impact areas, and training and maneuvering areas), infrastructure, and ancillary facilities. The appearance of Base facilities is functional in nature, characterized by exposed infrastructure, open storage, and training and maneuver areas.

The project site is located on the former Stuart Mesa West Agricultural Field in the southwestern portion of MCB Camp Pendleton. The project site is bordered by the existing MCTSSA cantonment area and Cockleburr Canyon to the northwest, I-5 to the east, Santa Margarita River to the southeast, and the Pacific Ocean to the west. The majority of the project site consists of previously disturbed, undeveloped former agricultural land and dirt access roads. An existing VORTAC facility is located within the former agricultural field. The project site is located on Stuart Mesa, at an elevation of approximately 50 feet (16 meters) above mean sea level, along the coastal bluffs. Site topography is relatively flat (less than one percent slope) and slopes gently to the west and south.

3.1.1.2 Project Visibility in Sensitive Viewing Areas

The project site is visible from surrounding public viewpoints in the project vicinity, primarily from passing motorists on I-5. From I-5, foreground and middleground vistas of previously disturbed, undeveloped former agricultural lands are prominent. Distant vistas of the coastal bluffs and Pacific Ocean are visible from this vantage point. Intervening development obstructs views of the project site from nearby Stuart Mesa Road. While the view of coastal bluffs and the Pacific Ocean enhances the visual quality of the project site for passing motorists, the project site is a component of the industrial Base complex and, therefore, the importance of on-site visual resources is low.

3.1.1.3 Glare

The absence of development throughout the project site results in a relatively low degree of daytime and nighttime lighting and glare. Existing development in the MCTSSA cantonment area northwest of the project site is illuminated, resulting in moderate nighttime glare.

3.1.2 Environmental Consequences

3.1.2.1 Alternative A

Proposed construction activities would require the use of excavators, bulldozers, and support equipment over an approximate 6-month period. Construction of the dirt access road in the main training area would occur within public viewsheds for individuals traveling on I-5 (Figure 2.1-1). The presence of construction equipment would be visually compatible with existing military activity in the project vicinity. Equipment associated with construction of the dirt access road in the main training area would be short-term and occur within an area that is accessible only to military personnel. After construction is complete, the new access road would be visually consistent (i.e., design [rough graded and leveled or established by repetitive use] would be of similar visual character) with the existing access roads in the project site. Construction of the new beach access routes near the coastal bluff would not be discernible due to the distance of this viewpoint from I-5. As existing expansive views of disturbed, undeveloped former agricultural land set against the backdrop of coastal bluffs and the Pacific Ocean would not be obstructed by proposed improvements, construction activities would not alter the overall visual character of the project site. Therefore, no significant impacts on aesthetics would occur.

Development of the site as a multipurpose training area would not represent a substantial change from its undeveloped natural character. Approximately 4.4 acres (1.78 hectares) would be developed to support the new beach access routes and dirt access road in the main training area, while approximately 269 acres (109 hectares) of contiguous areas of the project site would remain undeveloped to support training operations (e.g., maneuver training, aircraft operations, and logistics support). Vegetation within the undeveloped areas of the main training area would continue to be maintained with regular mowing and/or discing. In addition, proposed training operations, including use of existing roads to support components of amphibious operations training requirements, would be visually compatible with existing military activity in the project vicinity. Therefore, no significant impacts on aesthetics would occur.

The installation of lighting fixtures would not be required to support proposed training operations. All construction activities would occur during the daytime; therefore, lighting fixtures would not be required to illuminate construction areas. Proposed nighttime training activities (e.g., military vehicles headlights) would generate nighttime glare. However, because nighttime lighting would be minimal, no significant impacts resulting from glare would occur.

Due to the proximity of the proposed training area to I-5, fugitive dust generated during maneuver training and aircraft operations could obscure views of motorists traveling on I-5. Existing signage along the I-5 corridor indicates the possibility of dust clouds, and dust generated from training operations is anticipated to be intermittent and consistent with similar military training activities that occur along I-5 within MCB Camp Pendleton. In addition, all operations would be conducted in accordance with the requirements stipulated in the range regulations. Therefore, no significant impacts on aesthetics would occur.

3.1.2.2 No-Action Alternative

Under the No-Action Alternative, the former Stuart Mesa West Agricultural Field would not be converted into a multipurpose training area and general site improvements (i.e., construction and maintenance of new access routes), site maintenance (e.g., discing, grading, erosion control, digging, and fill), and associated training operations would not occur. However, the project site would be minimally maintained (i.e., periodically mowed). Existing conditions would remain as described in Section 3.1.1, *Affected Environment*, and the aesthetic environment would remain unchanged. Therefore, no impacts on aesthetics would occur.

3.2 Airspace

This section addresses airspace within the ROI considered relevant to the proposed action and any effects it could have on existing airspace users in this region.

3.2.1 Affected Environment

3.2.1.1 MCB Camp Pendleton Airspace Complex

Specific flight rules and procedures govern aircraft flights within the MCB Camp Pendleton airspace complex. Military aircraft operations are regulated by FAA-mandated restrictions, military aviation operations guidance, and other safety initiatives that regulate military flight operations throughout the area. Civil aircraft operations are governed primarily by Visual Flight Rules and Instrument Flight Rules. Flights operating under Visual Flight Rules are flown solely by reference to outside visual references (horizon, buildings, and flora, etc.), which permit navigation, orientation, and separation from terrain and other traffic. Instrument Flight Rules are established by the FAA to govern flights under conditions in which flight by outside visual reference is not safe. Flight operations under Instrument Flight Rules depend on flying by reference to instruments in the aircraft, and navigation is accomplished by reference to electronic signals.

The MCB Camp Pendleton airspace complex is located within a high-density air traffic region where civilian aircraft operate under both Visual Flight Rules and Instrument Flight Rules. To ensure safe, compatible use of this airspace by all civil and military interests, the FAA has designated special use airspace (restricted area [R-2503]) within the MCB Camp Pendleton airspace complex. R-2503 supports hazardous air and ground-based activities conducted at MCB Camp Pendleton by separating such activities from other non-participating aircraft operating in the surrounding areas. R-2503 is further subdivided into R-2503A (overlies coastal areas of MCB Camp Pendleton from surface to 2,000 feet [610 meters] mean sea level out to one nautical mile offshore), R-2503B (overlies MCB Camp Pendleton impact areas from the surface to 15,000 feet [4,572 meters] mean sea level), R-2503C (overlies the northern two-thirds of R-2503B from 15,000 to 27,000 feet [4,572 to 8,230 meters] mean sea level), and R-2503D (overlies R-2503A from 2,000 feet [610 meters] up to but not including 11,000 feet [3,353 meters] mean sea level). One or more R-2503 subdivisions may be activated, as needed, to accommodate various training activities. Activation of one of the subdivisions places limits on other non-participating civilian and military aircraft in the area.

The airspace surrounding MCB Camp Pendleton also includes uncontrolled Class G airspace that extends from the surface up to 1,200 feet (366 meters) above ground level. Air Traffic Control has no authority over operations in Class G airspace, which is used primarily by Visual Flight Rules civil aviation aircraft.

Military aircraft operating to/from different training areas within the MCB Camp Pendleton airspace complex utilize established transit routes/maneuver corridors that segregate these flights from other military activities within this complex and civilian air traffic operating outside of this airspace. These routes would also be used, as appropriate, for aircraft transiting to/from the project site.

Overall, the manner in which this airspace is managed and the standard flight routes and operating procedures military pilots adhere to while operating within this environment have collectively provided for the safe, compatible use of this airspace by all civil and military interests.

3.2.1.2 Aircraft Operations

The northern part of the project site underlies R-2503A, while the southern portion is located outside the restricted area within general aviation, unrestricted (Class G) airspace (Figure 3.2-1). R-2503A is designated for use from 0600 to 2400 hours (local) daily, and can be used other times as published by a Notice to Airmen. A total of 15,569 aircraft sorties were conducted in R-2503A in fiscal year 2013, which includes all training operations and aircraft transitions through this airspace (personal communication, Bill Lynch 2014).

Special Use Airspace	FIGURE 3.2-1

The FAA Los Angeles Air Route Traffic Control Center is the controlling air traffic control facility for R-2503. The MCB Camp Pendleton Scheduling Office is responsible for coordinating and scheduling military use of all R-2503 subdivisions, while the Range Control Facility ("LONGRIFLE") provides command and control of all military mission operations within this airspace/range complex.

Given the location and low maximum altitude (2,000 feet [610 meters] above mean sea level) of R-2503A, many Visual Flight Rules aircraft elect to either fly above this altitude or remain west of this restricted airspace regardless of its active status. Nonetheless, military pilots operating in and around R-2503A must be cautious of other air traffic in this area and any Visual Flight Rules aircraft that may have inadvertently entered the R-2503 airspace when activated.

3.2.2 Environmental Consequences

The evaluation of potential impacts on the airspace environment considers if and to what extent proposed aircraft operations could affect other airspace users within the MCB Camp Pendleton airspace complex. The proposed action would be conducted in conformance with FAA-mandated restrictions and would not affect standing USMC operating procedures that govern how military flight activities are conducted within the MCB Camp Pendleton airspace complex. The proposed action also would not require any changes to current airspace designations.

3.2.2.1 Alternative A

Alternative A would include rotary wing (AH-1Z, UH-1Y, CH-53) and tilt-rotor (MV-22) air operations to support amphibious, convoy, and medical evacuation training at the multipurpose training area. Aircraft crew members would decide where to land in the training area to best support units, which would generally occur on suitable landing areas in the north-central portion of the project site. The types of operations associated with Alternative A would be non-hazardous and consistent with existing non-restricted (Class G) airspace operations. Therefore, while aircraft operations would occur within restricted airspace that overlies the project site, they would not require activation of R-2503A. In addition, operations would be allowed outside the restricted area (i.e., the southern portion of the project site) within general aviation, unrestricted (Class G) airspace. Per FAA Regulation § 91.119 (Minimum Safe Altitudes) and Chief of Naval Operations Instruction 3710.7U, all aviation operations would occur at least 500 feet (152 meters) above the MCTSSA cantonment area, 200 feet (61 meters) above all vehicles or structures, including I-5, and 200 feet (61 meters) from all structures. During the breeding season (15 February through 30 August), all aircraft would maintain an altitude of at least 300 feet (91.4 meters) above ground level or more above nesting areas, and no aircraft landings would occur within 98 feet (30 meters) of fenced nesting areas.

Based on historical use of the other amphibious landing beaches at MCB Camp Pendleton, it is estimated that a maximum 180 aircraft landings would occur annually at the project site. This represents about one percent of the annual sorties currently conducted in R-2503A. Proposed training activities would be scheduled and coordinated in accordance with the requirements stipulated in the MCIWEST - MCB Camp Pendleton Range and Training Standard Operating Procedures (MCIWEST_MCB CAMPENO 3500.1 CH 1) (USMC 2013c). Also, proposed air operations to and from the project site would follow established transit routes/maneuver corridors that segregate military flights and civilian air traffic.

As noted in Section 2.1.1, *Proposed Training Operations*, the FAA VORTAC is located within the project site, but it would not be moved or adversely affected. Per FAA regulations, no obstacles would be constructed within a 1,000-foot (304-meter) radius of this facility to ensure there would be no interference with transmitted signals received by aircraft navigation systems for directional guidance. Additionally, all proposed aircraft operations within the VORTAC buffer area would be conducted in accordance with FAA regulations.

Overall, the small number of proposed air operations under Alternative A would have little effect on other airspace users in the ROI. Proposed operations would be scheduled, coordinated, and controlled in the same manner as flight activities currently conducted within the MCB Camp Pendleton airspace complex. Therefore, no significant impacts on airspace would occur.

3.2.2.2 No-Action Alternative

Under the No-Action Alternative, the former Stuart Mesa West Agricultural Field would not be converted into a multipurpose training area and general site improvements (i.e., construction and maintenance of new access routes), site maintenance (e.g., discing, grading, erosion control, digging, and fill), and associated training operations would not occur. However, the project site would be minimally maintained (i.e., periodically mowed). Existing airspace conditions would remain as described in Section 3.2.1, *Affected Environment*. Therefore, no impacts on airspace would occur.

3.3 Air Quality and Greenhouse Gases

The following section describes the existing air quality conditions of the project region and potential air quality impacts that would occur from the proposed action.

3.3.1 Affected Environment

Air quality at a given location can be described by the concentrations of various air pollutants in the atmosphere. The significance of a pollutant concentration is determined by comparing its concentration to an appropriate national and/or state ambient air quality standard. These standards represent allowable atmospheric concentrations that protect public health and welfare and include a reasonable margin of safety to protect the more sensitive individuals in the population. The United States Environmental Protection Agency (USEPA) established the National Ambient Air Quality Standards (NAAQS) to regulate the following criteria pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide, sulfur dioxide, particulate matter less than or equal to 10 microns (one millionth of a meter) in diameter (PM_{10}), particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), and lead. Units of concentration for these standards are generally expressed in parts per million or micrograms per cubic meter. The California Air Resources Board (ARB) establishes the state standards called the California Ambient Air Quality Standards (CAAQS). The NAAQS represent maximum acceptable concentrations that generally may not be exceeded more than once per year, except the annual standards, which may never be exceeded. The CAAQS represent maximum acceptable pollutant concentrations that are not to be equaled or exceeded. The national and state ambient air quality standards are shown in Table 3.3-1.

Air emissions produced from the proposed action would affect air quality within the immediate area of MCB Camp Pendleton and along aircraft flight routes connecting to this location within San Diego County. The project site is in the western portion of San Diego County and within the San Diego Air Basin (SDAB). Identifying the ROI for air quality requires knowledge of the pollutant types, source emission rates, the proximity of project emission sources to other emission sources, and local and regional meteorology. For inert pollutants (such as CO and particulates in the form of fugitive dust), the ROI generally is limited to a few miles downwind from a source. The ROI for reactive pollutants such as O_3 could extend much farther downwind than for inert pollutants. Ozone is formed in the atmosphere by photochemical reactions of previously emitted pollutants called precursors. Ozone precursors are mainly nitrogen oxides (NO_x) and photochemically reactive volatile organic compounds (VOCs).

Table 3.3-1. California and National Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards[a]	National Standards[a]	
			Primary[b]	Secondary[c]
Ozone	8-hour	0.07 ppm (137 μg/m^3)	0.075 ppm (147 μg/m^3)	Same as primary
	1-hour	0.09 ppm (180 μg/m^3)	—	—
Carbon monoxide	8-hour	9 ppm (10 mg/m^3)	9 ppm (10 mg/m^3)	—
	1-hour	20 ppm (23 mg/m^3)	35 ppm (40 mg/m^3)	—
Nitrogen dioxide	Annual	0.03 ppm (57 μg/m^3)	0.053 ppm (100 μg/m^3)	Same as primary
	1-hour	0.18 ppm (339 μg/m^3)	100 ppb	—
Sulfur dioxide	24-hour	0.04 ppm (105 μg/m^3)	—	—
	3-hour	—	—	0.5 ppm (1,300 μg/m^3)
	1-hour	0.25 ppm (655 μg/m^3)	0.075 ppm (196 μg/m^3)	—
PM_{10}	Annual	20 μg/m^3	—	—
	24-hour	50 μg/m^3	150 μg/m^3	Same as primary
$PM_{2.5}$	Annual	12 μg/m^3	15 μg/m^3	—
	24-hour	—	35 μg/m^3	—
Lead	Rolling 3-month average	—	0.15 μg/m^3	Same as primary
	30-day average	1.5 μg/m^3	—	—

Source: ARB 2013.
Notes: ppm = parts per million; ppb = parts per billion; μg/m^3 = micrograms per cubic meter.
[a] Concentrations are expressed first in units in which they were promulgated. Equivalent units given in parentheses.
[b] Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health.
[c] Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

In the presence of sunlight, the maximum effect of precursor emissions on O_3 levels usually occurs several hours after they are emitted and many miles from their source.

The analysis of proposed aircraft operations is limited to emissions that would occur within the lowest 3,000 feet (914 meters) of the atmosphere, as this is the typical depth of the atmospheric mixing layer where released emissions could affect ground-level pollutant concentrations. Emissions released above the mixing layer generally would not appreciably affect ground-level air quality.

3.3.1.1 Existing Air Quality

The USEPA designates all areas of the United States (U.S.) in terms of having air quality better than (attainment) or worse than (nonattainment) the NAAQS. An area generally is in nonattainment for a pollutant if its NAAQS has been exceeded more than once per year. Former nonattainment areas that have attained the NAAQS are designated as maintenance areas. Presently, the SDAB is in attainment of the NAAQS for all pollutants except O_3. Additionally, the western portion of the SDAB (the portion of the county generally west of the interior desert region) is also a maintenance area for CO.

The ARB also designates areas of the state that are in attainment or nonattainment of the CAAQS. An area is in nonattainment for a pollutant if its CAAQS have been exceeded more than once in 3 years. The ARB currently designates the SDAB as in nonattainment for O_3, PM_{10}, $PM_{2.5}$, and in attainment for all other CAAQS. The county is considered a severe ozone nonattainment area by the ARB.

Toxic air contaminants (TACs) include air pollutants that can cause serious illnesses or increased mortality, even in low concentrations. TACs are compounds that generally have no established ambient standards, but are known or suspected to cause short-term (acute) and/or long-term (chronic non-carcinogenic or carcinogenic) adverse health effects. The ARB designates diesel particulate matter from the combustion of diesel fuel as a TAC.

3.3.1.2 Greenhouse Gas Emissions

It is well-documented that the Earth's climate has fluctuated throughout its history. However, scientific evidence indicates a correlation between increasing global temperatures over the past century and the worldwide proliferation of greenhouse gas (GHG) emissions by human activity. The main source of GHGs from human activities is the combustion of fossil fuels, such as crude oil and coal. Climate change associated with global warming is predicted to produce negative environmental, economic, and social consequences across the globe.

GHGs trap heat in the atmosphere by absorbing the sun's natural energy. GHGs are released from natural processes and human activities. The most common GHGs emitted from natural processes and human activities include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide. Examples of GHGs created and emitted primarily through human activities include fluorinated gases and sulfur hexafluoride.

Each GHG is assigned a global warming potential (GWP). The GWP is a measure of the ability of a gas or aerosol to trap heat in the atmosphere. The GWP rating system is standardized to CO_2, which has a value of one. For example, CH_4 has a GWP of 28, which means that it has a global warming effect 28 times greater than CO_2 on an equal-mass basis (IPCC 2014), which means that CH_4 can be more detrimental to Earth's climate. To simplify GHG analyses, total GHG emissions from a source are often expressed as a CO_2 equivalent (CO_{2e}). The CO_{2e} is calculated by multiplying the emissions of each GHG by its GWP and adding the results together to produce a single, combined emission rate representing all GHGs. While CH_4 and nitrous oxide have much higher GWPs than CO_2, CO_2 is emitted in such higher quantities that it is the overwhelming contributor to CO_{2e} from both natural processes and human activities.

Federal agencies address emissions of GHGs by reporting and meeting reductions mandated in federal laws, Executive Orders, and agency policies. These requirements include the USEPA *Final Mandatory Reporting of Greenhouse Gases Rule*. Several states have promulgated laws as a means of reducing statewide levels of GHG emissions. In particular, the California Global Warming Solutions Act of 2006 (Assembly Bill 32) directs the State of California to reduce statewide GHG emissions to 1990 levels by the year 2020. Groups of states also have formed regionally based collectives (such as the Western Climate Initiative) to jointly address GHG pollutants.

The USMC takes proactive measures to reduce their overall emissions of GHGs. In an effort to reduce energy consumption, reduce dependence on petroleum, and increase the use of renewable energy resources in accordance with the goals set by Executive Orders and the Energy Policy Act of 2005, the Marine Corps and the Department of Defense (DoD) have implemented a number of renewable energy projects (e.g., photovoltaic solar systems, geothermal power, and wind generation) within the jurisdiction of MCIWEST (MCIWEST 2009, Marine Corps Expeditionary Energy Office 2011).

The potential effects of proposed GHG emissions are by nature global and cumulative impacts because individual sources of GHG emissions are not large enough to have an appreciable effect on climate change. Therefore, the impact of proposed GHG emissions to climate change is discussed in the context of cumulative impacts, as presented in Chapter 4, *Cumulative Impacts*, of this EA.

3.3.1.3 Applicable Rules and Regulations

Federal Regulations

The CAA of 1970 and subsequent amendments specify regulations for control of the nation's air quality. The USEPA is responsible for implementing most aspects of the CAA. Basic elements of the act include the NAAQS for criteria air pollutants, hazardous air pollutant standards, attainment plans, motor vehicle emission standards, stationary source emission standards and permits, and enforcement provisions. The CAA regulates emissions of criteria pollutants and air toxics to protect human health and welfare.

The CAA delegates the enforcement of the national standards to the states. In California, the ARB is responsible for enforcing air pollution regulations. In San Diego County, the ARB has delegated this responsibility to the San Diego County Air Pollution Control District (SDCAPCD).

The CAA establishes air quality planning processes and requires areas in nonattainment of a NAAQS to develop a State Implementation Plan (SIP) that details how the state will attain the standard within mandated time frames. The requirements and compliance dates for attainment are based on the severity of the nonattainment classification of the area.

Section 176(c) of the CAA, as articulated in the USEPA General Conformity Rule, states that a federal agency cannot issue a permit or support an activity unless the agency determines that it will conform to the most recent USEPA-approved SIP. This means that projects using federal funds or requiring federal approval in nonattainment or maintenance areas must not: 1) cause or contribute to any new violation of an NAAQS; 2) increase the frequency or severity of any existing violation; or 3) delay the timely attainment of any standard, interim emission reduction, or other milestone. Emissions of attainment pollutants are exempt from the conformity rule. Actions would conform to an SIP if their annual emissions remain less than applicable *de minimis* thresholds. Formal conformity determinations are required for any actions that exceed these thresholds. Based on the present attainment status of the SDAB, the proposed action would conform to the most recent USEPA-approved SIP if its annual construction or operational emissions do not exceed 100 tons of VOCs, CO, or NO_X. The conformity evaluation for the proposed action is included in Appendix E-2 (*Record of Non-Applicability*).

State Regulations

The California Clean Air Act of 1988 outlines a program to attain the CAAQS for O_3, nitrogen dioxide, sulfur dioxide, and CO by the earliest practical date. Since the CAAQS are more stringent than the NAAQS, attainment of the CAAQS will require more emission reductions than what will be required to show attainment of the NAAQS. Similar to the federal system, the state requirements and compliance dates are based on the severity of the ambient air quality standard violation within a region.

Local Regulations

The SDCAPCD has developed air quality plans to reduce emissions to a level that will bring the SDAB into attainment of the ambient air quality standards (SDCAPCD 2014a). Control measures for stationary sources proposed in the air quality plans and adopted by the SDCAPCD are incorporated into the SDCAPCD rules and regulations (SDCAPCD 2014b). The following SDCAPCD rules would apply to the proposed action:

- Rule 50 – Visible Emissions. A person shall not discharge into the atmosphere from any single source of emissions whatsoever any air contaminant for a period or periods aggregating more than three minutes in any period of 60 consecutive minutes which is darker in shade than that designated as Number 1 on the Ringelmann Chart, as published by the U.S. Bureau of Mines, or of such opacity as to obscure an observer's view to a degree greater than does smoke of a shade designated as Number 1 on the Ringelmann Chart;
- Rule 51 – Nuisance. A person shall not discharge from any source whatsoever such quantities of air contaminants or other material which cause injury, detriment, nuisance or annoyance to any considerable number of persons or to the public or which endanger the comfort, repose, health or safety of any such persons or the public or which cause or have a natural tendency to cause injury or damage to business or property;
- Rule 55 – Fugitive Dust Control. No person shall engage in construction or demolition activity subject to this rule in a manner that discharges visible dust emissions into the atmosphere beyond the property line for a period or periods aggregating more than 3 minutes in any 60-minute period; and
- Rule 1501 – Conformity of General Federal Actions. This rule implements the USEPA General Conformity Rule. Within the SDAB, if proposed annual emissions of VOCs, CO, or NO_x increase by less than 100 tons each, a CAA conformity determination is not required. If emissions of one or more of these compounds exceed a *de minimis* threshold, the USMC must demonstrate conformity under one of the methods prescribed by the rule.

3.3.2 Environmental Consequences

Air quality impacts from Alternative A were reviewed for significance relative to federal, state, and local air pollution standards and regulations. For the purposes of this analysis, if proposed emissions were projected not to exceed an applicable conformity *de minimis* threshold within the project region (100 tons per year of VOCs, CO, or NO_x), then impacts would not be significant. If proposed emissions were projected to exceed an applicable conformity *de minimis* threshold within the project region, further analysis would be needed to determine whether impacts were significant. In such cases, if emissions conform to the approved SIP, then impacts would not be significant. In the case of a criteria pollutant for which a project region attains an NAAQS, the analysis used the USEPA Prevention of Significant Deterioration threshold for new major sources of 250 tons per year as an indicator of significance of projected air quality impacts.

Due to the proximity of I-5 to the project site and the sensitivity of this transportation corridor to fugitive dust obscurations, the analysis also considers whether proposed activities would comply with applicable SDCAPCD fugitive dust rules. Violation of SDCAPCD Rules 50, 51, or 55 would result in a significant impact on air quality.

3.3.2.1 Alternative A

Construction

Air quality impacts from construction activities proposed under Alternative A, including construction of two new beach access routes and a dirt access road in the main training area and general site improvements, would occur from: 1) combustive emissions due to the use of fossil fuel-powered equipment and trucks; and 2) fugitive dust emissions (PM_{10} and $PM_{2.5}$) during earth-moving activities and the use of equipment and vehicles on exposed soils. Construction and operational activity data associated with Alternative A were used to estimate project combustive and fugitive dust emissions. Appendix E-1 (*Air Quality Calculations*) includes data and assumptions used to calculate emissions from these proposed activities. Since construction under this alternative would occur over approximately a 6-month period, the analysis assumed that all emissions from this activity would occur within one calendar year and before emissions generated by proposed training and maintenance operations.

Factors needed to derive construction source emission rates were obtained from the *EMFAC2014* model for on-road vehicles (ARB 2014), the *2011 Off-road Emissions Inventory model* for off-road equipment (ARB 2016), and special studies on fugitive dust (USEPA 1995, 2006). The analysis assumes that implementation of Special Conservation Measure 1 (*Fugitive Dust Control for Construction*) and Special Conservation Measure 2 (*Construction Equipment Emission Control Measures*) would reduce emissions of PM_{10} and $PM_{2.5}$ due to fugitive dust by 50 percent from uncontrolled levels during construction (refer to Appendix C, *Minimization, Mitigation, Monitoring, and Reporting Tracking Sheet*, for Special Conservation Measures 1 and 2).

Table 3.3-2 summarizes the annual and total emissions associated with construction activities under Alternative A. These data show that annual air pollutant emissions generated from these activities would be well below their applicable NEPA significance thresholds. Implementation of standard fugitive dust and construction equipment emission control measures (Special Conservation Measures 1 and 2) would further minimize emissions of PM_{10} and $PM_{2.5}$. Special Conservation Measure 1 (*Fugitive Dust Control for Construction*) also requires that the construction contractor demonstrate that the impact of fugitive dust from proposed construction activities to I-5 would comply with SDCAPCD Rule 50 (Visible Emissions) and Rule 51 (Nuisance). As a result, no significant construction-related impacts on air quality would occur.

Table 3.3-2. Emissions Due to Construction – Alternative A

Source Type	***Air Pollutant Emissions (Tons)***						
	VOC	***CO***	***NO_x***	***SO_2***	***PM_{10}***	***$PM_{2.5}$***	***CO_2e***
Off-Road Equipment Combustive Emissions	0.03	0.08	0.40	0.00	0.02	0.02	44
On-Road Truck Combustive Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.2
Fugitive Dust					1.08	0.11	
Total Emissions[1]	**0.03**	**0.08**	**0.40**	**0.00**	**1.10**	**0.13**	**44**
NEPA Significance Thresholds	**100[2]**	**100[2]**	**100[2]**	**250[3]**	**250[3]**	**250[3]**	**NA**

Notes: CO = carbon monoxide, CO_{2e} = CO_2 equivalent, NEPA = National Environmental Policy Act; NO_x = nitrogen oxides, PM_{10} = particulate matter less than or equal to 10 microns in diameter, $PM_{2.5}$ = particulate matter less than or equal to 2.5 in diameter, SO_2 = sulfur dioxide, VOC = volatile organic compound.
[1] Assumes all emissions would occur within one calendar year.
[2] Conformity *de minimis* threshold.
[3] USEPA Prevention of Significant Deterioration threshold.

Operations

Air quality impacts from Alternative A operations would occur from: 1) the combustion of fuels by tactical vehicles/support equipment and aircraft; and 2) fugitive dust generated during operation of equipment and rotary-wing and tilt-rotor aircraft landings on exposed soils. Factors needed to derive operational source emission rates were obtained from the sources mentioned above for proposed construction activities, previous NEPA analyses (Marine Corps Air Ground Combat Center Twenty-Nine Palms 2013 and USMC 2013a), and special studies on aircraft operations (Navy Aircraft Environmental Support Office 2000a and 2000b; 2001a and 2001b; 2002; 2009a, 2009b, 2009c, and 2009d; 2013).

Table 3.3-3 summarizes the annual emissions that would occur from training and maintenance operations proposed under Alternative A. These data show that annual air pollutant emissions generated from these activities would be below their applicable NEPA thresholds. Implementation of Special Conservation Measure 3 (*Procurement of Operational Equipment*) would further minimize combustive emissions from proposed training and maintenance operations (refer to Appendix C, *Minimization, Mitigation, Monitoring, and Reporting Tracking Sheet*, for Special Conservation Measure 3). As a result, total annual emissions from operations would not result in significant impacts on air quality.

Table 3.3-3. Annual Emissions Due to Training and Maintenance Operations – Alternative A

Activity/Source	*Air Pollutant Emissions (Tons)*						
	VOC	*CO*	*NOx*	*SO2*	*PM10*	*PM2.5*	*CO2e*
Amphibious Operations							
Vehicular Combustive Emissions	0.18	0.82	2.05	0.10	0.24	0.22	163
Fugitive Dust					8.50	1.36	
Tactical Vehicles							
Vehicular Combustive Emissions	0.06	0.22	0.92	0.01	0.04	0.04	115
Fugitive Dust					20.47	2.05	
Fording Training							
Vehicular Combustive Emissions	0.03	0.08	0.47	0.00	0.02	0.02	54
Fugitive Dust					17.07	1.71	
Combat Engineer Support Equipment							
Equipment Combustive Emissions	0.40	1.17	6.33	0.01	0.22	0.21	762
Fugitive Dust					2.48	0.25	
Operational Maintenance							
Vehicular Combustive Emissions	0.08	0.25	1.08	0.00	0.05	0.05	119
Fugitive Dust					1.98	0.20	
Aircraft Operations							
Aircraft Combustive Emissions	0.12	0.60	1.05	0.05	0.28	0.27	394
Fugitive Dust					0.09	0.01	
Total Emissions[a]	**0.87**	**3.14**	**11.90**	**0.17**	**51.44**	**6.37**	**1,608**
NEPA Significance Thresholds	**100[b]**	**100[b]**	**100[b]**	**250[c]**	**250[c]**	**250[c]**	**NA**

Notes: CO = carbon monoxide, CO_{2e} = CO_2 equivalent, NEPA = National Environmental Policy Act; NOx = nitrogen oxides, PM_{10} = particulate matter less than or equal to 10 microns in diameter, $PM_{2.5}$ = particulate matter less than or equal to 2.5 in diameter, SO_2 = sulfur dioxide, VOC = volatile organic compound.
[a] Assumes all emissions would occur within one calendar year.
[b] Conformity *de minimis* threshold.
[c] USEPA Prevention of Significant Deterioration threshold.

As shown in Table 3.3-3, unmitigated training and maintenance operations proposed under Alternative A would generate substantial amounts of fugitive dust (up to 52 tons per year). Since the project site is adjacent to I-5, fugitive dust generated by proposed operations could impact this transportation corridor when winds blow from the project site to I-5. Existing signage along the I-5 corridor indicates the possibility of dust clouds and dust generated from training operations is anticipated to be intermittent and consistent with similar military training activities that occur along I-5 within MCB Camp Pendleton. In addition, all operations would be conducted in accordance with the requirements stipulated in the range regulations. Therefore, no significant impacts on air quality would occur.

Proposed construction and operational equipment would emit TACs that could potentially impact public health. The main source of TACs would occur in the form of particulates from the combustion of diesel fuel. Due to the mobile and intermittent operation of proposed diesel-powered construction and operational equipment over a large area, there would be minimal ambient impacts of TACs in a localized area. As a result, no significant impacts on air quality would occur.

3.3.2.2 No-Action Alternative

Under the No-Action Alternative, the former Stuart Mesa West Agricultural Field would not be converted into a multipurpose training area and general site improvements (i.e., construction and maintenance of new access routes), site maintenance (e.g., discing, grading, erosion control, digging, and fill), and associated training operations would not occur. However, the project site would be minimally maintained (i.e., periodically mowed). Existing air quality conditions would remain as described in Section 3.3.1, *Affected Environment*. Therefore, no impacts on air quality would occur.

3.4 Biological Resources

The following section describes vegetation, general wildlife species, special status species, and wetlands and other waters of the U.S. within the ROI and provides analyses of the potential effects on these resources from the proposed action.

3.4.1 Affected Environment

3.4.1.1 Data Sources

Several project-specific natural resources studies were conducted in support of the proposed action, including:

- *Final Rare Plants Report for the Stuart Mesa West Training and Conversion Project* (Leidos 2014a);
- *Final Jurisdictional Determination Report for the Stuart Mesa West Training and Conversion Project* (Leidos 2014b) (Appendix F);
- *Final Results of Focused Surveys for Federally-listed Vernal Pool Branchiopods for the Stuart Mesa West Training and Conversion Project* (AMEC Environment & Infrastructure, Inc. 2014); and
- *Protocol Surveys of Federally-listed Coastal California Gnatcatcher for the Stuart Mesa West Training and Conversion Project* (AMEC Environment & Infrastructure, Inc. 2013 and Leidos 2015).

Light-footed Clapper (Ridgway's) Rail Survey, Marine Corps Base Camp Pendleton (HDR 2011), MCB Camp Pendleton Geographic Information System (GIS) (current as of November 2016) (MCB Camp Pendleton 2016), and *Status and Distribution of the Light-footed (Ridgway's) Clapper Rail in California* (Zembal et al. 2014) also covered and addressed habitats within the project site and buffer area. Additional information in support of this analysis was also derived from the following sources: MCB Camp Pendleton Integrated Natural Resource Management Plan (INRMP) (MCB Camp Pendleton 2012); *Riparian and Estuarine Programmatic Conservation Plan* and associated *Biological Opinion (1-6-95-F-02) Programmatic Activities and Conservation Plans in Riparian and Estuarine/Beach Ecosystems on Marine Corps Base, Camp Pendleton* (USFWS 1995); and the *MCB Camp Pendleton 2030 Master Pla*n (USMC 2010b), which provide general biological information about plant and wildlife species; and the MCB Camp Pendleton GIS database (MCB Camp Pendleton 2016). Plant community classification follows Oberbauer et al. (2008).

3.4.1.2 Plant Communities, Habitats, and Associated Wildlife

Approximately 95 percent of the project site is developed or disturbed as a result of past agricultural activities, and is exposed on a regular basis to military training noise including overhead aircraft, which overfly the project site en route to MCAS Camp Pendleton and other training areas. In addition, a transportation corridor including I-5 and a heavily used rail line borders approximately 1.3 miles (2.1 kilometers) of the northeastern project site boundary (Figure 2.1-1). The transportation corridor exposes habitat and associated wildlife to increased noise levels, which are estimated at 70 dB CNEL at approximately 400 feet (122 meters) and 65 dB CNEL at approximately 1,000 feet (305 meters) from the corridor (NAVFAC SW 2011).

Vegetation within the proposed main training area is currently maintained by discing and mowing to prevent vegetation growth in accordance with Categorical Exclusions 20110062A (25 July 2011) and 20110062A (1 September 2011) and is dominated by non-native plant species, especially introduced ruderal species, including crystal iceplant (*Mesembryanthemum crystalinum*), lesser swinecress (*Lepidium didymum*), weedy cudweed (*Pseudognaphalium luteo-album*), long-beak filaree (*Erodium botrys*), and yellow sweet clover (*Melilotus indicus*), that can germinate in disturbed soils. A limited number of non-native grass species, including red brome (*Bromus madtritensis* ssp. *rubens*), Mediterranean barley (*Hordeum marinum*), and goldentop (*Lamarkia aurea*), were identified during surveys of adjacent and comparable habitats and likely also occur at the project site. No project-specific general wildlife surveys were conducted; however, based on the plant communities present, the proposed main training area (former agricultural fields) likely support rodents, invertebrates, and small reptiles that have adapted to frequently disturbed habitats. A high diversity of songbirds and raptors are known to use the project vicinity, including northern harrier, peregrine falcon, red-tailed hawk, kestrel, and Cooper's hawk (HDR 2011). Raptors likely use the former agricultural fields and adjacent native areas for hunting and foraging. The project site is unlikely to serve as a wildlife travel corridor for larger species or provide more than limited and low-quality habitat for most species due to the level of disturbance and ongoing maintenance.

The western portion of the project site includes southern foredunes and sandy beach adjacent to the Pacific Ocean. Southern riparian scrub and coastal and valley freshwater marsh exist between the foredunes and the base of the coastal bluff. The coastal bluff supports coastal bluff scrub vegetation interspersed with patches of southern riparian scrub. Wild radish (*Raphanus sativa*), a non-native upland plant species, is established and co-dominates several of the native communities within the project site and buffer area. Invasive species including giant reed (*Arundo donax*) and perennial pepperweed (*Lepidium latifolium*) are present in the buffer area west of the project site. The coastal bluff and beaches to the west and south of the main training area provide habitat for common marine shorebirds and ground-nesting birds that may be present during the breeding season, which include several federally listed species such as the western snowy plover (*Charadrius alexandrinus nivosus*) and California least tern (*Sterna antillarum browni*). Additionally, the light-footed Ridgway's rail is known to occur year-round within estuarine habitat associated with the Santa Margarita River mouth. These species are addressed in Section 3.4.1.4, *Threatened and Endangered Species*.

Native communities are present to the north and south of the project site. Coastal sage scrub occurs on the south-facing bluffs between the main training area and the Santa Margarita Lagoon. Surrounding lands south of the project site are within the floodplain of the Santa Margarita River and lagoon, and the vegetation in this area is influenced by the hydrology of the river and tides. Sand bars or narrow tidal barriers form at the mouth of the Santa Margarita River, periodically closing the lagoon and impounding low stream flows. These barriers are breached during periods of high flows and storm events (MCB Camp Pendleton 2012). The lagoon is also subject to tidal influence when the Santa Margarita River mouth is open.

3.4.1.3 Migratory Bird Treaty Act Species

A complete list of all species of migratory birds protected by the Migratory Bird Treaty Act (MBTA) is in 50 CFR 10.13, which includes almost all birds found on MCB Camp Pendleton throughout the year. The MBTA prohibits the taking, killing, or possessing of migratory birds unless permitted by regulations promulgated by the Secretary of the Interior. The *Final Rule for the Take of Migratory Birds by the Armed Forces* (USFWS 2010) was issued on 28 February 2007, which authorizes the Armed Forces to take migratory birds as an incidental result of military readiness activities defined as training and operations that relate to combat and adequate and realistic testing and training of military equipment, vehicles, weapons, and sensors for proper operation and sustainability for combat use. Conditions of this authorization are the obligation of DoD installations to confer and cooperate when military readiness activities may have a significant adverse effect on a population of migratory bird species. MCB Camp Pendleton, through its INRMP and NEPA process, identifies measures to monitor, minimize, and mitigate – to the extent practicable – adverse impacts to migratory birds that may be attributable to military readiness activities. Military training associated with the proposed action would be subject to the *Final Rule for the Take of Migratory Birds by the Armed Forces*.

As described above, the *Final Rule for the Take of Migratory Birds by the Armed Forces* does not cover non-readiness activities (i.e., routine operations of installation operating support functions) such as natural resource management activities, installation support functions, operation of industrial activities, construction of facilities, and hazardous waste cleanup. In support of the Act, the DoD and the USFWS entered into a Memorandum of Understanding designed to promote the conservation of migratory birds by ensuring DoD operations (non-military readiness activities) are consistent with the Act.

MBTA-protected species are known to occur within the project site and buffer area, particularly associated with native communities along the coastal bluffs and the Santa Margarita Lagoon, and within the former agricultural field.

3.4.1.4 Threatened and Endangered Species

Management of species listed as threatened or endangered under the ESA at MCB Camp Pendleton is conducted through implementation of the INRMP (MCB Camp Pendleton 2012), *Riparian and Estuarine Programmatic Conservation Plan* and associated programmatic instructions, and additional reasonable and prudent measures stipulated in the Riparian BO. Additionally, project-specific measures are often developed during the ESA Section 7 consultation process for specific actions. These plans and programs manage the interactions between the training mission and natural resources with the goal of reducing impacts on federally listed plant and wildlife species.

The *Riparian and Estuarine Programmatic Conservation Plan* established specific management zones along the coastline. Within these established zones, management activities focus on maintaining wetland values of coastal lagoons, protecting and maintaining California least tern and western snowy plover nesting areas, and maximizing the probability for tidewater goby populations within the lagoon complex. The project site is located within the Santa Margarita River Management Zone, which includes the beach area extending from the southern end of White Beach to the southern end of the Santa Margarita Lagoon. Habitats within this management zone include least tern foraging areas; inter-tidal beaches (between mean low-water and mean high tide) for snowy plover foraging; all nesting locations for the western snowy plover, California least tern, and light-footed Ridgway's rail; salt pan; dune systems in nesting areas; salt marsh; mud flats; and all wetlands (USFWS 1995).

Several species that are federally listed as threatened or endangered have the potential to occur within the project vicinity based on the presence of similar habitat, occurrence records, and/or results of focused surveys (Table 3.4-1).

Table 3.4-1. Federally Listed Threatened and Endangered Plant and Animal Species Known to Occur or Potentially Occur in the Project Vicinity

Species	*Status*	*Habitat/Occurrence*
Thread-leaved brodiaea *Brodiaea filifolia*	FT, SE, 1B	Typically occurs on heavy soils in open grasslands, at the edges of vernal pools and hot springs, and in floodplains. Project-specific surveys in Spring 2012 did not identify this species. Based on the results of the protocol surveys, this species is considered not present and is not evaluated further.
Brand's phacelia *Phacelia stellaris*	FC, 1B	This species occurs in loamy sand on sand dunes, silty plains, and other sandy, sparsely vegetated areas near the coast within alluvial floodplains, coastal strands, coastal dunes, and coastal sage scrub. Project-specific surveys in Spring 2012 did not identify this species. Based on the results of the protocol surveys, this species is considered not present and is not evaluated further.
Least Bell's vireo *Vireo bellii pusillus*	FE, SE	This species primarily inhabits dense willow-dominated riparian habitats with lush understory vegetation, nesting in the understory and using taller trees for foraging and singing perches. MCB Camp Pendleton GIS identifies historic records for this species associated with Cockleburr Canyon approximately 500 feet (152 meters) north of the northernmost corner of the project site.
Southwestern willow flycatcher *Empidonax traillii extimus*	FE, SE	This species breeds in dense riparian vegetation along rivers, streams, or other wetlands. MCB Camp Pendleton GIS identifies historic records for this species associated with Cockleburr Canyon approximately 500 feet (152 meters) north of the northernmost corner of the project site.
Coastal California gnatcatcher *Polioptila californica californica*	FT, CSC	This species prefers open coastal sage scrub habitat with California sagebrush. This species has been observed approximately 4,265 feet (1,300 meters) from the project site. This species was found during protocol surveys conducted in 2012 approximately 750 feet (229 meters) or more north of the northern buffer area of the project site, north of Cockleburr Canyon (AMEC Environment & Infrastructure, Inc. 2013). An additional individual male was recorded in 2015 approximately 75 feet (22.9 meters) north of the project site, and 450 feet (137.2 meters) southwest of the existing MCTSSA cantonment area (Leidos 2015). Recent project-specific surveys did not encounter this species south of the former agricultural field, although MCB Camp Pendleton GIS data include historic identifications (most recently 2010; MCB Camp Pendleton 2016).
Riverside fairy shrimp *Streptocephalus woottoni*	FE	This fairy shrimp species occurs in seasonal, shallow, static pools that are filled by winter and spring rains. These pools occur in coastal sage scrub and may be natural as well as human-made depressions that temporarily impound water. Protocol surveys were conducted during the 2011/2012 and 2012/2013 wet seasons. Potentially suitable habitat was associated with actively used dirt roads that showed evidence of routine disturbance. No Riverside fairy shrimp were detected (AMEC Environment & Infrastructure, Inc. 2014). Based on the results of the protocol surveys, this species is considered not present and is not evaluated further.

Table 3.4-1. Federally Listed Threatened and Endangered Plant and Animal Species Known to Occur or Potentially Occur in the Project Vicinity

Species	***Status***	***Habitat/Occurrence***
San Diego fairy shrimp *Branchinecta sandiegonensis*	FE	This shrimp occurs in vernal pools and other seasonally ponded features fed by winter and spring rains in coastal southern California. Protocol surveys were conducted during the 2011/2012 and 2012/2013 wet seasons. Potentially suitable habitat was associated with actively used dirt roads that showed evidence of routine disturbance. No San Diego fairy shrimp were detected (AMEC Environment & Infrastructure, Inc. 2014). Based on the results of the protocol surveys, this species is considered not present and is not evaluated further.
Western snowy plover *Charadrius alexandrinus nivosus*	FT	Large nesting sites on MCB Camp Pendleton include: Santa Margarita River mouth (Blue Beach) north through Cockleburr Beach (including the project site); French and Aliso creeks (White Beach); and the salt flats of the Santa Margarita River Estuary (MCB Camp Pendleton 2016). The beaches within the project site (White Beach) are located within the Santa Margarita River Management Zone. Protection and management of the western snowy plover and its habitat are stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995).
California least tern *Sterna antillarum browni*	FE, SE	Approximately 25 percent of all California least tern nest locations occur at MCB Camp Pendleton (Marschalek 2012). On MCB Camp Pendleton, California least tern colonial nesting sites are located at the Santa Margarita River mouth (Blue Beach), North Beach (North), North Beach (South), French and Aliso creeks (White Beach), and the salt flats of the Santa Margarita River Estuary (MCB Camp Pendleton 2012). Least terns nest in large numbers between the southern beach extent of the project site and the Santa Margarita River Estuary (North Beach). Protection and management of the California least tern and its habitat are stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995).
Light-Footed Ridgway's (=Clapper) Rail *(Rallus obsoletus [=longirostris] levipes)*	FE, SE	Since the 1980s, the species has only been detected on MCB Camp Pendleton at the Santa Margarita River Estuary (MCB Camp Pendleton 2012). Protection and management of the light-footed Ridgway's rail and its habitat are stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995).
Steelhead *(Oncorhynchus mykiss)*	FE	MCB Camp Pendleton creeks and coastal habitats are within the southern California Distinct Population Segment's known distribution of the species. The most recent confirmed record for steelhead in the Santa Margarita River is from 2009 (MCB Camp Pendleton 2012). Based on the low likelihood of any project-related effects at the Santa Margarita River, and in combination with the lack of confirmed records, this species is not carried forward for further analysis.
Tidewater Goby *(Eucyclogobius newberryi)*	FE	This species occurs in coastal brackish water habitats (lagoons, estuaries, and marshes). Although known historically to occur in the Santa Margarita River, there have been no confirmed records for the Tidewater goby since 2001 (MCB Camp Pendleton 2012). Based on the low likelihood of any project-related effects at the Santa Margarita River, and in combination with the lack of confirmed records, this species is not carried forward for further analysis.

Table 3.4-1. Federally Listed Threatened and Endangered Plant and Animal Species Known to Occur or Potentially Occur in the Project Vicinity

Species	*Status*	*Habitat/Occurrence*
Status: Federal Status (determined by USFWS): FE Federally Listed Endangered FT Federally Listed Threatened FC Candidate for Federal Listing CSC California Special Concern Species California Native Plant Society Listing: List 1B: Plants rare, threatened, or endangered in California and elsewhere.		State Status (determined by California Department of Fish and Game): SE California State-Listed Endangered ST California State-Listed Threatened

Plants

Rare plant surveys were conducted at the project site and buffer area in Spring 2012, with focused, protocol surveys targeting thread-leaved brodiaea (*Brodiaea filifolia*; federally listed as threatened [1998; 63 FR 54975 54994]), Brand's phacelia (*Phacelia stellaris*; a candidate species for federal listing and California Rare Plant Rank[6] [CRPR] 1B.1), and Pendleton button celery (*Eryngium pendletonense*; CRPR 1B.1) (Leidos 2014a). In addition to the target species, surveys included a 100 percent inventory of all plants discovered to identify any non-target plant species listed as threatened or endangered by the USFWS and/or considered sensitive, rare, or special status with the state or the California Native Plant Society. No thread-leaved brodiaea or other federally listed plant species were found during the focused surveys. However, five CRPR list species were observed, including Brand's phacelia, Nuttall's lotus (*Acmispon prostratus*, CRPR 1B.1), coast woolly heads (*Nemacaulis denudata* var *denudata*, CRPR 1B.1), red sand verbena (*Abronia maritima*, CRPR 4.2), and southwestern spiny rush (*Juncus acutus* ssp. *leopoldii*, CRPR 4.2).

Wildlife

Several federally listed species have the potential to occur in the vicinity of the project site and buffer area, including the western snowy plover (*Charadrius alexandrinus nivosus*), California least tern (*Sterna antillarum browni*), and light-footed Ridgway's rail (*Rallus obsoletus levipes*). These species are managed on MCB Camp Pendleton through several mechanisms including the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995) and applicable programmatic instructions to reduce impacts on plant and wildlife species associated with riparian and estuarine/beach habitats.

Western Snowy Plover

The Pacific coast population of the western snowy plover was listed as threatened in 1993 (58 FR 12864–12874). Critical habitat has been established for the species, including a 2012 revised designation (77 FR 36727–36869); however, the USFWS determined that lands within MCB Camp Pendleton are exempt from critical habitat designation under section 4(a)(3) of the ESA because the MCB Camp Pendleton INRMP and *Riparian and Estuarine Programmatic Conservation Plan* establish conservation efforts that provide and will continue to provide a benefit to the species and its habitat. On MCB Camp Pendleton, the breeding season occurs from about 1 March through 15 September. On MCB Camp

[6] The California Native Plant Society inventories (the "Inventory") and evaluates the current conservation status of sensitive plants native to California. As part of the *Inventory*, sensitive plants receive a California Rare Plant Rank (CRPR). Plants with a CRPR of 1B are rare throughout their range with the majority of them endemic to California. CRPR 4 plants are of limited distribution or infrequent throughout a broader area in California, but are not considered "rare" from a statewide perspective. A detailed description of the program and definitions for additional California Rare Plant Rankings can be found at (http://www.rareplants.cnps.org/glossary.html#lists).

Pendleton, western snowy plover nesting sites have been found at the Las Flores Creek (Red Beach), the salt flats of the Santa Margarita Lagoon, and the most favored sites at the Santa Margarita River mouth (Blue Beach), French and Aliso creeks (White Beach Central), and Cockleburr Beach (White Beach South) (MCB Camp Pendleton 2016; Boylan et al. 2016b; MCB Camp Pendleton 2012). Western snowy plovers are also known to nest in scattered beach locations throughout much of MCB Camp Pendleton, including in and around Blue Beach and "Section F" within and adjacent to the project site. Occasionally, nests are also established outside of primary nesting habitat, such as within sandy areas in the former agricultural field. During the non-breeding season, the species forages and roosts in more widely scattered locations and likely utilizes all of the beaches at MCB Camp Pendleton. The number of western snowy plovers on-Base fluctuates annually. For example, over the last decade, annual counts ranged between 94 adults in 2005 and 2007, and 170 adults in 2012. In 2015, 102 adult western snowy plovers (making up 4.5 percent of western snowy plovers found on the Pacific coast) and 216 nests were documented on-Base (Boylan et al. 2016b; USFWS 2015). Approximately 30 percent of the MCB Camp Pendleton nesting population overwinters on-Base (USFWS 2007). Protection and management of the western snowy plover and its habitat is stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995).

California Least Tern

The California least tern was federally listed as endangered in 1970 (35 FR 8491–8498). No critical habitat rule has been established for the species. The California least tern is a small, migratory bird that nests and roosts in colonies on the beach. They typically arrive at MCB Camp Pendleton in March and depart by mid-September. On MCB Camp Pendleton, California least tern colonial nesting sites are located at the Santa Margarita River mouth (Blue Beach), North Beach (North), North Beach (South), French and Aliso creeks (White Beach), and the salt flats of the Santa Margarita Lagoon (MCB Camp Pendleton 2016; Boylan et al. 2016a; MCB Camp Pendleton 2012). Near the project site, least terns nest in large numbers between the southern beach extent of the project site and the Santa Margarita Lagoon (North Beach). In 2015, the California least tern breeding survey estimated 1,349 breeding pairs (approximately 20 percent of total state population), 1,375 nests (approximately 23 percent of total state population), and 188 fledglings on MCB Camp Pendleton (Frost 2015). For the most part, the California least tern population on MCB Camp Pendleton has remained stable over the past decade, with the exception of the number of fledglings, which has varied over time. The number of fledglings in 2015 represented a decrease from 2014, but aligned with the long-term average at MCB Camp Pendleton (2002–2015) (Boylan et al. 2016a). MCB Camp Pendleton maintains a fenced California least tern nesting area to further protect the species during the breeding season. Similar to the western snowy plover, protection and management of the California least tern and its habitat on MCB Camp Pendleton is stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995).

Light-footed Ridgway's (=Clapper) Rail

The light-footed Ridgway's rail was federally listed as endangered in 1970 (35 FR 16047–16048). No critical habitat rule has been established for the species. The light-footed Ridgway's rail is a medium-sized marsh bird that lives and breeds in coastal and freshwater marshes. Potential habitat for this species occurs in the project vicinity at San Mateo and San Onofre estuaries (Green Beach), Las Flores Estuary (Red Beach), and French Estuary (White Beach). However, since the 1980s, the species has only been detected on MCB Camp Pendleton at the Santa Margarita Lagoon, which is immediately south of the project site (MCB Camp Pendleton 2012). This species is the subject of annual statewide status and distribution surveys (2014 was the 35th year). Protection and management of light-footed Ridgway's rail habitat is stipulated in the *Riparian and Estuarine Programmatic Conservation Plan*. In addition, programmatic instructions that provide base-wide stipulations for avoidance and minimization of impacts to the species habitat, especially during the Special Management Season, are provided in the MCIWEST - MCB Camp Pendleton Range and Training Standard Operating Procedures (MCIWEST_MCB CAMPENO 3500.1 CH 1) (USMC 2013c).

Coastal California Gnatcatcher

The coastal California gnatcatcher was federally listed as threatened in 1993 (58 FR 16742–16757) pursuant to section 4(a)(3)(B) of the ESA. Critical habitat was originally designated for the coastal California gnatcatcher in 2000 (65 FR 63680–63743) and a revised designation was issued in 2007 (72 FR 72010–72213). Under the revised designation, MCB Camp Pendleton was exempted from any critical habitat pursuant to section 4(a)(3) of the ESA because the USFWS determined that the MCB Camp Pendleton INRMP provides a conservation benefit to the species. This species occurs almost exclusively within the coastal sage scrub vegetation community, but on occasion it can also be found in chaparral, grassland, or riparian communities adjacent to sage scrub habitat (USFWS 1995). Characteristic coastal sage scrub plant species include California sagebrush (*Artemisia californica*), various species of sage (*Salvia* spp.), California buckwheat (*Eriogonum fasciculatum*), laurel sumac (*Malosma laurina*), California encelia (*Encelia californica*), coyote brush (*Baccharis pilularis*), cholla cactus (*Cylindropuntia* spp.), and goldenbush (*Isocoma menziesii*) (Oberbauer et al. 2008). The coastal California gnatcatcher is known to occur on several areas on-Base including the project vicinity. Individual (non-nesting) coastal California gnatcatchers were identified in the project site buffer area to the west and east of the existing MCTSSA cantonment area. On-Base, the coastal California gnatcatcher and its associated habitat are formally protected and managed through project-specific ESA consultations, as well as the MCB Camp Pendleton INRMP (MCB Camp Pendleton 2012).

Least Bell's Vireo

The least Bell's vireo was federally listed as endangered in 1986 (51 FR 16474–16482). Critical habitat for this species was designated in six southern California counties in 1994 (59 FR 4845–4867); however, MCB Camp Pendleton lands were removed from the designation because the USFWS and the USMC have signed a Memorandum of Understanding designed to accomplish the same degree of habitat protection as critical habitat designations. Additional protective measures and management of the species and its habitat are stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995). The least Bell's vireo arrives at MCB Camp Pendleton from mid-March to early April and leaves for its wintering grounds in southern Baja California in August (Franzreb 1989). Vireos primarily inhabit dense, willow-dominated riparian habitats with lush understory vegetation. MCB Camp Pendleton GIS identifies historic records for this species associated with Cockleburr Canyon approximately 500 feet (152 meters) north of the northernmost corner of the project site (MCB Camp Pendleton 2016).

Southwestern Willow Flycatcher

The southwestern willow flycatcher was federally listed as endangered in 1995 (60 FR 10695–10715). The most recent designation of critical habitat for this species was completed in 2013 (78 FR 343–534). MCB Camp Pendleton was exempted from the critical habitat designation pursuant to Section 4(a)(3)(B)(i) of the ESA because the USFWS determined the conservation efforts identified in the MCB Camp Pendleton INRMP provide a benefit to the species and riparian habitat on MCB Camp Pendleton. Additional protective measures and management of the species and its habitat are stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995).

Based on 2013 data, the resident southwestern willow flycatcher population on MCB Camp Pendleton consisted of 3 males, 10 females, and 4 flycatchers of unknown sex. Eleven territories were established, consisting of 10 pairs, and one male of unknown status. In total, 10 females formed pair bonds with 2 male southwestern willow flycatchers. The majority of territories were located along the Santa Margarita River. One additional territory was established at Pilgrim Creek. All territories were located in mixed willow riparian habitat. Transient southwestern willow flycatchers have historically been recorded associated with Cockleburr Canyon outside of the project site but within approximately 500 feet (152 meters) of the northernmost project boundary (MCB Camp Pendleton 2016).

3.4.1.5 Wetlands and Other Waters of the U.S.

Surveys were conducted to determine the occurrence of wetlands and other bodies of water that may be subject to the regulatory jurisdiction of the USACE under Sections 401 and 404 of the Clean Water Act (33 CFR parts 320–330) (Leidos 2014b) (Appendix F, *Final Jurisdictional Determination Report for the Stuart Mesa West Training and Conversion Project*). Any project-related activities that have the potential to result in fill or impacts to areas determined to be jurisdictional by the USACE Los Angeles District will require regulatory coverage as prescribed by the Clean Water Act. Project activities that directly or indirectly affect features determined to be jurisdictional require submittal of a permit application to USACE and a clean water certification from the RWQCB.

The jurisdictional wetlands identified during project-specific surveys were associated with and within the floodplain of the Santa Margarita River and lagoon, south of the project site (Figure 3.4-1). Only one small area considered jurisdictional (less than 0.1 acre [0.04 hectare]) occurs near the drainage system along the western edge of the project site (Leidos 2014b).

No wetlands were recorded along the beach or coastal bluffs in the western portion of the project site; however, the USACE is reviewing the jurisdictional status of the wetlands within these areas. The Pacific Ocean is a Traditional Navigable Water**,** which is defined as “subject to the ebb and flow of the tides, and … presently used, has been used in the past, or may be susceptible for use to transport interstate or foreign commerce” (33 CFR 328.3(a)(1)). Jurisdictional waters include the Pacific Ocean up to the mean high tide line or mean high water.

3.4.2 Environmental Consequences

3.4.2.1 Alternative A

Construction

Plant Communities, Habitats, and Associated Wildlife

Alternative A includes construction of two new beach access routes from the White Beach Amphibious Landing Area to the main training area and a dirt access road in the southern portion of the main training area. General site improvements (e.g., site grading/routine maintenance) would also occur to control on-site vegetation. Proposed activities at the main training area would result in the removal of low-quality ruderal plant communities and any associated common wildlife species. The vegetation that would be removed under Alternative A is remnant of former agricultural activities and consists of non-native weedy species that provide some, but limited value to common wildlife. This area is currently managed by discing and mowing under separate programs and has not been allowed to re-establish in any meaningful way since the agricultural activities ceased. Because of the low-quality ruderal nature of this habitat and the site history as an agricultural field, removal and subsequent control of this community would represent a negligible adverse biological effect.

FIGURE 3.4-1

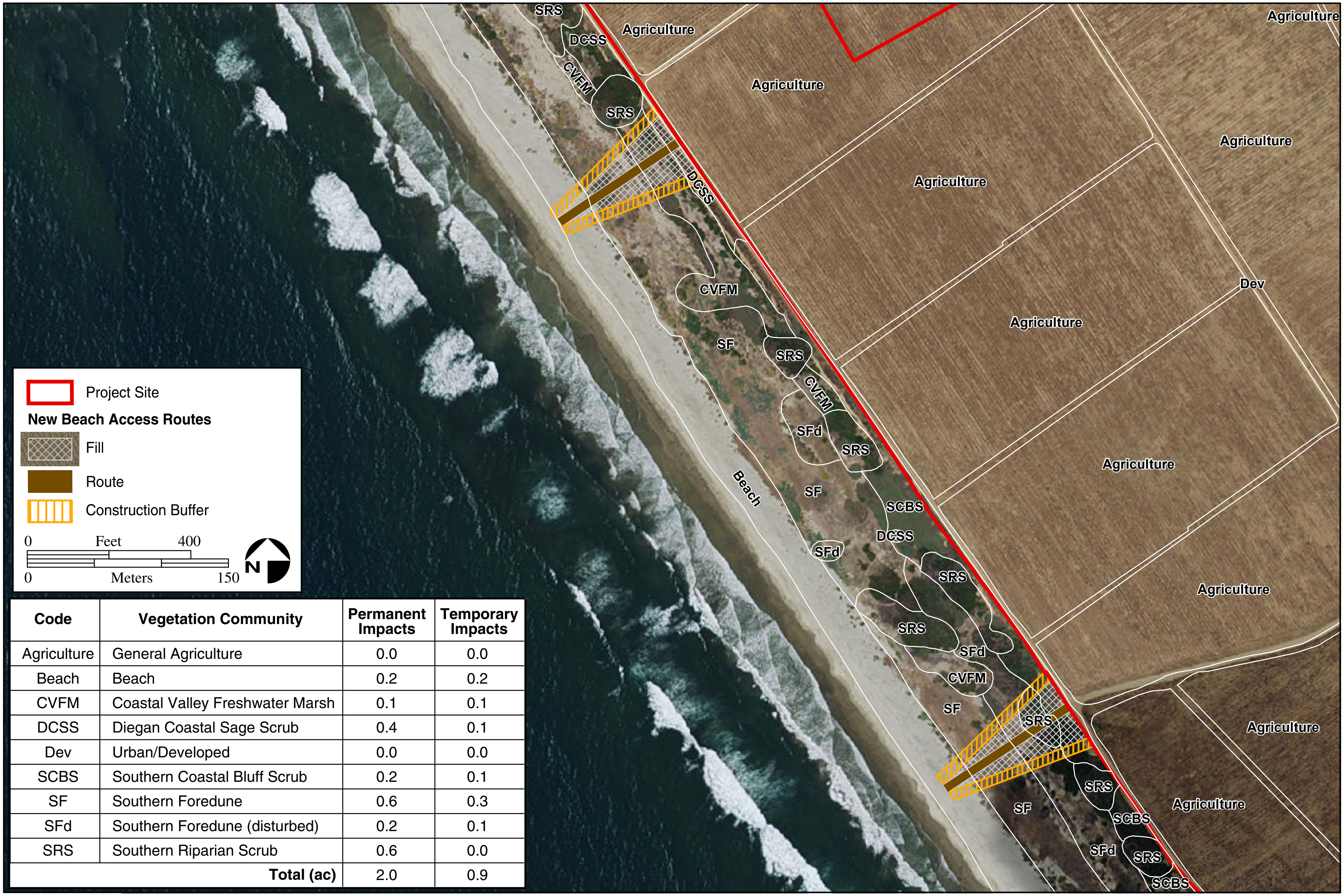
Wetlands and Jurisdictional Waters of the U.S. within the Project Site

As regulated under the Riparian BO and stipulated in Special Conservation Measure 4 (*Seasonal Avoidance for Federally Listed and MBTA-protected Bird Species*), construction and maintenance of the new beach access routes and dirt access road in the main training area would be scheduled outside the breeding season for most species, which would reduce the potential for impacts to essential life functions.

NEW BEACH ACCESS ROUTES

Construction of the two new beach access routes from the White Beach Amphibious Landing Area to the main training area would result in the permanent removal of approximately 2.6 acres (1.05 hectares) of coastal bluff scrub, foredune, riparian scrub, and beach communities, comprising approximately 0.5 acre (0.2 hectare) of permanent road and 2.1 acres (0.85 hectare) of 2:1 fill slopes (Figures 2.1-3 and 3.4-2). The fill is considered permanent; however, the slopes would be revegetated following the Riparian BO in a manner that minimizes erosion potential. To the maximum extent feasible, vegetation would be replaced with like-kind communities using an appropriate plant palette. Temporary impacts would also occur with the incidental loss of plant communities within the construction buffer (approximately 25 feet [8 meters] around the two new beach access routes). The loss of riparian plant communities on MCB Camp Pendleton is managed through the Riparian BO (USFWS 1995), which establishes compensation ratios for the permanent and temporary removal of riparian habitat. The permanent loss of dune habitat would be offset by the 2.1 acres (0.85 hectares) of dune habitat that was created between 2013 and 2016 adjacent to the project site (Figure 3.4-3) and the creation of an additional 0.5 acres (0.20 hectares) of dune habitat at a location approved by MCB Camp Pendleton Environmental Security and USFWS before construction of the two new beach access routes at a 1:1 mitigation ratio according to Marine Corps/USFWS project consultation precedent. All dune habitat restoration efforts would be coordinated with MCB Camp Pendleton Environmental Security. Occasional as-needed maintenance of the two new beach access routes would maintain access and prevent re-establishment of vegetation. Special Conservation Measure 5 (*Riparian Vegetation Removal Compensation*) would ensure the loss of riparian habitat is compensated for in accordance with the ratios identified in the Riparian BO.

Construction-related noise associated with construction of the two new beach access routes would temporarily and intermittently occur over the 6-month construction period. Similarly, occasional as-need maintenance, which could require the use of heavy equipment to repair the access routes or remove vegetation, would generate intermittent noise. Estimating that noise from construction equipment could range from 80 to 90 dB at 50 feet (15 meters) from the source (FHWA 2006), non-nesting birds and other wildlife, if present, could be disrupted by the increased noise levels (and visual cues) associated with construction activities. Using a rule of thumb that noise levels decrease 6 dB per doubling of distance, wildlife within approximately 400 feet (122 meters) of the proposed construction activities would potentially be exposed to noise levels above 65 dB. As a result, potential noise effects from construction and maintenance of the two new beach access routes would be limited to foredune and beach species within a 400-foot (122-meter) radius, which likely includes a number of common non-nesting bird species, as well as western snowy plovers (described in detail under *Threatened and Endangered Species*). Construction activities associated with the new beach access routes would be temporary and intermittent and would occur outside of the breeding season, and the potential for effects would occur over a matter of days to weeks within the construction period. In addition, the habitat and associated wildlife exposed to temporary construction noise levels are routinely subjected to military training activities, including aircraft overflights. Temporary construction-related noise levels would be within the type and magnitude of activities that currently occur within the project vicinity.



Code	Vegetation Community	Permanent Impacts	Temporary Impacts
Agriculture	General Agriculture	0.0	0.0
Beach	Beach	0.2	0.2
CVFM	Coastal Valley Freshwater Marsh	0.1	0.1
DCSS	Diegan Coastal Sage Scrub	0.4	0.1
Dev	Urban/Developed	0.0	0.0
SCBS	Southern Coastal Bluff Scrub	0.2	0.1
SF	Southern Foredune	0.6	0.3
SFd	Southern Foredune (disturbed)	0.2	0.1
SRS	Southern Riparian Scrub	0.6	0.0
	Total (ac)	2.0	0.9

Vegetation in the Vicinity of the New Beach Access Routes

FIGURE
3.4-2

Alternative A - Sensitive Species in the Project Vicinity

FIGURE 3.4-3

NEW MAIN TRAINING AREA ACCESS ROAD

Construction of the dirt access road would result in the removal of approximately 1.8 acres (0.73 hectare) of disturbed, ruderal plant communities within the main training area. Non-nesting wildlife associated with the existing ruderal habitat located within 400 feet (122 meters) of construction activities would be exposed to intermittent increased noise levels.

However, due to the lack of suitable habitat, non-nesting individuals are not likely to use the main training area other than incidentally, which therefore limits potentially affected resources to adjacent native habitats, and reduces the potential exposure to construction noise to those activities that would occur along the project site boundary (near adjacent native habitats).

Construction-related noise would occur near known federally listed species occurrences, including western snowy plover, least Bell's vireo, and coastal California gnatcatcher (described in detail under *Threatened and Endangered Species*). However, wildlife adjacent to the project site are exposed to continuous noise levels associated with the I-5 corridor (estimated at 70 dB at 400 feet [122 meters] from the corridor, and 65 dB at 1,000 feet [305 meters] from the corridor), which further reduces the area of habitat exposed to project-related temporary noise sources in excess of baseline conditions. Implementation of Special Conservation Measure 4 (*Seasonal Avoidance for Federally Listed and MBTA-protected Bird Species*) would ensure that all construction activities occur outside the breeding season for many species.

SITE GRADING/MAINTENANCE

Other general site grading/routine maintenance of on-site vegetation, would generate low-intensity noise levels, and occur infrequently for only short periods of times (days). If general site maintenance activities (e.g., mowing/discing, grading, erosion control, digging, and fill) are required within the special use areas, all activities will occur outside of the breeding season as identified in Special Conservation Measure 4 (*Seasonal Avoidance for Federally Listed and MBTA-protected Bird Species).*

Implementation of Special Conservation Measure 4 (*Seasonal Avoidance for Federally Listed and MBTA-protected Bird Species*) and Special Conservation Measure 5 (*Riparian Vegetation Removal Compensation*) would ensure that construction and maintenance of the new access routes would occur outside the breeding season for most species, would substantially reduce the level of effect on federally listed species, and would ensure the loss of riparian habitat is compensated for in accordance with the ratios identified in the Riparian BO (USFWS 1995) (refer to Appendix C, *Minimization, Mitigation, Monitoring, and Reporting Tracking Sheet*, for Special Conservation Measures 4 and 5). As a result, no significant impacts from construction and maintenance activities on plant communities, habitats, and associated wildlife would occur.

Migratory Bird Treaty Act Species

The proposed main training area does not support suitable habitat for MBTA-protected species that occur at MCB Camp Pendleton; however, suitable native habitats are present within the project site adjacent to the new beach access routes, along the beach at the amphibious landing areas, and within the buffer area north and south of the project site. As discussed previously, implementation of Special Conservation Measure 4 (*Seasonal Avoidance for Federally Listed and MBTA-protected Bird Species*) would ensure that all construction activities occur outside the breeding season for nesting birds protected under the MBTA. Therefore, no significant impacts from construction on MBTA-protected species would occur.

Threatened and Endangered Species

Construction of the new beach access routes would require the use of construction equipment in close proximity to known western snowy plover nesting habitat as described under *Plant Communities, Habitats, and Associated Wildlife*. However, implementation of Special Conservation Measure 4 (*Seasonal Avoidance for Federally Listed and MBTA-protected Bird Species*) would ensure that all construction activities (i.e., grading, vegetation removal, and maintenance) occur outside the breeding season for many species, including western snowy plover. Other federally listed species, including California least tern, light-footed Ridgway's rail, southwestern willow flycatcher, least Bell's vireo, and coastal California gnatcatcher, are located at least 1,000 feet (350 meters) away from the new beach access route locations and would not be exposed to the associated short-term noise level increases during construction.

Similarly, construction of the dirt access road in the main training area would occur near known federally listed species occurrences, including western snowy plover, least Bell's vireo, and coastal California gnatcatcher, which are known to occur immediately south and southwest of the main training area (Figure 3.4-2). Only a small fraction (less than 20 percent) of the main training area is less than 400 feet (122 meters) from known federally listed species occurrences. Therefore, only construction activity within that portion of the project site would expose federally listed species, if present, to temporary and intermittent construction noise. Furthermore, the species adjacent to the project site are subjected to continuous noise levels associated with the I-5 corridor (estimated at 70 dB at 400 feet [122 meters] from the corridor, and 65 dB at 1,000 feet [305 meters] from the corridor), which further reduces the amount of habitat temporarily exposed to noise in excess of baseline conditions. Implementation of Special Conservation Measure 4 (*Seasonal Avoidance for Federally Listed and MBTA-protected Bird Species*) would further ensure that all construction activities occur outside the breeding season for many species, including western snowy plover, least Bell's vireo, and coastal California gnatcatcher. Therefore, no significant impacts from construction on federally listed species would occur.

Wetlands and Other Waters of the U.S.

A small amount of jurisdictional wetlands (less than 0.1 acre [0.04 hectare]) occur along the western edge of the project site adjacent to the existing drainage system. No construction activities are proposed within this portion of the project site. Fill associated with construction of the two beach access routes would be placed above the mean high water line and high tide line. The USACE is reviewing the jurisdictional status of the wetlands along the beach and coastal bluffs and, if necessary, an individual permit may be required. Mitigation would be completed as deemed necessary by the USACE. Therefore, no significant impacts on wetlands and other waters of the U.S. would occur.

Operations

Proposed training activities, such as amphibious landings, movements to the main training area, and use of existing roads to support components of AAV driver training, would not include substantial earth-moving activities or vegetation removal. Trenching to establish firing positions and training activities with heavy equipment (tanks and amphibious vehicles) in the main training area would disturb existing vegetation; however, the communities present are already disturbed and support only ruderal plant communities that are adapted to disturbance. All proposed training that has the potential to impact riparian and estuarine/beach ecosystems and species would comply with programmatic avoidance measures, range regulations, and programmatic instructions stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995). The *Riparian and Estuarine Programmatic Conservation Plan* ensures that riparian and estuarine/beach communities on

MCB Camp Pendleton are sufficiently resilient to withstand natural and human disturbances, including military training activities.

All activity within the Santa Margarita River Management Zone, which includes the project site, is further managed through the establishment of minimum distances from sensitive species and habitats, as identified in the "Instructions for Military Training." Compliance with the stated measures, regulations, and instructions would be required under Alternative A. Alternative A also includes the establishment of Special Use Areas at the southern and northern portions of the main training area that would restrict training to foot mobile patrols only (i.e., no motorized vehicle activity) during the breeding season of most federally listed species that have the potential to occur within the Santa Margarita Lagoon and associated habitats (Figure 3.4-3).

Plant Communities, Habitats, and Associated Wildlife

Proposed training within the main training area would continually disturb low-value ruderal plant communities. Training activities (e.g., aircraft operations, basic AAV training, tactical vehicle operations, and non-live fire exercises) in this area would increase noise levels and disturb adjacent wildlife habitats. Rotor wash from aircraft during landings, takeoffs, and hovering above the ground would temporarily affect vegetation and wildlife habitat in the immediate vicinity of the aircraft. Dust deposits could affect essential plant processes including photosynthesis, respiration, and transpiration; dust could also result in the penetration of phytotoxic gaseous pollutants to nearby vegetation over time and potentially increase incidences of plant pests and diseases (Farmer 1993). However, the project site is currently mowed and disked, and has historically supported agricultural-related activities. Therefore, the conversion of the project site from agricultural lands to a training area would not appreciably change the value of habitat.

For nearby native habitats north, south, and west of the proposed main training area, noise and visual cues associated with training could adversely affect reproduction or other behavior, and potentially induce a startle response and cause possible injury to birds from uncontrolled flight, increase the expenditure of energy during critical periods, decrease the amount of time spent on life functions, temporarily mask auditory signals from other animals, and/or otherwise reduce the protection and stability of young animals. The magnitude of the impact would depend on the distance from the noise-producing event to the affected habitat. Due to the size of the main training area, large sections are more than 1,000 feet (305 meters) from native habitats. In addition, the majority of the proposed main training area is exposed to ongoing elevated noise levels generated from the I-5 corridor, which exceed some of the anticipated noise levels associated with proposed training activities. In addition, as a result of the historical agricultural activity at the site (including the use of heavy equipment), adjacent native communities have been routinely exposed to similar activities that are comparable to those proposed under Alternative A. Nonetheless, any increase in noise, or change in the type of noise, has some potential to affect nearby wildlife, primarily during key reproductive periods. To minimize the effects of training on wildlife, the Special Use Areas would be designated at the northern and southern portions of the project site to buffer training activity from adjacent native habitats. During the breeding season, only foot mobile patrols (i.e., no motorized vehicle activity) would be authorized in the Special Use Areas which would ensure a minimum 500-foot (152-meter) buffer between noise-producing training activities and native habitats. Although proposed training activities have the potential to disturb adjacent native habitats and associated wildlife, the magnitude of effects would be modest relative to the current noise levels generated from the I-5 corridor and military training activities. In addition, potential impacts would be further reduced by restricting training activities within the Special Use Areas (i.e., foot mobile patrols only) during the breeding season. Therefore, no significant impacts from operations on plant communities, habitats, and associated wildlife would occur.

Migratory Bird Treaty Act Species

No removal of nests or physical disturbance to habitats would occur during training activities. However, as discussed previously, noise and human activity can adversely affect reproduction, foraging, and behavior. The magnitude of impacts would be greatest during the breeding season; however, activities within the designated Special Use Areas would be restricted during the breeding season to buffer training activities from adjacent native habitats. In addition, because of the size of the main training area, large sections are more than 1,000 feet (305 meters) from native habitats suitable for MBTA-protected species. Also, the majority of the main training area is exposed to ongoing elevated noise levels generated from the I-5 corridor, which exceed some of the anticipated noise levels associated with training activities. Because no native habitat would be removed, and training within Special Use Areas adjacent to native habitats would be limited to non-noise producing activities during the breeding season, no significant impacts from operations on MBTA-protected species would occur.

Threatened and Endangered Species

With respect to proposed training operations, federally listed species would be subjected to ongoing vehicle operations and approaches, basic AAV training, aircraft operations, and the use of munitions. AAV approaches would occur year-round but would be restricted by the Riparian BO training regulations which define minimum distances to marked beach nests, as well as other noise and troop size restrictions (refer to Section 2.1.2, *Training Restrictions*). Noise from AAVs on soft sand is approximately 72 dB at 100 feet (31 meters), a distance within which beach nests could occur. These levels, in addition to associated visual cues, could disrupt nesting individuals; however, potential effects would be limited to the time period when each vehicle traverses the beach (estimated to be a matter of seconds). Vehicle training and general maintenance at the main training area would also result in temporary increases in noise. In general, noise from vehicular activity would decrease to below 65 dB at distances from approximately 150 feet (46 meters) to 300 feet (91 meters) from the source, depending on the vehicle. Due to the size of the main training area, approximately 85 percent of the project site is greater than 300 feet (91 meters) from native habitat. Only the Special Use Areas would be within 300 feet of known or historic federally listed species nests, and training within those areas would be restricted to foot mobile patrols (i.e., no motorized vehicle activity) during the breeding season.

With respect to aircraft operations, approximately 180 aircraft landings per year would occur in the main training area. Aircraft would generally approach the project site from the east and conduct operations on suitable landing areas that are free from obstacles (i.e., MCTSSA buildings, antenna, and RADOME) in the north-central portion of the project site. Assuming half of those sorties would occur during the breeding season, the frequency of effect would be limited to approximately 28 hours of flight time during the 6-month breeding season and effects would be limited to the portions of the project site within 1,000 feet (305 meters) of nesting activity. It is estimated that 35 percent of the project site is within 1,000 feet (305 meters) of nesting activity. However, aircraft would maintain an altitude of 300 feet (91.4 meters) above ground level or more above nesting areas and would be seasonally restricted by the training restrictions stipulated in the Riparian BO.

Similar to other noise-producing activities, noise level changes associated with non-live fire munitions and sound-simulating training aids would depend on the distance from the activity and the directional placement of the receptor. Munitions noise levels can exceed 87 dB at distances ranging from 525 feet (160 meters) to over 5,000 feet (1,524 meters) depending on the munition type. Shorter distances would result in higher noise levels, which could exceed 104 dB. For the larger munitions types, all training within the project site would result in increased noise levels at sensitive wildlife receptors independent of where the activity occurs. Under Alternative A, the establishment of Special Use Area would buffer most of the munitions-related noise at the fenced California least tern nesting area, the Santa Margarita Lagoon, and at known occurrences of coastal California gnatcatchers in upland habitats north and south of the main training area. The duration of the effect would be short-term and munition noise would be intermittent during training activities with breaks between noise-producing activities. Although Alternative A would adhere to the training restrictions in the Riparian BO, which include minimal distances from sensitive wildlife receptors, the potential for disturbances would still occur. The magnitude of effect would be greatest when training events occur during the breeding season.

Responses to increases in noise levels are likely to be variable and dependent on season, species, distance from existing noise sources such as the I-5 transportation corridor, and other factors (e.g., visual cues). Given the distance to noise-producing activities and implementation of training restrictions stipulated in the Riparian BO, nests of federally listed species are not likely to be abandoned during critical periods, and literature review suggests that at least some species are able to tolerate increases in noise levels without major changes in life functions. The most sensitive receptors would be associated with the fenced California least tern nesting area and western snowy plover nesting habitats within the Santa Margarita River Management Zone. At its closest point, the fenced California least tern nesting area is more than 450 feet (137 meters) from proposed training activities (not including the Special Use Area) and more than 1,000 feet (305 meters) from the closest new beach access route. However, for active snowy plover nests, even with minimum requirements, some nests could be exposed to auditory disturbances associated with proposed training activities. Other species such as coastal California gnatcatchers and least Bell's vireo could also be affected, but nesting locations are variable and would benefit from visual shields associated with topography and distance, as well as the designated Special Use Area training restrictions.

All proposed training that has the potential to impact riparian and estuarine/beach ecosystems and species would comply with programmatic avoidance measures, range regulations, and programmatic instructions stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995), which substantially reduces the magnitude of effect on federally listed species and associated habitats. Primarily, these measures restrict training operations during the breeding season within the Santa Margarita River Management Zone, which includes the project site, by buffering noise-producing activities from sensitive wildlife receptors and limiting the potential for adverse behavioral modifications. In addition, implementation of Special Conservation Measure 4 (*Seasonal Avoidance for Federally Listed and MBTA-protected Bird Species*) would minimize impacts on federally listed species and ensure compliance with prior USFWS consultations. Therefore, no significant impacts from operations on federally listed species would occur.

Wetlands and other Waters of the U.S.

Proposed training activities would not create fill and/or discharge fill or dredge material into waters of the U.S. Amphibious vehicle activities would occur below the mean high tide line. Therefore, no significant impacts from operations on wetlands and other waters of the U.S. would occur.

3.4.2.2 No-Action Alternative

Under the No-Action Alternative, the former Stuart Mesa West Agricultural Field would not be converted into a multipurpose training area and general site improvements (i.e., construction and maintenance of new access routes), site maintenance (e.g., discing, grading, erosion control, digging, and fill), and associated training operations would not occur. However, the project site would be minimally maintained (i.e., periodically mowed). Existing biological resources conditions would remain as described in Section 3.4.1, *Affected Environment*. Therefore, no impacts on biological resources would occur.

3.5 Cultural Resources

3.5.1 Affected Environment

Cultural resources are comprised of districts, buildings, sites, structures, areas of traditional use, or objects with historical, architectural, archeological, cultural, or scientific importance. They include archeological resources (both prehistoric and historic), historic architectural resources (physical properties, structures, or built items), and traditional cultural resources (those important to living Native Americans for religious, spiritual, ancestral, or traditional reasons).

The National Historic Preservation Act (NHPA) of 1966, as amended, sets forth national policy and procedures regarding historic properties. Federal regulations define historic properties to include prehistoric and historic sites, buildings, structures, districts, or objects listed or eligible for listing on the National Register of Historic Places (National Register), as well as artifacts, records, and remains related to such properties (NHPA, as amended [54 USC 300101 *et seq*.]). Compliance with Section 106 of the NHPA, which directs federal agencies to take into account the effect of a federal undertaking on a historic property, is outlined in the Advisory Council on Historic Preservation's regulations, *Protection of Historic Properties* (36 CFR Part 800).

3.5.1.1 Definition of the Area of Potential Effects

The Area of Potential Effects (APE) of an undertaking is defined at 36 CFR 800.16(d) as "the geographic area or areas within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist." The APE includes all areas of potential ground disturbance associated with proposed construction and operational activities. This includes the proposed training area and new beach access routes, areas of site improvements, and a buffer area that accounts for aircraft rotor wash in the main training area (Figure 3.5-1). To account for potential ground disturbance from aircraft rotor wash during hovering and landing/takeoff operations, the APE includes a 350-foot (107-meter) buffer area surrounding the main training area. The size of this buffer area is based on a standard approach used on other USMC rotary wing and tilt-rotor projects to address aircraft rotor wash effects on adjacent resources.

For historic architectural resources, the APE includes any viewsheds of historic buildings that may be affected by proposed construction or operational activities. For Native American resources, the APE includes the project site and the viewsheds of any traditional cultural resources that could be affected by proposed construction or operational activities.

3.5.1.2 Prehistoric and Historic Setting

Current knowledge of the prehistory of MCB Camp Pendleton and its relationship to developments throughout southern California is detailed in Reddy and Byrd (1997) and summarized below. The sequence begins in the Paleoindian period (11,500 to 8,500 Before Present [B.P.]), a time in which adaptations were formerly believed to be focused on the hunting of large game, but are now recognized to represent more generalized hunting and gathering, with considerable emphasis on marine resources (Erlandson and Colten 1991; Erlandson 1994; Jones 1991). The following period, the Archaic (8,500 to 1,300 B.P.), is generally considered as encompassing both a coastal and an inland focus, with the coastal Archaic represented by the shell middens of the La Jolla Complex and the inland Archaic represented by the Pauma Complex.

Cultural Resources Area of Potential Effects

FIGURE 3.5-1

Coastal settlement is also seen as having been significantly affected by the stabilization of sea levels around 4,000 years ago that led to siltation of coastal lagoons and a general decline in the productivity of many coastal habitats (Warren et al. 1961; Warren and Pavesic 1963; Warren 1968; Gallegos 1987; Masters and Gallegos 1997). Nevertheless, recent research on MCB Camp Pendleton has documented continued occupation along the coast well after this decline was in progress (Byrd 1996, 1998).

The Late Prehistoric period (1,300 to 200 B.P.) is marked by the appearance of small projectile points indicating the use of the bow and arrow, the common use of ceramics, and the replacement of inhumations with cremations, all characteristic of the San Luis Rey Complex as defined by Meighan (1954). Along the coast of northern San Diego County, deposits containing significant amounts of the little bean clam shell (*Donax gouldii*) are now widely assigned to the Late Prehistoric Period, based on a well-documented increase in the use of this resource at this time (Byrd 1996). Recent investigations on MCB Camp Pendleton also indicate increasing settlement of upland settings at this time.

When the Spanish arrived in southern California, the area of MCB Camp Pendleton was occupied by the Native American group known as the Luiseño, whose territory is thought to have comprised some 1,500 square miles (3,890 square kilometers) of coastal and interior California. Kroeber (1925) estimated a population of only 5,000 pre-contact Luiseño, while White (1963) and Shipek (1977) estimated a population closer to 10,000. Recent ethnohistoric studies for the MCB Camp Pendleton vicinity (Johnson and O'Neill 2001) identified several Luiseño communities within MCB Camp Pendleton boundaries. Identified communities within MCB Camp Pendleton include *Pange* and *Zoucche*, both within leased areas along San Mateo Creek; *Topomai* (or *Topome*), located partially within the grounds of the Ranch House complex and partially within MCAS Camp Pendleton; *Quigaia*, located in the Ysidora Basin area, within or near November training area; *Uchme*, located at the Las Flores ruins; *Chacape* and *Mocuachem*, both possibly within or near Papa One training area; and *Pomameye*, apparently within or near the Zulu Impact Area.

The area of MCB Camp Pendleton entered the historic record in 1769, when several locations now within MCB Camp Pendleton boundaries were described by members of the Portola expedition passing through on its way to Monterey. After Mission San Luis Rey was established in 1798, most of the land that was to become MCB Camp Pendleton was held by the mission, which used it primarily for grazing cattle and limited farming. After secularization, most of the area became part of the Rancho Santa Margarita y Las Flores, held by Pio and Andrés Pico and subsequently sold, in part, to Juan Forster and eventually (in 1883) to James C. Flood and Richard O'Neill, who presided over a number of improvements to the ranch. In addition to ranching, extensive dry land farming took place along the coastal terraces. The Magee family leased land to farm lima beans in the Las Flores/Red Beach area, and this farming continued after the government purchased the land.

Just before the U.S. entry into World War II, the U.S. Army had considered the purchase of the rancho as a training facility. After the U.S. Army decided against it, the USMC acquired the 125,000-acre (50,587-hectare) property in 1942, naming the facility after Joseph H. Pendleton, a popular 40-year veteran of the Marines. In 1944, MCB Camp Pendleton was declared a permanent installation, with the stated goal to be the center of all West Coast activities and the home of the 1st Marine Division. MCB Camp Pendleton served its role as a training and replacement command through both the Korean War and Vietnam War. The USMC broadened its mission capabilities during the 1980s and 1990s by combining infantry, armor, supply, and air power deployment in Grenada, Panama, Persian Gulf, Somalia, and during Operation Desert Shield and Desert Storm.

3.5.1.3 Cultural Resources within the Project Site

Records searches were conducted at the South Coastal Information Center of the California Historical Resources Information System in support of archeological surveys of the project site on 23 May and 20 October 2011 (SAIC 2013a, 2013b). The record searches were used to identify previous archeological investigations and recorded cultural resources within a 1-mile (1.6-kilometers) radius of the APE. Electronic databases and GIS layers provided by MCB Camp Pendleton were used to confirm and supplement the data from the South Coastal Information Center. The following provides a summary of those findings.

Archeological Survey Coverage. Thirty-one archeological investigations have been previously conducted within 1 mile (1.6 kilometers) of the APE, of which 11 overlapped with the APE. These studies include: Arrington (2006), Brown (1994, 1996), Cupples (1976), Navy (2006), Leidos (2016), Page (2010), Reddy (1998), Shultz (2011), and SAIC (2013a, 2013b). In particular, two recent surveys covered the majority of the project site during an 88-acre (36-hectare) cultural resources survey of the proposed expansion of the MCTSSA cantonment area (SAIC 2013a) and a 219-acre (89-hectare) cultural resources survey for the Stuart Mesa West Training and Conversion Project (SAIC 2013b). Six new prehistoric archeological sites (CA-SDI-20928, CA-SDI-20929, CA-SDI-20930, CA-SDI-20938, CA-SDI-20939, and CA-SDI-20940) were recorded during the two recent surveys.

Archeological Resources. Thirty-three previously recorded archeological sites are located within 1 mile (1.6 kilometers) of the APE, 10 of which are located within the APE (CA-SDI-4423/H, CA-SDI-12573, CA-SDI-12629/H, CA-SDI-12630/H, CA-SDI-20928, CA-SDI-20929, CA-SDI-20930, CA-SDI-20938, CA-SDI-20939, and CA-SDI-20940). These sites consist of prehistoric shell and lithic scatters, and, in some cases, historic artifacts. Leidos (2016) conducted Phase II archeological testing at the 10 sites located within the APE. Only one site (CA-SDI-4423/H) was recommended eligible for listing in the National Register.

Historic Buildings and Structures. There are no recorded historic buildings or structures located in the APE or adjacent to the APE.

Traditional Cultural Resources. There are no known traditional cultural recourses within or adjacent to the APE.

3.5.2 Environmental Consequences

Section 106 of the NHPA requires that federal agencies take into account the effects of their proposed actions on historic properties. Impacts on cultural resources are considered significant if a historic property, as defined under 36 CFR 60.4, would be physically damaged or altered, would be isolated from the context considered significant, or would be affected by project elements that would be out of character with the significant property or its setting.

3.5.2.1 Alternative A

Alternative A would convert the 273-acre (110-hectare) project site into a multipurpose training area (Figure 2.1-1). There are no historic buildings or structures and no known traditional cultural resources within or adjacent to the APE, but there is one archeological site within the APE (CA-SDI-4423/H) that was recommended eligible for listing in the National Register. The site is located within the buffer area of the project site and is not expected to receive direct impacts from proposed construction or training activities because it is located outside the main training area. Additionally, indirect impacts from airborne dust and debris caused by aircraft rotor wash from activities in the main training area are unlikely to affect

CA-SDI-4423/H because the intact prehistoric subsurface deposits are capped by approximately 12 to 16 inches (30 to 40 centimeters) of overburden composed of debris from nearby highway construction and maintenance. The overburden, therefore, would protect the buried deposit from any surface disturbance caused indirectly from activities associated with Alternative A. Therefore, no significant impacts on cultural resources would occur.

Although highly unlikely based on the findings of the Phase II archeological testing, it is possible that subsurface archeological material may be encountered during construction activities. Potential impacts to possible post-review discoveries would be reduced by implementing Special Conservation Measure 6 (*Construction Monitoring for the Beach Access Routes*) and Special Conservation Measure 7 *(Post-Review Discovery Procedures*) (refer to Appendix C, *Minimization, Mitigation, Monitoring, and Reporting Tracking Sheet*, for details).

The USMC has determined that effective protection measures would be employed to avoid adverse effects to any historic properties, per Stipulation III.D.(3) of the *Programmatic Agreement Among the USMC, the Advisory Council on Historic Preservation (ACHP), and the California State Historic Preservation Officer (SHPO) Regarding the Process for Compliance with Section 106 of the National Historic Preservation Act for Undertakings on Marine Corps Base Joseph H. Pendleton* (August 2014). Therefore, no review or consultation with the SHPO or ACHP is required before implementing the undertaking.

3.5.2.2 No-Action Alternative

Under the No-Action Alternative, the former Stuart Mesa West Agricultural Field would not be converted into a multipurpose training area and general site improvements (i.e., construction and maintenance of new access routes), site maintenance (e.g., discing, grading, erosion control, digging, and fill), and associated training operations would not occur. However, the project site would be minimally maintained (i.e., periodically mowed). Existing conditions would remain as described in Section 3.5.1, *Affected Environment*. Therefore, no impacts on cultural resources would occur.

3.6 Land Use and Coastal Zone Management

3.6.1 Affected Environment

3.6.1.1 Existing Land Uses

The project site is located on the previously disturbed, former Stuart Mesa West Agricultural Field within the 31 Area (Edson Range) on the southwestern portion of the Base. Although the project site was farmed for decades, the most recent agricultural lease expired in January 2011. Subsequently, the project site was disked and mowed in accordance with Categorical Exclusions 20110062 (25 July 2011), 20110062A (1 September 2011), and 20110062C (7 November 2011) to allow for soil sampling, repair, and maintenance.

There are approximately 13,500 acres (5,463 hectares) of land within MCB Camp Pendleton that are designated as Prime Farmland by the U.S. Department of Agriculture (USMC 2010b). Prime Farmland on MCB Camp Pendleton is located near the coastline, adjacent to the Base's northern and southern shorelines. Prime Farmland is defined as farmland with the best combination of physical and chemical characteristics that are able to sustain long-term agricultural production and produce sustained high yields with minimal soil loss. Federal protection of Prime Farmland is stipulated in the Environmental Protection Manual, MCO P11000.8B. While the project site is currently not used as farmland, it is designated as Prime Farmland by the Farmland Mapping and Monitoring Program.

3.6.1.2 Surrounding Land Uses

MCB Camp Pendleton is located on the coast in northern San Diego County. Situated within an unincorporated part of San Diego County, MCB Camp Pendleton is located north of the City of Oceanside and south of the City of San Clemente. Surrounding land uses to the west (Pacific Ocean) and east (Cleveland National Forest) include recreation (e.g., fishing, surfing, swimming, hiking, and camping). Lands to the north (City of San Clemente) and south (City of Oceanside) include residential and commercial uses. Surrounding lands to the east include residential and agricultural uses within the community of Fallbrook.

The predominant types of land uses at MCB Camp Pendleton include military training and training support facilities (e.g., controlled impact areas, dedicated impact areas, and training and maneuvering areas), and Base infrastructure and mission support facilities (e.g., developed areas, housing areas, and airfield). MCB Camp Pendleton has several developed areas that are isolated from each other by relatively large expanses of mostly undeveloped land used for training and maneuvers.

The existing undeveloped conditions support the training mission. Maneuvers are generally restricted to the undeveloped areas. The central portion of MCB Camp Pendleton is comprised of relatively undeveloped land for impact areas and training ranges, where detonations from explosives and other effects of training are farthest from the civilian community and other sensitive receptors. Land use intensity increases outward from the undeveloped center to the more developed support areas of the perimeter, including administration, supply, housing, and other functions.

Land uses surrounding the project site include the MCTSSA cantonment area and Cockleburr Canyon to the northwest, I-5 to the east, Santa Margarita River to the southeast, and the Pacific Ocean to the west. The MCTSSA cantonment area is a developed area that supports research and development activities for USMC Command, Control, Communications, Computers, and Intelligence (C4I) systems.

3.6.1.3 Land Use Management Plans

Legal requirements and plans pertinent to land use and development within the project site are described below.

Coastal Zone Management Act

The CZMA of 1972 (16 USC § 1451) encourages coastal states to be proactive in managing coastal zone uses and resources. The CZMA established a voluntary coastal planning program and participating states submit a Coastal Management Plan to the National Oceanic and Atmospheric Administration for approval. Under the CZMA, federal agency actions within or outside the coastal zone that affect any land or water use or natural resource of the coastal zone shall be carried out in a manner that is consistent to the maximum extent practicable with the enforceable policies of the approved state management programs. Each state defines its coastal zone in accordance with the CZMA. Excluded from any coastal zone are lands the use of which by law is subject solely to the discretion of the federal government or which are held in trust by the federal government (16 USC § 1453). Additionally, the project site is located in a designated security zone that is under the exclusive jurisdiction of the Navy and is not open to the public. Although MCB Camp Pendleton is federal government property and therefore excluded from the coastal zone, the Navy nonetheless conducted an effects analysis as part of its determination of the action's effects for purposes of federal consistency review under the CZMA. This was done to factually determine whether the action (even if conducted entirely on federal property) would affect any coastal use or resource.

MCB Camp Pendleton 2030 Base Master Plan

The *MCB Camp Pendleton 2030 Base Master Plan* (USMC 2010b) provides a basis for evaluating land use impacts. This document contains overall land management guidelines based on a consideration of the location of MCB Camp Pendleton, its infrastructure, operations, and natural resources. The plan describes development constraints as well as areas of development opportunity, such as areas that are economically and functionally capable of supporting development by virtue of location, space, topography, and access to utilities. Conformity with these guidelines is a key factor as to whether a specific land use is suitable for a given site or area. The plan identifies agricultural lands that are not being outleased as potential development and expansion areas (USMC 2010b).

3.6.2 Environmental Consequences

3.6.2.1 Alternative A

Land Use Compatibility

The proposed conversion of the former Stuart Mesa West Agricultural Field into a multipurpose training area would accommodate combined land, air, and sea training operations (amphibious landing operations) needed to support USMC mission requirements under 10 USC § 5063. The multipurpose training area is needed because MCB Camp Pendleton lacks sufficient dedicated training area that can accommodate all three types of training operations required for MAGTFs. Implementation of Alternative A would represent a change in the type of land use and intensity of uses at the project site; however, it would be consistent with the existing land use designations in the project vicinity and would be compatible with surrounding land uses. Therefore, no significant impacts on land use compatibility would occur.

Direct conversion of farmland occurs when an urban or other developed land use would replace agricultural uses or farmland. Projects are subject to Farmland Protection Policy Act requirements if they would irreversibly convert farmland (directly or indirectly) to non-agricultural uses and are completed by a federal agency or with assistance from a federal agency. While conversion of former agricultural lands (Prime Farmland) would occur as a result of this alternative, lands on MCB Camp Pendleton are not subject to the Farmland Protection Policy Act because acquisition or use of farmland by a federal agency for national defense purposes is exempt (Farmland Protection Policy Act § 1547(b); 7 CFR § 658.3(b) [citing USC § 4208(b)]). The average farm unit (i.e., average farm size) in California is 312 acres (California Department of Food and Agriculture 2014). Under this alternative, the former agricultural land within the project site is 273 acres (110 hectares), which represents 0.88 farm units. Approximately 4.4 acres (1.78 hectares) would be directly converted to support construction of the new beach access routes and dirt access road in the main training area. Approximately 269 acres (109 hectares) would be indirectly converted because access would be restricted for training, which would prohibit the ability to use the land for agriculture. Although project site soils are considered Prime Farmland, the site does not currently support agricultural operations and the agricultural viability of on-site soils is dependent on irrigation. Furthermore, agricultural lands that are not being outleased are identified as potential development and expansion areas in the *MCB Camp Pendleton 2030 Base Master Plan* (USMC 2010b). Therefore, conversion of the project site into a multipurpose training area to support USMC mission requirements would not significantly impact Prime Farmland.

Land Use Management Plans

The potential effects of this alternative were analyzed by evaluating reasonably foreseeable direct and indirect effects on coastal uses and resources. This alternative would be consistent with the existing land use designations in the project vicinity, and development at the project site would not represent a substantial change from the surrounding military character. This alternative would be located entirely within the restricted boundary of MCB Camp Pendleton and, therefore, the proposed land use conversion and military training operations would not affect public access to the shoreline at this location. Public views across the project site toward the Pacific Ocean from I-5 could occasionally include military vehicles, aircraft, and other ancillary training support equipment. However, such activities are currently viewed from I-5 within MCB Camp Pendleton. To avoid potential effects on sensitive habitats and listed species, all activities would be conducted in accordance with the avoidance and conservation measures stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995). In addition, stormwater Best Management Practices (BMPs) would be incorporated into the design and construction of the proposed access routes and implemented during training operations to protect coastal water quality to the maximum extent feasible. Therefore, Alternative A would have no effect on coastal zone uses or resources; thus it is consistent to the maximum extent practicable with the enforceable policies of California's *Coastal Management Plan*. Accordingly, a Coastal Consistency Negative Determination was submitted to the California Coastal Commission. The California Coastal Commission reviewed the Negative Determination and issued a concurrence letter on 14 January 2016 stating that the proposed action would not affect the coastal zone and, therefore, does not require a consistency determination (Appendix G, *California Coastal Commission Negative Determination Concurrence Letter*).

Alternative A would be sited, designed, and constructed consistent with the guidelines presented in the *MCB Camp Pendleton 2030 Base Master Plan*. Furthermore, no impacts to surrounding communities would occur because the proposed development would be contained within existing military designations at MCB Camp Pendleton. Therefore, no significant impacts on land use management plans would occur.

3.6.2.2 No-Action Alternative

Under the No-Action Alternative, the former Stuart Mesa West Agricultural Field would not be converted into a multipurpose training area and general site improvements (i.e., construction and maintenance of new access routes), site maintenance (e.g., discing, grading, erosion control, digging, and fill), and associated training operations would not occur. However, the project site would be minimally maintained (i.e., periodically mowed). Existing conditions would remain as described in Section 3.6.1, *Affected Environment*. Therefore, no impacts on land use and coastal zone management would occur.

3.7 Noise

This section analyzes the potential noise generated by proposed construction and training operations associated with the proposed action. While potential noise impacts on humans are discussed in this section, noise impacts on biological resources are discussed in Section 3.4, *Biological Resources*.

Noise Descriptions

Noise is considered to be unwanted sound that interferes with normal activities or otherwise diminishes the quality of the environment. Noise and sound are expressed in a logarithmic unit called the decibel (dB). Environmental noise measurements are usually on an "A-weighted" scale that filters out very low and very high frequencies to replicate human sensitivity. It is common to add the "A" to the measurement unit to identify that the measurement has been performed with this filtering process (dBA). In this document, the dB unit refers to A-weighted sound levels, unless otherwise stated.

A sound level of 0 dB is approximately the threshold of human hearing and is barely audible under extremely quiet listening conditions (Figure 3.7-1). Normal speech has a sound level of approximately 60 dB. Sound levels above 120 dB begin to be felt inside the human ear as discomfort, and sound levels between 130 to 140 dB are felt as pain (Berglund and Lindvall 1995). The minimum change in the sound level of individual events that an average human ear can detect is about 3 dB. On average, a person perceives a doubling (or halving) of the sound's loudness when there is a 10 dB change in sound level.

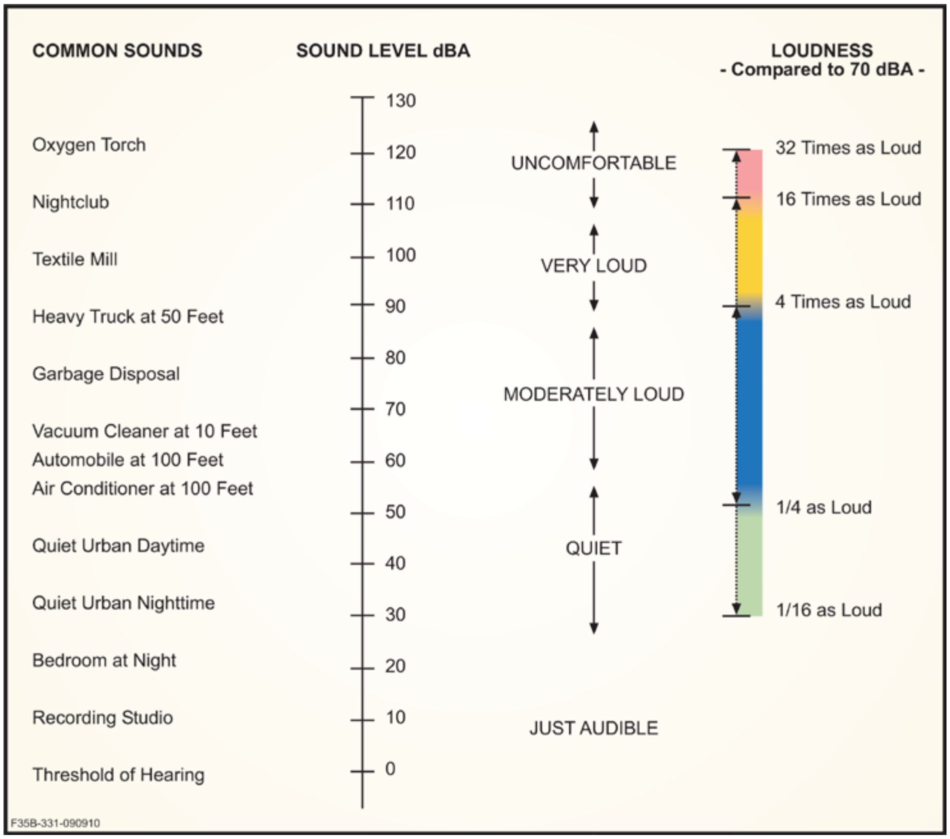


Figure 3.7-1. Typical A-Weighted Levels of Common Sounds

Several metrics are used to describe sounds which vary in intensity over time. The maximum noise level (L_{max}) noise metric represents the highest noise level reached during a noise event, and is used in this document to describe pass-by noise of aircraft and ground vehicles. The Community Noise Equivalent Level (CNEL) used in California is a time-averaged noise metric describing the cumulative noise environment of all of the noise events that occur over a 24-hour period. CNEL account for single-event noise levels and also weight or penalize those levels depending on the time period in which they occur. The CNEL metric adds 5 dB to all noise events which occur during 7:00 p.m. to 10:00 p.m. and adds 10 dB to those events which occur between 10:00 p.m. to 7:00 a.m. The Onset-Rate Adjusted Monthly variant of CNEL, denoted $CNEL_{mr}$, is specifically utilized for describing aircraft noise exposure.

Munitions noise (or, in this case, non-live fire and sound-simulating training aids) is qualitatively different from vehicle noise, and different noise metrics are used to describe it. Because munitions noise at low frequencies may generate impacts (e.g., structural rattle), the "A-weighting scale" is not used. Because munitions noise levels are so strongly influenced by meteorological conditions (e.g., winds, temperature inversions, etc.), the peak noise level reaching a particular location after a particular noise event may vary significantly. The metric peak noise exceeded by 15 percent of firing events (PK 15[met]) accounts for weather-influenced variation in received single-event peak noise levels. PK 15(met) is the peak noise level, without any frequency weighting, expected to be exceeded by 15 percent of all firing events.

Methodology

Proposed noise levels were considered in the context of baseline noise levels and local levels of noise sensitivity to assess noise impacts. Individual aircraft overflight noise events were calculated using the programs NOISEMAP and Rotorcraft Noise Model (RNM). RNM is a program designed to handle the complex noise distribution patterns generated by rotorcraft, and it was used for modeling tilt-rotor operations noise. NOISEMAP was used to model noise generated by those rotorcraft for which RNM noise profiles are not yet available. The semi-random distribution of operations and noise within the proposed training area was modeled using the program MOA-Range Noisemap. Munitions noise levels were calculated using the Small Arms Range Noise Assessment Model, version 2.6, and Blast Noise Version 2 Noise Impact Software.

3.7.1 Affected Environment

The project site is located within MCB Camp Pendleton and is exposed to military training noise, including overhead aircraft, on a regular basis. In addition, a transportation corridor including I-5 and a heavily used rail line are located adjacent to the eastern project site boundary. Military aircraft regularly overfly the project site en route to or from MCAS Camp Pendleton, which is located about 5 miles (8 kilometers) to the northeast. L_{max} associated with direct overflight of aircraft that frequently operate in the project vicinity are listed in Table 3.7-1.

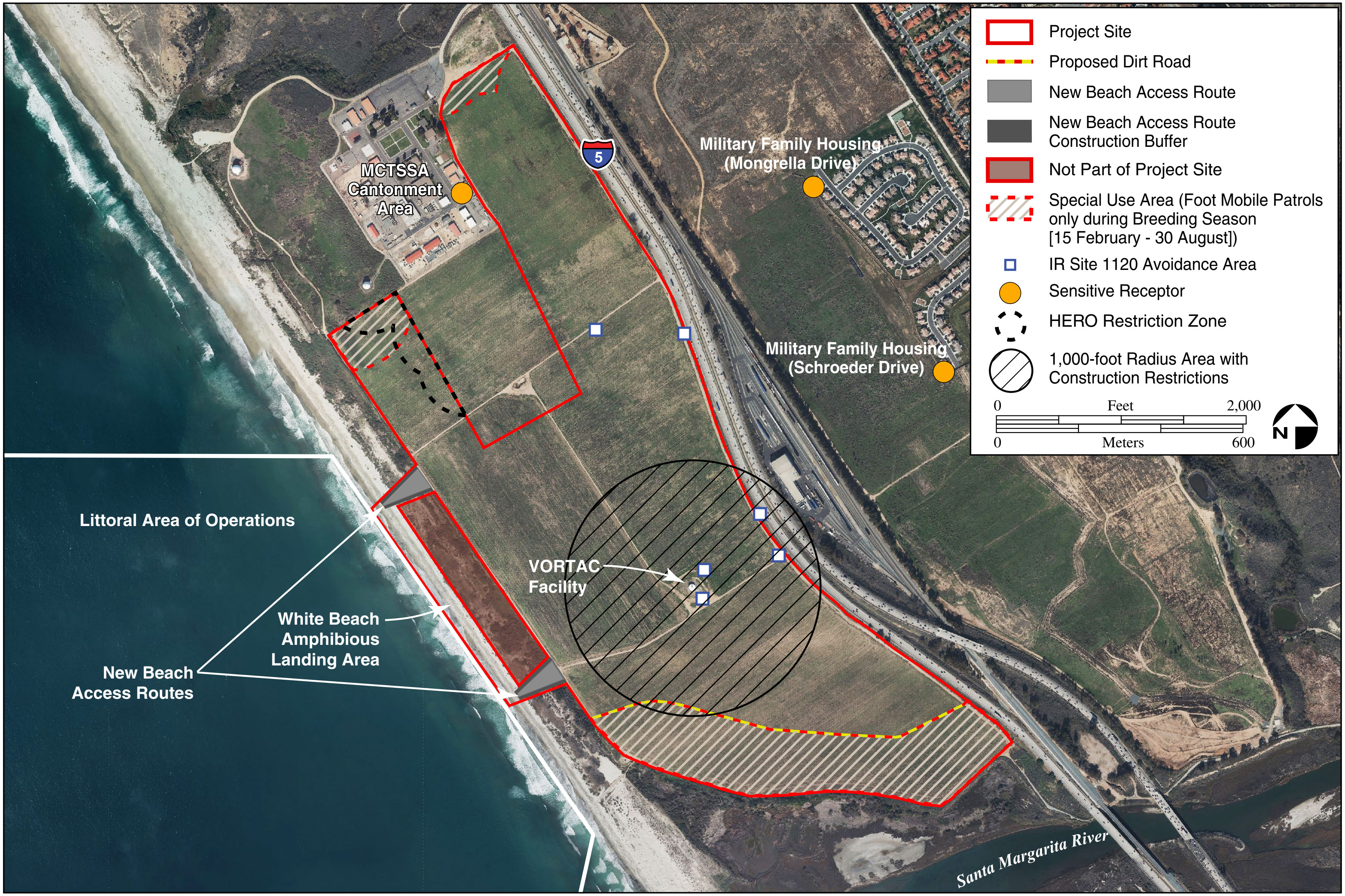
Table 3.7-1. Direct Overflight Maximum Noise Levels (L_{max})

Aircraft	*Flight Configuration*	*Lmax at Altitude (feet AGL)*					
		100	*200*	*300*	*500*	*900*	*1,200*
MV-22[1]	100 knots and 0 ° nacelle tilt	103	96	92	88	83	80
AH-1 / UH-1[2]	80 knots	99	94	89	84	79	76
H-53 2	100 knots	98	92	89	84	78	75

Notes: AGL = above ground level; L_{max} = maximum sound level.
[1] Rotorcraft Noise Model (RNM); used median monthly average acoustic propagation conditions (67° F and 69 percent relative humidity).
[2] SELCALC noise model; used median monthly average acoustic propagation conditions (67° F and 69 percent relative humidity).

In 2008, noise levels were recorded at several locations east of the project site on the opposite side of the I-5 corridor (Figure 3.7-2). During the measurement period, highway traffic noise was punctuated by noise generated by passing trains and rotorcraft overflights. Noise levels were highest adjacent to the transportation corridor, decreasing to 70 dB CNEL at approximately 400 feet (122 meters), and to 65 dB CNEL at approximately 1,000 feet (305 meters) from the I-5 corridor (NAVFAC SW 2011). Current noise levels at the project site are assumed to be similar to the noise levels measured on the opposite side of the I-5 corridor at similar distances.

Much of the area surrounding the project site is open (e.g., the Pacific Ocean and Santa Margarita River) or used in ways that are not noise-sensitive (e.g., I-5 transportation corridor). There are no public noise receptors within 1 mile (1.6 kilometers) of the project site, besides passing motorists on the I-5. Military residential areas within one mile of the project site include military bachelor enlisted quarters (BEQ) and military family housing. The nearest BEQs are located approximately 0.4 mile (0.6 kilometer) northeast of the project site, and existing military family housing residences are approximately 0.3 mile (0.5 kilometer) east of the project site. Any military family housing residences that are located in areas exposed to noise levels in excess of 70 dB CNEL are designed to provide 25 dB outdoor-to-indoor noise level reductions.



Alternative A - Human Sensitive Receptors

FIGURE 3.7-2

The nearest military facility is in the MCTSSA cantonment area adjacent to the northern project site boundary. Most of the MCTSSA facilities are built using heavy-duty construction materials, and are expected to provide relatively high outdoor-to-indoor noise level reduction. Additionally, military personnel and military contractors are not considered to be sensitive noise receptors as long as noise levels meet Occupational Safety and Health Administration (OSHA) safety standards.

3.7.2 Environmental Consequences

The most common impact associated with exposure to elevated noise levels is public annoyance. Annoyance is also the most severe category of noise impact expected to occur under the proposed action. When subjected to 65 dB, approximately 12 percent of persons exposed will be “highly annoyed” by the noise. At levels below 55 dB, the percentage of annoyance is correspondingly lower (less than 3 percent). The percentage of people annoyed by noise never drops to zero (some people are always annoyed), but at levels below 55 dB, it is reduced enough to be essentially negligible. Based on numerous sociological surveys and recommendations of federal interagency councils, the most common benchmark referred to is 65 dB. This threshold is often used to determine residential land use compatibility around airports, highways, or other transportation corridors. At a 75 dB threshold and above, auditory and non-auditory health effects cannot be categorically discounted, but this is well below levels at which hearing damage is a known risk (OSHA 1983).

3.7.2.1 Alternative A

Construction

Construction activities under Alternative A would include construction of two new beach access routes and a dirt access road in the main training area. Proposed construction equipment includes excavators, bulldozers, and other support equipment. Short-term noise associated with construction activities could range from 80 to 90 dB at 50 feet (15 meters) from the source (FHWA 2006). Noise generated during construction would be similar to noise levels generated by existing road traffic on I-5. While specific vehicles may be heard at nearby noise-sensitive locations (e.g., military family housing) at certain times, short-term construction noise would not be expected to be overly disruptive and would not be a substantial change from current conditions.

Operations

Aircraft Noise

For noise modeling purposes, aviation operations are based on supporting amphibious assaults for six large-scale exercises each year with a duration of 10 days each, for 60 total training days. During the first two days of the training events, there would be an estimated three sorties per day flown by AH-1Z, UH-1Y, CH-53, and MV-22 aircraft. UH-1Y, CH-53, and MV-22 aircraft would fly three sorties per day on about half of the subsequent days of the 10-day training event. AH-Z aircraft would be less likely to participate in training after the first two days. Roughly 40 percent of total aircraft training sorties would occur between 7:00 p.m. and 10:00 p.m. while training events after 10:00 p.m. would be infrequent.

Aircraft operations by UH-1Y, MV-22, and CH-53 aircraft would consist primarily of the aircraft approaching the main training area from either MCAS Camp Pendleton or the sea, landing in the training area to load/unload materials and/or personnel, and then departing. These aircraft would spend approximately 20 minutes above the main training area per sortie. AH-1Z aircraft would conduct reconnaissance and close-air support, spending approximately 90 minutes per training sortie over the main training area. Per FAA Regulation § 91.119 (Minimum Safe Altitudes) and Naval Air Training and Operating Procedures Standardization flight instructions (e.g., Chief of Naval Operations Instruction

3710.7U), aircraft would avoid all structures by a minimum of 500 feet (152 meters). Pilots approaching the training area from the east would typically overfly I-5 at altitudes of generally 200 to 500 feet (61 to 152 meters) above ground level.

Maximum noise levels associated with direct overflight for proposed operations are the same as those for existing overflights listed in Table 3.7-1. Information on the frequency of operations, time of day, altitude, and aircraft configuration were entered into the noise model MOA-Range Noisemap to generate an estimate of time-averaged noise levels (L_{dnmr}). The noise level generated by proposed aircraft training under Alternative A would be 56 dB L_{dnmr}.

The closest noise-sensitive land use to the main training area is the military family housing located on the other side of the I-5 corridor from the project site. The closest residences are located about 1,000 feet (305 meters) from the I-5 corridor and 1,500 feet (457 meters) from the main training area. As noted in Section 3.7.1, *Affected Environment*, the measured CNEL at 1,000 feet (305 meters) from the I-5 corridor was 65 dB. While operating in the main training area, noise from the proposed aircraft operations would be largely masked by noise generated from the I-5 corridor and other ongoing military aircraft overflights. Proposed training activities would not be expected to result in noticeable changes to existing time-averaged (i.e., CNEL) noise levels for the nearby military family housing.

Similarly, residents at the nearest BEQs would be able to hear aircraft activity at the project site and would hear any aircraft traveling along the adjacent coastline toward or away from the main training site (similar to existing conditions). The closest BEQs are 0.4 miles (0.6 kilometers) away, on the other side of the I-5 corridor, and noise levels at this distance would not be expected to be overly disruptive and would not be a substantial change from current conditions.

Surface Vehicle Noise

A wide variety of surface vehicles would be used within the main training area (refer to Table 2.1-1). Noise levels associated with several representative vehicle types are listed in Table 3.7-2. AAV would also generate noise as they maneuver through the littoral area of operations and cross the beach. Table 3.7-3 lists measured noise levels for the AAV under several operating conditions.

Table 3.7-2. Surface Vehicle Noise Levels

Vehicle Type	*Approximate Noise Level (dB) at 50 feet (15 mph)*
M1165 troop/cargo/radio MRC truck (HMMWV)	65
MK23 Cargo (medium tactical vehicle)	77
MK16 Tractor (logistical vehicle)	78
M9 ACE Combat Excavator (support engineering equipment, construction vehicle)	85
Stryker LAV (light armored vehicle)	84

Source: U.S. Army 2004.
Notes: dB = decibel; HMMWV = high-mobility, multipurpose wheeled vehicle; mph = miles per hour.

Table 3.7-3. Amphibious Assault Vehicle Noise Levels

Mode of Operation	*Approximate Noise Level (dB) at 100 feet*
Full power on soft, dry sand	72
Full power in surf	71
Paved road at approximately 45 miles per hour	88
Idling on pavement	73
Source: U.S. Army 2004. Notes: dB = decibel	

Surface vehicle noise generated during training activities would be similar to noise levels generated by existing road traffic on I-5. While specific vehicles may be heard at noise-sensitive locations (e.g., military family housing) at certain times, the noise would not be expected to be overly disruptive and would not be a substantial change from current conditions.

Munitions Noise

Proposed training activities would include the use of non-live fire munitions and sound-simulating training aids. These munitions would be used to increase combat-realism of the training events. Small arms that could be used during training include M-16 (5.56 mm blank rounds), M-60 (7.62 mm blank rounds), and M-2 (.50 caliber blank rounds). Firing of non-live (blank) rounds generates less noise than live rounds. The noise generated by firing depends on the location of the listener relative to the direction of fire. Table 3.7-4 lists the distances at which peak small arms noise levels drop below 87 dB and 104 dB PK 15(met) for firing that is perpendicular (i.e., at a 90 degree angle) relative to the direction to a listener. As noted in Section 3.7.1, *Affected Environment*, the PK 15(met) noise metric reflects un-weighted peak noise levels when weather conditions are "unfavorable" for noise transmission such that noise at the listener position would only be louder 15 percent of the time.

Table 3.7-4. Distance at which Small-Arms Peak Noise Levels are Below 87 and 104 dB PK 15(Met)

Weapon and Ammunition Type	*dB*	*Distance (Feet)*
M16 (5.56 mm blank)	87	525
	104	176
M 60 (7.62 mm blank)	87	3,779
	104	851
Mg M2 (.50 caliber blank)	87	5,061
	104	1,140
Source: Small Arms Range Noise Assessment Model. Notes: dB = decibel.		

Noise levels generated by 7.62 mm and .50 caliber blank rounds could exceed 87 dB but not 104 dB at the nearby military family housing (about 1,500 feet [457 meters] from the main training area) and the nearest BEQs (about 2,100 feet [640 meters] from the main training area). These noise levels are not typically considered to be compatible with residential land uses according to Army Regulation (AR) 200-1. However, AR 200-1 recommendations for land use are made with the general intent of application to training ranges where firing would be a daily event. Small arms firing in the main training area would likely occur only during six training exercises per year, and would be consistent with noise from other live-fire training that occurs on-Base.

Ground Burst Simulators are munitions commonly used to simulate the sounds of incoming enemy fire and explosive devices. Using Blast Noise Version 2 Noise Impact Software, it was calculated that Ground Burst Simulator noise levels decrease to below 115 dB PK 15(met) at a distance of 2,577 feet

(785 meters) from the detonation and to less than 130 dB PK 15(met) at 656 feet (200 meters) from the detonation point. According to AR 200-1, the risk of noise complaints is moderate when peak explosives munitions noise is between 115 and 130 dB PK 15(met) and is high when the noise level is greater than 130 dB PK 15(met). Detonations of Ground Burst Simulators in portions of the main training area that are within 2,577 feet (785 meters) of the nearby military family housing and the nearest BEQs could generate noise levels that would be expected to trigger a moderate risk of noise complaints. Similar to small arms firing, Ground Burst Simulator detonations in the main training area would likely occur only during six training exercises per year, and would be consistent with noise from other live-fire training that occurs on-Base.

Summary

While construction and operations-related surface vehicle noise as well as aircraft noise may be heard at noise-sensitive locations (e.g., military family housing) at certain times, the noise would not be expected to be overly disruptive and would not be a substantial change from current conditions. Expected project-related noise levels would be largely masked by current noise levels generated from the I-5 corridor and other ongoing military aircraft overflights. The one exception would be munitions noise generated by small arms firing and Ground Burst Simulator detonations, which would be at levels above thresholds identified in AR 200-1 and could result in a moderate risk of noise complaints from noise-sensitive locations (e.g., military family housing). However, munitions noise would likely occur only during six training exercises per year and would be consistent with noise from other live-fire training that occurs on-Base. Overall, no impacts to auditory health would be expected to occur from proposed construction activities or operations, and noise impacts would not be expected to be perceived as significant in nature. Therefore, no significant impacts on noise would occur.

3.7.2.2 No-Action Alternative

Under the No-Action Alternative, the former Stuart Mesa West Agricultural Field would not be converted into a multipurpose training area and general site improvements (i.e., construction and maintenance of new access routes), site maintenance (e.g., discing, grading, erosion control, digging, and fill), and associated training operations would not occur. However, the project site would be minimally maintained (i.e., periodically mowed). Existing conditions would remain as described in Section 3.7.1, *Affected Environment*, and the noise environment would remain unchanged. Therefore, no impacts on noise would occur.

3.8 Public Health and Safety

3.8.1 Affected Environment

3.8.1.1 Protection of Children (Executive Order 13045)

Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks (Protection of Children)*, was issued in 1997. This order requires each federal agency to "make it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children and shall…ensure that its policies, programs, activities and standards address disproportionate risks to children…."

The areas within MCB Camp Pendleton adjacent to the project site are military in nature and not accessible to the general public. No facilities used by children, such as family housing units, schools, or childcare centers, are adjacent to the project site. The closest facility is a military family housing area located 1,400 feet (426 meters) northeast of the project site across I-5.

3.8.1.2 Safety and Environmental Health

Electromagnetic Radiation

Communications and electronic devices (e.g., radar and other radio transmitters) are sources of electromagnetic radiation. Radar and other high-energy electromagnetic emissions can constitute a hazard to humans when they are exposed to such emissions/signals above a maximum power density. In addition, electromagnetic signals emanating from equipment can also interfere with and adversely affect ordnance. Hazards are reduced or eliminated by establishing minimum distances from electromagnetic radiation emitters for people, ordnance, and fuel. These effects are managed under the regulations of the Navy's Hazards of Electromagnetic Radiation to Personnel (HERP) program. Hazards to ordnance and fuel are managed by the Navy's HERO and Hazards of Electromagnetic Radiation to Fuel (HERF) programs (USMC 2010b).

Two permanent radar pads would be constructed in the western portion of the adjacent MCTSSA cantonment expansion area (Figure 2.1-2). These pads would be located approximately 70 feet (21 meters) from the project site. Temporary radar VHF, high-frequency, and ultra-high-frequency antennae would be placed on these pads for training/testing. Each antenna would be approximately 10 feet (3 meters) high and could remain in place for up to 6 months at a time. The antennas would be taken down after the training/testing is completed. In approximately 10 years, permanent antenna systems would be installed on these pads. There is a 354-feet (108-meter) arc around these pads that represents the ordnance separation distance around the radar antenna required to minimize HERO (Figure 2.1-2).

Electromagnetic Interference

The Communications Electronic Maintenance Division is responsible for monitoring the Base communication network. Interference from sources off-Base is not considered a significant problem. However, there is the potential for electromagnetic interference with the MCTSSA radio, radar, and beacon emissions (USMC 2010b).

3.8.1.3 Hazardous Materials and Waste

Installation Restoration Sites

The USMC's IR Program is responsible for identifying CERCLA releases, considering the risk to human health and the environment, and developing and selecting response actions when it is likely that a release could result in an unacceptable risk to human health and the environment. There are 74 locations on MCB Camp Pendleton identified as sites where the disposal or discharge of hazardous wastes may have resulted in potential environmental contamination. Once identified, these sites are researched, investigated, and remediated through the MCB Camp Pendleton IR Program. The Base has grouped the 74 contaminated sites into five operable units, based on similarities, such as the types of environmental issues, selected cleanup methods, and/or geographic location. To date, 58 of these IR sites have been remediated and/or closed with respect to regulatory compliance. The remaining 16 active IR sites are in different phases of the cleanup process (USMC 2010b, 2013b).

The project site is located within IR Site 1120, which is composed of 16 subsites located within the former Stuart Mesa Agricultural Field (Figure 3.8-1). Past activities associated with the former agricultural field, including vehicle fueling, chemical storage, and vehicle maintenance activities, resulted in environmental contamination. Eight of the 16 subsites are located east of I-5 at the former farming maintenance facility compound, which is located approximately 300 feet (92 meters) northeast of the project site at the closest point (Figure 3.8-1).

Installation Restoration Site 1120

FIGURE 3.8-1

The remaining eight subsites are located west of I-5 within and adjacent to the project site. Of the eight subsites in the project vicinity, one subsite is located immediately north of the project site (Subsite #9), one subsite is located within the MCTSSA expansion area (Site #16), and the remaining six subsites are located within the project site (Tidewater, Inc. 2014).

Preliminary soil sampling completed at the 16 subsites within IR Site 1120 indicated that soils are impacted above their respective project screening levels (i.e., action levels) for residual concentrations of petroleum hydrocarbons, organochlorine pesticides, and chlorinated herbicides. Within the project site, petroleum hydrocarbons were present in the vicinity of a former diesel pump shack (Subsite #11) and residual pesticide and herbicide concentrations are present in the vicinity of two former maintenance sheds (Subsite #10), a former filter station (Subsites #12 and #13), and a former wash pad (Subsites #14 and #15) (Figure 3.8-1). Within the MCTSSA expansion area (Subsite #16), elevated concentrations of both petroleum hydrocarbons and pesticide concentrations were present in the vicinity of two former maintenance sheds (Tidewater, Inc. 2014).

Health risk assessments indicated that the potential contaminant exposure pathways related to pesticide and herbicide concentrations include dermal contact with soil, ingestion of soil, and inhalation of airborne particles. These assessments identified future residents, industrial workers, and/or agricultural workers as having an excess cancer risk, primarily from toxaphene and dieldrin concentrations. With the exception of Subsite #16, located within the MCTSSA expansion area, the lateral and vertical extent of soil contamination has yet to be determined and groundwater quality has not been tested beneath IR Site 1120. In addition, the health risk assessments completed to-date did not include an evaluation with respect to potential exposure to petroleum hydrocarbons in soil (Tidewater, Inc. 2014).

In September 2012 and October 2013, soil excavations were completed at the maintenance facility compound and MCTSSA expansion area. Similar excavations have not been completed at the project site. To fully delineate the vertical and lateral extent of soil contamination at the project site, additional soil sampling and groundwater sampling will be completed at Subsites #10 through #15. Soils at Subsite #11 will be analyzed for petroleum hydrocarbon concentrations and the remaining subsite soils will be analyzed for residual pesticide and herbicide concentrations in accordance with a subsequent Remedial Design/Remedial Action Work Plan for IR Site 1120 (Tidewater, Inc. 2014). Similarly, soil and groundwater sampling will be completed at Subsites #1 through #9, which are located immediately adjacent and/or upgradient of the project site. Based on the results of the assessment, soil and/or groundwater remediation would be completed (as necessary), in accordance with a subsequent Remedial Design/Remedial Action Work Plan for IR Site 1120.

Pesticide and Herbicide Contamination

As previously discussed, the project site has been historically used for agricultural activities. As illustrated on Figure 3.8-2, multiple 800-gallon aboveground chemical tanks have been present along the northeastern project boundary. Based on a site reconnaissance, these tanks, which were used to store pesticides and herbicides, have been removed. A human health and ecological risk assessment (HHERA) (Parsons 2012) was completed for the project site to evaluate the risk of residual pesticide concentrations in on-site soils as a result of pesticide use and storage during past agricultural activities. As illustrated on Figure 3.8-2, the HHERA study area overlies the majority of the project site, but does not include the area that overlaps with the MCTSSA expansion area. The HHERA is included in Appendix H of this EA.

FIGURE 3.8-2

Risk Assessment and Storage Tank Locations

For risk assessment purposes, adverse health effects are classified into two broad categories, including carcinogens and noncarcinogens. Both types were detected during soil sampling at the project site, including elevated concentrations of the carcinogenic compounds toxaphene and dieldrin, which are present at levels that would cause a residential risk throughout most of the site, but would not cause a risk to industrial workers, construction workers, or trainers, each of which would be on-site more than trainees. Similarly, assumed exposures to carcinogenic compounds DDE, DDT, and heptachlor epoxide would cause a residential risk locally on the site, but would not cause a risk to industrial workers, construction workers, or trainers. Noncarcinogenic hazards, consisting primarily of potential exposure to methoxychlor, are also present at levels that would cause a residential risk throughout most of the project site, but would not cause a risk to industrial workers, construction workers, or trainers (Parsons 2012).

With respect to the portion of the project site that overlaps with the MCTSSA expansion area, a separate HHERA (Parsons 2011) indicated that elevated concentrations of the carcinogenic compound toxaphene were present at levels that would: 1) cause a residential risk throughout most of the site; and 2) locally cause a risk to industrial workers; but 3) would not cause a risk to construction workers. In September and October 2013, Naval Facilities Engineering Command Southwest excavated soils contaminated with petroleum hydrocarbons and organochlorine pesticide concentrations to facilitate the planned MCTSSA expansion activities. Contaminated soil with concentrations in excess of remedial goals was removed, in accordance with federal, state, and local regulations. These removal actions were subject to the requirements of the CERCLA (40 CFR Part 300) and Resource Conservation and Recovery Act (RCRA) (40 CFR 260). CERCLA removal actions are exempted from the procedural requirements of NEPA. Therefore, any such actions are not evaluated in this EA.

The noncarcinogenic hazards in the MCTSSA expansion area did not exceed the benchmark level of concern for all human receptors, which indicates that assumed exposures to residual pesticide concentrations are unlikely to result in adverse noncarcinogenic health effects for all human receptors (Parsons 2011).

Petroleum Site Remediation Program

Active remediation is occurring at multiple petroleum-based cleanup sites at MCB Camp Pendleton. Identification, assessment, and remedial actions of petroleum-contaminated sites at the Base are managed by the MCB Camp Pendleton Environmental Security Remediation Branch, which manages two categories of remediation sites including RCRA Facility Assessment (RFA) sites and underground storage tank sites. The RFA study conducted site inspections at 257 suspected contaminated sites throughout the Base. Of these sites, 107 require further investigation and possible cleanup actions, while 150 sites are recommended for “No Further Action.” Seven RFA sites were closed by the RWQCB based on completed remedial actions. The underground storage tank cleanup program was initiated to meet federal and state requirements that stipulated any underground storage tank installed before 1988 must be upgraded with secondary leak protection, replaced, or removed by 22 December 1998.

MCB Camp Pendleton met this requirement with a mass tank removal operation. By the end of 1998, 580 underground storage tanks from 454 locations were removed. Of the total underground storage tanks removed, 266 had failed integrity and released contamination into the subsurface environment, requiring future remedial actions (USMC 2010b).

As illustrated in Figure 3.8-2, a 500-gallon aboveground gasoline tank was located in the south-central portion of the project site, adjacent to the VORTAC facility. This tank, which was presumably used for fueling agricultural vehicles, has been removed from the project site. In addition, a 250-gallon aboveground gasoline storage tank is located immediately west of the project site, within the

MCTSSA cantonment area, and several gasoline and oil storage tanks are located approximately 300 feet (92 meters) east of the project site on the northeast side of I-5.

3.8.1.4 Ordnance Safety Zones and Aviation Safety Zones

The project site is partially located within the Explosives Safety Quantity-Distance (ESQD) arc from the Stuart Mesa Ammunition Handling Pad (Figure 3.8-3). However, this site was never developed and is unlikely to be used in the future to support the transfer of ammunition and explosives from MCB Camp Pendleton to naval ships for training operations and deployments. Currently, all ammunition logistics occur at either Red Beach (shore) or Landing Zone 21 Viewpoint (vertical replenishment).

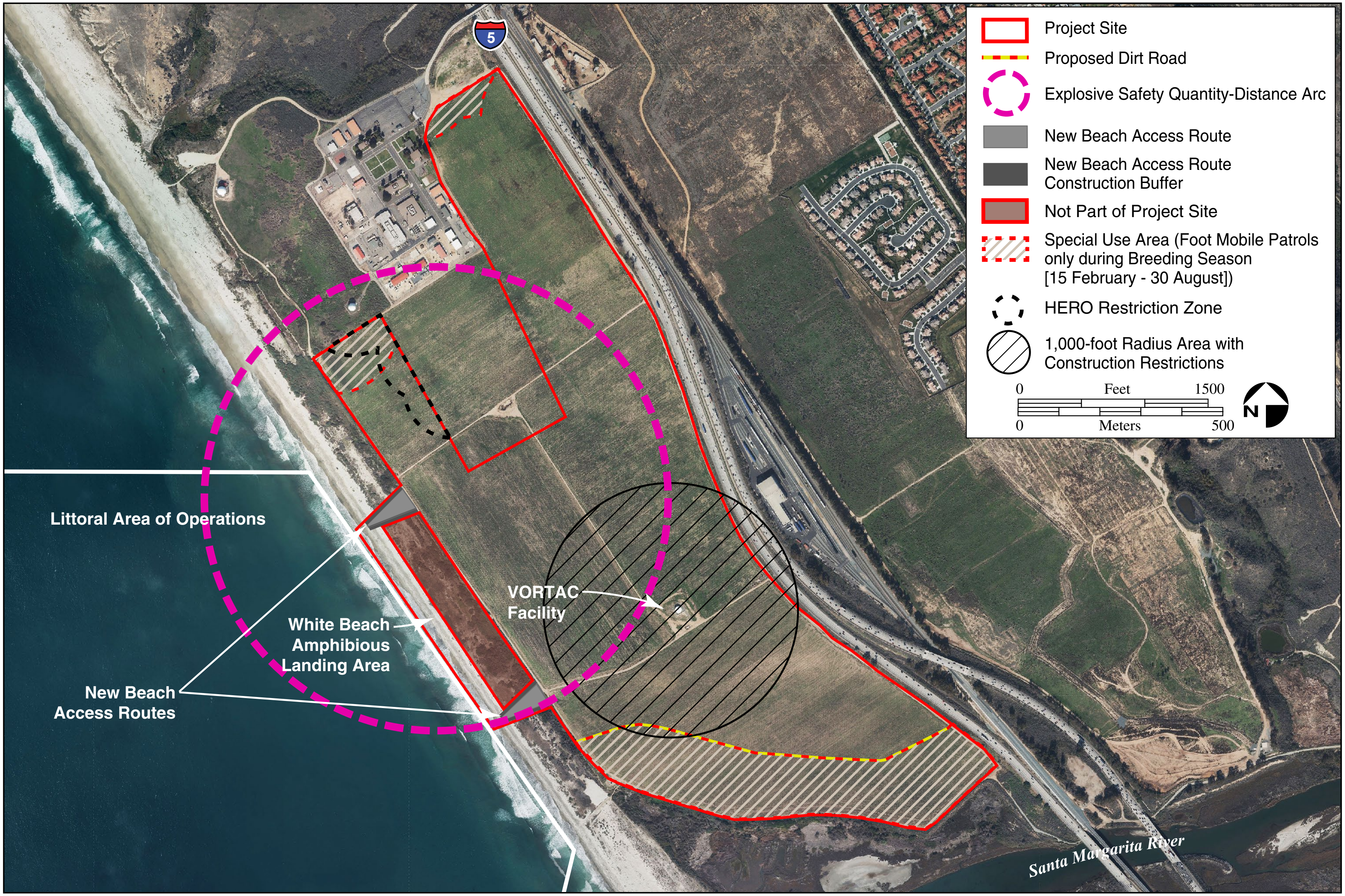
The DoD established the Air Installations Compatible Use Zone (AICUZ) program to plan effectively for land use compatibility surrounding military air installations. The purpose of the AICUZ includes minimizing public exposure to potential safety hazards associated with aircraft operations. The project site is not located within a designated aircraft Accident Potential Zone. However, the site is located within an Approach-Departure Clearance Zone of the Marine Corps Air Station Camp Pendleton airfield. Acceptable heights of buildings, towers, poles, and other possible obstructions to air navigation are defined by Imaginary Surfaces, which radiate at various increasing heights from the runway. There are no manmade or terrain obstructions that extend into the Imaginary Surfaces in the vicinity of the project site (USMC 2010b).

An FAA VORTAC facility is located in the south-central portion of the project site. The facility provides three individual services for aircraft operations: VOR azimuth, TACAN azimuth, and TACAN distance. Transmitted signals of VOR and TACAN are identified by a three-letter code transmission and are interlocked, so that pilots using a VOR azimuth with a TACAN distance know that both signals are from the same ground station. The frequency channels of the VOR and the TACAN at each VORTAC facility are “paired” in accordance with a national plan to simplify airborne operations. Construction within a 1,000-foot (304-meter) radius around the VORTAC facility is severely limited to prevent radio wave interference between the VORTAC site and using aircraft (FAA 1986).

3.8.1.5 Other Federal Health and Safety Requirements

The Navy has historically maintained safety and health programs to protect its personnel and property, and occupational health is a key element of the overall Navy Occupational Safety and Health program, which includes explosive, nuclear, aviation, industrial, and off-duty safety.

All proposed construction and operation activities must meet the requirements of the Energy Policy Act of 2005 (Section 109), Executive Order 13693 — Planning for Federal Sustainability in the Next Decade standards, and other applicable laws. These requirements are intended to ensure, wherever feasible, that pollution would be prevented or reduced at the source; pollution that cannot be prevented or recycled would be treated in an environmentally safe manner; and disposal or other releases to the environment would be employed as a last resort. These requirements would be contained in all construction contractor documents associated with the proposed action.



Stuart Mesa Ammunition Handling Pad Explosive Safety Quantity-Distance Arc

FIGURE 3.8-3

3.8.2 Environmental Consequences

3.8.2.1 Alternative A

Protection of Children (Executive Order 13045)

No schools, day-care centers, or family housing units are adjacent to the project site. All construction and training activities would be limited to the project site and access to this area is restricted. Therefore, no children would be exposed to environmental conditions or military activities in the project vicinity. Accordingly, no significant impacts would occur.

Safety and Environmental Health

The 354-foot (108-meter) arc around the radar pads in the MCTSSA expansion area (i.e., safe separation distance to minimize HERO) covers approximately 5.5 acres (2.2 hectares) of the northwestern portion of the project site. This area would be designated as a "HERO restriction zone," and the use of non-live fire munitions and refueling operations would not occur within this zone when radar activities are being conducted in the MCTSSA expansion area (Figure 2.1-2). All activities conducted within the HERO restriction zone would be coordinated in advance with MCTSSA personnel to ensure consistency with HERO program regulations and prevent electromagnetic interference with MCTSSA's transmission sources (i.e., radars, radio, and beacon emissions). In addition, communications used during proposed training activities, such as VHF communications used by combat units and ultra-high frequency communications (e.g., aircraft and satellite communications), would not generate large amounts of electromagnetic radiation. Therefore, no significant impacts on safety and environmental health would occur.

Hazardous Materials and Waste

Six subsites within active IR Site 1120 underlie the project site (Figure 3.8-1). Residual concentrations of petroleum hydrocarbons, organochlorine pesticides, and chlorinated herbicides have been detected in soils at these subsites. The vertical and lateral extent of contamination has not been determined; therefore, additional soil sampling and groundwater sampling will be completed in accordance with the Remedial Investigation Work Plan for IR Site 1120 (Tidewater, Inc. 2014). Soils at subsites within the project site will be analyzed for petroleum hydrocarbon concentrations (Subsite #11) and residual pesticide and herbicide concentrations (Subsites #10, #12–15). Based on the results of the assessment, soil and/or groundwater remediation would be completed (as necessary) in accordance with a subsequent Remedial Design/Remedial Action Work Plan for IR Site 1120. Similarly, soil and groundwater sampling will be completed at Subsites #1 through #9, which are located adjacent and/or upgradient of the project site. However, because the timing of soil sampling and remediation activities at subsites within the project site is unknown, these areas would be identified as "avoidance areas" until all necessary remediation activities are completed. Fencing will be installed around the IR Site 1120 subsites within the project site. Avoiding all IR Site 1120 subsites would eliminate risks associated with soil contamination to construction workers, operational personnel, and trainees. After all required CERCLA remediation activities are completed for the IR Site 1120 subsites, these areas would be used to support training operations. Therefore, no significant impacts associated with soils at IR Site 1120 would occur.

Groundwater quality beneath the project site has not been evaluated with respect to residual concentrations of petroleum hydrocarbons, pesticides, and herbicides detected in IR Site 1120 soils. Therefore, temporary groundwater monitoring wells would be installed under a separate action in accordance with the Remedial Investigation Work Plan for IR Site 1120 (Tidewater, Inc. 2014) and groundwater samples would be analyzed for potential contaminants. Alternative A would not include use of on-site groundwater for water supplies; therefore, any potential contaminants detected in the underlying groundwater, which is expected to be located at a depth of 40 to 60 feet (12 to 18 meters) below ground surface, would have no impact on construction workers, military personnel, or government/civilian personnel. Regardless of the lack of project-related human exposure, potential groundwater contamination would be fully assessed and remediated, in accordance with applicable federal, state, and local regulations. Therefore, no significant impacts associated with groundwater beneath IR Site 1120 would occur.

Off-site soil removal is not anticipated as part of Alternative A. However, in the event that previously unknown petroleum- or chemical-contaminated soil is discovered during grading (e.g., may be indicated by discoloration and odor), the MCB Camp Pendleton Environmental Security, Remediation Branch would be contacted and remedial requirements would be implemented in accordance with applicable federal, state, and local regulations. Appropriate petroleum and hazardous constituent sampling and testing would be completed for all soils removed from the project site to determine the off-site disposal designation, in accordance with 40 CFR 260 (*Federal Hazardous Waste Regulations*), and California Code of Regulations Title 22 (*Minimum Standards for Management of Hazardous and Extremely Hazardous Wastes*). If soil is determined to be hazardous waste, it would be stored and transported in accordance with 40 CFR and Title 22 regulations and other applicable federal, state, and local regulations. Hazardous waste must be removed from MCB Camp Pendleton within 60 days of initial generation, and proper hazardous waste manifest procedures would be followed for all hazardous waste generated and transported off-Base. All hazardous waste manifests would be signed by the MCB Camp Pendleton Environmental Security Hazardous Waste Branch before the waste leaves MCB Camp Pendleton. CERCLA removal actions are exempted from the procedural requirements of NEPA; consequently, any such actions are not part of the evaluations in this EA.

Petroleum Sites

Aboveground gasoline and chemical storage tanks were previously present in the southern portion of the project site (Figure 3.8-2). In addition, an aboveground gasoline storage tank is located immediately west of the project site, within the existing MCTSSA cantonment area, and several oil and gasoline storage tanks are located approximately 300 feet (92 meters) east of the project site, some of which appear to be hydrologically upgradient. As previously discussed, groundwater quality beneath the project site has not been evaluated with respect to residual concentrations of petroleum hydrocarbons. However, temporary groundwater monitoring wells would be installed in accordance with the Remedial Investigation Work Plan for IR Site 1120 (Tidewater, Inc. 2014) and groundwater samples would be analyzed for petroleum hydrocarbons that might have been released from any adjacent or upgradient fuel storage tanks. Alternative A would not include use of on-site groundwater for water supplies; therefore, any contaminants detected in the underlying groundwater would have no impact on construction workers or military personnel. Regardless of the lack of project-related human exposure, any potential groundwater contamination would be fully assessed and remediated, in accordance with applicable federal, state, and local regulations. Such remediation could occur simultaneous with Alternative A construction and operations, with no resultant impacts. Therefore, no significant impacts would occur.

Ordnance Safety Zones and Aviation Safety Zones

Under this alternative, the project site is partially located within the Stuart Mesa Ammunition Handling Pad ESQD Arc. However, this site was never developed and is unlikely to be used in the future to support the transfer of ammunition and explosives from MCB Camp Pendleton to naval ships for training operations. However, in the event the Stuart Mesa Ammunition Handling Pad is used in the future, personnel would be required to evacuate this portion of the project site during explosives handling operations at the pad. Explosives handling would occur in accordance with standard operating procedures governing the use, storage, and accountability of ammunition and explosives, including Naval Sea Systems Command Operating Procedures 5, Volume 1, Seventh Revision (*Ammunition and Explosives Safety Ashore*); MCO P8020.1 (*Marine Corps Ammunition Management and Explosive Safety*); and Naval Sea Systems Command SW020-AG-SAF-10 (*Transportation Safety Handbook for Ammunition Explosives and Related Hazardous Material*). As a result, no significant impacts on public health and safety would occur.

Under this alternative, the project site is not located within a designated aircraft Accident Potential Zone. However, the project site is located within an Approach-Departure Clearance Zone of the Marine Corps Air Station Camp Pendleton airfield. No infrastructure is proposed that would extend into the Imaginary Surfaces of the Approach-Departure Clearance Zone. The FAA VORTAC located within the project site would not be moved under this alternative and, per FAA regulations, no obstacles would be constructed within a 1,000-foot (304-meter) radius of this facility. All proposed aircraft operations within the VORTAC buffer area would be conducted in accordance with FAA regulations. Therefore, no significant impacts related to aircraft safety would occur.

Other Federal Health and Safety Requirements

All requirements of Executive Order 13693 (*Planning for Federal Sustainability in the Next Decade*) and other applicable laws, such as solid waste diversion and recycling and pollution prevention and management of toxic and hazardous materials, would be specified in construction contractor contracts and implemented using standard BMPs. These requirements would ensure, wherever feasible, that pollution would be prevented or reduced at the source and/or treated in an environmentally safe manner. The contractor would develop and disseminate a Spill Prevention, Control and Countermeasures Plan, as described in Appendix D (*Standard Construction Measures*). This plan would include all appropriate BMPs for stormwater discharges in accordance with the National Pollutant Discharge Elimination System (NPDES) General Construction Storm Water Permit (Order No. 2009-0009-DWQ/NPDES No. CAS000002) and site-specific Storm Water Pollution Prevention Plan. Examples of BMPs include establishment of designated areas for equipment fueling and maintenance; use of licensed, trained personnel for operation of vehicles and equipment; and completion of a regular, comprehensive equipment maintenance program. All vehicle fueling and maintenance would be completed in a designated area and primary (e.g., large plastic tarps or drip pans) and secondary (e.g., berms, spill containment booms, and/or absorbent pads) containment would be used to avoid any spills. Therefore, no significant impacts on public health and safety would occur.

3.8.2.2 No-Action Alternative

Under the No-Action Alternative, the former Stuart Mesa West Agricultural Field would not be converted into a multipurpose training area and general site improvements (i.e., construction and maintenance of new access routes), site maintenance (e.g., discing, grading, erosion control, digging, and fill), and associated training operations would not occur. However, the project site would be minimally maintained (i.e., periodically mowed). Existing conditions would remain as described in Section 3.8.1, *Affected Environment*. Therefore, no impacts on public health and safety would occur.

3.9 Utilities

3.9.1 Affected Environment

3.9.1.1 Solid Waste Disposal

Solid waste produced on MCB Camp Pendleton is collected by Base personnel and disposed of at the Las Pulgas and San Onofre landfills located on-Base. The Las Pulgas landfill accepts eligible biosolids for disposal, while the San Onofre landfill accepts USMC construction debris only. The Las Pulgas landfill currently has a capacity of 5,422,895 tons (4,919,568 metric tons), while the San Onofre landfill has a capacity of 563,677 tons (511,359 metric tons). The first phase of a five-phase expansion program has been completed on both landfills. With completion of Phase 5, the Las Pulgas landfill is not expected to reach capacity until 2188, while the San Onofre landfill is not expected to reach capacity until 2267. The Base currently participates in a recycling program that is managed by MCB Camp Pendleton Environmental Security through the Defense Reutilization and Marketing Office.

3.9.2 Environmental Consequences

3.9.2.1 Alternative A

Solid Waste Disposal

Construction of the two new beach access routes and dirt access road in the main training area would generate debris (e.g., soil and rock) that would require disposal. All materials would be disposed of in compliance with federal, state, local, and Marine Corps regulations for the collection and disposal of municipal solid waste. Much of this material would be recycled or reused, or otherwise diverted from landfills. All non-recyclable construction materials would be disposed of at the MCB Camp Pendleton San Onofre Landfill. Sufficient capacity exists within that landfill to accommodate the small volume of solid waste expected to be generated by Alternative A.

All construction would comply with the *Environmental Compliance and Protection Manual* (MCO5090.2A) and other applicable federal regulations, MCOs, and DoD Directives. In addition, all construction materials would be recycled in accordance with the DoD Green Procurement Program and Department of Navy Green Procurement Implementation Guide (Department of the Navy 2009). Proposed training operations would result in a negligible increase in demands on solid waste disposal. Therefore, no significant impacts on solid waste disposal would occur.

3.9.2.2 No-Action Alternative

Under the No-Action Alternative, the former Stuart Mesa West Agricultural Field would not be converted into a multipurpose training area and general site improvements (i.e., construction and maintenance of new access routes), site maintenance (e.g., discing, grading, erosion control, digging, and fill), and associated training operations would not occur. However, the project site would be minimally maintained (i.e., periodically mowed). Existing conditions would remain as described in Section 3.9.1, *Affected Environment*, and utility demands would remain unchanged. Therefore, no impacts on utilities would occur.

3.10 Water Resources

3.10.1 Affected Environment

3.10.1.1 Surface Water

The project site is located on Stuart Mesa, primarily within a small, unnamed watershed along the coastal bluffs of MCB Camp Pendleton, which drains toward the beach (Figure 3.10-1). However, the southeast portion of the project site drains to the Santa Margarita Lagoon and is within the Santa Margarita River Watershed. The Santa Margarita River was placed on the 303(d) list of impaired water bodies in 1986 for eutrophic conditions. Eutrophic conditions occur when dissolved oxygen levels are insufficient to support healthy aquatic life (<5 milligrams per liter [mg/L]). Total maximum daily loads to prevent eutrophic conditions are currently under development for the Santa Margarita Lagoon.

The project site was previously used for agriculture and is currently undeveloped. The on-site soils contained residual pesticide concentrations as a result of pesticide use and storage during past agricultural activities which required remediation (refer to Section 3.8, *Public Health and Safety*). Elevated concentrations of toxaphene, dieldrin, DDE, DDT, heptachlor, and methoxychlor are present at levels that would cause a residential risk but would not cause a risk to industrial workers, construction workers, or military personnel. Ecological receptors were not evaluated as actively managed agricultural lands generally do not provide habitat for ecological receptors (Parsons 2012). There are no water quality sampling data available for the surface water runoff from the project site; however, nutrients (nitrogen and phosphorous) have been detected in the shallow groundwater below the site (SSC-PAC 2011). Based on the soil sampling (Parsons 2012) and groundwater sampling (SSC-PAC 2011), surface runoff from the site may contain pesticides and nutrients from the historical agricultural activities. With the cessation of agricultural activities, pesticide, nitrogen, and phosphorous loading has stopped. Per the *Water Quality Control Plan for the San Diego Basin* objectives, concentrations of nitrogen and phosphorus must be maintained at levels below those which stimulate algae and emergent plant growth. Threshold total phosphorus concentrations must not exceed 0.05 mg/L in any stream at the point where it enters a standing body of water, nor 0.025 mg/L in any standing body of water. A desired goal in order to prevent plant nuisance in streams and other flowing waters is 0.1 mg/L total phosphorus (RWQCB San Diego Region 2016).

Rainfall along the coast at MCB Camp Pendleton averages between 10 and 14 inches (25 to 35 centimeters) per year. Approximately 75 percent of the precipitation falls between November and March (USMC 2007). The project site is relatively flat to gently sloping (mostly less than one percent slope to the west and southwest), which also reduces surface water velocities and associated erosion. Based on the moderately high to high capacity of the on-site soil, Marina coarse sandy loam, to transmit water and the less than one percent slope over most of the site, precipitation on the project site generally infiltrates into the soil until encountering the underlying hardpan (i.e., a layer of hard soil), along which the water flows laterally. Ponding occurs locally on the dirt roads as a result of soil compaction and local depressions in the topography. Surface runoff may only occur during extreme precipitation events where the rainfall intensity exceeds the capacity of the soil to infiltrate the rainfall. Runoff in these extreme events sheet flows to the west and southwest and is collected along existing drainage swales that run parallel to the bluff top. Runoff is prevented from flowing down the bluff by a protective berm and is directed to corrugated pipe slope drains (or down drains) that transport surface runoff to the base of the slope to the dunes on the beach (Figure 3.10-2). The southernmost of these drainage features has deteriorated and soil erosion has undermined the concrete pad under the pipe inlet, leaving the pad broken and the pipe non-functional.

MCB Camp Pendleton Watersheds

FIGURE
3.10-1

Stuart Mesa West Existing Drainage System

FIGURE 3.10-2

3.10.1.2 Groundwater

MCB Camp Pendleton's water supply is produced from aquifers that are recharged by percolation from overlying rivers and streams. The groundwater, which is in hydrologic contact with the Pacific Ocean, occurs in alluvium (i.e., loose, unconsolidated soil) in the stream valleys, overlying fairly impervious rock units. Except for the San Mateo Point housing, the entire MCB Camp Pendleton water supply is extracted from the Santa Margarita, Las Flores, San Onofre, and San Mateo watersheds (USMC 2007, 2010b).

MCB Camp Pendleton derives potable water from existing groundwater resources within its boundaries through a system of wells, water mains, booster pumps, and storage reservoirs located in the Santa Margarita, Las Flores, San Onofre, and San Mateo basins. Underground aquifers supply nearly all of the Base's domestic, agricultural, and industrial water needs.

The wells located in the alluvial valleys in the lower portions of the Santa Margarita River Hydrologic Unit are the principal source of water for the Base, including the project site (USMC 2007, 2010b). None of these drinking water wells are located in the project site.

Beneficial uses of groundwater within MCB Camp Pendleton, as specified in the *Water Quality Control Plan for the San Diego Basin* (RWQCB San Diego Region 2016), include municipal and domestic supply, agricultural supply, and industrial service supply. The treatment and quality of extracted groundwater used for potable water supply at MCB Camp Pendleton meets the regulatory health-based standards and the Maximum Contaminant Levels for drinking water, as prescribed by the Office of Drinking Water, California Department of Health Services. While drinking water standards for groundwater are met for most constituents in the MCB Camp Pendleton basins, recurring problems have been noted for total dissolved solids, conductivity, nitrate, iron, sodium, and bacteria (*E. coli*). Additionally, there is concern about potential seawater intrusion into the Base wells if water extraction exceeds the safe yield of individual basins. To date, frequent monitoring and extraction control of key wells appears to have helped to prevent seawater intrusion into the drinking water supply (USMC 2010b).

Non-potable groundwater is locally present within unconsolidated to semi-consolidated terrace deposits underlying the project site. Groundwater levels in the western portions of the project site were measured in 2010 as part of the study of the assessment of nutrients from groundwater entering the Santa Margarita Lagoon. Groundwater was found 28 feet (8.5 meters) below the ground surface (6 feet [1.8 meters] above sea level) in the western portion of the project site (Sampling location AGF-4). Nitrite + Nitrate concentrations (as N) were measured to be 92.5 mg/L (SSC-PAC 2011). Phosphate concentrations were measured at 0.01 mg/L. Based on the 2011 groundwater assessment, the groundwater from the former agricultural fields contributes 0.1 percent of the upstream loading of nitrogen to the lagoon in wet periods and 100 percent of the nutrients to the lagoon in the dry period (SSC-PAC 2011).

3.10.1.3 Floodplains/Flooding

Floodplains are defined as lowland and relatively flat areas adjoining inland and coastal waters that are subject to a one percent or greater chance of flooding in any given year. In general, there are four major flood-prone drainages on MCB Camp Pendleton, including areas along the Santa Margarita River, San Mateo Creek, San Onofre Creek, and Las Flores Creek. The project site is not located within the 100-year floodplain associated with these drainages and is not located in a flood-prone area (USMC 2010b).

3.10.2 Environmental Consequences

3.10.2.1 Alternative A

Construction

The coastal bluffs along the southwest perimeter of the project site are susceptible to erosion. To enhance access, two additional 25-foot (7-meter) wide dirt routes would be graded on the bluff from White Beach into the main training area (Figure 2.1-1). Removal of vegetation and soil disturbance to construct the beach access routes could cause erosion of the bluffs. In addition, a dirt access road would be constructed in the southern portion of the main training area across the former agricultural fields. Due to the soil disturbance, there is the potential for surface water runoff to transport sediments off site towards Santa Margarita Lagoon during construction.

Alternative A would incorporate BMPs into the project design to mitigate the adverse effects of construction-related erosion on water quality. Before construction, the Facilities Engineering and Acquisition Department would obtain authorization from the State Water Resources Control Board for construction under the NPDES General Permit for Storm Water Discharges Associated with Construction Activity (Order No. 2009-0009-DWQ/NPDES No. CAS000002). The contractor would be required to implement all appropriate BMPs for erosion and sedimentation control, as identified in Order No. 2009-0009-DWQ and as specified in a site-specific Storm Water Pollution Prevention Plan (refer to Appendix D, *Standard Construction Measures*, for additional details on BMPs recommended as standard requirements for construction contracts on MCB Camp Pendleton). Before commencement of grading, control devices such as silt fences, jute netting, geotextiles, and other materials would be placed within and around the proposed construction sites to reduce surface water flow velocities, slow down soil erosion and off-site transport, and protect sensitive habitats. A rock-lined construction entrance would be placed at all project site access points to help remove soil from vehicle tires. All construction contracts on MCB Camp Pendleton are completed in accordance with standard BMPs, referring specifically to erosion control and management (Appendix D, *Standard Construction Measures*). With implementation of BMPs, compliance with established plans and policies, and incorporation of standard erosion control measures, erosion impacts during construction should be minimized. With the erosion impacts minimized, the potential for sediment to be deposited off-site would be reduced and no significant impacts on water resources, including coastal zone resources, would occur.

Surface water and/or shallow groundwater quality impacts could potentially occur as a result of inadvertent dispersion of contaminants during construction and subsequent operations. Construction would require the use of vehicles and equipment powered by diesel fuel/gasoline and lubricated with oil and other mechanical fluids, which may be considered hazardous substances. Other types of construction waste, such as sediment, could affect downstream water quality or shallow groundwater quality. Accidental releases of such substances (e.g., spills arising from leakage of fuel, motor oil, or hydraulic fluid during operations and/or equipment maintenance) could also occur. As previously described, the Facilities Engineering and Acquisition Department would obtain authorization for construction under the NPDES General Permit for Discharges of Storm Water Discharges Associated with Construction Activity from the State Water Resources Control Board. The contractor would also develop and disseminate a Spill Prevention, Control and Countermeasures Plan, as described in Appendix D (*Standard Construction Measures*). Examples of BMPs include establishment of designated areas for equipment fueling and maintenance; use of licensed, trained personnel for operation of vehicles and equipment; and completion of a regular, comprehensive equipment maintenance program. As specified in Order No. 2009-0009-DWQ, stormwater discharges associated with construction activity must meet all applicable provisions of Sections 301 and 402 of the Clean Water Act, including pollutant discharge controls that utilize the best available technology (BAT) and best conventional pollutant control technology (BCT) economically achievable for toxic pollutants. Any releases of contaminated liquids to surface water during construction activities would be immediately reported to the MCB Camp Pendleton Environmental Security Water Quality Section Head and Spill Prevention Section Head.

In the event that shallow groundwater is encountered during construction, dewatering would be completed as specified in Appendix D (*Standard Construction Measures*). Should the project encounter groundwater during excavation, one of three options would be selected for disposal. Disposal into the sanitary sewer system would require approval from the Facilities Water Resources Division Wastewater Supervisor. Disposal of small volumes of groundwater to land must comply with the San Diego Basin Plan Waivers, with coordination with the MCB Camp Pendleton Environmental Security Water Quality Section. Disposal of groundwater to storm drains or surface waters would require coverage under a Groundwater Discharge Permit through the RWQCB. For each disposal option, sampling would be required and flow rates would need to meet appropriate requirements.

Operations

The proposed conversion of the former Stuart Mesa West Agricultural Field into a multipurpose training area under Alternative A would accommodate combined land, air, and sea training operations. The proposed land use conversion would effectively result in a change in disturbance from agricultural activities to military vehicle maneuvering. Previous agricultural activities reduced vegetation cover through periodic plowing of the fields which generally increased the potential for soil erosion. Military vehicle training also has the potential to increase soil erosion. The direct military vehicle impacts to vegetation include the crushing of foliage, root systems, and seedlings by the wheels or tracks and the uprooting of small plants. The existing site vegetation is mostly annual grasses and forbs due to the previous agricultural disturbances. Tracked vehicle training areas are generally colonized by annual grasses and forbs which are adapted to disturbances (Guretzky et al. 2005). Existing site vegetation of annual grasses and forbs associated with soil disturbance would likely continue to exist on-site in the future.

The proposed action also includes a new dirt access road that would be constructed in the southern portion of the main training area to support proposed training activities. The proposed access road would be approximately 25 feet (7.6 meters) wide and 3,170 linear feet (966 meters) long and rough-graded and leveled or established by repetitive use. The road would result in compaction of the existing soil and potentially increase runoff from the road surface. The road would be located upslope from the Special Use Area near Santa Margarita Lagoon. The Special Use Area near Santa Margarita Lagoon is restricted to foot travel during the breeding season of sensitive species. With less vehicle traffic in the Special Use Area, vegetation should be more extensive and provide a buffer that would absorb the potential minimal increase in runoff.

The slope of the project site is fairly flat with 0.5 to 1.0 percent slope in most portions of the former agricultural areas. In the southern portion of the site, there is a section with approximately 3 to 4 percent slope (Figure 3.10-2). The existing soils, Marina loamy coarse sands, have a low-moderate soil erodibility factor ($K = 0.24$) and are somewhat excessively drained with a moderately high to high capacity to transmit water (0.57 to 1.98 inches/hour) with a ponding or flooding frequency of zero (NRCS 2012). With the flat slopes, moderate to high capacity of the soils to infiltrate water, and low-moderate soil erodibility, the existing soil erosion potential of the project site is low. Runoff likely only occurs during extreme storm events. Runoff, when it occurs is collected by a series of drainage swales and berms which run parallel to the coastal bluffs and direct water to five slope drains to prevent erosion of the bluffs (Figure 3.10-2). MCB Camp Pendleton Environmental Security engineering staff has reviewed the existing site conditions and the proposed action and determined that there would be a negligible difference in stormwater runoff between current conditions and post-project implementation (Battista 2016).

With negligible changes in stormwater runoff, no additional modifications are required for the existing storm drainage system and no significant impacts to stormwater would occur. The existing storm drainage system would be maintained as part of ongoing MCB Camp Pendleton Facilities Maintenance Department maintenance activities.

MCB Camp Pendleton is currently in discussions with the RWQCB, USEPA, and California Department of Toxic Substances Control regarding the residual pesticides on-site. Several toxaphene hotspots have been identified for present avoidance and long-range cleanup (refer to Section 3.8, *Public Health and Safety*). These discussions may result in additional measures needed on-site as part of a CERCLA action, which is separate from the proposed action. Since hotspots will be avoided until cleanup actions have occurred, no significant impacts to surface water quality would occur from the pesticide concentrations.

The proposed action is expected to provide a significant long-term improvement in water quality in the Santa Margarita Lagoon. The conversion from agricultural fields to military training eliminates a major source of nutrients and pesticides to Santa Margarita Lagoon. Nitrite + Nitrate (as N) concentrations in the shallow groundwater are high (92 mg/L) from the decades of applying fertilizers and irrigation to the agricultural fields. The shallow groundwater from the former agricultural fields was estimated to contribute 0.1 percent of the upstream loading of nitrogen to the lagoon in wet periods and 100 percent of the nutrients to the lagoon in the dry period (SSC-PAC 2011). Without the continued summer irrigation of the agricultural fields, the groundwater seepage and associated nutrient loading and potential pesticide loading into the lagoon would be expected to decline significantly in the short-term. In the long-term, with fertilizers and pesticides no longer being applied to the fields, the nutrient levels in soils would be expected to decline toward background conditions through surface water transport and subsurface leaching of remaining nutrients. The residual pesticides should decline in concentration as they continue to naturally decay and break down.

This alternative would result in a negligible increase in overall MCB Camp Pendleton operations due to construction and maintenance of the new beach access routes, dirt access road in the main training area, and general site maintenance. As Alternative A would result in no consequential change in the level of operational activities and associated number of personnel, there would be a negligible increase in water use, and no significant impacts on groundwater supply would occur.

3.10.2.2 No-Action Alternative

Under the No-Action Alternative, the former Stuart Mesa West Agricultural Field would not be converted into a multipurpose training area and general site improvements (i.e., construction and maintenance of new access routes), site maintenance (e.g., discing, grading, erosion control, digging, and fill), and associated training operations would not occur. However, the project site would be minimally maintained (i.e., periodically mowed). Existing conditions would remain as described in Section 3.10.1, *Affected Environment*. Agricultural activities could resume along with the application of fertilizers, pesticides, and irrigation.

4 Cumulative Impacts

4.1 Introduction

CEQ regulations implementing NEPA require that the cumulative impacts of a proposed action be assessed (40 CFR Parts 1500–1508). A cumulative impact is defined as the following:

> The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR § 1508.7).

CEQ's guidance for considering cumulative effects states that NEPA documents "should compare the cumulative effects of multiple actions with appropriate national, regional, state, or community goals to determine whether the total effect is significant" (CEQ 1997).

The first step in assessing cumulative effects, therefore, involves identifying and defining the scope of other actions and their interrelationship with the proposed action or alternatives. The assessment must consider other projects that are near or coincide, spatially or temporally, with the proposed action and other actions. Section 4.2, *Projects Considered in the Cumulative Analysis*, identifies relevant past, present, and reasonably foreseeable future actions. Projects were selected because they are either similar to the proposed action, large enough to have far-reaching effects, or in proximity to the proposed action. Section 4.4, *Cumulative Impact Analysis*, provides an analysis of cumulative impacts for relevant environmental resources, and further defines the ROI and relevant projects for each resource area.

4.2 Projects Considered in the Cumulative Analysis

Information on past, present, and reasonably foreseeable future projects and their associated anticipated impacts was gathered through a review of available environmental documentation (conducted in May through June 2015) and in coordination with the Marine Corps. The majority of reasonably foreseeable future projects are base-wide utility infrastructure upgrades and expansions, construction of military facilities and support infrastructure, and military family housing projects. A list of the cumulative projects, summary information, and their associated impacts is presented in Appendix J (*Cumulative Projects List*).

4.3 Methodology

4.3.1 Geographic Scope of the Cumulative Effects

For this analysis, a geographic scope, or ROI, for each cumulative effects issue was established. The ROI is generally based on the natural boundaries of the resources affected, rather than jurisdictional boundaries. The geographic scope may be different for each cumulative effects issue. The geographic scope of cumulative effects often extends beyond the scope of the direct effects, but not beyond the scope of the direct and indirect effects of the proposed action and alternatives. The ROI is defined in Section 4.4, *Cumulative Impact Analysis*, for each resource listed below. Because ROIs vary for different resources, not all of the cumulative projects would be located within the ROI defined for a particular resource.

4.3.2 Time Frame of the Cumulative Effects Analysis

A time frame for each issue related to cumulative effects has been determined. The time frame is defined as the duration of the effects anticipated. Time frames, like geographic scope, can vary by resource. Each project in a region has its own implementation schedule, which may or may not coincide or overlap with the schedule for implementing the proposed action. This is a consideration for short-term impacts from the proposed action. However, to be conservative, the cumulative analysis assumes that all projects in the cumulative scenario are built and operating during the operating lifetime of the proposed action.

Past actions are projects that have been approved and/or permitted, and that have either very recently completed construction/implementation or have yet to complete construction/be implemented. Present actions are actions that are ongoing at the time of the analysis. Reasonably foreseeable future actions are those for which there are existing decisions, funding, or formal proposals, or which are highly probable based on known opportunities or trends. However, these are limited to within the designated geographic scope and time frame. Reasonably foreseeable future actions are not limited to those that are approved for funding. However, this analysis does not speculate about future actions that are merely possible, but not highly probable, based on information available at the time of this analysis.

4.4 Cumulative Impact Analysis

This section addresses the potential cumulative impacts of Alternative A in conjunction with the aforementioned cumulative projects. These projects represent past, present, and reasonably foreseeable actions with the potential for cumulative impacts when considered in conjunction with the potential impacts from Alternative A. However, if a project would not result in direct or indirect impacts on a resource area, it would not contribute to a cumulative impact on that resource area and no further evaluation from a cumulative impact perspective is warranted. The cumulative impact analysis focuses on: 1) those resource areas with the potential to be significantly impacted by Alternative A; and/or 2) those resource areas currently in poor or declining health, or at risk even if impacts associated with Alternative A would be relatively small (less than significant). The resources that do not meet these criteria are Airspace (Section 3.1); Aesthetics (Section 3.2); Land Use and Coastal Zone Management (Section 3.6); Public Health and Safety (Section 3.8); and Utilities (Section 3.9). Therefore, Alternative A would not cumulatively contribute to impacts to these resources areas, and they are not evaluated further in this section.

4.4.1 Air Quality and Greenhouse Gases

4.4.1.1 Criteria Pollutants

The ROI for the criteria air pollutant cumulative analysis is primarily the SDAB and more specifically in proximity to MCB Camp Pendleton. As described in Section 3.3, *Air Quality and Greenhouse Gases*, proposed construction, training, and maintenance activities would produce emissions that would remain below all emission significance thresholds under Alternative A. Emissions from cumulative projects potentially would contribute to ambient pollutant impacts generated from proposed activities. However, these emissions would occur far enough away from the locations of proposed construction and operational activities such that they would produce low ambient pollutant impacts in proximity to the project site. Therefore, air quality impacts from proposed construction and operational emissions, in combination with emissions from cumulative projects, would not be substantial enough to contribute to an exceedance of an ambient air quality standard. Implementation of standard fugitive dust measures (Special Conservation Measure 1), construction equipment emission control measures (Special Conservation Measure 2), and procurement of operational equipment (Special Conservation Measure 3) would ensure that air emissions from proposed construction activities under Alternative A would not result in significant impacts. As a result, construction, training, and maintenance activities would not produce cumulatively significant impacts on criteria pollutant levels.

4.4.1.2 Greenhouse Gases

The potential effects of proposed GHG emissions are by nature global and cumulative impacts, as individual sources of GHG emissions are not large enough alone to have an appreciable effect on climate change. Therefore, an appreciable impact on global climate change would only occur when proposed GHG emissions combine with GHG emissions from other human activities on a global scale.

Currently, there are no formally adopted or published NEPA thresholds of significance for GHG emissions. Therefore, in the absence of an adopted or science-based NEPA significance threshold for GHGs, this EA compares the maximum amount of combined construction and operational GHG emissions that would occur from Alternative A to the U.S. net GHG emissions inventory of 2012 to determine the relative increase in proposed GHG emissions. Appendix E-1 (*Air Quality Calculations*) presents estimates of GHG emissions generated by Alternative A.

Table 4.4-1 summarizes the net change in annual GHG emissions that would occur from construction and operations (i.e., training and maintenance activities) under Alternative A. These data show that the ratio of CO_2e emissions from Alternative A to the CO_2e emissions associated with the net U.S. sources in 2012 is approximately 0.0015/5,547 million metric tons, or about 0.00003 percent of the U.S. CO_2e emissions inventory.

Table 4.4-1. Alternative A - Maximum Annual GHG Emissions

Scenario	*Metric Tons per Year*			
	CO_2	*CH_4*	*N_2O*	*CO_2e*
Proposed Action Emissions	-	-	-	1,459
U.S. 2012 Net Emissions (10^6 metric tons)	-	-	-	5,547
Emissions as a percent of U.S. Emissions	-	-	-	0.00003

Source: USEPA 2015.
Notes: CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; CO_2e = carbon dioxide equivalent.
$CO_2e = (CO_2 * 1) + (CH_4 * 21) + (N_2O * 296)$.

Because GHG emissions from Alternative A would equate to minimal amounts of the U.S. inventory, they would not substantially contribute to global climate change. Therefore, GHG emissions from the proposed action would not result in cumulatively significant impacts to global climate change.

Renewable energy projects currently implemented and planned within the jurisdiction of MCIWEST would reduce emissions of GHGs by about 250,000 metric tons (CO_2*e*) from current operations over a 25-year life cycle (MCIWEST 2009). These projects include thermal and photovoltaic solar systems, geothermal power plants, and wind generators.

Climate Change Adaptation

In addition to assessing whether Alternative A would potentially impact climate change, the following considers how climate change could impact these actions and what adaptation strategies, if any, would be required to respond to these future conditions. For projects within southern California, the main effect of climate change to consider is increased temperatures, droughts, wildfires, and sea level rise as documented in *Our Changing Climate 2012 – Vulnerability & Adaptation to the Increasing Risks from Climate Change in California* (California Energy Commission 2012). Current operations at MCB Camp Pendleton have adapted to the relatively arid conditions in the area, as well as the prevalence of wildfires.

Exacerbation of these conditions in the future could impede proposed construction and operational activities during extreme events. The effects of sea level rise over the next 50 years would not substantially reduce the beach area adjacent to the project site and no measures currently are proposed to mitigate this effect. No other substantial effects from future climate change would impact proposed construction and operational activities.

4.4.2 Biological Resources

For the purposes of biological resources, the ROI for the assessment of cumulative impacts varies and is based on the presence of suitable habitat and known occurrences of a specific resource. Projects with potential direct and indirect impacts on biological resources include those that would result in the loss of native plant communities, permanent loss of sensitive plant populations, species losses that affect population viability, and reduction in adjacent habitat quality from temporary actions. For native plant and wildlife communities, other significant impacts could include habitat fragmentation or the permanent loss of contiguous (interconnecting) native habitats such as migration or movement corridors.

All projects at MCB Camp Pendleton are required to adhere to various protection measures designed to minimize effects to vulnerable species and their habitats, including riparian, wetlands, coastal sage scrub, and estuarine/beach habitats. Furthermore, the potential for cumulative effects on biological resources at MCB Camp Pendleton associated with habitat and wildlife disturbance is reduced because of ongoing monitoring and management activities that minimize adverse effects from development and operations. Potential cumulative effects of federal actions on federally listed endangered species are addressed project-by-project through the Section 7 ESA consultation process with USFWS. Through this process MCB Camp Pendleton and USFWS jointly assess project-specific effects and develop and implement appropriate measures that reflect current conditions and status of the species. Consultation has resulted in development of conservation programs for federally listed species and their habitats, such as the USFWS Riparian BO that covers activities included in the *Riparian and Estuarine Programmatic Conservation Plan* (USFWS 1995). As a result, potential cumulative impacts on federally listed species are effectively reduced through avoidance, minimization, and/or compensation measures as required. Collectively, these requirements ensure that the incremental effects of individual projects do not result in cumulatively significant impacts to biological resources.

As discussed in Section 3.4, *Biological Resources*, Alternative A would not result in significant impacts on biological resources. Implementation of Special Conservation Measure 4 (*Seasonal Avoidance for Federally Listed and MBTA-protected Bird Species*) and Special Conservation Measure 5 (*Riparian Vegetation Removal Compensation*), and compliance with the programmatic avoidance measures and instructions stipulated in the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian BO (USFWS 1995), would ensure construction and operations associated with Alternative A would contribute minimally to adverse effects on biological resources. Similarly, the spatial and temporal extent of impacts to biological resources from other cumulative projects are expected to be limited due to implementation of Special Conservation Measures and permit conditions that are comparable to those associated with Alternative A. As a result, Alternative A, combined with other cumulative projects, would not result in cumulatively significant impacts on biological resources.

4.4.3 Cultural Resources

The ROI for potential cumulative impacts on cultural resources consists of MCB Camp Pendleton and adjacent communities. Regional development and urbanization in southern California has resulted in extensive impacts on cultural resources, especially the destruction of archaeological sites and historic buildings. These types of cultural resources are limited, which is one of the reasons why strict federal and state regulations have been implemented to provide management and regulatory oversight.

Present and reasonably foreseeable projects at MCB Camp Pendleton that involve ground-disturbing activities and/or modification or demolition of buildings or structures could result in impacts to cultural resources. Federal projects that have the potential to affect historic properties (assuming the presence of such properties) would undergo NHPA Section 106 review to consider any effects that the project may have on historic properties (as defined at 36 CFR 800.16). The significance of any effects would also be reviewed under NEPA.

As discussed in Section 3.5, *Cultural Resources*, there is one archeological site within the APE (CA-SDI-4423/H) that was recommended eligible for listing in the National Register, but it would not be affected by Alternative A. Although highly unlikely, the potential to impact previously unrecorded cultural resources during ground-disturbing activities would be reduced by implementing Special Conservation Measure 6 (*Construction Monitoring for the Beach Access Routes*) and Special Conservation Measure 7 (*Post-Review Discovery Procedures*). The USMC has determined that effective protection measures would be employed to avoid adverse effects to any historic properties. Similarly, other cumulative projects would be subject to Section 106 review to consider their potential impacts to cultural resources. As a result, Alternative A, combined with other cumulative projects, would not result in significant cumulative impacts to cultural resources.

4.4.4 Noise

The ROI for potential cumulative impacts to noise consists of the project site and adjacent areas on MCB Camp Pendleton and surrounding communities. Development throughout MCB Camp Pendleton and the surrounding areas would result in intermittent, short-term noise impacts throughout the region. The duration of these localized impacts would be limited to the construction phases of the individual projects and confined to the immediate construction area. Short-term noise associated with construction activities could range from 80 to 90 dB at 50 feet (15 meters) from the source. For Alternative A, construction-related noise would be similar to existing noise levels generated by traffic on I-5. While specific vehicles could be heard at nearby noise-sensitive locations (e.g., military family housing) at certain times, short-term construction noise would not be expected to be overly disruptive and would not be a substantial change from current conditions. Other cumulative projects that could coincide in time with the Alternative A would also be short-term and localized. They would comply with applicable federal, state, and local regulations and/or requirements and would have to implement noise protection measures (e.g., solid walls, fences, or earthen mounds) and/or limit the hours of construction, as necessary, to minimize construction-related noise impacts. Therefore, cumulative construction-related noise impacts from Alternative A, in conjunction with other projects in the regional vicinity, would not be cumulatively significant.

Proposed cumulative projects would generate increased levels of training and operations activity at MCB Camp Pendleton that could increase noise levels affecting adjacent sensitive noise receptors. Noise generated by training activities (e.g., aircraft operations, tactical vehicle operations, and non-live fire munitions) under Alternative A would not substantially differ from the existing noise environment within the project vicinity. Expected project-related noise levels would be largely masked by current noise levels generated from the I-5 corridor and other ongoing military aircraft overflights. The one exception would be munitions noise generated by small arms firing and Ground Burst Simulator detonations, which could result in a moderate risk of noise complaints from noise-sensitive locations (e.g., nearby military family housing). However, munitions noise would likely occur only during six training exercises per year and would be consistent with noise from other live-fire training that occurs on-Base. Therefore, cumulative operations-related noise impacts from Alternative A, in conjunction with other cumulative projects, would not be cumulatively significant.

4.4.5 Water Resources

The ROI for water resources includes those areas that contain surface water or groundwater features within the same watershed as Alternative A. Direct impacts to water resources include the discharge of waste materials that would affect downstream water quality, the increase in structures and other impermeable surfaces that affect the volumes or patterns of surface flow or increase potentials for flooding within drainage areas, and increases in soil disturbance during construction and operations resulting in additional sedimentation into surrounding creeks and the Pacific Ocean. Cumulative development in proximity to the Santa Margarita River and Pacific Ocean (i.e., receiving waters for cumulative projects), including the MCTSSA Cantonment Area Expansion Project, Santa Margarita River Railroad Bridge Replacement and Second Track Project, and Stuart Mesa Bridge Project, could result in temporary and localized effects to water quality that could be individually comparable to those associated with Alternative A. Proposed construction activities could contribute to increased runoff, increased erosion, and off-site sedimentation into the adjacent Santa Margarita River and Pacific Ocean. Alternative A would incorporate BMPs for erosion and sedimentation control, as identified in Order No. 2009-0009-DWQ and as specified in a site-specific Storm Water Pollution Prevention Plan to mitigate the adverse effects of construction-related erosion on water quality. Potential surface water and/or shallow groundwater quality impacts associated with the inadvertent dispersion of contaminants during construction would be minimized by implementation of a Spill Prevention, Control, and Countermeasures Plan. In the event that shallow groundwater is encountered during construction, dewatering activities would comply with the Groundwater Discharge Permit, San Diego Basin Plan Waivers, and Facilities Water Resources Division Sanitary Sewer System requirements, depending upon the method of disposal. Therefore, cumulative construction-related water resource impacts from Alternative A, in conjunction with other projects in the regional vicinity, would not be cumulatively significant.

Alternative A would result in a change in the type and level of activities within the project site. However, there would be a negligible difference in stormwater runoff between current conditions and post-project implementation. The proposed action is expected to provide a significant long-term improvement in water quality in the Santa Margarita Lagoon. The conversion from agricultural fields to military training eliminates a major source of nutrients and pesticides to Santa Margarita Lagoon. Other reasonably foreseeable projects, such as the MCTSSA Cantonment Area Expansion Project, would also eliminate the agricultural use of the land, resulting in improvements to surface and groundwater quality. The other reasonably foreseeable projects would also comply with applicable federal, state, and local regulations and/or requirements. This would minimize the majority of potential impacts from other projects in the regional vicinity. Therefore, the cumulative operations-related water resource impacts from Alternative A, in conjunction with other cumulative projects, would not be cumulatively significant.

Adherence to BMPs during construction and training operations would protect coastal water quality to the maximum extent feasible. Other reasonably foreseeable projects adjacent to the coastal zone at MCB Camp Pendleton would also comply with applicable CZMA regulations and/or requirements, and would have to implement similar types of BMPs and protection measures. Therefore, cumulative coastal zone resource impacts from Alternative A, in conjunction with other cumulative projects, would not be cumulatively significant.

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Appendix A

Public Participation Process

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Public Participation Process

As part of this Environmental Assessment (EA), the United States Marine Corps (USMC) conducted a public involvement process to solicit input from interested parties on the proposed action. The USMC published a public notice of the preparation of an EA for the Stuart Mesa West Training and Conversion at Marine Corps Base (MCB) Camp Pendleton in the *San Diego Union Tribune, North County Edition*, and *Orange County Register* newspapers on 4-6 December 2015. The Department of the Navy will announce the release of the Final EA and Finding of No Significant Impact (FONSI) by publishing an Notice Of Availability (NOA) in the above-listed newspapers. The Final EA and FONSI will be available on the MCB Camp Pendleton website or by contacting MCB Camp Pendleton, Environmental Security.

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Appendix B

Applicable Federal Regulations, Instructions, and Public Law

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Applicable Federal Regulations, Instructions, and Public Law

Name	***Regulation***
National Environmental Policy Act of 1969	42 USC §§ 4321–4370h
Council on Environmental Quality Regulations for Implementing the Procedural Provisions of National Environmental Policy Act	40 CFR Parts 1500–1508
Department of the Navy Procedures for Implementing National Environmental Policy Act	32 CFR Part 775
Environmental Compliance and Protection Manual Chapter 12	Marine Corps Order P5090.2A, Change 3
National Historic Preservation Act	54 USC § 300101 *et seq.*
Clean Water Act	33 USC §§ 1251–1387
Clean Air Act, as amended, including 1990 General Conformity Rule	USC §§ 7401–7671q
Comprehensive Environmental Response, Compensation, and Liability Act	42 USC §§ 9601–9675
Resource Conservation and Recovery Act	42 USC §§ 6901–6992k
Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations, 11 February 1994	Executive Order 12898
Protection of Children from Environmental Health Risks and Safety Risks, 23 April 1997	Executive Order 13045
Endangered Species Act	16 USC §§ 1531–1544
Coastal Zone Management Act	16 USC §§1451 -1465 and 15 CFR Parts 923 and 930
Migratory Bird Treaty Act	16 USC §§ 703–712
Responsibility of Federal Agencies to Protect Migratory Birds, 11 January 2001	Executive Order 13186
Invasive Species	Executive Order 13112
Native Americans Graves Protection and Repatriation Act	25 USC §§ 3001–3013 and 40 CFR Part 10
Federal Compliance with Pollution Control Standards	Executive Order 12088
Greening the Government through Waste Prevention, Recycling, and Federal Acquisition	Executive Order 13101
Greening the Government through Efficient Energy Management	Executive Order 13123
Greening the Government through Leadership in Environmental Management	Executive Order 13148
Planning For Federal Sustainability in the Next Decade	Executive Order 13693
United Facilities Criteria for Low Impact Development	United Facilities Criteria 3-210-10
American Indian Religious Freedom Act	PL 95-341; 42 USC §§ 1996 and 1996a
Archaeological Resource Protection Act	16 USC §§ 470aa–470mm; PL 96-95 and Amendments
Federal Aviation Administration Order 7400.2	49 USC § 40103(b)
Operation Risk Management	Marine Corps Order 3500.27A
National Register of Historic Places	36 CFR Part 60

Applicable Federal Regulations, Instructions, and Public Law

Name	***Regulation***
Operational Risk Management	Office of the Chief of Naval Operations 3500.39A
Pollution Prevention Act of 1990	42 USC §§ 13101–13109
Sikes Act	16 USC §§ 670–670f, 74 Stat. 1052, as amended, PL 86-797, approved 15 September 1960
Waste Discharge Requirements for Discharge of Storm Water Runoff Associated with Construction and Land Disturbance Activities	State of California Water Resources Control Board Order No. 2009-0009-DWQ; National Pollutant Discharge Elimination System General Permit No. CAS000002
California Coastal Act	PRC §§ 30000 - 30900
Notes: CFR = Code of Federal Regulations; MCAS = Marine Corps Air Station; PL = Public Law; PRC = Public Resources Code; USC = United States Code.	

Appendix C

Minimization, Mitigation, Monitoring, and Reporting Tracking Sheet (MMMR)

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MINIMIZATION, MITIGATION, MONITORING, AND REPORTING (MMMR) TRACKING SHEET Stuart Mesa West Training and Conversion at MCB Camp Pendleton							
Number	***Minimization, Mitigation, Monitoring, Reporting Measures***	***Environmental Assessment Section***	***Implementation Procedure or Action***	***Responsible Organization***	***Deliverable/ Report***	***Compliance Schedule***	***Verification of Compliance***
Special Conservation Measures							
1	The project proponent, construction oversight authority, or duly designated contractor would ensure that fugitive dust emissions do not extend beyond the property line for more than 3 minutes in any 60-minute period and would mitigate fugitive dust to minimize track out/carry out emissions during demolition, construction, and transport in accordance with San Diego County Air Pollution Control District (SDCAPCD) Rule – Fugitive Dust Control. The construction authority also would demonstrate that the impact of fugitive dust from proposed construction activities to Interstate 5 (I-5) would comply with SDAPCD Rule 50 (Visible Emissions) or Rule 51 (Nuisance). The construction contractor would implement the following measures, where applicable, to minimize fugitive dust emissions: a. Use water trucks or sprinkler systems to keep all areas of vehicle movement damp enough to prevent dust from leaving the construction area. b. Minimize the amount of disturbed ground area at a given time. c. Minimize traffic speeds on all unpaved roads. d. Install gravel pads at construction area access points to prevent tracking of soil onto paved roads. e. Provide temporary wind fencing around sites being graded or cleared. f. Suspend all soil disturbance activities when winds exceed 25 miles per hour or when visible dust plumes emanate from the site. Stabilize all disturbed areas at this time. g. Cover truck loads that haul dirt, sand, or gravel or maintain at least two feet of freeboard in accordance with Section 23114 of the California Vehicle Code. h. After completion of clearing, grading, earthmoving, or excavation, treat the disturbed areas by watering,	Section 3.3	Implement fugitive dust control measures.	Contractor	None	During Construction	Verified by: Date:

MINIMIZATION, MITIGATION, MONITORING, AND REPORTING (MMMR) TRACKING SHEET ***Stuart Mesa West Training and Conversion at MCB Camp Pendleton***							
Number	***Minimization, Mitigation, Monitoring, Reporting Measures***	***Environmental Assessment Section***	***Implementation Procedure or Action***	***Responsible Organization***	***Deliverable/ Report***	***Compliance Schedule***	***Verification of Compliance***
	re-vegetation, or by spreading non-toxic soil binders until they are developed to prevent dust generation. i. Designate personnel to monitor the dust control program and to order increased watering, as necessary, to prevent the transport of dust off-site. Their duties shall include holiday and weekend periods when work may not be in progress.						
2	The construction contractor would implement the following measures during proposed construction activities, where feasible: a. Maintain equipment according to manufacturer specifications. b. Restrict idling of equipment and trucks to a maximum of five minutes at any location. c. Use diesel oxidation catalysts and/or catalyzed diesel particulate traps on equipment exhaust systems. d. Use electricity from power poles rather than temporary diesel- or gasoline-powered generators. e. Provide temporary traffic control, such as a flag person, during all phases of construction to maintain smooth traffic flow. f. Keep construction equipment and equipment staging areas away from sensitive receptor areas. g. Re-route construction trucks away from congested streets or sensitive receptor areas. h. Use construction equipment with engines that meet United States Environmental Protection Agency (USEPA) Tier 3 and 4 non-road standards. i. Use alternatively-fueled construction equipment, such as natural gas, liquefied gas, or electric.	Section 3.3	Implement construction equipment emission control measures.	Contractor	None	During Construction	Verified by: Date:
3	Marine Corps Base (MCB) Camp Pendleton Environmental Security would approve all operational equipment proposed for use on-site that would generate air emissions before procurement.	Section 3.3	Approve construction equipment that would generate air emissions.	MCB Camp Pendleton Environmental Security	None	Before and During Construction	Verified by: Date:

MINIMIZATION, MITIGATION, MONITORING, AND REPORTING (MMMR) TRACKING SHEET ***Stuart Mesa West Training and Conversion at MCB Camp Pendleton***							
Number	***Minimization, Mitigation, Monitoring, Reporting Measures***	***Environmental Assessment Section***	***Implementation Procedure or Action***	***Responsible Organization***	***Deliverable/ Report***	***Compliance Schedule***	***Verification of Compliance***
4	To the maximum extent feasible, vegetation removal and management associated with the construction and maintenance of the two new beach access routes and dirt access road in the main training, and general site maintenance (e.g., mowing/discing, grading, erosion control, digging, and fill) within the special use areas, would occur from 01 September to 14 February, which is outside the breeding season for federally listed species and most nesting birds protected under the Migratory Bird Treaty Act (MBTA). If critical trimming or removal of vegetation during the peak breeding season (15 February to 31 August) is required, a pre-activity survey by a qualified wildlife biologist, hired by the project proponent and approved by MCB Camp Pendleton Environmental Security shall be completed to confirm that active nests would not be affected by the maintenance activity or associated noise. The wildlife biologist must conduct the survey within three days of the start of the activity.	Section 3.4	Seasonal avoidance of federally listed and MBTA-protected bird species.	Contractor/ MCB Camp Pendleton Environmental Security	None	During Construction	Verified by: Date:
5	Impacts to any riparian habitat, regardless of listed species presence, would be offset in accordance with the Riparian Biological Opinion (BO). Compensation is based on the total amount of riparian habitat impacted. MCB Camp Pendleton proposes two alternatives for compensating impacts to riparian habitat: 1) compensating on-Base at the Santa Margarita River in the form of native riparian habitat, with cost identified in the Riparian BO adjusted for inflation; or 2) utilizing MCB Camp Pendleton's future mitigation requirements to be fulfilled by conservation actions elsewhere within the ecoregion that promote recovery efforts of endangered and threatened species or their habitats (up to 20 percent annual total as identified in the Riparian BO). Any reduction of impacts to riparian	Section 3.4	Compensate for impacts to riparian habitat in accordance with the Riparian BO.	Project Proponent	None	After construction	Verified by: Date:

MINIMIZATION, MITIGATION, MONITORING, AND REPORTING (MMMR) TRACKING SHEET
Stuart Mesa West Training and Conversion at MCB Camp Pendleton

Number	***Minimization, Mitigation, Monitoring, Reporting Measures***	***Environmental Assessment Section***	***Implementation Procedure or Action***	***Responsible Organization***	***Deliverable/ Report***	***Compliance Schedule***	***Verification of Compliance***
	habitat achieved during the final design stage would proportionally reduce the amount of restoration implemented.						
6	A qualified archeological and Native American monitor would be present during all ground-disturbing activities related to the construction of the new beach access routes. Monitors would be hired by the construction contractor and would meet the approval of MCB Camp Pendleton.	Section 3.5	Monitor construction of new beach access routes	Contractor	None	During Construction	Verified by: Date:
7	While not anticipated, in the event that previously unrecorded archaeological resources, cultural items, or human remains are encountered during ground disturbing activities, MCB Camp Pendleton would manage these resources in accordance with the National Historic Preservation Act (NHPA) and other federal laws and regulations, Marine Corps and Department of Defense (DoD) regulations, instructions, and orders, and DoD American Indian and Alaska Native Policy.	Section 3.5	Implement post review discovery procedures	MCB Camp Pendleton	None	During Construction	Verified by: Date:

Appendix D

Standard Construction Measures

Standard Construction Measures

Several non-project-specific measures that are standard requirements for construction contracts on Marine Corps Base (MCB) Camp Pendleton would also be implemented as part of the action alternative.

1. A qualified archaeological and Native American monitor will be present during all ground-disturbing activities. This monitor will be hired by the contractor and meet the approval of MCB Camp Pendleton. As required, a qualified archaeologist and Native American monitor would conduct the Special Conservation Measures listed in the Environmental Assessment (EA).
2. Before the bidding process, the construction contractor(s) will be informed of the cultural resources constraints for this project by MCB Camp Pendleton. The contractor(s) will be responsible for impacts to cultural resources that occur as a direct result of construction activities outside the limits of construction. All areas to be avoided will be clearly marked on project maps provided to the contractor. These areas will be designated as “no construction” zones. These areas will be flagged by the project archaeologist before the onset of construction activities. The project footprint, including staging areas and temporary access roads, will be sited to avoid or minimize impacts to cultural resources. Final construction designs for the project will be provided to MCB Camp Pendleton Environmental Security. These designs will include the final footprint of all facilities relative to cultural resources and will include a table showing final permanent and temporary impacts.
3. In the event that archaeological materials (e.g., shell, wood, bone, or stone artifacts) are found or suspected during project operations or the project footprint is altered, work must be halted in the area of discovery and MCB Camp Pendleton Environmental Security notified at (760) 725-9738, as soon as practicable, but no longer than 24 hours after the discovery. Project work at the discovery site shall not proceed until the Base Archaeologist has the opportunity to evaluate the find and gives permission to resume construction activities.
4. Wildfires will be prevented by exercising care when driving and by not parking vehicles where catalytic converters can ignite dry vegetation. In times of high fire hazard, trucks may need to carry water and shovels or fire extinguishers in the field. The use of shields, protective mats, or other fire prevention equipment will be used during grinding and welding to prevent or minimize the potential for fire. No smoking or disposal of cigarette butts will take place within vegetated areas.
5. During construction, field crews will refer environmental issues, including wildlife relocation, dead or sick wildlife, hazardous waste, or questions about avoiding environmental impacts, to Naval Facilities Engineering Command (NAVFAC) Southwest, MCB Camp Pendleton Environmental Security, and the Facilities Engineering and Acquisition Department.
6. Construction vehicles will use existing access roads whenever possible. Where new access is required, all vehicles will use the same route. All access routes outside of existing roads or the construction corridor will be clearly marked (i.e., flagged and/or staked) before the onset of construction. All access routes outside of existing roads or the construction area will be delineated on the grading plans and reviewed by the qualified archaeological monitor, NAVFAC Southwest and MCB Camp Pendleton Environmental Security, and approved by the ROICC.

7. Staging areas will be placed within existing roads or inside the limits of construction. To the degree feasible, staging areas will be located in disturbed habitat, such as existing dirt roadways. Staging areas will be delineated on the grading plans, which will be reviewed by the qualified biological monitor, NAVFAC Southwest, and MCB Camp Pendleton Environmental Security archaeological monitor, and approved by the ROICC.

8. Fueling and maintenance of equipment will take place within existing paved areas or the identified laydown area, but not closer than 100 feet (30 meters) to drainages. An appropriate fueling area will be marked on construction plans. Emergency provisions will be in place at all crossings before the onset of construction to prevent accidental spills from contaminated downstream habitats. The construction contractor will also develop and disseminate a Spill Prevention, Control and Countermeasures (SPCC) plan. Contractor equipment will be checked for leaks before operation and repaired as necessary. “No-fueling zones” will also be designated on construction maps.

9. Cleaning of vehicles and equipment should take place offsite to the greatest extent possible. If it is necessary to clean vehicles onsite, vehicles may be rinsed with water and designated bermed areas must be used to prevent rinse water contact with stormwater, creeks, rivers, and other water bodies. Soaps or detergents should not be used.

10. The construction contractor shall follow the requirements for stormwater drainage design found in the MCB Camp Pendleton Requirements.

11. Site design must account for both water quality treatment and water quantity/flood control. Contractors must comply with specific stormwater design standards found in the MCB Camp Pendleton Requirements, latest edition, which can be obtained from Public Works. Low Impact Design (LID) strategies are described in detail in Unified Facilities Criteria (UFC) 3-210-10. The *California Stormwater Quality Association Stormwater Best Management Practices Handbook for New Development and Redevelopment* should be used as guidance for design of Best Management Practices (BMPs) and pollutant source control. LID techniques may also be used to meet Leadership in Energy and Environmental Design (LEED) requirements including:

    a) Federal projects with a footprint of 5,000 square feet or greater must implement LID in accordance with the Energy Independence and Security Act (EISA) (2007) and Department of Defense LID policies (2007, 2008, 2010). A comprehensive set of stormwater planning, design and construction elements must be used to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow. This will be achieved with LID techniques using the 95th percentile, 24-hour storm, or via a site-specific hydrologic analysis using continuous simulation modeling or other tools.

    b) MCB Camp Pendleton has been designated a Nontraditional Permittee under the California Phase 2 Small Municipal Separate Storm Sewer System (MS4) Permit, State Water Resources Control Board (SWRCB) Order No. 2013-0001-DWQ (NPDES No. CAS000004). Contractors must comply with Post Construction Standards found in Section F.5.g of the Small MS4 Permit. Design storm criteria are given in the permit.

12. The construction contractor would obtain coverage under the California Construction General Permit for stormwater, SWRCB Order No. 2009-0009-DWQ (NPDES No. CAS 000002), as amended in 2010 and 2012 for projects that have a total area of one acre or more of soil disturbance, or are less than one acre but are part of a larger project (common plan of development). Soil disturbance includes, but is not limited to, clearing, grading, grubbing, excavation, demolition, stockpiling, trenching, laydown areas, and construction of access roads. Permitted construction projects must comply with the provisions described below:

a) The contractor must complete a Risk Determination and prepare a draft Storm Water Pollution Prevention Plan (SWPPP) in accordance with the risk level requirements in the Permit. Submit the draft SWPPP and Risk Determination to the ROICC for review at least 60 days before planned initiation of any soil disturbance. The SWPPP must be prepared, stamped and revised by a Qualified SWPPP Developer (QSD) (licensed engineer, hydrologist, or other qualified professional identified in the Permit).

b) The contractor must obtain coverage under the General Permit by uploading a Notice of Intent (NOI), approved SWPPP, Risk Determination, Site Map, and other supporting documentation to the California Stormwater Multi-Application and Report Tracking System (SMARTS) website. The ROICC will review, certify, and submit the NOI to the SWRCB. The contractor must submit a hard copy of the Certification Statement from SMARTS, together with a check for the permit fee, to the San Diego Regional Water Quality Control Board (RWQCB). The contractor shall pay the permit fee, excluding the ambient monitoring surcharge. Allow 7-14 days for fee processing. A Waste Discharge Identification (WDID) number must be received from SMARTS before initiation of any soil disturbance.

c) The project must comply with all provisions described in the Permit and must strictly follow the SWPPP. The SWPPP must be maintained at the project site and updated as necessary to track modifications, BMP location and implementation, training, etc. The Certification Statement must be included in the on-site SWPPP.

d) On-site stormwater compliance shall be the responsibility of the contractor’s QSP (certified professional identified in the Permit). The QSP is responsible for all required inspections, sampling, recordkeeping and corrective actions. The contractor will upload all required documentation to the SMARTS website and notify the ROICC that documents are ready for review, certification and submittal.

e) Annually by 1 August, or upon completion of construction, whichever comes first, the contractor must upload a draft Annual Report, including records of all inspections, sampling and corrective actions to the SMARTS website. The ROICC will review, certify and submit the Annual Report to the SWRCB.

f) Upon completion of construction, the contractor must upload the Notice of Termination (NOT) and supporting documentation to the SMARTS website. The ROICC will review, certify and submit the NOT to the SWRCB. In order to terminate coverage, the project must meet permanent stabilization requirements specified within the Permit. The Annual Report and NOT must be accepted by the SWRCB before the contractor may be released from the contract.

13. If the proposed activity will, or is likely to, involve groundwater extraction (dewatering) at construction sites, foundation dewatering, or groundwater extraction associated with a remediation/cleanup project, contact MCB Camp Pendleton Environmental Security Stormwater Section for guidance at 725-9760. Disposal options for groundwater may include the following: (1) Low volume discharges of uncontaminated groundwater to land must comply with the San Diego Basin Plan Conditional Waiver No. 3, “Low Threat Discharges to Land” found in San Diego RWQCB Resolution No. R9-2014-0041. Land applied water may not run off. (2) Discharges to the sanitary sewer system must be requested through the Facilities Wastewater Operation Supervisor at (760) 725-4018. (3) If options (1) and (2) are not feasible, discharges to storm drains or surface waters (including seasonally dry channels) must obtain coverage under the San Diego General Groundwater Permit, RWQCB Order No. R9-2008-0002. Sampling and/or treatment will be required and are the contractor’s responsibility. Application for permit coverage, including baseline sampling and work plan prepared by licensed engineer, must be submitted to the ROICC at least 60 days before the planned commencement of the discharge. The ROICC will review and certify the application, and the contractor will then submit the application

and permit fee to the RWQCB. A WDID number must be received from the RWQCB before initiation of dewatering. Permit termination is accomplished via a letter from the contractor certifying all dewatering activities have been completed and the site has been restored, with a cover letter from the ROICC.

14. Erosion and siltation of off-site areas during construction will be controlled and minimized. The contractor will prepare a SWPPP and obtain coverage under the General Construction Storm Water Permit (2009-0009-DWQ). The ROICC will review and approve the SWPPP and provide oversight over SWPPP implementation. The SWPPP will include BMPs such as silt fences, siltation basins, gravel bags, or other controls during construction and revegetation phases of the project as found in the *California Stormwater Quality Association Construction Best Management Practice Handbooks* (California Stormwater Quality Association 2009). Contractors shall use only certified weed-free straw wattles, straw bales, and/or hay bales.
15. Stormwater BMPs shall include but not be limited to the following practices, and these shall be detailed in the SWPPP. Stormwater and erosion controls shall be installed at the very beginning of soil disturbance on the construction site. Silt fencing will be placed around the perimeter of the project site. Stockpiles of soil, concrete material, etc. will be covered with a tarp or blanket and/or surrounded with certified weed-free straw wattles or gravel bags. Slopes will be protected with certified weed-free straw wattles or blankets. Whenever possible, grading will be phased to limit soil exposure. Finished areas will be revegetated or hydroseeded as soon as possible. Storm drain inlets will be protected using gravel bags or straw wattles. Construction entrances will be stabilized. Materials that could impact stormwater runoff will be stored in lockers, on pallets, inside rubber berms or indoors. Material storage areas will be located away from existing storm drains. Sedimentation basins will be constructed where appropriate and shall include additional filters for drainage (gravel bags, silt fencing, filter fabric, etc.) where necessary. Sediment will be allowed to settle out for several days before draining sediment basins, and discharge shall be filtered or sprayed onto grass when necessary. Check dams will be used to reduce runoff velocities where necessary. BMPs will be regularly inspected and repaired. Damaged or worn silt fences, wattles, gravel bags, etc. shall be replaced before rain events.
16. After construction of new buildings or potable water pipes, irrigation systems or firefighting pipes, hydrostatic testing may be required. If there will be discharges of potable water resulting from hydrostatic testing, repair or maintenance of potable water pipelines, tanks or vessels associated with drinking water purveyance and storage, contact Environmental Security Stormwater Section at (760) 725-9760. Disposal options may include the following: (1) Low volume discharges to land must comply with San Diego Basin Plan Conditional Waiver No. 3, “Low Threat Discharges to Land” found in San Diego RWQCB Resolution No. R9-2014-0041. Land applied water may not run off. (2) Discharges to the sanitary sewer system must be requested through the Facilities Maintenance Department (FMD) Wastewater Operation Supervisor at (760) 725-4018. (3) If options (1) and (2) are not feasible, discharges to storm drains or surface waters (including seasonal waters) must obtain coverage under the San Diego RWQCB Order No. R9-2010-0003 (NPDES NO. CAG679001), General Waste Discharge Requirements for Discharges of Hydrostatic Test Water and Potable Water to Surface Waters and Storm Drains or Other Conveyance Systems or the equivalent permit from the SWRCB. Dechlorination and BMPs will be required and flow rate may be capped.
17. All landscaping must be in accordance with the most recent version of the *Camp Pendleton Base Exterior Architecture Plan* (BEAP). In accordance with this plan, and Marine Corps Order (MCO) P5090 2A, 11201.2A which calls for the use of native plants in landscaping, only native plants, and non-native plants found in the BEAP “acceptable plant” list can be planted in landscaping or project revegetation efforts (BEAP, Basewide Master Plant List, pages 3-61 to 3-65).

18. The action proponent, or their contractor, will ensure that construction and demolition debris resulting from construction activities will be properly disposed of, including asphalt or concrete, and must not be discarded onsite. In the event of excavation of asphalt or concrete, excess material should be disposed of in accordance with California Code of Regulations Title 14, Division 3, Article 5.9.
19. All trash shall be disposed of properly. Following project completion, all equipment and waste must be removed from the site. The site shall be restored to the original condition once the project is completed. At least fifty percent (50%) of the construction and demolition debris generated must be diverted from placement in a landfill through recycling or reuse (MCO P5090.2A, Chapter 11 (Sec.2), 11201(4)). Soil will be re-contoured before habitat restoration.
20. Implement material and waste management programs during construction, such as solid, sanitary, septic, hazardous, contaminated soil, concrete, and construction waste management; spill prevention; appropriate material delivery and storage; employee training; dust control; and vehicle and equipment cleaning, maintenance, and fueling. Each of these programs would address proper secondary containment requirements, spill prevention and protection, structural material storage needs, proper concrete washout design and containment, perimeter and surface protection for laydown and maintenance areas, and relaying all such requirements to construction staff. Storage, use, and disposal of hazardous materials would be conducted in accordance with local, state, and federal guidelines pertaining to handling, storage, transport, disposal, and use of such materials.
21. All generators over 50 brake horse power would be permitted by the San Diego Air Pollution Control District to ensure proper compliance. This includes both portable and emergency generators. Current permits would be kept on site with the permits easily accessible and displayed as per the requirements within the permit.
22. No night work is anticipated for construction of this project; however, if night work and lighting is required, a qualified biologist will monitor all night-time construction activities in and adjacent to sensitive habitat to avoid disturbance to listed or Migratory Bird Treaty Act (MBTA) species. Any night lighting used will be shielded and directed away from any sensitive habitat. Project excavation which intercepts groundwater must comply with the General Waste Discharge Requirements (WDR) for Discharges from Groundwater Extraction and Similar Discharges to surface Waters within the San Diego Region except for the San Diego Bay (Order No. R9-2008-0002). The contractor must submit a NOI, project map, and initial sampling report to the San Diego RWQCB to obtain permission to dewater construction excavations and discharge to municipal storm drain, surface water, or dry channels. Discharge would be sampled to ensure that it complies with discharge and receiving water limits. For small discharges, the permit may be avoided if the FMD Wastewater Supervisor allows the discharge into sanitary sewer. A waiver may be obtained, with assistance from MCB Camp Pendleton Environmental Security, for limited discharge to land.
23. Construction workers will be prohibited from bringing domestic pets to construction sites to ensure they would not affect wildlife through harassment or predation in adjacent natural habitats.
24. Project design for all electrical upgrades and associated facilities will follow the raptor protection guidelines supported by the Base's avian protection program, as stated in Section 4.3.5.2 of the *Integrated Natural Resource Management Plan* (MCB Camp Pendleton 2012). Following these guidelines would facilitate compliance with the Bald and Golden Eagle Protection Act and MBTA.

References

California Storm Water Quality Association. 2009. *California Stormwater Quality Association Construction Best Management Practice Handbooks*. Website: https://www.casqa.org/store/products/tabid/154/p-167-construction-handbookportal-initial-subscription.aspx.

Marine Corps Base Camp Pendleton 2012. 2007 (2012-Update) Integrated Natural Resources Management Plan. Marine Corps Base Camp Pendleton. March.

Appendix E

Air Quality Technical Data

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Appendix E-1

Air Emission Calculations

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Appendix E.1 - Air Emission Calculations - Project Alternatives for the MCB Camp Pendleton Stuart Mesa Project EA

Table E.1-1. Emission Source Data for Construction of Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

Source Type	*Hp Rating*	*Load Factor (1)*	*Number Active*	*Hours/ Day*	*Total Work Days*	*Total Hp-Hrs*
Off-Road Construction Equipment						
Bulldozer - D9	405	0.43	2	8	6.0	16,774
Grader - 130G	125	0.41	2	8	6.0	4,936
Loader Backhoe - CAT420DIT	88	0.37	2	8	6.0	3,136
Scraper - 621B	365	0.48	2	8	6.0	16,875
Tractor - John Deere TRAM 624KR	198	0.37	2	8	6.0	7,056
Tractor - MC1150E/MC1155E	118	0.37	2	8	6.0	4,205
Water Truck	175	0.46	2	8	12.9	16,615
Fugitive Dust (2)	NA	NA	3	NA	25.8	77
On-Road Trucks						
Activity/Equipment Type		*Average Weight (Tons) (3)*	*Miles/ Round Trip (4)*	*Daily Trips*	*Total Work Days*	*Total Miles*
Material Delivery Truck - Onbase		30	6.2	2	1.7	21
Mataerial Delivery Truck - Offbase		30	20	2	1.7	69

Notes: (1) Average daily value from ARB In-Use Off-Road Equipment Inventory Model, where applicable (ARB 2011).

(2) Number Active = average daily acres disturbed on a continuous basis and Total Hp-Hrs = total acre-days for the entire activity.

(3) Average of loaded and unloaded weights.

(4) Assumes that 2.2 onbase miles occur on unpaved roads.

Table E.1-2. Construction Equipment and Activity Emission Factors - MCB Camp Pendleton Stuart Mesa West Project EA

	Fuel	*Emission Factors (Grams/Horsepower-Hour)*								
Project Year 2010/Source Type	*Type*	*VOC*	*CO*	*NOx*	*SOx*	*PM*	*PM10*	*PM2.5*	*CO2*	*References*
Off-Road Equipment - 25-50 Hp	D	1.01	1.53	5.21	0.01	0.45	0.45	0.41	568	(1)
Off-Road Equipment - 51-120 Hp	D	0.47	2.37	5.39	0.01	0.41	0.41	0.38	568	(1)
Off-Road Equipment - 121-175 Hp	D	0.44	0.87	5.70	0.01	0.31	0.31	0.29	568	(1)
Off-Road Equipment - 176-250 Hp	D	0.34	0.75	5.40	0.01	0.20	0.20	0.18	568	(1)
Off-Road Equipment - 251-500 Hp	D	0.33	0.84	4.91	0.00	0.19	0.19	0.17	568	(1)
Off-Road Equipment - 501-750 Hp	D	0.32	1.33	4.87	0.00	0.19	0.19	0.17	568	(1)
Off-Road Equipment - >750 Hp	D	0.37	0.76	6.65	0.00	0.21	0.21	0.19	568	(1)
On-road Truck - Idle (Gms/Hr)	D	4.05	6.20	12.10	0.02	0.50	0.50	0.46	2,228	(2)
On-road Truck - 5 mph (Gms/Mi)	D	3.94	7.11	27.15	0.02	0.45	0.45	0.43	3,438	(2)
On-road Truck - 25 mph (Gms/Mi)	D	0.66	2.19	10.74	0.02	0.17	0.17	0.16	1,996	(2)
On-road Truck - 55 mph (Gms/Mi)	D	0.24	1.00	8.04	0.02	0.17	0.17	0.16	1,545	(2)
On-Road Trucks - Onbase Composite (Gms/Mi)	D	0.98	2.68	12.38	0.02	0.20	0.20	0.19	2,140	(2)
On-Road Trucks - Offbase Composite (Gms/Mi)	D	0.32	1.24	8.58	0.02	0.17	0.17	0.16	1,635	(2)
Unpaved Road Dust - Cement Truck						10.58	3.12	0.31		(3)
Unpaved Road Dust - Materials Truck						10.82	3.19	0.32		(3)
Disturbed Ground - Fugitive Dust						55.00	26.95	2.75		(4)

Notes: (1) Composites developed from the ARB OFFROAD2011 emissions model (ARB 2012), except CO data derived from nonroad certification data found in *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling -- Compression-Ignition* (USEPA 2004).

(2) Generated with the use of the EMFAC2014 model for calendar year 2014 for truck fleet in San Diego County (ARB 2014). Assumes annual average temperatures. Units in grams/mile, except grams/hour for idling. Offbase composite factors based on a trip of 20/80% 25/55 mph. Onbase composite factors based on a trip of 10/90% 5/25 mph. Although not shown in these calculations, emissions from 15 minutes of idling mode included for each truck round trip.

(3) From section 13.2.2 of AP-42 (USEPA 2006). See Table G-___ for details. Units in Lb/VMT.

(4) Units in lbs/acre-day from section 11.2.3 of AP-42 (USEPA 1995). Emissions reduced by 50% from uncontrolled levels to simulate implementation of best management practices for fugitive dust control. PM10/PM2.5 portions from ARB 2012.

Table E.1-3. Total Construction Emissions for Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

	Total Pounds							
Source Type	*VOC*	*CO*	*NOx*	*SOx*	*PM*	*PM10*	*PM2.5*	*CO2*
Off-Road Construction Equipment								
Bulldozer - D9	12.20	31.06	181.57	0.18	7.03	7.03	6.46	21,016
Grader - 130G	4.79	9.47	62.03	0.06	3.37	3.37	3.10	6,185
Loader Backhoe - CAT420DIT	3.27	16.39	37.27	0.04	2.83	2.83	2.61	3,929
Scraper - 621B	12.28	31.25	182.67	0.18	7.07	7.07	6.50	21,142
Tractor - John Deere TRAM 624KR	5.29	11.67	84.00	0.08	3.11	3.11	2.86	8,841
Tractor - MC1150E/MC1155E	4.38	21.97	49.97	0.05	3.80	3.80	3.50	5,269
Water Truck	16.12	31.87	208.79	0.19	11.36	11.36	10.45	20,817
Subtotal - Equipment Combustive Emissions	58	154	806	1	39	39	35	87,198
Fugitive Dust					4,257	2,086	213	
On-Road Trucks								
Material Delivery Truck - Onbase Combustive	0.08	0.17	0.67	0.00		0.01	0.01	118
Material Delivery Truck - Onbase Unpaved Road Dust					231	68	7	
Mataerial Delivery Truck - Offbase Combustive	0.05	0.19	1.30	0.00		0.03	0.02	248
Subtotal - On-Road Trucks Combustive Emissions	0.13	0.36	1.97	0.00		0.04	0.04	366
Subtotal - On-Road Trucks Fugitive Dust					231	68	7	
Total Construction Emissions (Pounds)	58	154	808	1	4,526	2,193	255	87,564
Total Construction Emissions (Tons)	0.03	0.08	0.40	0.00	2.26	1.10	0.13	44

Calculation of Annual Emissions for Off-Road Equipment

Emission Factor (g/hp-hr) x Total Horsepower-hours (hp-hr/yr) x 1 lb/453.6 g = Annual Emissions (lb/yr)

Calculation of Annual Emissions for On-Road Vehicles

Emission Factor (g/mile) x Number of daily truck trips x Round-trip distance (mile) x Number of working days x 1 lb/453.6 g = Annual Emissions (lb/yr)

Calculation of Annual Emissions for PM fugitive dust - ground disturbance

Emission Factor (lb/acre-day) x Acreage Disturbed (acres) x Annual number of working days (day/yr) = Annual Emissions (lb/yr)

Table E.1-4. Emission Source Data for Construction of Alternative B - MCB Camp Pendleton Stuart Mesa West Project EA

Source Type	*Hp Rating*	*Load Factor (1)*	*Number Active*	*Hours/ Day*	*Total Work Days*	*Total Hp-Hrs*
Off-Road Construction Equipment						
Bulldozer - D9	405	0.43	2	8	14	39,010
Grader - 130G	125	0.41	2	8	14	11,480
Loader Backhoe - CAT420DIT	88	0.37	2	8	14	7,293
Scraper - 621B	365	0.48	2	8	14	39,245
Tractor - John Deere TRAM 624KR	198	0.37	2	8	14	16,410
Tractor - MC1150E/MC1155E	118	0.37	2	8	14	9,780
Water Truck	175	0.46	2	8	30	38,640
Fugitive Dust (2)	NA	NA	5	NA	60	300
On-Road Trucks						
Activity/Equipment Type		*Average Weight (Tons) (3)*	*Miles/ Round Trip (4)*	*Daily Trips*	*Total Work Days*	*Total Miles*
Cement Truck - Onbase		28.5	6.2	10	4	248
Cement Truck - Offbase		28.5	15	10	4	600
Material Delivery Truck - Onbase		30	6.2	2	5	62
Mataerial Delivery Truck - Offbase		30	20	2	5	200

Notes: (1) Average daily value from ARB In-Use Off-Road Equipment Inventory Model, where applicable (ARB 2011).

(2) Number Active = average daily acres disturbed on a continuous basis and Total Hp-Hrs = total acre-days for the entire activity.

(3) Average of loaded and unloaded weights.

(4) Assumes that 2.2 onbase miles occur on unpaved roads.

Table E.1-5. Total Construction Emissions for Alternative B - MCB Camp Pendleton Stuart Mesa West Project EA

	Total Pounds							
Source Type	*VOC*	*CO*	*NOx*	*SOx*	*PM*	*PM10*	*PM2.5*	*CO2*
Off-Road Construction Equipment								
Bulldozer - D9	28.38	72.24	422.26	0.42	16.34	16.34	15.03	48,874
Grader - 130G	11.14	22.02	144.26	0.13	7.85	7.85	7.22	14,383
Loader Backhoe - CAT420DIT	7.60	38.11	86.67	0.08	6.59	6.59	6.07	9,138
Scraper - 621B	28.55	72.68	424.81	0.42	16.44	16.44	15.12	49,168
Tractor - John Deere TRAM 624KR	12.30	27.13	195.36	0.19	7.24	7.24	6.66	20,560
Tractor - MC1150E/MC1155E	10.19	51.10	116.21	0.11	8.84	8.84	8.13	12,253
Water Truck	37.48	74.11	485.56	0.44	26.41	26.41	24.29	48,411
Subtotal - Equipment Combustive Emissions	136	357	1,875	2	90	90	83	202,786
Fugitive Dust					16,500	8,085	825	
On-Road Trucks								
Cement Truck - Onbase Combustive	0.90	2.01	7.84	0.01		0.15	0.14	1,367
Cement Truck - Onbase Unpaved Road Dust					2,623	774	77	
Cement Truck - Offbase Combustive	0.42	1.64	11.35	0.03		0.22	0.21	2,163
Material Delivery Truck - Onbase Combustive	0.22	0.50	1.96	0.00		0.04	0.04	342
Material Delivery Truck - Onbase Unpaved Road Dust					671	198	20	
Mataerial Delivery Truck - Offbase Combustive	0.14	0.55	3.78	0.01		0.07	0.07	721
Subtotal - On-Road Trucks Combustive Emissions	1.68	4.70	24.92	0.05		0.49	0.46	4,592
Subtotal - On-Road Trucks Fugitive Dust					3,294	972	97	
Total Construction Emissions (Pounds)	137	362	1,900	2	19,884	9,147	1,005	207,379
Total Construction Emissions (Tons)	0.07	0.18	0.95	0.00	9.94	4.57	0.50	104

Calculation of Annual Emissions for Off-Road Equipment

Emission Factor (g/hp-hr) x Total Horsepower-hours (hp-hr/yr) x 1 lb/453.6 g = Annual Emissions (lb/yr)

Calculation of Annual Emissions for On-Road Vehicles

Emission Factor (g/mile) x Number of daily truck trips x Round-trip distance (mile) x Number of working days x 1 lb/453.6 g = Annual Emissions (lb/yr)

Calculation of Annual Emissions for PM fugitive dust - ground disturbance

Emission Factor (lb/acre-day) x Acreage Disturbed (acres) x Annual number of working days (day/yr) = Annual Emissions (lb/yr)

Table E.1-6. AAV Engine Data for Amphibious Operations - Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

Activity	Annual Hours (1)	*Average % of Full Engine Power* 0-20	21-40	41-60	61-80	81-100
Idle	915	915				
Half Throttle	915			915		
Full Throttle	330					330
Total Activity	2,160	915		915		330

Notes: (1) Assumes that year 2000 AVTB and FSSG operations equal to 2001 operations.

Table E.1-7. AAV Engine Fuel Usage Factors for Amphibious Operations - Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

Activity		*Total Pounds of JP-8 Fuel Usage/Engine Load Factor %* 0-20	21-40	41-60	61-80	81-100
Idle		24,582				
Half Throttle				79,531		
Full Throttle						49,930
Total Fuel Usage - Lb	154,043	24,582		79,531		49,930
Hourly Fuel Usage/Engine Power Setting - Lb (1)		26.9	57.2	86.9	117.0	151.3

Notes: (1) Equal to hourly fuel usage/throttle setting for the VTA525 engine times 452/525 Hp to estimate fuel usage for the AAV fleet engine aveage rating of 452 Hp. Data for the VTA525 engine extracted from *Gaseous and Particulate Emissions Indexes from Amphibious Engines* (AESO 2001).

Table E.1-8. Emission Factors for AAV Operations - MCB Camp Pendleton Stuart Mesa West Project EA

Source Type	*Emission Factor (Pounds/1000 Pounds of JP-8 Fuel) (1)* VOC	CO	NOx	SOx	PM10	PM2.5	CO2	Reference
AAV Engine - 1 to 20% Full Throttle	6.42	32.38	11.06	1.24	6.80	6.26	3,096	(1)
AAV Engine - 21 to 40% Full Throttle	3.04	7.78	18.11	1.24	3.13	2.88	3,096	(1)
AAV Engine - 41 to 60% Full Throttle	1.72	7.49	25.05	1.24	2.55	2.34	3,096	(1)
AAV Engine - 61 to 80% Full Throttle	1.47	5.42	32.12	1.24	2.52	2.31	3,096	(1)
AAV Engine - 81 to 100% Full Throttle	1.31	5.17	36.75	1.24	2.17	1.99	84	(1)
Fugitive Dust - Unpaved Roads					3.13	0.31		(2)

Notes: (1) Data extracted from *Gaseous and Particulate Emissions Indexes from Amphibious Engines* (AESO 2002), except SOx based on an average sulfur content of 0.062 percent (AESO 2013).

(2) AP-42 Volume I, Section 13.2.2 (EPA 2006). Based on a AAV weight of 28.7 tons. Units in pounds/vehicle mile travelled (VMT).

Table E.1-9. Annual Emissions for AAV Amphibious Operations - Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

Activity	*Emissions (Tons Per Year)* VOC	CO	NOx	SOx	PM10	PM2.5	CO2
Idle	0.08	0.40	0.14	0.02	0.08	0.08	38.05
Half Throttle	0.07	0.30	1.00	0.05	0.10	0.09	123.11
Full Throttle	0.03	0.13	0.92	0.03	0.05	0.05	2.09
Fugitive Dust - Unpaved Roads (1)					8.50	1.36	
Total Annual Baseline Emissions	0.18	0.82	2.05	0.10	8.73	1.58	163.25

Notes: (1) Based on an average fuel usage of 0.75 miles per gallon.

Table E.1-10. AAV Engine Data for Amphibious Operations - Alternative B - MCB Camp Pendleton Stuart Mesa West Project EA

	Annual	*Average % of Full Engine Power*				
Activity	*Hours (1)*	*0-20*	*21-40*	*41-60*	*61-80*	*81-100*
Idle	1,220	1,220				
Half Throttle	1,220			1,220		
Full Throttle	440					440
Total Activity	2,880	1,220		1,220		440

Notes: (1) Assumes that year 2000 AVTB and FSSG operations equal to 2001 operations.

Table E.1-11. AAV Engine Fuel Usage Factors for Amphibious Operations - Alternative B - MCB Camp Pendleton Stuart Mesa West Project EA

		Total Pounds of JP-8 Fuel Usage/Engine Load Factor %				
Activity		*0-20*	*21-40*	*41-60*	*61-80*	*81-100*
Idle		32,776				
Half Throttle				106,041		
Full Throttle						66,573
Total Fuel Usage - Lb	205,391	32,776		106,041		66,573
Hourly Fuel Usage/Engine Power Setting - Lb (1)		26.9	57.2	86.9	117.0	151.3

Notes: (1) Equal to hourly fuel usage/throttle setting for the VTA525 engine times 452/525 Hp to estimate fuel usage for the AAV fleet engine aveage rating of 452 Hp. Data for the VTA525 engine extracted from *Gaseous and Particulate Emissions Indexes from Amphibious Engines* (AESO 2001).

Table E.1-12. Annual Emissions for AAV Amphibious Operations - Alternative B - MCB Camp Pendleton Stuart Mesa West Project EA

	Emissions (Tons Per Year)						
Activity	*VOC*	*CO*	*NOx*	*SOx*	*PM10*	*PM2.5*	*CO2*
Idle	0.11	0.53	0.18	0.02	0.11	0.10	50.74
Half Throttle	0.09	0.40	1.33	0.07	0.14	0.12	164.15
Full Throttle	0.04	0.17	1.22	0.04	0.07	0.07	2.78
Fugitive Dust - Unpaved Roads (1)					11.33	1.81	
Total Annual Baseline Emissions	0.24	1.10	2.73	0.13	11.65	2.10	217.67

Notes: (1) Based on an average fuel usage of 0.75 miles per gallon.

	A	B	C	D	E	F	G
1	Table E.1-13. Emission Source Data for Tactical Vehicles - MCB Camp Pendleton Stuart Mesa West Project EA						
2–3	*Activity/Equipment Type*	*Number of Vehicles*	*Annual Miles*	*Miles per Gallon (1)*	*Total Gallons*	*Hp*	*Total Hp-Hr (2)*
4	Tactical Vehicles						
5	AAV-7	30	1,728	0.75	2,304		
6	Abrams Main Battle Tank - M1A1	18	550	0.33	1,667		
7	Assault Breacher Vehicle	5	550	0.36	1,528		
8	Extended Cargo Truck - MK27/28	70	3,840	3.85	998	440	19,576
9	Fox NBC Reconnaissance Vehicle - M93	4	960	5.93	162	320	3,174
10	High-Mobility Artillery Rocket System (HIMARS)	8	200	3.85	52	330	1,019
11	HIMARS Resupply Vehicle - MK37	8	1,920	3.85	499	440	9,788
12	HMMWV - M1114	25	1,920	14.00	137	150	2,689
13	HMMWV Expanded Capacity Armament Carrier - M1151	25	1,920	11.05	174	190	3,406
14	HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	300	1,920	11.05	174	190	3,406
15	HMMWV Expanded Capacity General Purpose Vehicle - M1165	300	1,920	11.05	174	190	3,406
16	Light Armored Vehicle (All Variants)	184	6,400	5.17	1,238	275	24,273
17	Standard Cargo Truck - MK23/25	400	3,840	3.85	998	440	19,576
18	Z-Backscatter Van	4	200	15.00	13	225	261
19	Notes: (1) Data obtained from the 29 Palms LAS FEIS (MCAGCC 2012) and manufacturer specifications.						
20	(2) Based on a diesel fuel usage rate of 0.051 gallons per Hp-Hr.						

	I	J	K	L	M	N	O	P	Q	R
1	Table E.1-14. Tactical Vehicles Emission Factors - MCB Camp Pendleton Stuart Mesa West Project EA									
2	*Source Type*	*Emission Factors (Pounds/1000 Gallons)*								
3		*VOC*	*CO*	*NO_X*	*SO_X*	*PM*	*PM_{10}*	*$PM_{2.5}$*	*CO_2*	*Reference*
4	Tank Vehicles and ABV									
5	Abrams Tank/Bridge Vehicles	0.06	0.45	118.80	1.24	1.56	1.56	1.52	21,053	(1)
6	Assault Breacher/Recovery Vehicles	14.10	101.60	170.88	1.24	1.71	1.71	1.57	21,053	(2)
7										
8	Other Tactical Vehicles	*Emission Factors (Grams/Horsepower-Hour)*								
9	Off-Road Equipment - 121-175 Hp	0.44	0.87	5.70	0.01	0.31	0.31	0.29	568	(3)
10	Off-Road Equipment - 176-250 Hp	0.34	0.75	5.40	0.01	0.20	0.20	0.18	568	(3)
11	Off-Road Equipment - 251-500 Hp	0.33	0.84	4.91	0.00	0.19	0.19	0.17	568	(3)
12	Notes: (1) From FEIS for Land Acquisition (Marine Corps Air Ground Combat Center Twenty-Nine Palms [MCAGCC] 2012).									
13	(2) From FEA for Proposed ABV Action at MCAGCC (MCAGCC 2003).									
14	(3) From Table E.1-2 (ARB 2012 and USEPA 2004).									
15	(4) GHG Emission Factors for (a) Tank Vehicles and ABVs from General Reporting Protocol, Tables C.3 and C.6 jet fuel (California									
16	Climate Action Registry 2009) and (b) Other TV from ARB 2013.									

	T	U	V	W	X	Y	Z	AA	AB
1	Table E.1-15. Total Tactical Vehicles Emissions - MCB Camp Pendleton Stuart Mesa West Project EA								
2		*Pounds per Year*							
3	*Activity/Equipment Type*	*ROG*	*CO*	*NO_X*	*SO_X*	*PM*	*PM_{10}*	*$PM_{2.5}$*	*CO_2*
4	*Tactical Vehicles*								
5	AAV	27.02	117.36	392.40	19.43		39.90	36.71	48,506
6	Abrams Main Battle Tank - M1A1	0.10	0.75	198.00	2.07	2.60	2.60	2.53	35,088
7	Assault Breacher Vehicle	21.54	155.22	261.07	1.89	2.61	2.61	2.40	32,164
8	Extended Cargo Truck - MK27/28	14.24	36.25	211.91	0.21	8.20	8.20	7.54	24,527
9	Fox NBC Reconnaissance Vehicle - M93	2.31	5.88	34.36	0.03	1.33	1.33	1.22	3,977
10	High-Mobility Artillery Rocket System (HIMARS)	0.74	1.89	11.03	0.01	0.43	0.43	0.39	1,276
11	HIMARS Resupply Vehicle - MK37	7.12	18.13	105.95	0.11	4.10	4.10	3.77	12,263
12	HMMWV - M1114	2.61	5.16	33.79	0.03	1.84	1.84	1.69	3,369
13	HMMWV Expanded Capacity Armament Carrier - M1151	2.55	5.63	40.55	0.04	1.50	1.50	1.38	4,267
14	HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	2.55	5.63	40.55	0.04	1.50	1.50	1.38	4,267
15	HMMWV Expanded Capacity General Purpose Vehicle - M1165	2.55	5.63	40.55	0.04	1.50	1.50	1.38	4,267
16	Light Armored Vehicle (All Variants)	17.66	44.95	262.74	0.26	10.17	10.17	9.35	30,411
17	Standard Cargo Truck - MK23/25	14.24	36.25	211.91	0.21	8.20	8.20	7.54	24,527
18	Z-Backscatter Van	0.20	0.43	3.11	0.00	0.12	0.12	0.11	328
19	Total Emissions (Pounds)	115	439	1,848	24	44	84	77	229,237
20	Total Emissions (Tons) [1]	0.06	0.22	0.92	0.01	0.02	0.04	0.04	114.62
21	*Calculation of Annual Emissions for Tactical Vehicles*								
22	Emission Factor (g/hp-hr) x total Hp-hrs x 1 lb/453.6 g = Annual Emissions (lb/yr)								
23	*Calculation of Abrams Tank/Bridge Vehicles and Assault Breacher Vehicle*								
24	Emission Factor (lbs/1000 gals) x Total Gals x 1 /1000 = Annual Emissions (lb/yr)								

	A	B	C	D	E	F	G
1	Table E.1-16. Emission Source Data for Fording Training Vehicles - MCB Camp Pendleton Stuart Mesa West Project EA						
2		*Number of*	*Annual*	*Miles per*	*Total*		
3	*Activity/Equipment Type*	*Vehicles*	*Miles*	*Gallon (1)*	*Gallons*	*Hp*	*Total Hp-Hr (2)*
4	Fording Training Vehicles						
5	Extended Cargo Truck - MK27/28	20	3,840	3.85	998	440	19,576
6	HIMARS Resupply Vehicle - MK37	10	1,920	3.85	499	440	9,788
7	HMMWV - M1114	10	1,920	14.00	137	150	2,689
8	HMMWV Expanded Capacity Armament Carrier - M1151	10	1,920	11.05	174	190	3,406
9	HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	10	1,920	11.05	174	190	3,406
10	HMMWV Expanded Capacity General Purpose Vehicle - M1165	10	1,920	11.05	174	190	3,406
11	Light Armored Vehicle (All Variants)	24	6,400	5.17	1,238	275	24,273
12	Standard Cargo Truck - MK23/25	20	3,840	3.85	998	440	19,576
13	Notes: (1) Data obtained from the 29 Palms LAS FEIS (MCAGCC 2012) and manufacturer specifications.						
14	(2) Based on a diesel fuel usage rate of 0.051 gallons per Hp-Hr.						

	T	U	V	W	X	Y	Z	AA	AB
1	Table E.1-17. Total Fording Training Vehicle Emissions - MCB Camp Pendleton Stuart Mesa West Project EA								
2		*Pounds per Year*							
3	*Activity/Equipment Type*	*ROG*	*CO*	*NO_X*	*SO_X*	*PM*	*PM_{10}*	*$PM_{2.5}$*	*CO_2*
4	*Tactical Vehicles*								
5	Extended Cargo Truck - MK27/28	14.24	36.25	211.91	0.21	8.20	8.20	7.54	24,527
6	HIMARS Resupply Vehicle - MK37	7.12	18.13	105.95	0.11	4.10	4.10	3.77	12,263
7	HMMWV - M1114	2.61	5.16	33.79	0.03	1.84	1.84	1.69	3,369
8	HMMWV Expanded Capacity Armament Carrier - M1151	2.55	5.63	40.55	0.04	1.50	1.50	1.38	4,267
9	HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	2.55	5.63	40.55	0.04	1.50	1.50	1.38	4,267
10	HMMWV Expanded Capacity General Purpose Vehicle - M1165	2.55	5.63	40.55	0.04	1.50	1.50	1.38	4,267
11	Light Armored Vehicle (All Variants)	17.66	44.95	262.74	0.26	10.17	10.17	9.35	30,411
12	Standard Cargo Truck - MK23/25	14.24	36.25	211.91	0.21	8.20	8.20	7.54	24,527
13	Total Emissions (Pounds)	64	158	948	1	37	37	34	107,899
14	Total Emissions (Tons) [1]	0.03	0.08	0.47	0.00	0.02	0.02	0.02	53.95
15	*Calculation of Annual Emissions for Tactical Vehicles*								
16	Emission Factor (g/hp-hr) x total Hp-hrs x 1 lb/453.6 g = Annual Emissions (lb/yr)								
17	*Calculation of Abrams Tank/Bridge Vehicles and Assault Breacher Vehicle*								
18	Emission Factor (lbs/1000 gals) x Total Gals x 1 /1000 = Annual Emissions (lb/yr)								

	A	B	C	D	E	F
1	Table E.1-18. Emission Source Data for Combat Engineer Support Equipment - MCB Camp Pendleton Stuart Mesa West Project E					
2		*Number of*		*Gallons/*	*Annual*	*Total*
3	*Source Type*	*Vehicles*	*Hp*	*Hour (1)*	*Hours*	*Gallons*
4	Tracked Vehicles					
5	Armored Vehicle Launched Bridge	8	750	15.3	480	7,344
6	Hercules Recovery Vehicle - M88A2	2	1,050	21.4	200	4,284
7		*Hp*	*Load*	*Number*	*Annual*	*Total*
8		*Rating*	*Factor (2)*	*Active*	*Hours*	*Hp-Hrs*
9	Wheeled Vehicles					
10	Combat Excavator - M9	295	0.38	10	960	107,616
11	Logistics Vehicle System - PU + RBU - MK15-18	450	0.38	40	1,200	205,200
12	Dump Truck - MK 29/30	440	0.38	20	1,920	321,024
13	Tractor - MK31	440	0.38	10	250	41,800
14	Wrecker - MK36	440	0.38	10	400	66,880
15	HIMARS Resupply Vehicle - MK37	440	0.38	16	800	133,760
16	Logistics Vehicle System - Power Unit - MK48	450	0.38	40	850	145,350
17	Notes: (1) Based on a diesel fuel usage rate of 0.051 gallons per Hp-Hr and an engine operation load of 40% full power.					
18	(2) Average daily value from ARB In-Use Off-Road Equipment Inventory Model for off-road truck (ARB 2011).					

	S	T	U	V	W	X	Y	Z	AA
1	Table E.1-19. Total Emissions from Combat Engineer Support Equipment - MCB Camp Pendleton Stuart Mesa West Project EA								
2		*Total Pounds*							
3	*Source Type*	*VOC*	*CO*	*NOx*	*SOx*	*PM*	*PM10*	*PM2.5*	*CO2*
4	Armored Vehicle Launched Bridge	0.44	3.30	872.47	9.11	11.46	11.46	11.16	154,612
5	Hercules Recovery Vehicle - M88A2	60.40	435.25	732.05	5.31	7.33	7.33	6.74	90,190
6	Combat Excavator - M9	78.29	199.29	1,164.89	1.16	45.08	45.08	41.47	134,828
7	Logistics Vehicle System - PU + RBU - MK15-18	149.29	380.00	2,221.19	2.22	85.95	85.95	79.08	257,088
8	Dump Truck - MK 29/30	233.55	594.49	3,474.93	3.47	134.47	134.47	123.71	402,200
9	Tractor - MK31	30.41	77.41	452.46	0.45	17.51	17.51	16.11	52,370
10	Wrecker - MK36	48.66	123.85	723.94	0.72	28.01	28.01	25.77	83,792
11	HIMARS Resupply Vehicle - MK37	97.31	247.70	1,447.89	1.44	56.03	56.03	51.55	167,583
12	Logistics Vehicle System - Power Unit - MK48	105.74	269.17	1,573.34	1.57	60.88	60.88	56.01	182,104
13	Total Emissions (Pounds)	804	2,330	12,663	25	447	447	412	1,524,767
14	Total Emissions (Tons)	0.40	1.17	6.33	0.01	0.22	0.22	0.21	762.38
15	Calculation of Annual Emissions for Off-Road Equipment								
16	Emission Factor (g/hp-hr) x Total Horsepower-hours (hp-hr/yr) x 1 lb/453.6 g = Annual Emissions (lb/yr)								
17	Calculation of Annual Emissions for On-Road Vehicles								
18	Emission Factor (g/mile) x Number of daily truck trips x Round-trip distance (mile) x Number of working days x 1 lb/453.6 g = Annual Emissions (lb/yr)								
19	Calculation of Annual Emissions for PM fugitive dust - ground disturbance								
20	Emission Factor (lb/acre-day) x Acreage Disturbed (acres) x Annual number of working days (day/yr) = Annual Emissions (lb/yr)								
21									

Table E.1-20. Emission Source Data for Operational Maintenance - Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

Source Type	*Hp Rating*	*Load Factor (1)*	*Number Active*	*Annual Hours*	*Total Hp-Hrs*
Bulldozer - D9	405	0.43	16	180	31,347
Container Handler - Kalmar Rough Terrain	400	0.20	8	346	27,648
Crane - LRT	80	0.29	8	180	4,176
Crane - Terex MAC-50 50 Ton	305	0.29	8	180	15,921
Forklift - Extended Boom MMV Container	120	0.20	16	180	4,320
Forklift - TX51-19M and D Rough Terrain	120	0.20	16	180	4,320
Grader - 130G	125	0.41	16	180	9,225
Loader - CAT 277B/C MTL Multi Terrain	78	0.37	16	691	19,948
Loader Backhoe - CAT420DIT	88	0.37	16	180	5,861
Scraper - 621B	365	0.48	16	180	31,536
Tractor - Crawler John Deere 850J Medium	192	0.43	16	180	14,861
Tractor - John Deere TRAM 624KR	198	0.37	16	180	13,187
Tractor - MC1150E/MC1155E	118	0.37	16	180	7,859

Notes: (1) Average daily value from ARB In-Use Off-Road Equipment Inventory Model, where applicable (ARB 2011).

Table E.1-21. Annual Emissions for Operational Maintenance - Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

	Total Pounds							
Source Type	*VOC*	*CO*	*NOx*	*SOx*	*PM*	*PM10*	*PM2.5*	*CO2*
Bulldozer - D9	22.81	58.05	339.32	0.34	13.13	13.13	12.08	39,274
Container Handler - Kalmar Rough Terrain	20.11	51.20	299.28	0.30	11.58	11.58	10.65	34,639
Crane - LRT	4.35	21.82	49.62	0.05	3.77	3.77	3.47	5,232
Crane - Terex MAC-50 50 Ton	11.58	29.48	172.34	0.17	6.67	6.67	6.14	19,947
Forklift - Extended Boom MMV Container	4.50	22.57	51.33	0.05	3.90	3.90	3.59	5,412
Forklift - TX51-19M and D Rough Terrain	4.50	22.57	51.33	0.05	3.90	3.90	3.59	5,412
Grader - 130G	8.95	17.69	115.92	0.11	6.30	6.30	5.80	11,558
Loader - CAT 277B/C MTL Multi Terrain	20.79	104.23	237.04	0.23	18.03	18.03	16.59	24,992
Loader Backhoe - CAT420DIT	6.11	30.62	69.64	0.07	5.30	5.30	4.87	7,343
Scraper - 621B	22.94	58.40	341.36	0.34	13.21	13.21	12.15	39,510
Tractor - Crawler John Deere 850J Medium	11.14	24.57	176.91	0.17	6.55	6.55	6.03	18,619
Tractor - John Deere TRAM 624KR	9.88	21.80	156.99	0.15	5.81	5.81	5.35	16,521
Tractor - MC1150E/MC1155E	8.19	41.06	93.38	0.09	7.10	7.10	6.54	9,846
Total Emissions (Pounds)	156	504	2,154	2	105	105	97	238,305
Total Emissions (Tons)	0.08	0.25	1.08	0.00	0.05	0.05	0.05	119.15

Calculation of Annual Emissions for Off-Road Equipment

Emission Factor (g/hp-hr) x Total Horsepower-hours (hp-hr/yr) x 1 lb/453.6 g = Annual Emissions (lb/yr)

Calculation of Annual Emissions for On-Road Vehicles

Emission Factor (g/mile) x Number of daily truck trips x Round-trip distance (mile) x Number of working days x 1 lb/453.6 g = Annual Emissions (lb/yr)

Calculation of Annual Emissions for PM fugitive dust - ground disturbance

Emission Factor (lb/acre-day) x Acreage Disturbed (acres) x Annual number of working days (day/yr) = Annual Emissions (lb/yr)

Table E.1-22. Emission Source Data for Operational Maintenance - Alternative B - MCB Camp Pendleton Stuart Mesa West Project EA

Source Type	*Hp Rating*	*Load Factor (1)*	*Number Active*	*Annual Hours*	*Total Hp-Hrs*
Bulldozer - D9	405	0.43	16	250	43,538
Container Handler - Kalmar Rough Terrain	400	0.20	8	480	38,400
Crane - LRT	80	0.29	8	250	5,800
Crane - Terex MAC-50 50 Ton	305	0.29	8	250	22,113
Forklift - Extended Boom MMV Container	120	0.20	16	250	6,000
Forklift - TX51-19M and D Rough Terrain	120	0.20	16	250	6,000
Grader - 130G	125	0.41	16	250	12,813
Loader - CAT 277B/C MTL Multi Terrain	78	0.37	16	960	27,706
Loader Backhoe - CAT420DIT	88	0.37	16	250	8,140
Scraper - 621B	365	0.48	16	250	43,800
Tractor - Crawler John Deere 850J Medium	192	0.43	16	250	20,640
Tractor - John Deere TRAM 624KR	198	0.37	16	250	18,315
Tractor - MC1150E/MC1155E	118	0.37	16	250	10,915

Notes: (1) Average daily value from ARB In-Use Off-Road Equipment Inventory Model, where applicable (ARB 2011).

Table E.1-23. Annual Emissions for Operational Maintenance - Alternative B - MCB Camp Pendleton Stuart Mesa West Project EA

	Total Pounds							
Source Type	*VOC*	*CO*	*NOx*	*SOx*	*PM*	*PM10*	*PM2.5*	*CO2*
Bulldozer - D9	31.67	80.63	471.27	0.47	18.24	18.24	16.78	54,547
Container Handler - Kalmar Rough Terrain	27.94	71.11	415.66	0.41	16.08	16.08	14.80	48,110
Crane - LRT	6.04	30.30	68.92	0.07	5.24	5.24	4.82	7,267
Crane - Terex MAC-50 50 Ton	16.09	40.95	239.36	0.24	9.26	9.26	8.52	27,704
Forklift - Extended Boom MMV Container	6.25	31.35	71.30	0.07	5.42	5.42	4.99	7,517
Forklift - TX51-19M and D Rough Terrain	6.25	31.35	71.30	0.07	5.42	5.42	4.99	7,517
Grader - 130G	12.43	24.57	161.00	0.15	8.76	8.76	8.06	16,052
Loader - CAT 277B/C MTL Multi Terrain	28.87	144.76	329.22	0.32	25.04	25.04	23.04	34,711
Loader Backhoe - CAT420DIT	8.48	42.53	96.73	0.09	7.36	7.36	6.77	10,198
Scraper - 621B	31.87	81.11	474.11	0.47	18.35	18.35	16.88	54,876
Tractor - Crawler John Deere 850J Medium	15.47	34.13	245.71	0.24	9.10	9.10	8.37	25,859
Tractor - John Deere TRAM 624KR	13.73	30.28	218.04	0.21	8.08	8.08	7.43	22,946
Tractor - MC1150E/MC1155E	11.38	57.03	129.70	0.12	9.87	9.87	9.08	13,675
Total Emissions (Pounds)	216	700	2,992	3	146	146	135	330,980
Total Emissions (Tons)	0.11	0.35	1.50	0.00	0.07	0.07	0.07	165.49

Calculation of Annual Emissions for Off-Road Equipment

Emission Factor (g/hp-hr) x Total Horsepower-hours (hp-hr/yr) x 1 lb/453.6 g = Annual Emissions (lb/yr)

Calculation of Annual Emissions for On-Road Vehicles

Emission Factor (g/mile) x Number of daily truck trips x Round-trip distance (mile) x Number of working days x 1 lb/453.6 g = Annual Emissions (lb/yr)

Calculation of Annual Emissions for PM fugitive dust - ground disturbance

Emission Factor (lb/acre-day) x Acreage Disturbed (acres) x Annual number of working days (day/yr) = Annual Emissions (lb/yr)

Table E.1-24. Emission Source Data for the Operation of Vehicles on Unpaved Surfaces - MCB Camp Pendleton Stuart Mesa West Project EA

Activity/Equipment Type	Weight (Tons)	Unpaved Emission Factor (Lb/VMT) PM	PM_{10}	$PM_{2.5}$	Annual Miles	% Unpaved Travel (1)	Unpaved Miles
Tactical Vehicles							
AAV	28.7	10.61	3.13	0.31	1,728	90%	254
Abrams Main Battle Tank - M1A1	70.0	15.85	4.68	0.47	550	90%	495
Assault Breacher Vehicle	55.0	14.22	4.20	0.42	550	90%	495
Extended Cargo Truck - MK27/28	31.1	11.00	3.25	0.32	3,840	50%	1,920
Fox NBC Reconnaissance Vehicle - M93	18.7	8.75	2.58	0.26	960	50%	480
High-Mobility Artillery Rocket System (HIMARS)	12.0	7.17	2.12	0.21	200	50%	100
HIMARS Resupply Vehicle - MK37	31.1	11.00	3.25	0.32	1,920	50%	960
HMMWV - M1114	3.0	3.84	1.13	0.11	1,920	50%	960
HMMWV Expanded Capacity Armament Carrier - M1151	5.8	5.15	1.52	0.15	1,920	50%	960
HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	5.8	5.15	1.52	0.15	1,920	50%	960
HMMWV Expanded Capacity General Purpose Vehicle - M1165	5.8	5.15	1.52	0.15	1,920	50%	960
Light Armored Vehicle (All Variants)	14.1	7.71	2.27	0.23	6,400	90%	5,760
Standard Cargo Truck - MK23/25	31.1	11.00	3.25	0.32	3,840	50%	1,920
Z-Backscatter Van	5.3	4.94	1.46	0.15	200	50%	100
Fording Training							
Extended Cargo Truck - MK27/28	31.1	11.00	3.25	0.32	3,840	50%	1,920
HIMARS Resupply Vehicle - MK37	31.1	11.00	3.25	0.32	1,920	50%	960
HMMWV - M1114	3.0	3.84	1.13	0.11	1,920	50%	960
HMMWV Expanded Capacity Armament Carrier - M1151	5.8	5.15	1.52	0.15	1,920	50%	960
HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	5.8	5.15	1.52	0.15	1,920	50%	960
HMMWV Expanded Capacity General Purpose Vehicle - M1165	5.8	5.15	1.52	0.15	1,920	50%	960
Light Armored Vehicle (All Variants)	14.1	7.71	2.27	0.23	6,400	90%	5,760
Standard Cargo Truck - MK23/25	31.1	11.00	3.25	0.32	3,840	50%	1,920
Combat Engineer Support Equipment							
Ground Disturbance (2)	3	110.0	55.0	5.5	30		
Operational Maintenance							
Ground Disturbance - Alternative A (2)	2	110.0	55.0	5.5	36		
Ground Disturbance - Alternative B (2)	2	110.0	55.0	5.5	50		

Notes: (1) Estimates

(2) Weight = daily disturbed acreage and Annual Miles = total annual days of disturbance. Emission factors in lb/acre-day.

Table E.1-25. Annual Dust Emissions from the Operation of Vehicles on Unpaved Surfaces - MCB Camp Pendleton Stuart Mesa West Project EA

Equipment Type	*Annual Emissions - Tons*		
	PM	*PM_{10}*	*$PM_{2.5}$*
Tactical Vehicles			
AAV	1.35	0.40	0.04
Abrams Main Battle Tank - M1A1	3.92	1.16	0.12
Assault Breacher Vehicle	3.52	1.04	0.10
Extended Cargo Truck - MK27/28	10.56	3.12	0.31
Fox NBC Reconnaissance Vehicle - M93	2.10	0.62	0.06
High-Mobility Artillery Rocket System (HIMARS)	0.36	0.11	0.01
HIMARS Resupply Vehicle - MK37	5.28	1.56	0.16
HMMWV - M1114	1.84	0.54	0.05
HMMWV Expanded Capacity Armament Carrier - M1151	2.47	0.73	0.07
HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	2.47	0.73	0.07
HMMWV Expanded Capacity General Purpose Vehicle - M1165	2.47	0.73	0.07
Light Armored Vehicle (All Variants)	22.19	6.55	0.66
Standard Cargo Truck - MK23/25	10.56	3.12	0.31
Z-Backscatter Van	0.25	0.07	0.01
Tactical Vehicles - Total Emissions	69.34	20.47	2.05
Fording Training			
Extended Cargo Truck - MK27/28	10.56	3.12	0.31
HIMARS Resupply Vehicle - MK37	5.28	1.56	0.16
HMMWV - M1114	1.84	0.54	0.05
HMMWV Expanded Capacity Armament Carrier - M1151	2.47	0.73	0.07
HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	2.47	0.73	0.07
HMMWV Expanded Capacity General Purpose Vehicle - M1165	2.47	0.73	0.07
Light Armored Vehicle (All Variants)	22.19	6.55	0.66
Standard Cargo Truck - MK23/25	10.56	3.12	0.31
Ford Training Vehicles - Total Emissions	57.85	17.07	1.71
Combat Engineer Support Equipment			
Ground Disturbance	4.95	2.48	0.25
Operational Maintenance			
Ground Disturbance - Alternative A	3.96	1.98	0.20
Ground Disturbance - Alternative B	5.50	2.75	0.28

Table E.1-26. Proposed Aircraft Operations - MCB Camp Pendleton Stuart Mesa West Project EA

Aircraft Type	*Annual Sorties*	*Cruise Mode/ Sortie at Project Site (Hours)*	*Operations per Sortie*	
			Landings	*Other*
AH-1	16	1.50	-	1
CH-53	16	0.33	1	1
MV-22	40	0.33	1	1
UH-1	40	0.33	1	1

Notes: (1) Assumes

Table E.1-27. Aircraft Transit Flights Distances/Durations - MCB Camp Pendleton Stuart Mesa West Project EA

	Cruising	*Round Trip Distance (NM)*			*Round Trip Cruise Duration (Hrs)*			*Origin Fraction*			*Composite Round Trip*
Aircraft Type	*Speed (Kts)*	*MCAS CP*	*CP ATA*	*MCAS Mir*	*MCAS CP*	*CP ATA*	*MCAS Mir*	*MCAS CP*	*CP ATA*	*MCAS Mir*	*Cruise Duration (Hrs)*
AH-1	100	10.4	3.5	49.4	0.10	0.03	0.49	0.6	0.4		0.08
CH-53	120	10.4	3.5	49.4	0.09	0.03	0.41		0.4	0.6	0.26
MV-22	140	10.4	3.5	49.4	0.07	0.02	0.35		0.4	0.6	0.22
UH-1	100	10.4	3.5	49.4	0.10	0.03	0.49	0.6	0.4		0.08

Table E.1-28. AH-1 Aircraft Emission Factors - MCB Camp Pendleton Stuart Mesa West Project EA

Operation Type	*Engine Power Setting*	*Fuel Flow Rate/ Aircraft (Lb/Hr)*	*VOC*	*CO*	*NOx*	*SO2*	*PM10*	*PM2.5*	*CO2*	*References*
			Engine Emission Factors - Pounds/1000 Pounds Fuel							
Cruise	38% Q	850	0.56	10.54	5.55	0.40	4.20	4.16	3,216	1
		Fuel/Operation (Lb)	*Emissions per Operation - Pounds*							
LTO		428	0.33	7.08	2.09	0.17	1.80	1.78	852	1
Mountain Pad Landing		67	0.04	0.76	0.36	0.03	0.28	0.28	214	2

Notes: The AH-1W/Z helicopters have 2 T700-GE-401C engines.

(1) AESO Memorandum Report No. 9824, Revision B, Aircraft Emissions Estimates: AH-1W Takeoff and Landing Cycle and In-Frame, Maintenance Testing Using JP-5, November 2009.

(2) AESO Memorandum Report No. 9961, Revision A, Aircraft Emissions Estimates: AH-1 Mission Operations Using JP-5, November 2009.

Table E.1-29. CH-53 Aircraft Emission Factors - MCB Camp Pendleton Stuart Mesa West Project EA

Operation Type	*Engine Power Setting*	*Fuel Flow Rate/ Aircraft (Lb/Hr)*	*VOC*	*CO*	*NOx*	*SO2*	*PM10*	*PM2.5*	*CO2*	*References*
			Engine Emission Factors - Pounds/1000 Pounds Fuel							
Cruise	70% Qeng	4,464	0.15	2.13	8.08	0.40	2.21	2.19	3,210	1
		Fuel/Aircraft Op (Lb)	*Emissions per Operation - Pounds*							
LTO		1,746	11.24	22.86	8.86	0.70	3.76	3.72	5,605	1
Mountain Pad Landing		540	0.52	1.94	4.03	0.22	1.19	1.18	1,733	2

Notes: The CH-53 helicopter has 3 T64-GE-415 engines.

(1) AESO Memorandum Report No. 9822, Revision C, Aircraft Emissions Estimates: H-53 Takeoff and Landing Cycle and In-Frame, Maintenance Testing Using JP-5, February 2000, except CO2 emissions based upon a factor of 3,210 lb/1000 lb fuel.

(2) AESO Memorandum Report No. 9960, Revision B, Aircraft Emissions Estimates: H-53 Mission Operations Using JP-5, April 2000, except CO2 emissions based on a factor of 3,210 lb/1000 lb fuel.

Table E.1-30. MV-22 Aircraft Emission Factors - MCB Camp Pendleton Stuart Mesa West Project EA

Operation Type	Engine Power Setting	Fuel Flow Rate/ Engine (Lb/Hr)	VOC	CO	NOx	SO2	PM10	PM2.5	CO2	References
			Individual Engine Emission Factors - Pounds/1000 Pounds Fuel							
FW (0°) Cruise		3,820	0.01	0.52	14.09	0.40	1.58	1.56	3,209	1
Helo (16°) Cruise		3,060	0.01	0.79	11.64	0.40	1.58	1.56	3,212	1
Average Cruise		3,440	0.01	0.66	12.87	0.40	1.58	1.56	3,211	1
		Fuel/Aircraft Op (Lb)	Emissions per Operation - Pounds							
LTO		1,289	0.08	5.33	9.25	0.52	1.73	1.71	4,151	1
Single Pad or Confined Area Landing - Pounds		592	0.01	0.29	8.87	0.24	0.94	0.93	1,899	2

Notes: The MV-22 aircraft has 2 T406-AD-400 engines.

(1) AESO Memorandum Report No. 9946, Revision E, Aircraft Emissions Estimates: V-22 Landing and Takeoff Cycle and In-Frame, Engine Maintenance Testing Using JP-5, January 2001. LTO data based on a short landing (airplane mode).

(2) AESO Memorandum Report No. 9965, Revision B, Aircraft Emissions Estimates: V-22 Mission Operations Using JP-5, January 2001.

Table E.1-31. HH-1/UH-1 Aircraft Emission Factors - MCB Camp Pendleton Stuart Mesa West Project EA

Operation Type	Engine Power Setting	Fuel Flow Rate/ Aircraft (Lb/Hr)	VOC	CO	NOx	SO2	PM10	PM2.5	CO2	References
			Engine Emission Factors - Pounds/1000 Pounds Fuel							
Cruise	54% Qeng	692	0.13	1.01	5.79	0.40	4.20	4.16	3,207	1
		Fuel/Aircraft Op (Lb)	Emissions per Operation - Pounds							
LTO		280	0.67	3.32	1.28	0.11	1.18	1.17	893	1
Mountain Pad Landing		209	0.01	0.23	0.32	0.03	0.27	0.27	209	2

Notes: The HH-1/UH-1 helicopters have 2 T400-CP-400 engines.

(1) AESO Memorandum Report No. 9904, Revision B, Aircraft Emissions Estimates: HH/UH-1N Takeoff and Landing Cycle and In-Frame, Maintenance Testing Using JP-5, November 2009.

(2) AESO Memorandum Report No. 9962, Revision A, Aircraft Emissions Estimates: UH-1 and HH-1 Mission Operations Using JP-5, November 2009.

Table E.1-32. Fugitive Dust Emission Factors for One Aircraft Pad Landing within Imperial County - Proposed USMC Rotary Wing and Tilt-Rotor Training Operations.

Aircraft	*Total Engine Hp Rating*	*Rotor Diameter (Ft) (1)*	*Disturbed Area (m^2) (2)*	*U_{10} (m/s) (3)*	*Threshold Friction Velocity u_t (m/s) (4)*	*Friction Velocity u* (m/s) (5)*	*P (Gm/m^2) (6)*	*Pounds/LTO (7)*		
								PM	*PM10*	*PM2.5*
AH-1W/Z	3,380	48.0	1,513	32.3	1.70	1.710	0.24	0.82	0.41	0.06
CH-53	7,850	79.0	4,098	32.5	1.70	1.721	0.56	5.06	2.53	0.38
MV-22	12,300	84.0	4,633	32.7	1.70	1.732	0.87	8.87	4.43	0.66
UH-1N	2,500	48.0	1,513	32.2	1.70	1.707	0.18	0.61	0.31	0.05
UH-1Y	3,656	49.0	1,576	32.3	1.70	1.710	0.27	0.92	0.46	0.07

Notes: (1) Due to rotor overlap, actual diameters for CH-46 and MV-22 used in the calculations = 84.3' and 84', respectively.

(2) Equal to 3 times the rotor diameter - the area of disturbance expected from rotary wing aircraft during a desert landing and take-off.

(3) Wind speeds at 10 meter level (U_{10}) for the MV-22 based upon wind speeds measured at 1 meter above ground when this aircraft hovered at 20' AGL (Bell Boeing 2008). Equates to equation #5 presented in AP-42 Section 13.2.5 (EPA 2006). This approach assumes that the maximum aircraft downdraft approaches the fastest mile wind speed. Wind speeds for all other aircraft estimated by multiplying U_{10} for the MV-22 times the ratio of the horsepower rating of each aircraft divided by the horsepower rating of the MV-22. This approach was taken, as data are not available to adequately estimate the down draft wind speeds for these aircraft, yet aircraft horsepower rating is proportional to potential thrust or the ability of an aircraft to generate down draft.

(4) Threshold friction velocity value chosen from values listed for surface types identified in Table 8-3 in the WRAP Fugitive Dust Handbook (Countess Environmental 2006). Data on climatic conditions, soil and vegetation conditions described in Archaeological and Biological surveys for the proposed landing zones (LZs), and observations of dust emissions generated by a CH-46 landing at the existing Canary LZ, were used in this selection process (SAIC 2011 and 2012b).

(5) Equates to equation #4 presented in AP-42 Section 13.2.5.

(6) Equates to equation #3 presented in AP-42 Section 13.2.5.

(7) Equal to Disturbed Area times P. These values are annual averages.

Table E.1-33. Fugitive Dust Emission Factors for One Rotary Wing and Tilt-Rotor Aircraft Pad Landing - MCB Camp Pendleton Stuart Mesa West Project EA.

Aircraft	*Total Engine Hp Rating*	*Rotor Diameter (Ft) (1)*	*Disturbed Area (m^2) (2)*	*U_{10} (m/s)*	*Threshold Friction Velocity (m/s)*	*U* (m/s)*	*P (Gm/m^2) (3)*	*Pounds/LTO (4)*		
								PM	*PM10*	*PM2.5*
AH-1W/Z	3,380	48.0	1,513				0.20	0.65	0.33	0.05
CH-53	7,850	79.0	4,098				0.45	4.04	2.02	0.30
MV-22	12,300	84.0	4,633				0.69	7.09	3.55	0.53
UH-1N	2,500	48.0	1,513				0.15	0.49	0.24	0.04
UH-1Y	3,656	49.0	1,576				0.21	0.74	0.37	0.06

Notes: (1) Due to rotor overlap, actual diameters for CH-46 and MV-22 used in the calculations = 84.3' and 84', respectively.

(2) Equal to 3 times the rotor diameter - the area of disturbance expected from rotary wing aircraft during a desert landing and take-off.

(3) P values = 80% of those defined for the Imperial Valley (IV) project region, as determined for the MV-22 Training EA (USMC 2013). While the Stuart Mesa West project site has a cooler and more humid climate than the IV MV-22 project region, the project site has fairly silty soils that have the potential to generate substantial amounts of dust from rotary wing aircraft downwash.

(4) Equal to Disturbed Area times P. These values are annual averages.

Table E.1-34. Annual Emissions from Aircraft Operations - MCB Camp Pendleton Stuart Mesa West Project EA.

	Annual Emissions (Tons)						
Operation/Aircraft Type	*VOC*	*CO*	*NOx*	*SO2*	*PM10*	*PM2.5*	*CO2*
Landing and Take-off							
AH-1	0.00	0.06	0.02	0.00	0.01	0.01	6.82
CH-53	0.09	0.18	0.07	0.01	0.03	0.03	44.84
MV-22	0.00	0.11	0.19	0.01	0.03	0.03	83.02
UH-1	0.01	0.07	0.03	0.00	0.02	0.02	17.86
Subtotal	0.11	0.41	0.30	0.02	0.10	0.10	152.53
Transit to and from Project Site							
AH-1	0.00	0.01	0.00	0.00	0.00	0.00	1.67
CH-53	0.00	0.02	0.07	0.00	0.02	0.02	29.65
MV-22	0.00	0.01	0.20	0.01	0.02	0.02	48.96
UH-1	0.00	0.00	0.01	0.00	0.00	0.00	3.39
Subtotal	0.00	0.04	0.28	0.01	0.05	0.05	83.67
Cruise Mode at Project Site							
AH-1	0.01	0.11	0.06	0.00	0.04	0.04	32.80
CH-53	0.00	0.03	0.10	0.00	0.03	0.03	37.83
MV-22	0.00	0.01	0.29	0.01	0.04	0.04	72.89
UH-1	0.00	0.00	0.03	0.00	0.02	0.02	14.66
Subtotal	0.01	0.15	0.47	0.02	0.12	0.12	158.18
Pad Landings							
AH-1							
CH-53	0.00	0.02	0.03	0.00	0.01	0.01	13.87
MV-22	0.00	0.01	0.18	0.00	0.02	0.02	37.98
UH-1	0.00	0.00	0.01	0.00	0.01	0.01	4.18
Subtotal	0.00	0.03	0.22	0.01	0.03	0.03	56.03
Pad Landings - Dust							
AH-1							
CH-53					0.02	0.00	
MV-22					0.07	0.01	
UH-1					0.01	0.00	
Subtotal					0.09	0.01	
Total Combustive Aircraft Emissions	0.12	0.60	1.05	0.05	0.28	0.27	394.39
Total Fugitive Dust Emissions					0.09	0.01	

Table E.1-35. Annual Construction and Operational Emissions - MCB Camp Pendleton Stuart Mesa West Project EA - Alternative A

	Annual Emissions (Tons per Year)								*MT*
Activity/Source	*VOC*	*CO*	*NO_X*	*SO_X*	*PM*	*PM_{10}*	*$PM_{2.5}$*	*CO_2*	*CO_2*
Construction									
Combustive Emissions from Equipment	0.03	0.08	0.40	0.00	0.02	0.02	0.02	43.78	40
Fugitive Dust					2.24	1.08	0.11		
Construction Total Emissions	0.03	0.08	0.40	0.00	2.26	1.10	0.13	43.78	40
Amphibious Operations									
AAV Combustive Emissions	0.18	0.82	2.05	0.10		0.24	0.22	163.25	148
Fugitive Dust						8.50	1.36		
Amphibious Operations Total Emissions	0.18	0.82	2.05	0.10		8.73	1.58	163.25	148
Tactical Vehicles									
Tactical Vehicles Combustive Emissions	0.06	0.22	0.92	0.01	0.02	0.04	0.04	114.62	104
Fugitive Dust					69.34	20.47	2.05		-
Tactical Vehicles Total Emissions	0.06	0.22	0.92	0.01	69.36	20.51	2.09	114.62	104.01
Fording Training									
Fording Training Vehicles Combustive Emissions	0.03	0.08	0.47	0.00	0.02	0.02	0.02	53.95	49
Fugitive Dust					57.85	17.07	1.71		-
Fording Training Total Emissions	0.03	0.08	0.47	0.00	57.86	17.09	1.72	53.95	48.96
Combat Engineer Support Equipment									
Support Equipment Combustive Emissions	0.40	1.17	6.33	0.01	0.22	0.22	0.21	762.38	692
Fugitive Dust					4.95	2.48	0.25		-
Combat Engineer Support Total Emissions	0.40	1.17	6.33	0.01	5.17	2.70	0.45	762.38	691.82
Operational Maintenance									
Maintenance Vehicles Combustive Emissions	0.08	0.25	1.08	0.00	0.05	0.05	0.05	119.15	108
Fugitive Dust					3.96	1.98	0.20		-
Operational Maintenance Total Emissions	0.08	0.25	1.08	0.00	4.01	2.03	0.25	119.15	108.12
Aircraft Operations									
Aircraft Combustive Emissions	0.12	0.60	1.05	0.05		0.28	0.27	394.39	358
Fugitive Dust						0.09	0.01		
Aircraft Operations Total Emissions	0.12	0.60	1.05	0.05		0.37	0.29	394.39	357.88
Total Annual Emissions (1)	0.87	3.14	11.90	0.17	136.41	51.44	6.37	1,608	1,459
Conformity Thresholds - Tons per Year	100	100	100						
Exceed De Minimis Thresholds?	N	N	N	NA	NA	NA	NA	NA	NA

Notes: (1) Excludes construction, as this would occur in a calendar year prior to initiation of proposed training activities.

Table E.1-36. Annual Construction and Operational Emissions - MCB Camp Pendleton Stuart Mesa West Project EA - Alternative B

	Annual Emissions (Tons per Year)								MT
Activity/Source	*VOC*	*CO*	*NO_X*	*SO_X*	*PM*	*PM_{10}*	*$PM_{2.5}$*	*CO_2*	*CO_2*
Construction									
Combustive Emissions from Equipment	0.07	0.18	0.94	0.00	0.04	0.04	0.04	101.56	92
Fugitive Dust					9.90	4.53	0.46		
Construction Total Emissions	0.07	0.18	0.94	0.00	9.94	4.57	0.50	101.56	92
Amphibious Operations									
AAV Combustive Emissions	0.24	1.10	2.73	0.13		0.32	0.29	217.67	198
Fugitive Dust						11.33	1.81		
Amphibious Operations Total Emissions	0.24	1.10	2.73	0.13		11.65	2.10	217.67	198
Tactical Vehicles									
Tactical Vehicles Combustive Emissions	0.06	0.22	0.92	0.01	0.02	0.04	0.04	114.62	104
Fugitive Dust					69.34	20.47	2.05		-
Tactical Vehicles Total Emissions	0.06	0.22	0.92	0.01	69.36	20.51	2.09	114.62	104.01
Fording Training									
Fording Training Vehicles Combustive Emissions	0.03	0.08	0.47	0.00	0.02	0.02	0.02	53.95	49
Fugitive Dust					57.85	17.07	1.71		-
Fording Training Total Emissions	0.03	0.08	0.47	0.00	57.86	17.09	1.72	53.95	48.96
Combat Engineer Support Equipment									
Support Equipment Combustive Emissions	0.40	1.17	6.33	0.01	0.22	0.22	0.21	762.38	692
Fugitive Dust					4.95	2.48	0.25		-
Combat Engineer Support Total Emissions	0.40	1.17	6.33	0.01	5.17	2.70	0.45	762.38	691.82
Operational Maintenance									
Maintenance Vehicles Combustive Emissions	0.11	0.35	1.50	0.00	0.07	0.07	0.07	165.49	150
Fugitive Dust					5.50	2.75	0.28		-
Operational Maintenance Total Emissions	0.11	0.35	1.50	0.00	5.57	2.82	0.34	165.49	150.17
Aircraft Operations									
Aircraft Combustive Emissions	0.12	0.60	1.05	0.05		0.28	0.27	394.39	358
Fugitive Dust					0.09	0.01	-		
Aircraft Operations Total Emissions	0.12	0.60	1.05	0.05	0.09	0.29	0.27	394.39	357.88
Total Annual Emissions (1)	0.96	3.51	13.01	0.20	138.07	55.06	6.98	1,708	1,550
Conformity Thresholds - Tons per Year	100	100	100						
Exceed De Minimis Thresholds?	N	N	N	NA	NA	NA	NA	NA	NA

Notes: (1) Excludes construction, as this would occur in a calendar year prior to initiation of proposed training activities.

Appendix E-2

Record of Non-Applicability (RONA)

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UNITED STATES MARINE CORPS
MARINE CORPS INSTALLATIONS WEST-MARINE CORPS BASE
BOX 555010
CAMP PENDLETON, CALIFORNIA 92055-5010

5090
CG
1 OCT 2019

MEMORANDUM FOR THE RECORD

From: Commanding General
To: Director, Environmental Security

Subj: RECORD OF NON-APPLICABILITY (RONA) FOR STUART MESA WEST TRAINING AND CONVERSION, MARINE CORPS BASE, CAMP PENDLETON

Ref: (a) U.S. Environmental Protection Agency, Determining Conformity of General Federal Actions to State or Federal Implementation Plans; Final Rule, published in the Federal Register on 30 November 1993 (40 CFR Parts 6, 51, and 93)
(b) U.S. Environmental Protection Agency, Revisions to the General Conformity Regulations; Final Rule, published in the Federal Register on 5 April 2010 (40 CFR Parts 51 and 93)

Encl: (1) Record of Non-Applicability (RONA) Air Emission Calculations

1. References (a) and (b) provide implementing guidance for documenting Clean Air Act (CAA) Conformity Determination requirements. The General Conformity Rule applies to federal actions proposed within areas which are designated as either non-attainment or maintenance areas for a National Ambient Air Quality Standard (NAAQS) for any of the criteria pollutants.

2. An emissions analysis was conducted (enclosure 1) and it was determined that *de minimis* thresholds for applicable criteria pollutants would not be exceeded as a result of implementation of the proposed action. A formal conformity determination is not considered necessary.

3. The proposed action would occur within the San Diego Air Basin (SDAB) portion of Marine Corps Base, Camp Pendleton (MCB CamPen). This portion of the SDAB is currently in non-attainment of the 8 hour ozone (O_3) NAAQS and is a maintenance area for carbon monoxide (CO) NAAQS. The SDAB is in attainment of the NAAQS for all other criteria pollutants. Therefore, only project emissions of CO and O_3 (or its

precursors, volatile organic compounds and oxides of nitrogen [NO_x]) were analyzed for conformity rule applicability. The annual *de minimis* threshold levels for this region are 100 tons of Volatile Organic Compounds, NO_x, and CO. Federal actions may be exempt from conformity determinations if they do not exceed *de minimis* threshold levels.

4. The Marine Corps does not anticipate that the proposed action would result in an increase in the number or frequency of traffic operations at MCB CamPen. Therefore, the Marine Corps determined that additional emissions analyses are not warranted for the proposed action.

5. To the best of my knowledge, the information presented in this Record of Non-Applicability is correct and accurate, and I concur in the finding that implementation of the proposed action does not require a formal CAA conformity determination.

DAN CONLEY

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Dir, ENVSEC
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Enclosure 1

Record of Non-Applicability (RONA)
Air Emission Calculations

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Appendix E.2 Attachment 1 - Air Emission Calculations for Record of Nonapplicability (RONA) -
MCB Camp Pendleton Stuart Mesa West Training and Conversion Proposed Action (Project Alternative A)

Table E.2-1. Emission Source Data for Construction of Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

Source Type	*Hp Rating*	*Load Factor (1)*	*Number Active*	*Hours/ Day*	*Total Work Days*	*Total Hp-Hrs*
Off-Road Construction Equipment						
Bulldozer - D9	405	0.43	2	8	6.0	16,774
Grader - 130G	125	0.41	2	8	6.0	4,936
Loader Backhoe - CAT420DIT	88	0.37	2	8	6.0	3,136
Scraper - 621B	365	0.48	2	8	6.0	16,875
Tractor - John Deere TRAM 624KR	198	0.37	2	8	6.0	7,056
Tractor - MC1150E/MC1155E	118	0.37	2	8	6.0	4,205
Water Truck	175	0.46	2	8	12.9	16,615
Fugitive Dust (2)	NA	NA	3	NA	25.8	77
On-Road Trucks						
Activity/Equipment Type		*Average Weight (Tons) (3)*	*Miles/ Round Trip (4)*	*Daily Trips*	*Total Work Days*	*Total Miles*
Material Delivery Truck - Onbase		30	6.2	2	1.7	21
Mataerial Delivery Truck - Offbase		30	20	2	1.7	69

Notes: (1) Average daily value from ARB In-Use Off-Road Equipment Inventory Model, where applicable (ARB 2011).

(2) Number Active = average daily acres disturbed on a continuous basis and Total Hp-Hrs = total acre-days for the entire activity.

(3) Average of loaded and unloaded weights.

(4) Assumes that 2.2 onbase miles occur on unpaved roads.

Table E.2-2. Construction Equipment and Activity Emission Factors - MCB Camp Pendleton Stuart Mesa West Project EA

	Fuel	*Emission Factors (Grams/Horsepower-Hour)*								
Project Year 2010/Source Type	*Type*	*VOC*	*CO*	*NOx*	*SOx*	*PM*	*PM10*	*PM2.5*	*CO2*	*References*
Off-Road Equipment - 25-50 Hp	D	1.01	1.53	5.21	0.01	0.45	0.45	0.41	568	(1)
Off-Road Equipment - 51-120 Hp	D	0.47	2.37	5.39	0.01	0.41	0.41	0.38	568	(1)
Off-Road Equipment - 121-175 Hp	D	0.44	0.87	5.70	0.01	0.31	0.31	0.29	568	(1)
Off-Road Equipment - 176-250 Hp	D	0.34	0.75	5.40	0.01	0.20	0.20	0.18	568	(1)
Off-Road Equipment - 251-500 Hp	D	0.33	0.84	4.91	0.00	0.19	0.19	0.17	568	(1)
Off-Road Equipment - 501-750 Hp	D	0.32	1.33	4.87	0.00	0.19	0.19	0.17	568	(1)
Off-Road Equipment - >750 Hp	D	0.37	0.76	6.65	0.00	0.21	0.21	0.19	568	(1)
On-road Truck - Idle (Gms/Hr)	D	4.05	6.20	12.10	0.02	0.50	0.50	0.46	2,228	(2)
On-road Truck - 5 mph (Gms/Mi)	D	3.94	7.11	27.15	0.02	0.45	0.45	0.43	3,438	(2)
On-road Truck - 25 mph (Gms/Mi)	D	0.66	2.19	10.74	0.02	0.17	0.17	0.16	1,996	(2)
On-road Truck - 55 mph (Gms/Mi)	D	0.24	1.00	8.04	0.02	0.17	0.17	0.16	1,545	(2)
On-Road Trucks - Onbase Composite (Gms/Mi)	D	0.98	2.68	12.38	0.02	0.20	0.20	0.19	2,140	(2)
On-Road Trucks - Offbase Composite (Gms/Mi)	D	0.32	1.24	8.58	0.02	0.17	0.17	0.16	1,635	(2)
Unpaved Road Dust - Cement Truck						10.58	3.12	0.31		(3)
Unpaved Road Dust - Materials Truck						10.82	3.19	0.32		(3)
Disturbed Ground - Fugitive Dust						55.00	26.95	2.75		(4)

Notes: (1) Composites developed from the ARB OFFROAD2011 emissions model (ARB 2012), except CO data derived from nonroad certification data found in *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling -- Compression-Ignition* (USEPA 2004).

(2) Generated with the use of the EMFAC2014 model for calendar year 2014 for truck fleet in San Diego County (ARB 2014). Assumes annual average temperatures. Units in grams/mile, except grams/hour for idling. Offbase composite factors based on a trip of 20/80% 25/55 mph. Onbase composite factors based on a trip of 10/90% 5/25 mph. Although not shown in these calculations, emissions from 15 minutes of idling mode included for each truck round trip.

(3) From section 13.2.2 of AP-42 (USEPA 2006). See Table G-___ for details. Units in Lb/VMT.

(4) Units in lbs/acre-day from section 11.2.3 of AP-42 (USEPA 1995). Emissions reduced by 50% from uncontrolled levels to simulate implementation of best management practices for fugitive dust control. PM10/PM2.5 portions from ARB 2012.

Table E.2-3. Total Construction Emissions for Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

	Total Pounds							
Source Type	*VOC*	*CO*	*NOx*	*SOx*	*PM*	*PM10*	*PM2.5*	*CO2*
Off-Road Construction Equipment								
Bulldozer - D9	12.20	31.06	181.57	0.18	7.03	7.03	6.46	21,016
Grader - 130G	4.79	9.47	62.03	0.06	3.37	3.37	3.10	6,185
Loader Backhoe - CAT420DIT	3.27	16.39	37.27	0.04	2.83	2.83	2.61	3,929
Scraper - 621B	12.28	31.25	182.67	0.18	7.07	7.07	6.50	21,142
Tractor - John Deere TRAM 624KR	5.29	11.67	84.00	0.08	3.11	3.11	2.86	8,841
Tractor - MC1150E/MC1155E	4.38	21.97	49.97	0.05	3.80	3.80	3.50	5,269
Water Truck	16.12	31.87	208.79	0.19	11.36	11.36	10.45	20,817
Subtotal - Equipment Combustive Emissions	58	154	806	1	39	39	35	87,198
Fugitive Dust					4,257	2,086	213	
On-Road Trucks								
Material Delivery Truck - Onbase Combustive	0.08	0.17	0.67	0.00		0.01	0.01	118
Material Delivery Truck - Onbase Unpaved Road Dust					231	68	7	
Mataerial Delivery Truck - Offbase Combustive	0.05	0.19	1.30	0.00		0.03	0.02	248
Subtotal - On-Road Trucks Combustive Emissions	0.13	0.36	1.97	0.00		0.04	0.04	366
Subtotal - On-Road Trucks Fugitive Dust					231	68	7	
Total Construction Emissions (Pounds)	58	154	808	1	4,526	2,193	255	87,564
Total Construction Emissions (Tons)	0.03	0.08	0.40	0.00	2.26	1.10	0.13	44

Calculation of Annual Emissions for Off-Road Equipment

Emission Factor (g/hp-hr) x Total Horsepower-hours (hp-hr/yr) x 1 lb/453.6 g = Annual Emissions (lb/yr)

Calculation of Annual Emissions for On-Road Vehicles

Emission Factor (g/mile) x Number of daily truck trips x Round-trip distance (mile) x Number of working days x 1 lb/453.6 g = Annual Emissions (lb/yr)

Calculation of Annual Emissions for PM fugitive dust - ground disturbance

Emission Factor (lb/acre-day) x Acreage Disturbed (acres) x Annual number of working days (day/yr) = Annual Emissions (lb/yr)

Table E.2-4. AAV Engine Data for Amphibious Operations - Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

Activity	*Annual Hours (1)*	*Average % of Full Engine Power 0-20*	*21-40*	*41-60*	*61-80*	*81-100*
Idle	915	915				
Half Throttle	915			915		
Full Throttle	330					330
Total Activity	2,160	915		915		330

Notes: (1) Assumes that year 2000 AVTB and FSSG operations equal to 2001 operations.

Table E.2-5. AAV Engine Fuel Usage Factors for Amphibious Operations - Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

Activity		*Total Pounds of JP-8 Fuel Usage/Engine Load Factor % 0-20*	*21-40*	*41-60*	*61-80*	*81-100*
Idle		24,582				
Half Throttle				79,531		
Full Throttle						49,930
Total Fuel Usage - Lb	154,043	24,582		79,531		49,930
Hourly Fuel Usage/Engine Power Setting - Lb (1)		26.9	57.2	86.9	117.0	151.3

Notes: (1) Equal to hourly fuel usage/throttle setting for the VTA525 engine times 452/525 Hp to estimate fuel usage for the AAV fleet engine aveage rating of 452 Hp. Data for the VTA525 engine extracted from *Gaseous and Particulate Emissions Indexes from Amphibious Engines* (AESO 2001).

Table E.2-6. Emission Factors for AAV Operations - MCB Camp Pendleton Stuart Mesa West Project EA

Source Type	*Emission Factor (Pounds/1000 Pounds of JP-8 Fuel) (1) VOC*	*CO*	*NOx*	*SOx*	*PM10*	*PM2.5*	*CO2*	*Reference*
AAV Engine - 1 to 20% Full Throttle	6.42	32.38	11.06	1.24	6.80	6.26	3,096	(1)
AAV Engine - 21 to 40% Full Throttle	3.04	7.78	18.11	1.24	3.13	2.88	3,096	(1)
AAV Engine - 41 to 60% Full Throttle	1.72	7.49	25.05	1.24	2.55	2.34	3,096	(1)
AAV Engine - 61 to 80% Full Throttle	1.47	5.42	32.12	1.24	2.52	2.31	3,096	(1)
AAV Engine - 81 to 100% Full Throttle	1.31	5.17	36.75	1.24	2.17	1.99	84	(1)
Fugitive Dust - Unpaved Roads					3.13	0.31		(2)

Notes: (1) Data extracted from *Gaseous and Particulate Emissions Indexes from Amphibious Engines* (AESO 2002), except SOx based on an average sulfur content of 0.062 percent (AESO 2013).
(2) AP-42 Volume I, Section 13.2.2 (EPA 2006). Based on a AAV weight of 28.7 tons. Units in pounds/vehicle mile travelled (VMT).

Table E.2-7. Annual Emissions for AAV Amphibious Operations - Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

Activity	*Emissions (Tons Per Year) VOC*	*CO*	*NOx*	*SOx*	*PM10*	*PM2.5*	*CO2*
Idle	0.08	0.40	0.14	0.02	0.08	0.08	38.05
Half Throttle	0.07	0.30	1.00	0.05	0.10	0.09	123.11
Full Throttle	0.03	0.13	0.92	0.03	0.05	0.05	2.09
Fugitive Dust - Unpaved Roads (1)					8.50	1.36	
Total Annual Baseline Emissions	0.18	0.82	2.05	0.10	8.73	1.58	163.25

Notes: (1) Based on an average fuel usage of 0.75 miles per gallon.

	A	B	C	D	E	F	G
1	Table E.2-8. Emission Source Data for Tactical Vehicles - MCB Camp Pendleton Stuart Mesa West Project EA						
2	*Activity/Equipment Type*	*Number of*	*Annual*	*Miles per*	*Total*		
3		*Vehicles*	*Miles*	*Gallon (1)*	*Gallons*	*Hp*	*Total Hp-Hr (2)*
4	Tactical Vehicles						
5	AAV-7	30	1,728	0.75	2,304		
6	Abrams Main Battle Tank - M1A1	18	550	0.33	1,667		
7	Assault Breacher Vehicle	5	550	0.36	1,528		
8	Extended Cargo Truck - MK27/28	70	3,840	3.85	998	440	19,576
9	Fox NBC Reconnaissance Vehicle - M93	4	960	5.93	162	320	3,174
10	High-Mobility Artillery Rocket System (HIMARS)	8	200	3.85	52	330	1,019
11	HIMARS Resupply Vehicle - MK37	8	1,920	3.85	499	440	9,788
12	HMMWV - M1114	25	1,920	14.00	137	150	2,689
13	HMMWV Expanded Capacity Armament Carrier - M1151	25	1,920	11.05	174	190	3,406
14	HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	300	1,920	11.05	174	190	3,406
15	HMMWV Expanded Capacity General Purpose Vehicle - M1165	300	1,920	11.05	174	190	3,406
16	Light Armored Vehicle (All Variants)	184	6,400	5.17	1,238	275	24,273
17	Standard Cargo Truck - MK23/25	400	3,840	3.85	998	440	19,576
18	Z-Backscatter Van	4	200	15.00	13	225	261
19	Notes: (1) Data obtained from the 29 Palms LAS FEIS (MCAGCC 2012) and manufacturer specifications.						
20	(2) Based on a diesel fuel usage rate of 0.051 gallons per Hp-Hr.						

Table E.2-9. Tactical Vehicles Emission Factors - MCB Camp Pendleton Stuart Mesa West Project EA

Source Type	*Emission Factors (Pounds/1000 Gallons)*								*Reference*
	VOC	*CO*	*NO_X*	*SO_X*	*PM*	*PM_{10}*	*$PM_{2.5}$*	*CO_2*	
Tank Vehicles and ABV									
Abrams Tank/Bridge Vehicles	0.06	0.45	118.80	1.24	1.56	1.56	1.52	21,053	(1)
Assault Breacher/Recovery Vehicles	14.10	101.60	170.88	1.24	1.71	1.71	1.57	21,053	(2)
Other Tactical Vehicles	*Emission Factors (Grams/Horsepower-Hour)*								
Off-Road Equipment - 121-175 Hp	0.44	0.87	5.70	0.01	0.31	0.31	0.29	568	(3)
Off-Road Equipment - 176-250 Hp	0.34	0.75	5.40	0.01	0.20	0.20	0.18	568	(3)
Off-Road Equipment - 251-500 Hp	0.33	0.84	4.91	0.00	0.19	0.19	0.17	568	(3)

Notes: (1) From FEIS for Land Acquisition (Marine Corps Air Ground Combat Center Twenty-Nine Palms [MCAGCC] 2012).

(2) From FEA for Proposed ABV Action at MCAGCC (MCAGCC 2003).

(3) From Table E.2-2 (ARB 2012 and USEPA 2004).

(4) GHG Emission Factors for (a) Tank Vehicles and ABVs from General Reporting Protocol, Tables C.3 and C.6 jet fuel (California Climate Action Registry 2009) and (b) Other TV from ARB 2013.

	T	U	V	W	X	Y	Z	AA	AB
1	Table E.2-10. Total Tactical Vehicles Emissions - MCB Camp Pendleton Stuart Mesa West Project EA								
2		*Pounds per Year*							
3	*Activity/Equipment Type*	*ROG*	*CO*	*NO_X*	*SO_X*	*PM*	*PM_{10}*	*$PM_{2.5}$*	*CO_2*
4	*Tactical Vehicles*								
5	AAV	27.02	117.36	392.40	19.43		39.90	36.71	48,506
6	Abrams Main Battle Tank - M1A1	0.10	0.75	198.00	2.07	2.60	2.60	2.53	35,088
7	Assault Breacher Vehicle	21.54	155.22	261.07	1.89	2.61	2.61	2.40	32,164
8	Extended Cargo Truck - MK27/28	14.24	36.25	211.91	0.21	8.20	8.20	7.54	24,527
9	Fox NBC Reconnaissance Vehicle - M93	2.31	5.88	34.36	0.03	1.33	1.33	1.22	3,977
10	High-Mobility Artillery Rocket System (HIMARS)	0.74	1.89	11.03	0.01	0.43	0.43	0.39	1,276
11	HIMARS Resupply Vehicle - MK37	7.12	18.13	105.95	0.11	4.10	4.10	3.77	12,263
12	HMMWV - M1114	2.61	5.16	33.79	0.03	1.84	1.84	1.69	3,369
13	HMMWV Expanded Capacity Armament Carrier - M1151	2.55	5.63	40.55	0.04	1.50	1.50	1.38	4,267
14	HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	2.55	5.63	40.55	0.04	1.50	1.50	1.38	4,267
15	HMMWV Expanded Capacity General Purpose Vehicle - M1165	2.55	5.63	40.55	0.04	1.50	1.50	1.38	4,267
16	Light Armored Vehicle (All Variants)	17.66	44.95	262.74	0.26	10.17	10.17	9.35	30,411
17	Standard Cargo Truck - MK23/25	14.24	36.25	211.91	0.21	8.20	8.20	7.54	24,527
18	Z-Backscatter Van	0.20	0.43	3.11	0.00	0.12	0.12	0.11	328
19	Total Emissions (Pounds)	115	439	1,848	24	44	84	77	229,237
20	Total Emissions (Tons) [1]	0.06	0.22	0.92	0.01	0.02	0.04	0.04	114.62
21	*Calculation of Annual Emissions for Tactical Vehicles*								
22	Emission Factor (g/hp-hr) x total Hp-hrs x 1 lb/453.6 g = Annual Emissions (lb/yr)								
23	*Calculation of Abrams Tank/Bridge Vehicles and Assault Breacher Vehicle*								
24	Emission Factor (lbs/1000 gals) x Total Gals x 1 /1000 = Annual Emissions (lb/yr)								

	A	B	C	D	E	F	G
1	Table E.2-11. Emission Source Data for Fording Training Vehicles - MCB Camp Pendleton Stuart Mesa West Project EA						
2		*Number of*	*Annual*	*Miles per*	*Total*		
3	*Activity/Equipment Type*	*Vehicles*	*Miles*	*Gallon (1)*	*Gallons*	*Hp*	*Total Hp-Hr (2)*
4	Fording Training Vehicles						
5	Extended Cargo Truck - MK27/28	20	3,840	3.85	998	440	19,576
6	HIMARS Resupply Vehicle - MK37	10	1,920	3.85	499	440	9,788
7	HMMWV - M1114	10	1,920	14.00	137	150	2,689
8	HMMWV Expanded Capacity Armament Carrier - M1151	10	1,920	11.05	174	190	3,406
9	HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	10	1,920	11.05	174	190	3,406
10	HMMWV Expanded Capacity General Purpose Vehicle - M1165	10	1,920	11.05	174	190	3,406
11	Light Armored Vehicle (All Variants)	24	6,400	5.17	1,238	275	24,273
12	Standard Cargo Truck - MK23/25	20	3,840	3.85	998	440	19,576
13	Notes: (1) Data obtained from the 29 Palms LAS FEIS (MCAGCC 2012) and manufacturer specifications.						
14	(2) Based on a diesel fuel usage rate of 0.051 gallons per Hp-Hr.						

	T	U	V	W	X	Y	Z	AA	AB
1	Table E.2-12. Total Fording Training Vehicle Emissions - MCB Camp Pendleton Stuart Mesa West Project EA								
2		*Pounds per Year*							
3	*Activity/Equipment Type*	*ROG*	*CO*	*NO_X*	*SO_X*	*PM*	*PM_{10}*	*$PM_{2.5}$*	*CO_2*
4	*Tactical Vehicles*								
5	Extended Cargo Truck - MK27/28	14.24	36.25	211.91	0.21	8.20	8.20	7.54	24,527
6	HIMARS Resupply Vehicle - MK37	7.12	18.13	105.95	0.11	4.10	4.10	3.77	12,263
7	HMMWV - M1114	2.61	5.16	33.79	0.03	1.84	1.84	1.69	3,369
8	HMMWV Expanded Capacity Armament Carrier - M1151	2.55	5.63	40.55	0.04	1.50	1.50	1.38	4,267
9	HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	2.55	5.63	40.55	0.04	1.50	1.50	1.38	4,267
10	HMMWV Expanded Capacity General Purpose Vehicle - M1165	2.55	5.63	40.55	0.04	1.50	1.50	1.38	4,267
11	Light Armored Vehicle (All Variants)	17.66	44.95	262.74	0.26	10.17	10.17	9.35	30,411
12	Standard Cargo Truck - MK23/25	14.24	36.25	211.91	0.21	8.20	8.20	7.54	24,527
13	Total Emissions (Pounds)	64	158	948	1	37	37	34	107,899
14	Total Emissions (Tons) [1]	0.03	0.08	0.47	0.00	0.02	0.02	0.02	53.95
15	*Calculation of Annual Emissions for Tactical Vehicles*								
16	Emission Factor (g/hp-hr) x total Hp-hrs x 1 lb/453.6 g = Annual Emissions (lb/yr)								
17	*Calculation of Abrams Tank/Bridge Vehicles and Assault Breacher Vehicle*								
18	Emission Factor (lbs/1000 gals) x Total Gals x 1 /1000 = Annual Emissions (lb/yr)								

Table E.2-13. Emission Source Data for Combat Engineer Support Equipment - MCB Camp Pendleton Stuart Mesa West Project E

Source Type	*Number of Vehicles*	*Hp*	*Gallons/ Hour (1)*	*Annual Hours*	*Total Gallons*
Tracked Vehicles					
Armored Vehicle Launched Bridge	8	750	15.3	480	7,344
Hercules Recovery Vehicle - M88A2	2	1,050	21.4	200	4,284
	Hp Rating	*Load Factor (2)*	*Number Active*	*Annual Hours*	*Total Hp-Hrs*
Wheeled Vehicles					
Combat Excavator - M9	295	0.38	10	960	107,616
Logistics Vehicle System - PU + RBU - MK15-18	450	0.38	40	1,200	205,200
Dump Truck - MK 29/30	440	0.38	20	1,920	321,024
Tractor - MK31	440	0.38	10	250	41,800
Wrecker - MK36	440	0.38	10	400	66,880
HIMARS Resupply Vehicle - MK37	440	0.38	16	800	133,760
Logistics Vehicle System - Power Unit - MK48	450	0.38	40	850	145,350

Notes: (1) Based on a diesel fuel usage rate of 0.051 gallons per Hp-Hr and an engine operation load of 40% full power.
(2) Average daily value from ARB In-Use Off-Road Equipment Inventory Model for off-road truck (ARB 2011).

	S	T	U	V	W	X	Y	Z	AA
1	Table E.2-14. Total Emissions from Combat Engineer Support Equipment - MCB Camp Pendleton Stuart Mesa West Project EA								
2		*Total Pounds*							
3	*Source Type*	*VOC*	*CO*	*NOx*	*SOx*	*PM*	*PM10*	*PM2.5*	*CO2*
4	Armored Vehicle Launched Bridge	0.44	3.30	872.47	9.11	11.46	11.46	11.16	154,612
5	Hercules Recovery Vehicle - M88A2	60.40	435.25	732.05	5.31	7.33	7.33	6.74	90,190
6	Combat Excavator - M9	78.29	199.29	1,164.89	1.16	45.08	45.08	41.47	134,828
7	Logistics Vehicle System - PU + RBU - MK15-18	149.29	380.00	2,221.19	2.22	85.95	85.95	79.08	257,088
8	Dump Truck - MK 29/30	233.55	594.49	3,474.93	3.47	134.47	134.47	123.71	402,200
9	Tractor - MK31	30.41	77.41	452.46	0.45	17.51	17.51	16.11	52,370
10	Wrecker - MK36	48.66	123.85	723.94	0.72	28.01	28.01	25.77	83,792
11	HIMARS Resupply Vehicle - MK37	97.31	247.70	1,447.89	1.44	56.03	56.03	51.55	167,583
12	Logistics Vehicle System - Power Unit - MK48	105.74	269.17	1,573.34	1.57	60.88	60.88	56.01	182,104
13	Total Emissions (Pounds)	804	2,330	12,663	25	447	447	412	1,524,767
14	Total Emissions (Tons)	0.40	1.17	6.33	0.01	0.22	0.22	0.21	762.38
15	Calculation of Annual Emissions for Off-Road Equipment								
16	Emission Factor (g/hp-hr) x Total Horsepower-hours (hp-hr/yr) x 1 lb/453.6 g = Annual Emissions (lb/yr)								
17	Calculation of Annual Emissions for On-Road Vehicles								
18	Emission Factor (g/mile) x Number of daily truck trips x Round-trip distance (mile) x Number of working days x 1 lb/453.6 g = Annual Emissions (lb/yr)								
19	Calculation of Annual Emissions for PM fugitive dust - ground disturbance								
20	Emission Factor (lb/acre-day) x Acreage Disturbed (acres) x Annual number of working days (day/yr) = Annual Emissions (lb/yr)								

Table E.2-15. Emission Source Data for Operational Maintenance - Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

Source Type	*Hp Rating*	*Load Factor (1)*	*Number Active*	*Annual Hours*	*Total Hp-Hrs*
Bulldozer - D9	405	0.43	16	180	31,347
Container Handler - Kalmar Rough Terrain	400	0.20	8	346	27,648
Crane - LRT	80	0.29	8	180	4,176
Crane - Terex MAC-50 50 Ton	305	0.29	8	180	15,921
Forklift - Extended Boom MMV Container	120	0.20	16	180	4,320
Forklift - TX51-19M and D Rough Terrain	120	0.20	16	180	4,320
Grader - 130G	125	0.41	16	180	9,225
Loader - CAT 277B/C MTL Multi Terrain	78	0.37	16	691	19,948
Loader Backhoe - CAT420DIT	88	0.37	16	180	5,861
Scraper - 621B	365	0.48	16	180	31,536
Tractor - Crawler John Deere 850J Medium	192	0.43	16	180	14,861
Tractor - John Deere TRAM 624KR	198	0.37	16	180	13,187
Tractor - MC1150E/MC1155E	118	0.37	16	180	7,859

Notes: (1) Average daily value from ARB In-Use Off-Road Equipment Inventory Model, where applicable (ARB 2011).

Table E.2-16. Annual Emissions for Operational Maintenance - Alternative A - MCB Camp Pendleton Stuart Mesa West Project EA

	Total Pounds							
Source Type	*VOC*	*CO*	*NOx*	*SOx*	*PM*	*PM10*	*PM2.5*	*CO2*
Bulldozer - D9	22.81	58.05	339.32	0.34	13.13	13.13	12.08	39,274
Container Handler - Kalmar Rough Terrain	20.11	51.20	299.28	0.30	11.58	11.58	10.65	34,639
Crane - LRT	4.35	21.82	49.62	0.05	3.77	3.77	3.47	5,232
Crane - Terex MAC-50 50 Ton	11.58	29.48	172.34	0.17	6.67	6.67	6.14	19,947
Forklift - Extended Boom MMV Container	4.50	22.57	51.33	0.05	3.90	3.90	3.59	5,412
Forklift - TX51-19M and D Rough Terrain	4.50	22.57	51.33	0.05	3.90	3.90	3.59	5,412
Grader - 130G	8.95	17.69	115.92	0.11	6.30	6.30	5.80	11,558
Loader - CAT 277B/C MTL Multi Terrain	20.79	104.23	237.04	0.23	18.03	18.03	16.59	24,992
Loader Backhoe - CAT420DIT	6.11	30.62	69.64	0.07	5.30	5.30	4.87	7,343
Scraper - 621B	22.94	58.40	341.36	0.34	13.21	13.21	12.15	39,510
Tractor - Crawler John Deere 850J Medium	11.14	24.57	176.91	0.17	6.55	6.55	6.03	18,619
Tractor - John Deere TRAM 624KR	9.88	21.80	156.99	0.15	5.81	5.81	5.35	16,521
Tractor - MC1150E/MC1155E	8.19	41.06	93.38	0.09	7.10	7.10	6.54	9,846
Total Emissions (Pounds)	156	504	2,154	2	105	105	97	238,305
Total Emissions (Tons)	0.08	0.25	1.08	0.00	0.05	0.05	0.05	119.15

Calculation of Annual Emissions for Off-Road Equipment

Emission Factor (g/hp-hr) x Total Horsepower-hours (hp-hr/yr) x 1 lb/453.6 g = Annual Emissions (lb/yr)

Calculation of Annual Emissions for On-Road Vehicles

Emission Factor (g/mile) x Number of daily truck trips x Round-trip distance (mile) x Number of working days x 1 lb/453.6 g = Annual Emissions (lb/yr)

Calculation of Annual Emissions for PM fugitive dust - ground disturbance

Emission Factor (lb/acre-day) x Acreage Disturbed (acres) x Annual number of working days (day/yr) = Annual Emissions (lb/yr)

Table E.2-17. Emission Source Data for the Operation of Vehicles on Unpaved Surfaces - MCB Camp Pendleton Stuart Mesa West Project EA

Activity/Equipment Type	*Weight (Tons)*	*Unpaved Emission Factor (Lb/VMT)*			*Annual Miles*	*% Unpaved Travel (1)*	*Unpaved Miles*
		PM	*PM_{10}*	*$PM_{2.5}$*			
Tactical Vehicles							
AAV	28.7	10.61	3.13	0.31	1,728	90%	254
Abrams Main Battle Tank - M1A1	70.0	15.85	4.68	0.47	550	90%	495
Assault Breacher Vehicle	55.0	14.22	4.20	0.42	550	90%	495
Extended Cargo Truck - MK27/28	31.1	11.00	3.25	0.32	3,840	50%	1,920
Fox NBC Reconnaissance Vehicle - M93	18.7	8.75	2.58	0.26	960	50%	480
High-Mobility Artillery Rocket System (HIMARS)	12.0	7.17	2.12	0.21	200	50%	100
HIMARS Resupply Vehicle - MK37	31.1	11.00	3.25	0.32	1,920	50%	960
HMMWV - M1114	3.0	3.84	1.13	0.11	1,920	50%	960
HMMWV Expanded Capacity Armament Carrier - M1151	5.8	5.15	1.52	0.15	1,920	50%	960
HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	5.8	5.15	1.52	0.15	1,920	50%	960
HMMWV Expanded Capacity General Purpose Vehicle - M1165	5.8	5.15	1.52	0.15	1,920	50%	960
Light Armored Vehicle (All Variants)	14.1	7.71	2.27	0.23	6,400	90%	5,760
Standard Cargo Truck - MK23/25	31.1	11.00	3.25	0.32	3,840	50%	1,920
Z-Backscatter Van	5.3	4.94	1.46	0.15	200	50%	100
Fording Training							
Extended Cargo Truck - MK27/28	31.1	11.00	3.25	0.32	3,840	50%	1,920
HIMARS Resupply Vehicle - MK37	31.1	11.00	3.25	0.32	1,920	50%	960
HMMWV - M1114	3.0	3.84	1.13	0.11	1,920	50%	960
HMMWV Expanded Capacity Armament Carrier - M1151	5.8	5.15	1.52	0.15	1,920	50%	960
HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	5.8	5.15	1.52	0.15	1,920	50%	960
HMMWV Expanded Capacity General Purpose Vehicle - M1165	5.8	5.15	1.52	0.15	1,920	50%	960
Light Armored Vehicle (All Variants)	14.1	7.71	2.27	0.23	6,400	90%	5,760
Standard Cargo Truck - MK23/25	31.1	11.00	3.25	0.32	3,840	50%	1,920
Combat Engineer Support Equipment							
Ground Disturbance (2)	3	110.0	55.0	5.5	30		
Operational Maintenance							
Ground Disturbance - Alternative A (2)	2	110.0	55.0	5.5	36		
Ground Disturbance - Alternative B (2)	2	110.0	55.0	5.5	50		

Notes: (1) Estimates

(2) Weight = daily disturbed acreage and Annual Miles = total annual days of disturbance. Emission factors in lb/acre-day.

Table E.2-18. Annual Dust Emissions from the Operation of Vehicles on Unpaved Surfaces - MCB Camp Pendleton Stuart Mesa West Pr

Equipment Type	*Annual Emissions - Tons*		
	PM	*PM_{10}*	*$PM_{2.5}$*
Tactical Vehicles			
AAV	1.35	0.40	0.04
Abrams Main Battle Tank - M1A1	3.92	1.16	0.12
Assault Breacher Vehicle	3.52	1.04	0.10
Extended Cargo Truck - MK27/28	10.56	3.12	0.31
Fox NBC Reconnaissance Vehicle - M93	2.10	0.62	0.06
High-Mobility Artillery Rocket System (HIMARS)	0.36	0.11	0.01
HIMARS Resupply Vehicle - MK37	5.28	1.56	0.16
HMMWV - M1114	1.84	0.54	0.05
HMMWV Expanded Capacity Armament Carrier - M1151	2.47	0.73	0.07
HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	2.47	0.73	0.07
HMMWV Expanded Capacity General Purpose Vehicle - M1165	2.47	0.73	0.07
Light Armored Vehicle (All Variants)	22.19	6.55	0.66
Standard Cargo Truck - MK23/25	10.56	3.12	0.31
Z-Backscatter Van	0.25	0.07	0.01
Tactical Vehicles - Total Emissions	69.34	20.47	2.05
Fording Training			
Extended Cargo Truck - MK27/28	10.56	3.12	0.31
HIMARS Resupply Vehicle - MK37	5.28	1.56	0.16
HMMWV - M1114	1.84	0.54	0.05
HMMWV Expanded Capacity Armament Carrier - M1151	2.47	0.73	0.07
HMMWV Expanded Capacity Cargo Troop/Carrier IAP/Armor Ready - M1152 (A1)	2.47	0.73	0.07
HMMWV Expanded Capacity General Purpose Vehicle - M1165	2.47	0.73	0.07
Light Armored Vehicle (All Variants)	22.19	6.55	0.66
Standard Cargo Truck - MK23/25	10.56	3.12	0.31
Ford Training Vehicles - Total Emissions	57.85	17.07	1.71
Combat Engineer Support Equipment			
Ground Disturbance	4.95	2.48	0.25
Operational Maintenance			
Ground Disturbance - Alternative A	3.96	1.98	0.20
Ground Disturbance - Alternative B	5.50	2.75	0.28

Table E.2-19. Proposed Aircraft Operations - MCB Camp Pendleton Stuart Mesa West Project EA

Aircraft Type	*Annual Sorties*	*Cruise Mode/ Sortie at Project Site (Hours)*	*Operations per Sortie*	
			Landings	*Other*
AH-1	16	1.50	-	1
CH-53	16	0.33	1	1
MV-22	40	0.33	1	1
UH-1	40	0.33	1	1

Notes: (1) Assumes

Table E.2-20. Aircraft Transit Flights Distances/Durations - MCB Camp Pendleton Stuart Mesa West Project EA

	Cruising	Round Trip Distance (NM)			Round Trip Cruise Duration (Hrs)			Origin Fraction			Composite Round Trip
Aircraft Type	Speed (Kts)	MCAS CP	CP ATA	MCAS Mir	MCAS CP	CP ATA	MCAS Mir	MCAS CP	CP ATA	MCAS Mir	Cruise Duration (Hrs)
AH-1	100	10.4	3.5	49.4	0.10	0.03	0.49	0.6	0.4		0.08
CH-53	120	10.4	3.5	49.4	0.09	0.03	0.41		0.4	0.6	0.26
MV-22	140	10.4	3.5	49.4	0.07	0.02	0.35		0.4	0.6	0.22
UH-1	100	10.4	3.5	49.4	0.10	0.03	0.49	0.6	0.4		0.08

Table E.2-21. AH-1 Aircraft Emission Factors - MCB Camp Pendleton Stuart Mesa West Project EA

Operation Type	Engine Power Setting	Fuel Flow Rate/ Aircraft (Lb/Hr)	VOC	CO	NOx	SO2	PM10	PM2.5	CO2	References
			Engine Emission Factors - Pounds/1000 Pounds Fuel							
Cruise	38% Q	850	0.56	10.54	5.55	0.40	4.20	4.16	3,216	1
		Fuel/Operation (Lb)	Emissions per Operation - Pounds							
LTO		428	0.33	7.08	2.09	0.17	1.80	1.78	852	1
Mountain Pad Landing		67	0.04	0.76	0.36	0.03	0.28	0.28	214	2

Notes: The AH-1W/Z helicopters have 2 T700-GE-401C engines.

(1) AESO Memorandum Report No. 9824, Revision B, Aircraft Emissions Estimates: AH-1W Takeoff and Landing Cycle and In-Frame, Maintenance Testing Using JP-5, November 2009.

(2) AESO Memorandum Report No. 9961, Revision A, Aircraft Emissions Estimates: AH-1 Mission Operations Using JP-5, November 2009.

Table E.2-22. CH-53 Aircraft Emission Factors - MCB Camp Pendleton Stuart Mesa West Project EA

Operation Type	Engine Power Setting	Fuel Flow Rate/ Aircraft (Lb/Hr)	VOC	CO	NOx	SO2	PM10	PM2.5	CO2	References
			Engine Emission Factors - Pounds/1000 Pounds Fuel							
Cruise	70% Qeng	4,464	0.15	2.13	8.08	0.40	2.21	2.19	3,210	1
		Fuel/Aircraft Op (Lb)	Emissions per Operation - Pounds							
LTO		1,746	11.24	22.86	8.86	0.70	3.76	3.72	5,605	1
Mountain Pad Landing		540	0.52	1.94	4.03	0.22	1.19	1.18	1,733	2

Notes: The CH-53 helicopter has 3 T64-GE-415 engines.

(1) AESO Memorandum Report No. 9822, Revision C, Aircraft Emissions Estimates: H-53 Takeoff and Landing Cycle and In-Frame, Maintenance Testing Using JP-5, February 2000, except CO2 emissions based upon a factor of 3,210 lb/1000 lb fuel.

(2) AESO Memorandum Report No. 9960, Revision B, Aircraft Emissions Estimates: H-53 Mission Operations Using JP-5, April 2000, except CO2 emissions based on a factor of 3,210 lb/1000 lb fuel.

Table E.2-23. MV-22 Aircraft Emission Factors - MCB Camp Pendleton Stuart Mesa West Project EA

Operation Type	*Engine Power Setting*	*Fuel Flow Rate/ Engine (Lb/Hr)*	*VOC*	*CO*	*NOx*	*SO2*	*PM10*	*PM2.5*	*CO2*	*References*
			Individual Engine Emission Factors - Pounds/1000 Pounds Fuel							
FW (0°) Cruise		3,820	0.01	0.52	14.09	0.40	1.58	1.56	3,209	1
Helo (16°) Cruise		3,060	0.01	0.79	11.64	0.40	1.58	1.56	3,212	1
Average Cruise		3,440	0.01	0.66	12.87	0.40	1.58	1.56	3,211	1
		Fuel/Aircraft Op (Lb)	*Emissions per Operation - Pounds*							
LTO		1,289	0.08	5.33	9.25	0.52	1.73	1.71	4,151	1
Single Pad or Confined Area Landing - Pounds		592	0.01	0.29	8.87	0.24	0.94	0.93	1,899	2

Notes: The MV-22 aircraft has 2 T406-AD-400 engines.

(1) AESO Memorandum Report No. 9946, Revision E, Aircraft Emissions Estimates: V-22 Landing and Takeoff Cycle and In-Frame, Engine Maintenance Testing Using JP-5, January 2001. LTO data based on a short landing (airplane mode).

(2) AESO Memorandum Report No. 9965, Revision B, Aircraft Emissions Estimates: V-22 Mission Operations Using JP-5, January 2001.

Table E.2-24. HH-1/UH-1 Aircraft Emission Factors - MCB Camp Pendleton Stuart Mesa West Project EA

Operation Type	*Engine Power Setting*	*Fuel Flow Rate/ Aircraft (Lb/Hr)*	*VOC*	*CO*	*NOx*	*SO2*	*PM10*	*PM2.5*	*CO2*	*References*
			Engine Emission Factors - Pounds/1000 Pounds Fuel							
Cruise	54% Qeng	692	0.13	1.01	5.79	0.40	4.20	4.16	3,207	1
		Fuel/Aircraft Op (Lb)	*Emissions per Operation - Pounds*							
LTO		280	0.67	3.32	1.28	0.11	1.18	1.17	893	1
Mountain Pad Landing		209	0.01	0.23	0.32	0.03	0.27	0.27	209	2

Notes: The HH-1/UH-1 helicopters have 2 T400-CP-400 engines.

(1) AESO Memorandum Report No. 9904, Revision B, Aircraft Emissions Estimates: HH/UH-1N Takeoff and Landing Cycle and In-Frame, Maintenance Testing Using JP-5, November 2009.

(2) AESO Memorandum Report No. 9962, Revision A, Aircraft Emissions Estimates: UH-1 and HH-1 Mission Operations Using JP-5, November 2009.

Table E.2-25. Fugitive Dust Emission Factors for One Aircraft Pad Landing within Imperial County - Proposed USMC Rotary Wing and Tilt-Rotor Training Operations.

Aircraft	*Total Engine Hp Rating*	*Rotor Diameter (Ft) (1)*	*Disturbed Area (m^2) (2)*	*U_{10} (m/s) (3)*	*Threshold Friction Velocity u_t (m/s) (4)*	*Friction Velocity u* (m/s) (5)*	*P (Gm/m^2) (6)*	*Pounds/LTO (7)*		
								PM	*PM10*	*PM2.5*
AH-1W/Z	3,380	48.0	1,513	32.3	1.70	1.710	0.24	0.82	0.41	0.06
CH-53	7,850	79.0	4,098	32.5	1.70	1.721	0.56	5.06	2.53	0.38
MV-22	12,300	84.0	4,633	32.7	1.70	1.732	0.87	8.87	4.43	0.66
UH-1N	2,500	48.0	1,513	32.2	1.70	1.707	0.18	0.61	0.31	0.05
UH-1Y	3,656	49.0	1,576	32.3	1.70	1.710	0.27	0.92	0.46	0.07

Notes: (1) Due to rotor overlap, actual diameters for CH-46 and MV-22 used in the calculations = 84.3' and 84', respectively.

(2) Equal to 3 times the rotor diameter - the area of disturbance expected from rotary wing aircraft during a desert landing and take-off.

(3) Wind speeds at 10 meter level (U_{10}) for the MV-22 based upon wind speeds measured at 1 meter above ground when this aircraft hovered at 20' AGL (Bell Boeing 2008). Equates to equation #5 presented in AP-42 Section 13.2.5 (EPA 2006). This approach assumes that the maximum aircraft downdraft approaches the fastest mile wind speed. Wind speeds for all other aircraft estimated by multiplying U_{10} for the MV-22 times the ratio of the horsepower rating of each aircraft divided by the horsepower rating of the MV-22. This approach was taken, as data are not available to adequately estimate the down draft wind speeds for these aircraft, yet aircraft horsepower rating is proportional to potential thrust or the ability of an aircraft to generate down draft.

(4) Threshold friction velocity value chosen from values listed for surface types identified in Table 8-3 in the WRAP Fugitive Dust Handbook (Countess Environmental 2006). Data on climatic conditions, soil and vegetation conditions described in Archaeological and Biological surveys for the proposed landing zones (LZs), and observations of dust emissions generated by a CH-46 landing at the existing Canary LZ, were used in this selection process (SAIC 2011 and 2012b).

(5) Equates to equation #4 presented in AP-42 Section 13.2.5.

(6) Equates to equation #3 presented in AP-42 Section 13.2.5.

(7) Equal to Disturbed Area times P. These values are annual averages.

Table E.2-26. Fugitive Dust Emission Factors for One Rotary Wing and Tilt-Rotor Aircraft Pad Landing - MCB Camp Pendleton Stuart Mesa West Project EA.

Aircraft	*Total Engine Hp Rating*	*Rotor Diameter (Ft) (1)*	*Disturbed Area (m^2) (2)*	*U_{10} (m/s)*	*Threshold Friction Velocity (m/s)*	*U* (m/s)*	*P (Gm/m^2) (3)*	*Pounds/LTO (4)*		
								PM	*PM10*	*PM2.5*
AH-1W/Z	3,380	48.0	1,513				0.20	0.65	0.33	0.05
CH-53	7,850	79.0	4,098				0.45	4.04	2.02	0.30
MV-22	12,300	84.0	4,633				0.69	7.09	3.55	0.53
UH-1N	2,500	48.0	1,513				0.15	0.49	0.24	0.04
UH-1Y	3,656	49.0	1,576				0.21	0.74	0.37	0.06

Notes: (1) Due to rotor overlap, actual diameters for CH-46 and MV-22 used in the calculations = 84.3' and 84', respectively.

(2) Equal to 3 times the rotor diameter - the area of disturbance expected from rotary wing aircraft during a desert landing and take-off.

(3) P values = 80% of those defined for the Imperial Valley (IV) project region, as determined for the MV-22 Training EA (USMC 2013). While the Stuart Mesa West project site has a cooler and more humid climate than the IV MV-22 project region, the project site has fairly silty soils that have the potential to generate substantial amounts of dust from rotary wing aircraft downwash.

(4) Equal to Disturbed Area times P. These values are annual averages.

Table E.2-27. Annual Emissions from Aircraft Operations - MCB Camp Pendleton Stuart Mesa West Project EA.

	Annual Emissions (Tons)						
Operation/Aircraft Type	*VOC*	*CO*	*NOx*	*SO2*	*PM10*	*PM2.5*	*CO2*
Landing and Take-off							
AH-1	0.00	0.06	0.02	0.00	0.01	0.01	6.82
CH-53	0.09	0.18	0.07	0.01	0.03	0.03	44.84
MV-22	0.00	0.11	0.19	0.01	0.03	0.03	83.02
UH-1	0.01	0.07	0.03	0.00	0.02	0.02	17.86
Subtotal	0.11	0.41	0.30	0.02	0.10	0.10	152.53
Transit to and from Project Site							
AH-1	0.00	0.01	0.00	0.00	0.00	0.00	1.67
CH-53	0.00	0.02	0.07	0.00	0.02	0.02	29.65
MV-22	0.00	0.01	0.20	0.01	0.02	0.02	48.96
UH-1	0.00	0.00	0.01	0.00	0.00	0.00	3.39
Subtotal	0.00	0.04	0.28	0.01	0.05	0.05	83.67
Cruise Mode at Project Site							
AH-1	0.01	0.11	0.06	0.00	0.04	0.04	32.80
CH-53	0.00	0.03	0.10	0.00	0.03	0.03	37.83
MV-22	0.00	0.01	0.29	0.01	0.04	0.04	72.89
UH-1	0.00	0.00	0.03	0.00	0.02	0.02	14.66
Subtotal	0.01	0.15	0.47	0.02	0.12	0.12	158.18
Pad Landings							
AH-1							
CH-53	0.00	0.02	0.03	0.00	0.01	0.01	13.87
MV-22	0.00	0.01	0.18	0.00	0.02	0.02	37.98
UH-1	0.00	0.00	0.01	0.00	0.01	0.01	4.18
Subtotal	0.00	0.03	0.22	0.01	0.03	0.03	56.03
Pad Landings - Dust							
AH-1							
CH-53					0.02	0.00	
MV-22					0.07	0.01	
UH-1					0.01	0.00	
Subtotal					0.09	0.01	
Total Combustive Aircraft Emissions	0.12	0.60	1.05	0.05	0.28	0.27	394.39
Total Fugitive Dust Emissions					0.09	0.01	

Table E.2-28. Annual Construction and Operational Emissions - MCB Camp Pendleton Stuart Mesa West Project EA - Alternative A

	Annual Emissions (Tons per Year)								*MT*
Activity/Source	*VOC*	*CO*	*NO_X*	*SO_X*	*PM*	*PM_{10}*	*$PM_{2.5}$*	*CO_2*	*CO_2*
Construction									
Combustive Emissions from Equipment	0.03	0.08	0.40	0.00	0.02	0.02	0.02	43.78	40
Fugitive Dust					2.24	1.08	0.11		
Construction Total Emissions	0.03	0.08	0.40	0.00	2.26	1.10	0.13	43.78	40
Amphibious Operations									
AAV Combustive Emissions	0.18	0.82	2.05	0.10		0.24	0.22	163.25	148
Fugitive Dust						8.50	1.36		
Amphibious Operations Total Emissions	0.18	0.82	2.05	0.10		8.73	1.58	163.25	148
Tactical Vehicles									
Tactical Vehicles Combustive Emissions	0.06	0.22	0.92	0.01	0.02	0.04	0.04	114.62	104
Fugitive Dust					69.34	20.47	2.05		-
Tactical Vehicles Total Emissions	0.06	0.22	0.92	0.01	69.36	20.51	2.09	114.62	104.01
Fording Training									
Fording Training Vehicles Combustive Emissions	0.03	0.08	0.47	0.00	0.02	0.02	0.02	53.95	49
Fugitive Dust					57.85	17.07	1.71		-
Fording Training Total Emissions	0.03	0.08	0.47	0.00	57.86	17.09	1.72	53.95	48.96
Combat Engineer Support Equipment									
Support Equipment Combustive Emissions	0.40	1.17	6.33	0.01	0.22	0.22	0.21	762.38	692
Fugitive Dust					4.95	2.48	0.25		-
Combat Engineer Support Total Emissions	0.40	1.17	6.33	0.01	5.17	2.70	0.45	762.38	691.82
Operational Maintenance									
Maintenance Vehicles Combustive Emissions	0.08	0.25	1.08	0.00	0.05	0.05	0.05	119.15	108
Fugitive Dust					3.96	1.98	0.20		-
Operational Maintenance Total Emissions	0.08	0.25	1.08	0.00	4.01	2.03	0.25	119.15	108.12
Aircraft Operations									
Aircraft Combustive Emissions	0.12	0.60	1.05	0.05		0.28	0.27	394.39	358
Fugitive Dust						0.09	0.01		
Aircraft Operations Total Emissions	0.12	0.60	1.05	0.05		0.37	0.29	394.39	357.88
Total Annual Emissions (1)	0.87	3.14	11.90	0.17	136.41	51.44	6.37	1,608	1,459
Conformity Thresholds - Tons per Year	100	100	100						
Exceed De Minimis Thresholds?	N	N	N	NA	NA	NA	NA	NA	NA

Notes: (1) Excludes construction, as this would occur in a calendar year prior to initiation of proposed training activities.

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Appendix F

Final Jurisdictional Determination Report for the Stuart Mesa West Training and Conversion Project

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Final Jurisdictional Determination Report

for the Stuart Mesa West Training and Conversion Project

Marine Corps Base
Camp Pendleton, California

March 2014

Final Jurisdictional Determination Report

for the Stuart Mesa West Training and Conversion Project

Marine Corps Base
Camp Pendleton, California

March 2014

Cover photo: Wetland with yerba mansa (*Anemopsis californica*)

Executive Summary

Surveys were conducted at Marine Corps Base (MCB) Camp Pendleton, California in support of a National Environmental Policy Act (NEPA) action for the areas associated with the proposed Stuart Mesa West Training and Conversion (SMWTC) Environmental Assessment at MCB Camp Pendleton. The purpose of the surveys was to determine the occurrence of wetlands and other bodies of water that may be subject to the regulatory jurisdiction of the United States (U.S.) Army Corps of Engineers (USACE) under Sections 401 and 404 of the Clean Water Act (CWA) (33 Code of Federal Regulations [CFR] parts 320 – 330). Surveys were conducted in conjunction with vernal pool fairy shrimp surveys and rare plant surveys, the results of which will be submitted in separate reports.

Delineations of jurisdictional wetlands and other waters of the U.S. were conducted on 14 to 16 May 2012 and 1 June 2012. Wetlands were delineated following the 1987 *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and *Arid West Regional Supplement* (USACE 2008), per the requirements of the Los Angeles District of the USACE. A total of 17.1 acres (6.9 hectares) of jurisdictional wetlands were identified at the southeastern portion of the survey area, within the floodplain of the Santa Margarita River and estuary. This includes 12.1 acres (4.9 hectares) of palustrine, emergent, persistent, seasonally flooded-tidal (PEM1R), 4.9 acres (2.0 hectares) of palustrine emergent/scrub-shrub, seasonally flooded-tidal (SS1R), and one small area (0.1 acres/0.04 hectares) of open water associated with a channel in the floodplain. The jurisdictional wetlands within the survey area are adjacent to the Santa Margarita River and would be considered either wetlands adjacent to traditional navigable waters (TNW) or wetlands adjacent to relatively permanent waters (RPW). In addition, the survey area is located along the shore-line of the Pacific Ocean. No wetlands were identified in the southwestern portion of the study area, although the shore up to the high water level of 8.8 feet (2.7 meter) above National Oceanic and Atmospheric Administration (NOAA) Station 9410170 San Diego Datum (NOAA 2012) are jurisdictional waters of the U.S. Eight isolated temporarily-ponded basins located in disturbed areas on the top of Stuart Mesa were investigated, but none of these areas met all three criteria for determination of wetlands.

Any project related activities that have the potential to result in fill or impacts to areas determined to be jurisdictional by the USACE Los Angeles District will require regulatory coverage as prescribed by Sections 401 and 404 of the CWA. Construction associated with culvert drainage repair and erosion control measures, including armoring of the access road, have the potential to directly or indirectly affect jurisdiction wetlands in the project area. Training activities on the beach may affect jurisdictional waters of the U.S. if they occur within the high water level (i.e., high tide line). If it is determined that project activities will directly or indirectly affect features determined to be jurisdictional, it will require submittal of a permit application to USACE and a clean water certification from the Regional Water Quality Control Board. If the direct or indirect effects of the project action would result in a "minimal amount" of potential fill into jurisdictional wetlands or waters of the U.S., and potential loss of jurisdictional features is minimized, coverage under an existing Nationwide Permit (NWP) may be possible.

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Attachments

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Acronyms

BO	Biological Opinion
CFR	Code of Federal Regulations
CWA	Clean Water Act
ES	Environmental Security
GIS	Geographic Information System
GPS	Global Positioning System
MCB	Marine Corps Base
MCTSSA	Marine Corps Tactical Systems Support Activity
NAVFAC SW	Naval Facilities Engineering Command Southwest
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWI	National Wetland Inventory
NWP	Nationwide Permit
NWPL	National Wetland Plant List
OHWM	Ordinary High Water Mark
PEM1R	Palustrine, emergent, persistent seasonally flooded-tidal
RPW	Relatively Permanent Waters
RWQCB	Regional Water Quality Control Board
SAIC	Science Applications International Corporation
SMWTC	Stuart Mesa West Training and Conversion
SS1R	Scrub-shrub seasonally flooded-tidal (SS1R)
TNW	Traditional Navigable Waters
U.S.	United States
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USMC	U.S. Marine Corps
WIS	Wetland Indicator Status

1 Introduction

Surveys were conducted in support of a National Environmental Policy Act (NEPA) action on Marine Corps Base (MCB) Camp Pendleton, California. The objective of the surveys was to determine the occurrence and extent of wetlands and other features that may be subject to the regulatory jurisdiction of the United States (U.S.) Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act (CWA) (33 Code of Federal Regulations [CFR] parts 320 – 330) or the Regional Water Quality Control Board (RWQCB) under Section 401 (Water Quality Certification) of the CWA. The surveys also included an assessment of vernal pools within the same project area.

This report summarizes data collection and analysis conducted for the areas associated with the proposed Stuart Mesa West Training and Conversion (SMWTC) Environmental Assessment at MCB Camp Pendleton. The determinations herein are subject to verification by the MCB Camp Pendleton Environmental Security (ES) Land Management Branch, Naval Facilities Engineering Command Southwest (NAVFAC SW), and ultimately by the Los Angeles District of the USACE.

A description of the project site and proposed project are included in Section 2. Methods used to conduct the surveys and the results are included in Section 3. For the purpose of this report, vegetation categories are described using *Draft Vegetation Communities of San Diego County* (Oberbauer et al. 2008). Wetlands and other waters of the U.S. are classified according to the *Cowardin Classification of Wetlands and Deepwater Habitat of the United States* (Cowardin et al. 1979), which is also used by the USACE for jurisdictional determination. Plant names follow *The Jepson Manual* (Baldwin et al. 2012); plants are also assigned a Wetland Indicator Status (WIS) following the 2012 National Wetland Plant List (NWPL) (Lichvar and Kartesz 2009). A list of plant species observed during the wetland delineation surveys is provided in Attachment A. Attachment B includes copies of wetland delineation forms. Attachment C includes representative photos of the survey area, and Attachment D identifies surveyor teams.

2 Site and Project Description

2.1 Project Location

The proposed SMWTC project site is located on MCB Camp Pendleton, the U.S. Marine Corps' (USMC's) major amphibious training center for the West Coast (Figure 1). MCB Camp Pendleton is a 200-square mile (518-square kilometer) area located primarily within the northern portion of San Diego County, 40 miles (64 kilometers) north of downtown San Diego. The Orange County line is contiguous with the northwest boundary of MCB Camp Pendleton; Riverside County is to the north but not adjacent to the boundary of MCB Camp Pendleton. The City of San Clemente and the Cleveland National Forest border MCB Camp Pendleton to the north and east, with the community of Fallbrook and the Naval Weapons Station – Seal Beach/Fallbrook Annex to the east. The City of Oceanside is located to the south. The survey area is part of the former Stuart Mesa West Agricultural Field.

The project site is located on Stuart Mesa just northeast of the Pacific Ocean, south of Cockleburr Canyon, west of Newton Canyon and Interstate 5, and northwest of the Santa Margarita River (Figure 2). The purpose of the proposed action is to develop a new training area on MCB Camp Pendleton that can accommodate combined land, air, and sea training operations. A new training area is needed to support USMC mission requirements because MCB Camp Pendleton currently lacks a training area that can accommodate all three types of training operations. The proposed new training area would address this deficiency and meet the need for a dedicated amphibious operations training area at MCB Camp Pendleton that can accommodate large-scale amphibious operations.

Stuart Mesa West Training and Conversion Project Location

FIGURE 1

Stuart Mesa West Training and Conversion Project Area and Jurisdictional Determination/Vernal Pool Assessment Survey Area

FIGURE 2

2.2 Proposed Project

The proposed project would result in a change of land use for about 233 acres (94 hectares) of the existing Stuart Mesa West Agricultural Field located on Stuart Mesa between Cockleburr Canyon to the northwest and the Santa Margarita River to the southeast. The USMC outleased the field to Singh and Sons, who grew tomatoes until their lease expired in January 2011. The land is currently lying fallow.

Depending on the specific mission, training could range from a single company commander conducting maneuvers with three infantry platoons to full battalion training (up to 400 personnel), with integrated amphibious operations, infantry movements, air support, and logistics support. The proposed new training area would be available for operations 24 hours per day and year-round; however, some training restrictions may occur during sensitive breeding seasons. Specific training elements proposed for the new training area include the following:

- *Amphibious Landings*. Amphibious assault vehicles would cross the tidal zone and come ashore at the beach directly west of the main training area. Offloaded Marines and tracked or wheeled vehicles would proceed to the main training area via the existing access road or a potential new access road. A logistics/Command Post Operations would be set up in the beachhead area, and maneuvers and firing (non-live fire) may be conducted off of the beachhead. Conceptually, the training would allow Marines to simulate a beach assault/landing, secure the beach, and then move the units off the beach to establish a beachhead for logistical supply and Command Post Operations.
- *Land-based Maneuvers*. Once in the main training area, infantry and mechanized formation training would occur. Training would include trenching to dig fighting positions, bury communication wire (about 12 inches in depth), and create percolation ponds (about 2 feet in depth). Training may include use of non-live fire and sound simulating training aids.
- *Air Support*. Rotary wing and tilt-rotor aircraft would be used to support amphibious, convoy and medical evacuation operations. There would be no designated landing zone in the training area. Aircraft crew members would make the decision as to where to land in the training area to best support units. Air support would usually consist of two aircraft, and it is estimated that about 160 aircraft landings would occur per year.
- *Logistics Support*. A wide range of logistics support may be provided during proposed training operations, depending on mission objectives, such as refueling motorized and mechanized equipment, setting up food and shower facilities, and even constructing a temporary ammunition dump within the proposed training area.

The proposed undertaking would involve some site improvements to the project area, including development of an AAV driver's course, possible erosion-control measures, modifying and/or constructing beach access roads, possibly constructing a barrier along the freeway, and general site grading/routine maintenance to control on-site vegetation.

3 Background

3.1 Regulatory Setting

Federal wetlands and other waters of the U.S. have legal protection in accordance with Sections 401 and 404 of the CWA (33 U.S. Code [U.S.C.] Section 1344). The USACE generally requires the issuance of an individual permit, or coverage under an existing Nationwide Permit (NWP), for all actions that have the potential to degrade or modify these features.

Section 401 of the CWA (33 U.S.C. 1341) requires all applicants that apply for a Federal license or permit to conduct an activity that may result in a discharge of a pollutant into waters of the U.S. to obtain certification from the State in which the discharge originates. As a result, proposed fill or development in jurisdictional features requires coordination with the appropriate RWQCB that administers Section 401 and provides certification. The RWQCB also plays a role in review of water quality and wetland issues, including avoidance and minimization of impacts. Section 401 certification is required prior to issuance of a Section 404 permit.

3.2 Definitions

As defined under Section 404 of the CWA, wetlands are areas that are "inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Wetlands generally include swamps, marshes, bogs, and similar areas (Unites States Environmental Protection Agency [USEPA], 40 CFR 230.3 and USACE, 33 CFR 328.3). Wetlands are recognized as a special aquatic site under the Section 404(b)(1) guidelines, and a "no net loss" policy continues to guide federal regulatory actions affecting wetlands under Section 404. Jurisdictional wetland areas are identified and delineated according to the USACE's *Arid West Regional Supplement* (USACE 2008), per the requirements of the Los Angeles District of the USACE.

Jurisdictional wetlands are a subset of waters of the U.S., which include, in addition to wetlands as defined above, areas subject to the ebb and flow of the tide and areas that are within the limits of ordinary high water. Waters are currently described as any areas that might be considered waterways, either for commerce or recreation, even on a limited scale. Frequently, the term "wetlands and other waters of the U.S." is used when describing areas under USACE jurisdiction. Jurisdictional boundaries of waters of the U.S. are determined with consideration of recent guidance from the USEPA and the USACE on implementing the Supreme Court's decision in the consolidated cases Rapanos v. United States and Carabell v. United States (USEPA and USACE 2007). Under that decision, the USACE will assert jurisdiction over the following features:

Traditional Navigable Waters. Traditional Navigable Waters (TNWs) are all waters subject to the ebb and flow of the tides, and waters that are presently used, have been used in the past, or may be susceptible for use to transport interstate or foreign commerce (33 CFR 328.3(a)(1)).

Wetlands adjacent to TNWs. Wetlands are defined as cited above. The term "adjacent" means bordering, contiguous, or neighboring, meeting one of the following criteria: 1) there is an unbroken surface or shallow sub-surface connection to the TNW; 2) the wetland is physically separated from the TNW artificially by a man-made dike, or by natural barrier such as a berm or dune; or 3) the wetland is reasonably close to the TNW, such that direct ecological interconnections are present.

Non-navigable, but Relatively Permanent Waters (RPWs) that are tributaries to TNWs. These are waters that typically flow year-round or continuously for at least three months. The boundaries of such waters are determined by the limits of ordinary high water (33 CFR Part 328.3).

Wetlands adjacent to RPWs. The guidance stipulates that a continuous surface connection must be present between the wetland and RPW. If such connection is not present, additional criteria must be satisfied.

Non-RPWs and adjacent wetlands with a significant nexus to TNWs. To establish a significant nexus requires an assessment of the flow characteristics and functions of the tributary and any adjacent wetland to determine if they significantly affect the chemical, physical, and biological integrity of downstream navigable waters.

4 Methodology

Prior to conducting field sampling, reviews of existing data were conducted. These reviews included aerial photography, rainfall records to determine if seasonal conditions were normal, the National Wetlands Inventory (NWI) (U.S. Fish and Wildlife Service [USFWS] 2012) and soil survey data (Natural Resources Conservation Service [NRCS] 2012).

Surveys were conducted from 14 to 16 May 2012, and 1 June 2012. The surveys were conducted in conjunction with the rare plant surveys (Leidos [formally Science Applications International Corporation (SAIC)] 2012). The survey area was based on the project footprint and an associated 350-foot (107-meter) buffer (Figure 2). The size of the buffer follows the standard approach used on other USMC rotary wing and tilt-rotary projects to address aircraft rotor wash effects from aircraft landing operations. The survey area, as shown on Figure 2, excludes developed areas associated with the existing Marine Corps Tactical Systems Support Activity Cantonment Area (MCTSSA) facility and Interstate 5, and excludes areas north/east of Interstate 5 because the interstate provides a physical barrier for project-related effects. Per the direction of MCB Camp Pendleton ES, the survey area excludes the area historically used for agriculture (although the outer edge of the agricultural area and adjacent dirt roads were examined). Finally, the survey area excluded the beach and some sections of the foredunes and estuary due to the presence of or habitat for nesting snowy plover (*Charadrius alexandrines nivosus*), California least tern (*Sterna antillarum brownii*), and light-footed clapper rail (*Rallus longirostris levipes*) habitat (kick off meeting on 2 May 2012, with Barak Sheami [ES]).

Survey points were mapped electronically using a Trimble Geo XT2005 sub-meter Differential Global Positioning System (GPS) unit and plotted in the field on ortho-rectified aerial photos.

The jurisdictional determination surveys were conducted by walking the survey area and visually observing areas of potential wetlands or waters of the U.S. based on the presence of hydrophytic plants, standing water or saturated soils, or other soil surface features that indicate surface water or saturated conductions recently occurred (e.g., low spots, darker soils, cracks in the soil surface, dried algae, etc.). Areas identified as potential wetlands were further investigated using the wetland delineation method. Where wetland delineation is performed, a narrow pit up to 24 inches in depth is dug to look for indicators of wetland conditions in each of three parameters: hydrophytic vegetation, hydric soils, and wetland hydrology. Data are recorded on wetland determination data forms for the arid west region (USACE 2008). Positive indicators for each of three parameters are required for a wetland to meet the USACE criteria for jurisdictional wetland determination, as follows:

1) *Hydrophytic vegetation* is defined as macrophytic vegetation that is adapted to, and occurs in, areas where soils are frequently or permanently saturated of sufficient duration to exert a controlling influence on the plant species present. Plant species adjacent to the delineation pit were identified and included following the “50/20 rule,” meaning that plant species in each layer of the vegetation (herb, shrub, tree, and vine) were included in order of abundance until at least 50 percent of the total vegetation cover was accounted for, and all species with at least 20 percent relative cover were included. Plants are assigned a WIS based on their frequency of occurrence in wetland habitats following the NWPL (Lichvar and Kartesz 2009), which is an update of the 1988 *National List of Plant Species that Occur in Wetlands* (Reed 1988). The USACE issued a Final Notice requiring the use of the 2012 NWPL for delineations conducted after 1 June 2012 (USACE 2012). A list of plant species observed during the wetland delineation surveys is provided in Attachment A, including the WIS from the 2012 NWPL with changes from the previous Reed (1988) list noted in parentheses. The WIS categories (USACE 2012; Lichvar and Gillrich 2011) are defined as:

    - UPL (Obligate Upland) = Plants that almost never occur in water or saturated soils.

- FACU (Facultative Upland) = Plants that typically occur in xeric (dry) or mesic (moist) nonwetland habitats but may frequently occur in standing water or saturated soils.
- FAC (Facultative) = Plants that occur in a variety of habitats, including wetland and mesic to xeric nonwetland habitats but often occur in standing water or saturated soils.
- FACW (Facultative Wetland) = Plants that nearly always occur in areas of prolonged flooding or require standing water or saturated soils but may, on rare occasions, occur in nonwetlands.
- OBL (Obligate Wetland) = Plants that always occur in standing water or in saturated soils.

The hydrophytic vegetation parameter is met when at least one of the following tests is fulfilled:

- The prevalent vegetation (more than 50 percent of the dominant plant species) is typically adapted to areas having wetland hydrology and hydric soil conditions and rated OBL, FACW, or FAC.
- The prevalence index, which is a value determined by accounting for the relative cover and WIS and ranges from 1 (only OBL species present) to 5 (only UPL species present), is less than or equal to 3.
- Vegetation has morphological adaptations to growing in inundated or saturated conditions

2) *Hydric soils*, which are indicative of wetlands, are defined as soils that are sufficiently ponded, flooded, or saturated throughout the growing season to produce anaerobic conditions that favor the growth of hydrophytic vegetation (Environmental Laboratory 1987). Hydric soils are identified based on observable properties that result from prolonged saturated-anaerobic conditions. To assess whether hydric soil was present at each sample point, a soil pit was excavated to a depth of 24 inches (when possible), and soil attributes (including color, mottling, texture, grain size, structure, streaking, degree of saturation) were recorded on the delineation forms. Soil colors were assessed using *Munsell Soil Color Charts* (Munsell Color 1992). Other than direct observation of saturated conditions, low chroma (dark) or gley soil colors are among the most conspicuous indicators of hydric soils.
3) *Wetland hydrology* refers to inundation and/or saturation of the soil by flooding or a shallow water table for a prolonged period during the growing season, such that the character of the soil and vegetation are substantially different from areas that do not experience inundation/saturation in this manner. The identification of wetland hydrology follows the Environmental Laboratory (1987) delineation manual and *Arid West Regional Supplement* (USACE 2008). Geomorphic features associated with flooding (e.g., channels, shorelines) and sediment deposits are among the indicators of wetland hydrology.

The *USACE Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the United States* (Lichvar and McColley 2008) was referenced to determine the boundaries of the non-wetland waters of the U.S. In addition, waters of the U.S. are determined with consideration of recent guidance from the USEPA and the USACE on implementing the Supreme Court's decision in the consolidated cases Rapanos v. United States and Carabell v. United States (USEPA and USACE 2007). Under that decision, the USACE will assert jurisdiction over TNWs, wetlands adjacent to TNWs, relatively permanent non-navigable tributaries to TNWs that flow at least seasonally (typically defined as supporting continuous flow for at least three months), and wetlands that abut such tributaries. The USACE may also assert jurisdiction over tributaries to features that do not have seasonal flow only if there is a specific nexus for doing so, such as if the flow characteristics and functions of the tributary significantly affect the chemical, physical, and biological integrity of downstream navigable waters, or if adjacent wetlands are present. The USACE will not assert jurisdiction over swales and erosional features.

Within the project area, the Pacific Ocean is a TNW; the landward limit of jurisdiction is the high tide line in tidal waters (USACE 2008). The limits of jurisdiction (i.e., high tide line or high water line) were determined by accessing tidal data from the National Oceanic and Atmospheric Administration (NOAA) Station 9410230 in La Jolla, CA (the closest station to the project area).

5 Review of Existing Information

5.1 Vegetation

Vegetation mapping was not included as part of the survey, although the existing MCB Camp Pendleton Geographic Information System (GIS) vegetation data (2012) were used to assist with the mapping of jurisdictional features. The survey area consisted of southern foredunes, coastal bluff scrub, Diegan coastal sage scrub, riparian habitats dominated by willow species (including southern riparian scrub, woodland and forest), coastal and valley freshwater marsh, southern coastal sat marsh, former agricultural lands dominated by weedy native and non-native herbaceous plants, and disturbed areas (i.e., dirt roads). As described above, the survey excluded the agricultural lands, although vernal pools were recorded by AMEC (2014) on the edge of the agricultural field as well as in disturbed areas such as dirt roads and cleared areas.

5.2 Climate/Hydrology

In general, the Base has a semiarid Mediterranean climate with warm, dry summers and mild, wet winters. Daytime temperatures rarely exceed 95 degrees Fahrenheit (35 degrees Celsius) in the summer, and nighttime temperatures usually remain above freezing in the winter. Winds generally originate from the west or southwest, carrying in cool, moist offshore air. Night and early morning overcast is common throughout the spring and summer. Coastal fog averages 29 days per year, being heaviest during the fall and winter months (MCB Camp Pendleton 2007). The topography on the Base varies from coastal plains and canyons to mountains in more inland areas, and precipitation is variable. Stuart Mesa is located on the coast and seasonal rainfall along the coast averages between 10 and 14 inches (25 to 35 centimeters) per year with approximately 75 percent of the Base's precipitation falling between November and March (MCB Camp Pendleton 2007). In recent years, annual rainfall was lower resulting in drought conditions, but 14 inches (35 centimeters) of rain fell during the 2009 – 2010 rainy season and 16 inches (40 centimeters) of rain (slightly above average precipitation) during the 2010 – 2011 rainy season (October 2010 to May 2011). From 1 October 2011 through 1 June 2012, the area received average rainfall, 10.8 inches, (27.4 centimeters), with just over 1 inch (2.5 centimeters) of rain falling on 26 April 2012 and 0.07 inch (1.8 centimeters) falling at the beginning of May 2012 (Weather Underground 2012). There was no precipitation and the survey area was dry at the time the jurisdictional determination surveys were conducted.

Stuart Mesa is located between the Santa Margarita River watershed and the Aliso watershed (MCB Camp Pendleton 2007). The northern floodplain of the Santa Margarita River is along the southern boundary of the survey area, Cockleburr Creek is just outside the northern boundary, and the Pacific Ocean is to the west. Start Mesa is surrounded by a steep bluff, and it appears that drainage from the mesa is surface run-off that is either directed into culverts at the top of the bluff, flows into erosion features that were apparent along the bluff, or leaches into the sandy marine terrace soils.

5.3 Soils

The soils within the SMWTC project and survey area are depicted in Figure 3. A portion of the project site is atop Stuart Mesa which is on a marine terrace with soils consisting of marine loamy coarse sand.

Soils within the Stuart Mesa West Training and Conversion Project and Survey Area

FIGURE 3

These are deep soils (generally more than 80 inches) with a high to moderate capacity for drainage. Along the western side of the mesa, within the survey area, are coastal beaches consisting of soils that are coarse to fine sands. These soils have a high capacity to transmit water, although may be poorly drained due to the frequency of tidal flooding and high water table. Along the southern edge of the survey area and Santa Margarita River floodplain, the soils are Diablo clay, which have a moderately low to moderately high capacity for drainage (NRCS 2012).

5.4 National Wetlands Inventory

The USFWS is the principal Federal agency that provides information to the public on the extent and status of the Nation's wetlands. The agency has developed a series of topical maps to show wetlands and deepwater habitats, referred to as the NWI. The NWI uses high altitude imagery and identifies wetlands based on the visible presence of wetland vegetation or hydrology. The NWI is not intended to define limits of jurisdiction of any federal, state, or local agency (USFWS 2012), but is used as a tool that contributes to the existing information available for the survey area. Figure 4 depicts the wetlands in the survey area identified by the NWI, which are primarily associated with the Santa Margarita River floodplain and estuary to the south, and a narrow band of palustrine emergent marsh vegetation between the beach and the base of the slope near the southwest corner of the survey area. In addition, Cocklebur Creek (not surveyed) is just outside the northeastern edge of the survey area and supports a mix of palustrine forested, scrub/shrub, and emergent marsh wetland types.

6 Field Survey Results

6.1 Jurisdictional Wetlands

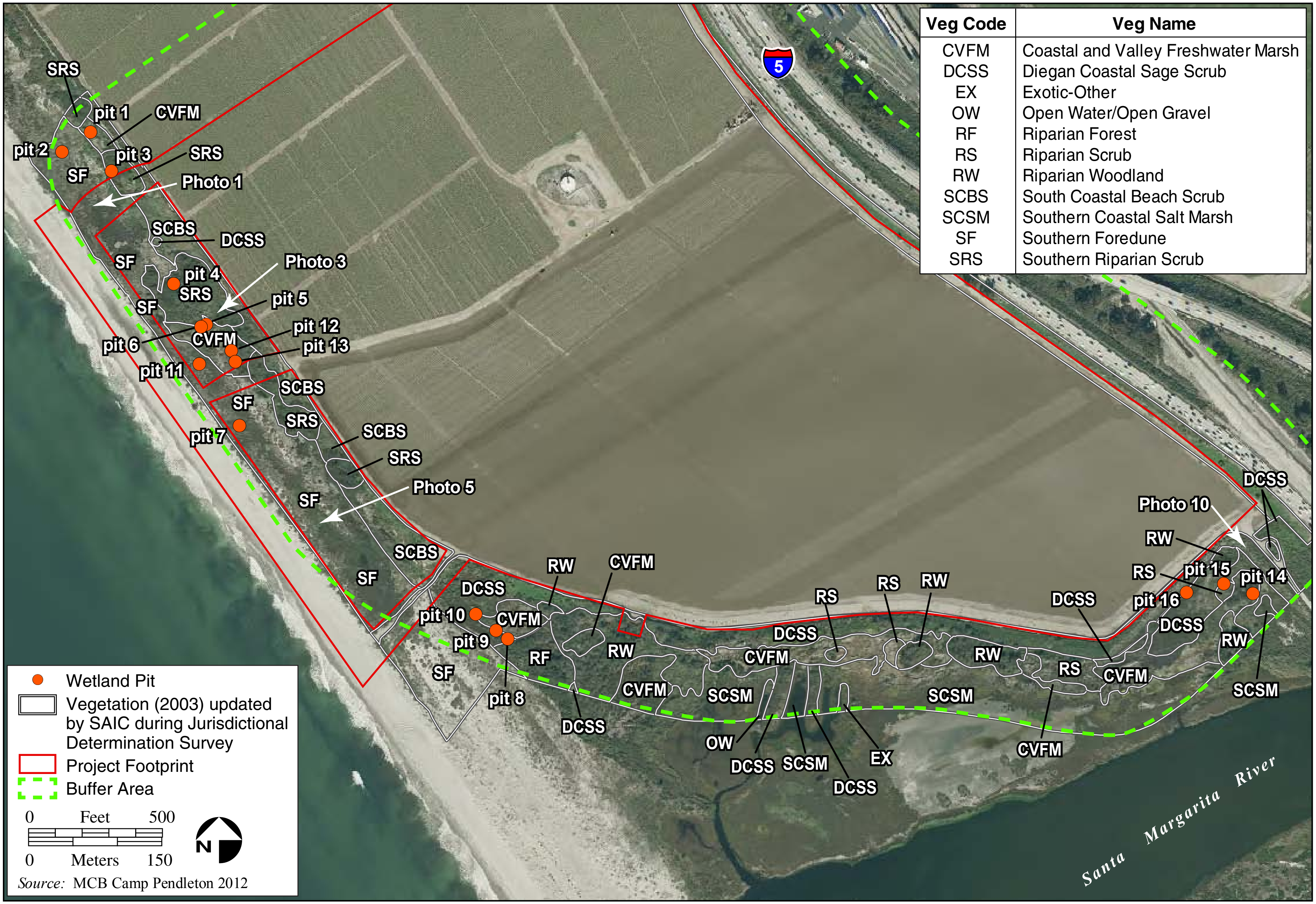
Figure 5 depicts the locations of the wetland delineation soil pits investigated during the surveys and the vegetation types within the survey area. As previously stated, the vegetation types are from MCB Camp Pendleton 2012 GIS data and are classified according to the *Draft Vegetation Communities of San Diego County* (Oberbauer et al. 2008) classification system and/or the classification system used in the Biological Opinion (BO) for programmatic activities and conservation plans in riparian and estuarine/beach ecosystems on MCB Camp Pendleton (USFWS 1995). Table 1 is a comparison of the vegetation/habitat systems, including Oberbauer 2008, the Riparian BO (USFWS 1995), and the Cowardin classification system (Cowardin et al. 1979). Attachment A Table A-1 includes a list of plant species identified during surveys and their WIS. Copies of the wetland delineation forms are included in Attachment B, and Table B-1 is a summary of the results including a determination of whether the vegetation, soils, and hydrology met the wetland determination criteria and if a significant nexus were present.

Table 1. Comparison of Vegetation/Habitat Classification Systems at the SMWC Survey Area

Oberbauer et al 2008	MCBCP Riparian BO (USFWS 1995)	Cowardin et al 1979
Southern Coastal Salt Marsh, Coastal and Valley Freshwater Marsh	Freshwater Marsh	Palustrine, emergent, persistent, seasonally flooded-tidal (PEM1R)
Coastal and Valley Freshwater Marsh, Southern Riparian Scrub, Southern Willow Scrub, Southern Riparian Woodland, Southern Riparian Forest	Freshwater Marsh, Riparian Scrub, Riparian Woodland	Palustrine Emergent/Scrub-Shrub, seasonally flooded-tidal (SS1R)
Intertidal Estuary	Open Water/Open Gravel	Estuarine Intertidal Unconsolidated Shore, irregularly flooded (E2USN)
Southern Foredunes, Coastal Bluff Scrub, Diegan Coastal Sage Scrub	N/A	N/A (Uplands)
Disturbed Habitat, Urban/Developed	Disturbed/Developed Lands	N/A
Notes: N/A = Not Applicable; category not defined in classification system.		

National Wetland Inventory for the Stuart Mesa West Training and Conversion Project and Survey Area

FIGURE 4



Vegetation Types and Location of Soil Pits within the Stuart Mesa West Training and Conversion Survey Area

FIGRE 5

The western portion of the project area includes sandy beach adjacent to the Pacific Ocean, grading into southern foredunes, with areas of southern riparian scrub and coastal and valley freshwater marsh between the foredunes and the base of the coastal bluff. The coastal bluff supports coastal bluff scrub vegetation interspersed with patches of southern riparian scrub. Topographically, there were two berms that parallel the shoreline within the western portion of the survey area. Closer to the bluff were large patches of willows, including arroyo willow (*Salix lasiolepis*) and sand bar willow (*Salix exigua*) alternating with emergent marsh plant species such as cattails (*Typha latifolia*) and bulrush (*Schoenoplectus* [=*Scirpus]americanus*). Several wetland delineation pits were investigated in this area. Pits 1, 3, 6 and 13 were located within areas dominated by emergent marsh vegetation; Pits 4 and 12 were in areas dominated by willows, and Pit 5 was in a transition area on the edge of a willow canopy where watercress (*Nasturtium officinale*) was dominant (Figure 5). The wetlands at the base of the bluff have a nexus to the Pacific Ocean because their proximity to the shoreline, low elevation, and well-drained sandy soils, means a fluctuating water table close to the surface is likely. According to the USACE definition, the USACE would assert jurisdiction over wetlands adjacent to a TNW where there is an unbroken surface or shallow sub-surface connection to the TNW. However, none of these areas met all three criteria (vegetation, soils and hydrology) for determination of wetlands (see Table B-1 and forms in Attachment B). None of the pits had positive indicators for wetland hydrology although cattails, bulrush, or watercress, obligate wetland plant species, were included as dominant plant species at Pits 1, 3, 6 and 13. At all of these data points, and throughout this area, the cattails and bulrush had experienced significant die back and little to no new growth was observed. Wild radish (*Raphanus sativa*), a non-native upland plant species, was co-dominant in all of these data points indicating the area was drier in the past year, allowing the establishment of upland plants (Photos 1 to 4). At Pit 6, the vegetation did not meet the criterion for hydrophytic vegetation due to the presence of wild radish as a dominant species. Since none of the data points in this area met all three criteria for determination of wetlands, they were not identified as jurisdictional wetland features. This includes the area identified as palustrine emergent marsh by the NWI (Figure 4).

The dieback of perennial wetland plant species, such as cattails and bulrush, coupled with the presence of an annual/biennial upland species such as wild radish may indicate a recent change in hydrology. The mesa at the top of the bluff had been used for irrigated croplands until very recently (2011), and the soils on the mesa are deep, high to moderately drained soils, and it is likely the irrigation was a source of water supporting the wetlands at the base of the bluff. The past few years experienced normal to above average rainfall; if the wetlands at the base of the bluff were supported only by natural drainage, the die back of perennial wetland vegetation and encroachment by upland weedy species would not be as severe.

Three data points (Pits 2, 7, and 11) were investigated in a swale area between the two berms that paralleled the sandy beach. Although mapped as southern coastal foredunes (Figure 5), a wide area of lower topography between the berms was dominated by wetland plant species including fleshy jaumea (*Jaumea carnosa*, an obligate wetland plant species) and salt grass (*Distichlis spicata*, a facultative wetland plant species). Heliotrope (*Heliotropium curassavicum)*, now assigned a WIS of FACU was also present in this area. Pits 2, 7, and 11 were investigated within the areas dominated by these species (Photos 5 and 6). While all three of these data points met the criterion for hydrophytic vegetation, none had positive indicators for hydric soils or wetland hydrology and all locations were determined to not be jurisdictional wetlands.

The south and southwestern portion of the survey area is within the floodplain of the Santa Margarita River and estuary, and the vegetation in this area is influenced by the hydrology of the river and tides. Sand bars or narrow tidal barriers form at the mouth of the Santa Margarita River, periodically closing the estuary and impounding low stream flows. These barriers are breached during periods of high flows and storm events (MCB Camp Pendleton 2007). The estuary is also subject to tidal influence when the mouth is open. The survey area was restricted to a portion of the northern floodplain of the estuary and not all of the survey area was accessible due to difficulty of access or biological resource constraints (i.e., endangered species habitat). Data points investigated included Pits 8, 9, and 10 in the southwestern portion of the survey area, and Pits 14, 15 and 16 in the southeastern portion of the survey area (Figure 5).

This portion of the Santa Margarita River is periodically subject to the ebb and flow of the tides and would be considered a TNW. The wetlands within the floodplain are likely flooded at certain times of the year and would therefore periodically have a surface water connection to the Santa Margarita River as well as shallow sub-surface connection when the water level in the estuary is low (i.e., non-rainy season and periods of lower tides). These wetlands may also have been affected by the irrigation at the top of the bluff, but because they are in the floodplain, the natural hydrology of the river and the tides exert a larger influence on these wetlands. According to the USACE definition, the wetlands associated with the Santa Margarita floodplain are adjacent to a TNW and under the jurisdiction of the USACE. In addition, several of the data points met all three criteria for determination of wetlands (Attachment B, Table B-1). Jurisdictional wetlands were identified in this area and are depicted in Figure 6.

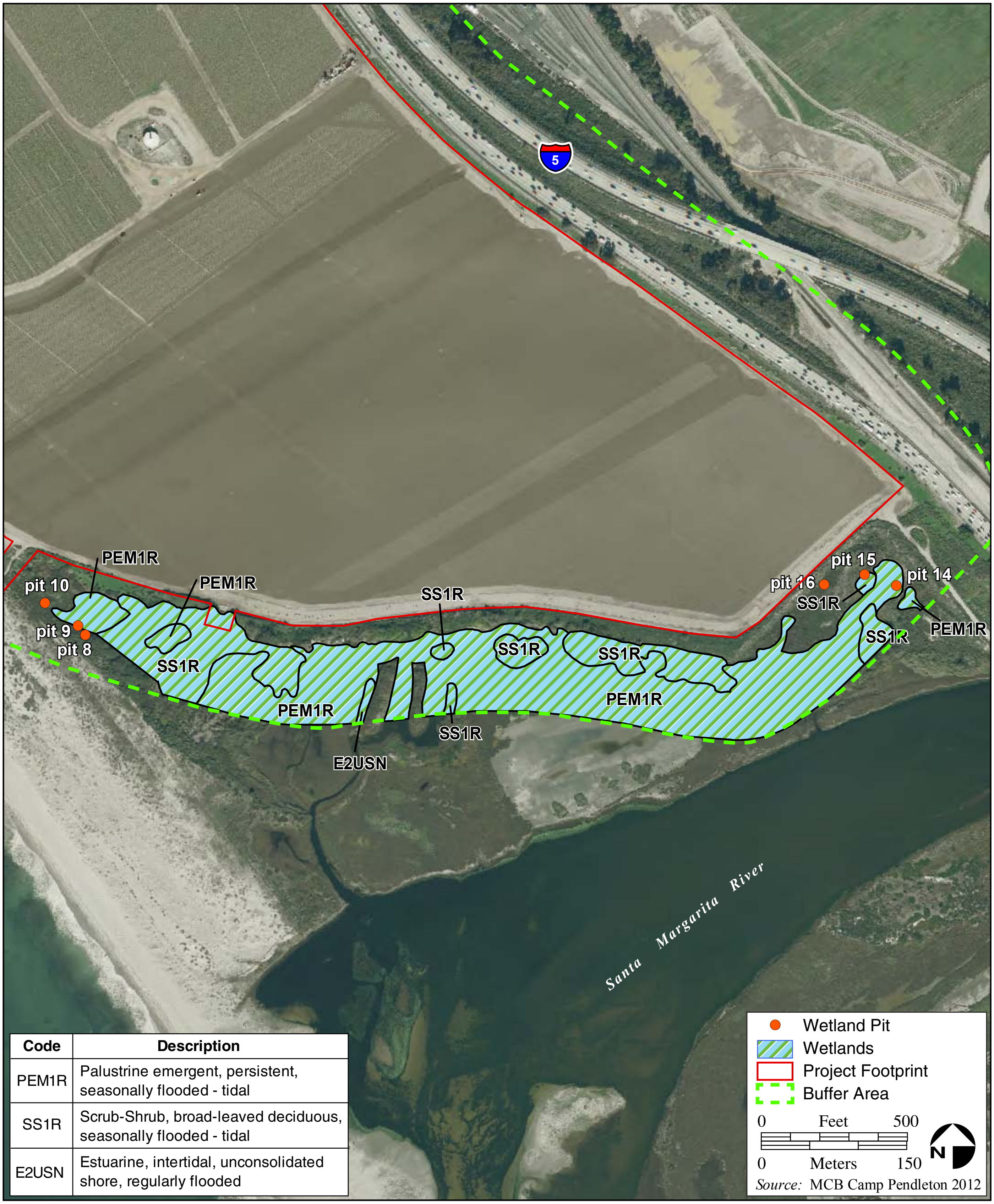
In the southwestern portion of the survey area, Pits 8 and 9 (Photos 7 to 9) were investigated in an area mapped as coastal and valley freshwater marsh and dominated by a dense stand of cattails (Figure 5). The cattails had died back significantly forming a dense mat of dried vegetation, but regrowth was apparent throughout the area. Pit 8 was located near the edge of the mat where coyote brush (*Baccharis pilularis*), a native upland shrub was dominant with an understory of yerba mansa (*Anemopsis californica*), an obligate wetland plant species. Pit 8 met the criteria for hydrophytic vegetation and hydric soils, but did not meet the criterion for wetland hydrology. Pit 9 was adjacent to Pit 8 where the cattails were dominant and met the criteria for determination of jurisdictional wetlands. In addition, Pit 10 was also in an area dominated by coyote bush with an understory of Baltic rush (*Juncus balticus*) and met the criteria for hydrophytic vegetation and hydric soils, but did not meet the criterion for wetland hydrology. Both Pit 8 and Pit 10 were within an area mapped as Diegan coastal sage scrub and were determined to be on the edge of the jurisdictional wetland boundary. The hydrology in this area may be affected by an erosional feature to the south which was vegetated with dense riparian woodland and forest dominated by an impenetrable stand of willows (Figure 5). The riparian vegetation extends to the top of the bluff and appears to be associated with a landslide. The vegetation or soil may cut off surface flow of water from the river and estuary into the cattail marsh. However, the existing hydrology from precipitation, runoff, or underground flows is sufficient to support jurisdictional wetlands.

Pits 14, 15 and 16 were located at the base of the bluff in the southeast corner of the survey area (Photos 10 to 12). This area is mapped as coastal and valley freshwater marsh, southern coastal salt marsh, riparian scrub, and Diegan coastal sage scrub (Figure 5). Pits 14 and 15 met all three criteria for determination of jurisdictional wetlands. Pit 16 was located at the base of the bluff in an area dominated by coast goldenbush (*Isocoma mensiezii*), a facultative wetland plant species. Although Pit 16 met the criteria for hydrophytic vegetation and hydric soils, it did not meet the criterion for wetland hydrology and it was determined that the shrub dominated areas likely indicated the boundary of the jurisdictional wetlands.

The wetland delineation data indicated jurisdictional wetlands are present in the southern portion of the survey area. Figure 6 depicts the boundaries of USACE jurisdictional wetlands based on a combination of the results of the data, additional observations of areas excluded from the surveys from vantage points above or adjacent to excluded areas, and the existing mapped vegetation. Jurisdictional wetlands were mapped according to the Cowardin classification system and are presented in Figure 6 and Table 2.

Table 2. Jurisdictional Wetlands in the SMWTC Survey Area.

Cowardin et al 1979	Oberbauer et al 2008	Acres (Hectares)
Palustrine, emergent, persistent, seasonally flooded-tidal (PEM1R)	Southern Coastal Salt Marsh, Coastal and Valley Freshwater Marsh	12.1 (4.9)
Palustrine Emergent/Scrub-Shrub, seasonally flooded-tidal (SS1R)	Coastal and Valley Freshwater Marsh, Southern Riparian Scrub, Southern Willow Scrub, Southern Riparian Woodland, Southern Riparian Forest	4.9 (2.0)
Estuarine Intertidal Unconsolidated Shore, irregularly flooded (E2USN)	Intertidal Estuary	0.1 (0.04)
N/A (Uplands)	Southern Foredunes, Coastal Bluff Scrub, Diegan Coastal Sage Scrub	N/A
	Total	**17.1 (6.9)**
Notes: N/A = Not Applicable.		



Code	Description
PEM1R	Palustrine emergent, persistent, seasonally flooded - tidal
SS1R	Scrub-Shrub, broad-leaved deciduous, seasonally flooded - tidal
E2USN	Estuarine, intertidal, unconsolidated shore, regularly flooded

Jurisdictional Wetlands within the Stuart Mesa West Training and Conversion Survey Area

FIGURE 6

There are a total of 17.1 acres (6.9 hectares) of jurisdictional wetlands within the project area (Figure 6). This includes one small area (0.1 acres, 0.04 hectares) of open water associated with a channel in the floodplain. There are small areas of uplands surrounded by wetlands within the project area. These were mapped as Diegan coastal sage scrub and are likely associated with mounds (i.e., sediment deposits) with slightly higher elevation that became colonized with shrub species. It is common for estuarine floodplains to have fluctuating microtopography especially in the densely vegetated areas. Slight changed in elevation within an estuary can result in significant changes in vegetation type. The areas classified as Diegan coastal sage scrub were considered uplands and omitted from the jurisdictional wetland boundaries. The jurisdictional wetlands within the project area are adjacent to the Santa Margarita River, which is a permanent water body at this location, and close to the Pacific Ocean. The wetlands would be considered either wetlands adjacent to TNW or wetlands adjacent to RPW.

6.2 Waters of the U.S.

In accordance with the USACE definition, the Pacific Ocean is a TNW**,** which is defined as all waters subject to the ebb and flow of the tides, and waters that are presently used, have been used in the past, or may be susceptible for use to transport interstate or foreign commerce (33 CFR 328.3(a)(1)). Therefore, jurisdictional waters of the U.S. within the project area include the Pacific Ocean up to the mean high tide line or mean high water, which is 9.0 feet (2.7 meters) above Station Datum. Figure 7 depicts the mean high water level based on data from the NOAA Station 9410230 La Jolla, CA. Mean sea level at this station is 7.1 feet (2.2 meters), and mean low water is 5.3 feet (1.6 meters) (NOAA 2012). Only the mean high water level is depicted on Figure 7 because current available topographic data for this area is not detailed enough to sufficiently depict all data (this figure will be updated if additional data become available). The mean high water level is shown as this represents the boundary of USACE jurisdictional waters of the U.S.

6.3 Assessment of Vernal Pools

Several small, isolated areas of standing water (basins), were identified within the survey area (Photos 13 to 15). These areas were identified as vernal pools because of their potential to support federally listed fairy shrimp, an endemic vernal pool invertebrate. However, MCB Camp Pendleton defines a vernal pool as “a naturally occurring shallow depression underlain by a substrate (e.g., hardpan, clay, basalt) that holds water for an extended period during the rainy season, but is typically dry most of the year and has the capability to support a unique biota of plants and animals, including federally listed Brachiopod species” (MCB Camp Pendleton 2007). The basins within the survey area are the result of disturbance, although they do hold water for an extended period and may support fairy shrimp. The basins are all isolated with no connection—surface or subsurface—to a USACE jurisdictional feature. These depressions were mapped by AMEC Environment and Infrastructure, Inc during focused surveys for fairy shrimp (AMEC 2014). The focused fairy shrimp surveys were conducted to determine the presence or absence of listed fairy shrimp within the basins. A total of eight basins were identified and mapped within the survey area (Figure 8). The eight basins consist of road ruts or past-disturbance depressions within dirt roads, cleared areas or other disturbances in the survey area. No federally listed fairy shrimp were found in any of the eight basins during the surveys. For the vernal pool assessment, Leidos (formally SAIC) completed wetland delineation forms for all of the basins (Appendix B, forms VP-1 through VP-8). Because digging is not allowed in features that have the potential to support fairy shrimp, all of the basins were assigned a positive indicator for hydric soils (indicator F9 vernal pools), meeting the hydric soils criterion. In addition, all of the basins held water for sufficient time to meet the wetland hydrology criterion (AMEC 2014). However, none of the basins met the criterion for wetland vegetation. VP #s 1, 2 and 8 had no vegetation within the depressions. Although hydrophytic plant species were present in some basins, non-wetland plant species were dominant. None of the basins met all three criteria for determination of jurisdictional wetlands and there was a high level of disturbance within all basins.

Boundary of Jurisdictional Waters of the US (i.e., mean high tide line) within the Stuart Mesa West Training and Conversion Survey Area

FIGURE 7

7 Summary

Delineations of wetlands and other waters of the U.S. were conducted on 14 to 16 May 2012 and 1 June 2012. Wetlands were delineated following the 1987 *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and *Arid West Regional Supplement* (USACE 2008), per the requirements of the Los Angeles District of the USACE. A total of 17.1 acres (6.9 hectares) of jurisdictional wetlands were identified at the southeastern portion of the project area, within the floodplain of the Santa Margarita River and estuary. This includes 12.1 acres (4.9 hectares) of palustrine, emergent, persistent, seasonally flooded-tidal (PEM1R), 4.9 acres (2 hectares) of palustrine emergent/scrub-shrub, seasonally flooded-tidal (SS1R), and one small area (0.1 acres/0.04 hectares) of open water associated with a channel in the floodplain (Figure 6). The jurisdictional wetlands within the survey area are adjacent to the Santa Margarita River and would be considered either wetlands adjacent to TNW or wetlands adjacent to RPW. In addition, the survey area is located along the shore-line of the Pacific Ocean. No wetlands were identified in the southwestern portion of the study area, although the shore up to the high water level of 8.8 feet (2.7 meters) above NOAA Station 9410230 La Jolla Datum (NOAA 2012) are jurisdictional waters of the U.S. (Figure 7). In addition, eight isolated temporarily-ponded basins located in disturbed areas on the top of Stuart Mesa were investigated, but none of these areas met all three criteria for determination of wetlands (Figure 8).

8 Recommendations

Any project related activities or construction within areas ultimately determined to be jurisdictional by the USACE Los Angeles District will require regulatory coverage as prescribed by Sections 401 and 404 of the CWA. Construction associated with culvert drainage repair and erosion control measures have the potential to directly or indirectly affect jurisdiction wetlands in the project area, depending on final design elements. Training actives within the high tide line or high water level may affect jurisdictional waters of the U.S. Any activities, including construction of culverts or earth moving, or that have the potential to result in discharges of fill or material within features determined to be jurisdictional, will require submittal of a permit application to USACE and a clean water certification from the RWQCB. If the direct or indirect effects of the project action would result in a “minimal amount” of potential fill into jurisdictional wetlands or waters of the U.S., and potential loss of jurisdictional features is minimized, coverage under an existing NWP may be possible.

Location of Seasonal Basins (Vernal Pools) within the Stuart Mesa West Training and Conversion Survey Area

FIGURE 8

9 References

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Attachment A

Plant List

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Table A-1. Plant Species identified during 2012 SMWT Surveys				
Species Name	**Common Name**	***Family***	***Form[1]***	***Wetland Indicator Status[2]***
Abronia maritima	red sand verbena	Nyctaginaceae	NPH	--
Abronia umbellata	pink sand verbena	Nyctaginaceae	NPH	--
Acmispon prostratus (= *Lotus nuttallianus*)	Nuttall's lotus	Fabaceae	NAH	--
Amblyopappus pusillus	pineapple weed	Asteraceae	NAH	FACW
Ambrosia chamissonis	beach bur	Asteraceae	NPH	--
Ambrosia psilostachya	western ragweed	Asteraceae	NAH	FACU (FAC)
Anagallis arvensis	scarlet pimpernel	Myrsinaceae	IAH	FAC
Anemopsis californica	yerba mansa	Saururaceae	NPH	OBL
Apium graveolens	celery	Apiaceae	IA/BH	NI (FACW*)
Artemisia californica	coastal sage brush	Asteraceae	NPS	--
Atriplex amnicola	goosefoot	Chenopodiaceae	IPS	FAC
Atriplex lentiformis	quail bush	Chenopodiaceae	NPS	FAC
Atriplex semibaccata	Australian salt bush	Chenopodiaceae	IPH	FAC
Arundo donax	giant reed	Poaceae	IPH	FACW
Baccharis pilularis	coyote bush	Asteraceae	NPS	--
Baccharis salicifolia	mulefat	Asteraceae	NPS	FAC (FACW)
Brassica nigra	black mustard	Brassicaceae	IAH	--
Brassica rapa	field mustard	Brassicaceae	IAH	FACU
Bromus diandrus	ripgut brome	Poaceae	IAG	--
Bromus rubens (= *B. madritensis* ssp. *rubens*)	red brome	Poaceae	IAG	UPL
Cakile maritima	sea rocket	Brassicaceae	IAH	FAC
Calystegia macrostegia ssp. *arida*	morning glory	Convolvulaceae	NPHV	--
Camissoniopsis bistorta (= *Camissonia bistorta*)	California sun cup	Onagraceae	NAH	--
Camissoniopsis cherianthifolia (= *Camissonia cherianthifolia*)	beach evening primrose	Onagraceae	NPH	--
Carpobrotus chilensis	sea fig	Aizoaceae	IPH	FACU
Centaurea melitensis	tocalote	Asteraceae	IAH	--
Chamaesyce maculata	spotted spurge	Euphorbiaceae	IAH	--
Chenopodium album	lamb's quarters	Chenopodiaceae	IAH	FACU
Chenopodium ambrosioides	Mexican tea	Chenopodiaceae	IAPH	FAC
Conium maculatum	poison hemlock	Apiaceae	IPH	FACW
Conyza canadensis	common horseweed	Asteraceae	NAH	FACU
Cotula coronopifolia	brass buttons	Asteraceae	IAH	OBL (FACW)
Crassula connata	sand pygmy weed	Crassulaceae	NAH	FAC
Cylindropuntia sp.	ornamental cactus	Cactaceae	IPS	--
Cynodon dactylon	Bermuda grass	Poaceae	IPG	FACU (FAC)
Datura wrightii	jimsonweed	Solanaceae	NPH	--
Deinandra fasciculata	fascicled tarweed	Asteraceae	NAH	FACU (NI)
Distichlis spicata	saltgrass	Poaceae	IAH	FAC (FACW)
Emex spinosa	devil's thorn	Polygonaceae	NPS	--
Encelia californica	California encelia	Asteraceae	IAH	--
Erodium botrys	long-beak filaree	Geraniaceae	IAG	FACU
Festuca (=*Vulpia*) *myuros*	rattail fescue	Poaceae	NPH	--
Foeniculum vlugare	fennel	Apiaceae	IPH	--
Heliotropium curassavicum	heliotrope	Boraginaceae	NAH	FACU (OBL)
Heterotheca grandiflora	telegraph weed	Asteraceae	IAG	--

Table A-1. Plant Species identified during 2012 SMWT Surveys				
Species Name	**Common Name**	***Family***	***Form[1]***	***Wetland Indicator Status[2]***
Hordeum marinum	seaside barley	Poaceae	NPS	FAC
Hypochaeris glabra	smooth catsear	Asteraceae	IAH	--
Isocoma mensiezii	coast goldenbush	Asteraceae	NPH	FAC
Jaumea carnosa	marsh jaumea	Asteraceae	NPH	OBL
Juncus acutus ssp. *leopoldii*	spiny rush	Juncaceae	NPH	FACW
Juncus balticus	Baltic rush	Juncaceae	NPH	OBL
Lactuca serriola	wild lettuce	Asteraceae	IAH	FACU (FAC)
Lamarkia aurea	goldentop	Poaceae	IAH	FACU
Lepidium (= *Cornopus*) *didymum*	lesser swinecress	Brassicaceae	IAH	--
Lepidium latifolium	perennial pepperweed	Brassicaceae	IPH	FAC (FACW)
Lepidium virginicum	peppercress	Brassicaceae	NAH	FACU
Malacothrix sp.	--------	Asteraceae	IAH	--
Malosma laurina	laurel sumac	Anacardiaceae	NPS	--
Malva parviflora	cheeseweed	Malvaceae	IAH	--
Marrubium vlugare	horehound	Lamiaceae	IAH	FACU (FAC)
Matricaria discoidea (= *Chamomilla suaveolens*)	common pineappleweed	Asteraceae	IAH	FACU
Medicago polymorpha	bur clover	Fabaceae	IAH	FACU (FAC)
Melilotus indicus	yellow sweet clover	Fabaceae	IAH	FACU
Mesembryanthemum crystallinum	crystalline ice plant	Aizoaceae	IAH	FACU
Mesembryanthemum nodiflorum	slenderleaf iceplant	Aizoaceae	IAH	FAC
Nemacaulis denudata var. *denudata*	woolly heads	Polygonaceae	IPS	FAC
Nicotiana glauca	tree tobacco	Solanaceae	IPS	FAC
Oenothera elata	Eevening primrose	Onagraceae	NPH	FACW
Opuntia sp.	prickly pear	Cactaceae	IAH	--
Opuntia littoralis	pricklypear	Cactaceae	NPS	--
Oxalis pes-caprae	Bermuda buttercup	Oxalidaceae	NPH	--
Peritoma arborea (= *Isomeris arborea*)	bladderpod	Cleomaceae	NPS	--
Phacelia distans	common phacelia	Boraginaceae	NAH	OBL (--)
Phacelia stellaris	Brand's phacelia	Boraginaceae	NAH	--
Pluchea odorata	salt marsh fleabane	Asteraceae	NPH	FACW
Poa secunda	pine bluegrass	Poaceae	NPG	FACU
Polypogon monspeliensis	annual rabbitsfoot grass	Poaceae	NAG	FACW
Pseudognaphalium (= *Gnaphalium*) *luteo-album*	weedy cudweed	Asteraceae	IAH	FAC (FACW-)
Raphanus sativus	wild radish	Brassicaceae	IA/PH	--
Rhus integrifolia	lemonade berry	Anacardiaceae	NPS	--
Ricinus communis	castorbean	Euphorbiaceae	IPS	FACU
Rumex crispus	curly dock	Polygonaceae	IPH	FAC (FACW)
Salicornia pacifica (= Salicornia virginica)	Pacific swampfire	Chenopodiaceae	NPH	OBL
Salix exigua	sandbar willow	Salicaceae	NPS	FACW (OBL)
Salix laevigata	red willow	Salicaceae	NPT	FACW
Salix lasiolepis	arroyo willow	Salicaceae	NPS/T	FACW
Salsola australis	Russian thistle	Chenopodiaceae	IAH	--
Sambucus nigra ssp. *caerulea* (= *S. mexicana*)	blue elderberry	Adoxaceae	NPS	FACU

Table A-1. Plant Species identified during 2012 SMWT Surveys				
Species Name	**Common Name**	***Family***	***Form***[1]	***Wetland Indicator Status***[2]
Schoenoplectus (= *Scirpus*) sp.	bulrush	Cyperaceae	NPH	OBL
Schoenoplectus (= *Scirpus*) *americanus*	bulrush	Cyperaceae	NPH	OBL
Senecio californicus	California ragwort	Asteraceae	NAH	--
Sisymbrium irio	London rocket	Brassicaceae	IAH	--
Solanum douglasii	Douglas' nightshade	Solanaceae	NPH	FAC
Sonchus asper	spiny sowthistle	Asteraceae	IAH	FAC
Spergularia boconni	Boccone's sandspurry	Caryophyllaceae	IAH	FACW
Stephanomeria sp.	wire lettuce	Asteraceae	NAH	--
Tetragonia tetragonioides	New Zealand spinach	Aizoaceae	IA/PH	--
Trifolioum sp.	clover	Fabaceae	AH	--
Typha latifolia	broad-leaved cattail	Typhaceae	NPH	OBL
Urtica dioica	stinging nettle	Urticaceae	NPH	FAC (FACW)
Urtica urens	dwarf nettle	Urticaceae	NPH	--
Verbena lasiostachys	western verbena	Verbenaceae	NPH	FAC

Notes:

Plant names follow the Jepson Manual (Baldwin et al 2012).

1. Form: N=Native/I=Introduced; A=Annual/B=Biennial; P=Perennial; H=Herb/S=Shrub/T=Tree/V=Vine/F=Fern/G=Grass.
2. WIS-2012 NWPL (Lichvar and Kartesz 2009); (Reed 1988); WIS in parentheses is from Reed (1988):
   UPL (Obligate Upland) = Plants that almost never occur in water or saturated soils.
   FACU (Facultative Upland) = Plants that typically occur in xeric or mesic nonwetland habitats but may frequently occur in standing water or saturated soils.
   FAC (Facultative) = Plants that occur in a variety of habitats, including wetland and mesic to xeric nonwetland habitats but often occur in standing water or saturated soils
   FACW (Facultative Wetland) = Plants that nearly always occur in areas of prolonged flooding or require standing water or saturated soils but may, on rare occasions, occur in nonwetlands.
   OBL (Obligate Wetland) = Plants that always occur in standing water or in saturated soils.
   — No WIS.

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Attachment B

Forms

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Table B-1. Summary of Wetland Delineation Data for the SMWT Survey Area						
Pit	***Wetland Indicator Parameters Present? (Yes/No)***			***Significant Nexus***	***Is site in a USACE Jurisdictional Wetland? (Yes/No)***	***Comments***
	Vegetation	**Soils**	**Hydrology**			
1	Yes	Yes	No	Yes	**No**	Patch of cattails at base of bluff.
2	Yes	No	No	Yes	**No**	Dune swale area parallel to beach, between two sandy berms.
3	Yes	No	No	Yes	**No**	Cattails present but dead with no new growth apparent. Adjacent to erosion from bluff.
4	Yes	No	No	Yes	**No**	Large patch of willows associated with slide from bluff, cattails overtaken by wild radish.
5	Yes	Yes	No	Yes	**No**	Soils moist by not saturated and no positive indicators of wetland hydrology, was hydrology previously altered by irrigation of crops on mesa?
6	No	Yes	No	Yes	**No**	Large patch of tules, but most have died back with some new growth of tules and wild radish (an upland plant)
7	Yes	No	No	Yes	**No**	Dune swale area parallel to beach, between two sandy berms. Groundwater may influence vegetation but insufficient to result in positive indicators for wetland soils and hydrology.
8	Yes	Yes	No	Yes	**No**	Large patch of cattails, mostly dead with some new growth and yerba mansa. Large patch of willows appears to be associated with a slide from the bluff; may have cut off this area from surface water influence associated with the river and estuary.
9	**Yes**	**Yes**	**Yes**	Yes	**Yes**	Lowest part of depression in cattail patch has positive indicators for wetland soils and hydrology. Coyote brush beginning to establish in cattails, but cattails dominant at time of survey.
10	Yes	Yes	No	Yes	**No**	Wetland plants in understory of upland shrub dominated area.
11	Yes	No	No	Yes	**No**	Dune swale between sandy berms.
12	Yes	No	No	Yes	**No**	Base of slope where slide had occurred in the past. Willows dominant on slide.
13	Yes	No	No	Yes	**No**	Base of slope where cattails are dominant.
14	**Yes**	**Yes**	**Yes**	Yes	**Yes**	Both pits area at base of slope in area adjacent to the Santa Margarita River and estuary. No barriers to surface flooding at this location.
15	**Yes**	**Yes**	**Yes**	Yes	**Yes**	
16	Yes	Yes	No	Yes	**No**	Shrub dominated areas likely indicate boundary of jurisdictional wetlands.

Table B-1. Summary of Wetland Delineation Data for the SMWT Survey Area						
	Wetland Indicator Parameters Present? (Yes/No)				***Is site in a USACE Jurisdictional Wetland? (Yes/No)***	
Pit	**Vegetation**	**Soils**	**Hydrology**	***Significant Nexus***		***Comments***
Assessment of Seasonally Ponded Basins (Vernal Pools*)						
VP 1	No	Yes	Yes	No	**No**	All basins were in depressions in disturbed areas such and cleared areas, roads, and ditches in the agricultural field. Three had no vegetation and others were dominated by non-native upland plant species. All had a high level of disturbance.
VP 2	No	Yes	Yes	No	**No**	
VP 3	No	Yes	Yes	No	**No**	
VP 4	No	Yes	Yes	No	**No**	
VP 5	No	Yes	Yes	No	**No**	
VP 6	No	Yes	Yes	No	**No**	
VP 7	No	Yes	Yes	No	**No**	
VP 8	No	Yes	Yes	No	**No**	

Notes:

*A Vernal pool is defined as "a naturally occurring shallow depression underlain by a substrate (e.g., hardpan, clay, basalt) that holds water for an extended period during the rainy season, but is typically dry most of the year and has the capability to support a unique biota of plants and animals, including federally listed Brachiopod species" (MCB Camp Pendleton 2007). The basins within the survey area are the result of disturbance, although they do hold water for an extended period and may support fairy shrimp (fairy shrimp survey results presented in a separate report).

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa C. Pen City/County: San Diego Sampling Date: 15-May-12

Applicant/Owner: DoD State: CA Sampling Point: SM A+1

Investigator(s): L. Brown, T. Schwenwetter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): base of bluff Local relief (concave, convex, none): concave Slope (%): 0%

Subregion (LRR): LRRC Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Cr Coastal beaches NWI classification: PEM

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

* Are Vegetation ____, Soil ✓, or Hydrology ____ significantly disturbed? No Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ✓, or Hydrology ____ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✓ No ____	Is the Sampled Area within a Wetland?	Yes ____ No X
Hydric Soil Present? Yes ✓ No ____		
Wetland Hydrology Present? Yes ____ No ✓		

Remarks: Patch of typha at base of coastal bluff - Runoff from mesa is directed off of bluff. Mesa was farmed in past with irrigated crops

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 10m²)			
1. Salix lasiolepis	3%	Y	FACW
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 3m²)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 1m²)			
1. Typha latifolia	95%	Y	OBL
2. Raphanus sativa	10%	N	–
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover	109%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

✓ Dominance Test is >50%

__ Prevalence Index is ≤3.0[1]

__ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

✓ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks: Need to see if wetland veg is associated with culverts.

SOIL

Sampling Point: SMPit 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-3	2.5Y 2.5/1	100%	—					loamy sand
3-16	2.5Y 5/2	100%	—					sand
16-21	2.5Y 5/3	100%	—					clay

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ✓ Sandy Mucky Mineral (S1) – ? 1-3"
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: Clay
Depth (inches): 16"

Hydric Soil Present? Yes ✓ No ___

Remarks: Clay layer at 16". Roots present throughout soil layers (likely typha)
?: soil feels btwn gritty/greasy, no staining on fingers, no fibers observed with hand lense

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- X FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches): ___
Water Table Present?	Yes ___	No X	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches): ___

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Runoff source is from precipitation only, but artifical water sources were present until 2010. stems + lvs on surface, not decomposed.

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stewart Mesa C. Pen City/County: San Diego Sampling Date: 15-May-12

Applicant/Owner: DoD State: CA Sampling Point: SM Pit 2

Investigator(s): L Brown, T. Schwenwetter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace (dunes) Local relief (concave, convex, none): none Slope (%): 0%

Subregion (LRR): LRR C Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Cr - Coastal beaches NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? No Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✓ No ___		
Hydric Soil Present? Yes ___ No ✓	Is the Sampled Area within a Wetland?	Yes ___ No ✓
Wetland Hydrology Present? Yes ___ No ✓		

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 0)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 0)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 1 m^2)			
1. Heliotropium curassavicum	60%	Y	FACU
2. Distichlis spicata	30%	Y	FAC
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover			
Woody Vine Stratum (Plot size: 0)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum * 0 % Cover of Biotic Crust 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species	30	x 3 = 90
FACU species	60	x 4 = 240
UPL species		x 5 =
Column Totals:	90 (A)	330 (B)

Prevalence Index = B/A = 330/90 = 3.6

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks:

* ~30% litter (dead Cakile maritima), 70% plot cover

SOIL

Sampling Point: SM Pit 2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-8	2.5Y 5/2	100%						fine sand
8-13	2.5Y 4/3	100%						sand
13-24"	2.5Y 4/3	100%						coarse sand

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ___
Depth (inches): ___

Hydric Soil Present? Yes ___ No ✓

Remarks: 0-8" - roots, organic matter incl. sticks & leaves, not decomposed.
8-24 - no organic matter or roots, sandy.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✓ Depth (inches): ___
Water Table Present? Yes ___ No ✓ Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ___ No ✓ Depth (inches): ___

Wetland Hydrology Present? Yes ___ No ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Soil at bottom of pit is slightly moist, but not wet or saturated (coarse sand particles)

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa C Pon City/County: San Diego Sampling Date: 15-May-12

Applicant/Owner: Dept of Defense State: CA Sampling Point: SM Pit 3

Investigator(s): L. Brown, D.T. Schonwetter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): base of slope Local relief (concave, convex, none): none Slope (%): 0%

Subregion (LRR): LRR C Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: CR coastal beaches NWI classification: PEM

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ✓, or Hydrology ✓ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ____
Hydric Soil Present?	Yes ____	No ✓
Wetland Hydrology Present?	Yes ____	No ✓

Is the Sampled Area within a Wetland? Yes ____ No ✓

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ~~10~~)	Absolute % Cover	Dominant Species?	Indicator Status
1. ~~Salix lasiolepis~~	~~45%~~		
2.			
3.			
4.			
= Total Cover	~~45%~~		
Sapling/Shrub Stratum (Plot size: 3m²)			
1. Salix lasiolepis	45%	Y	FACW
2.			
3.			
4.			
5.			
= Total Cover	45%		
Herb Stratum (Plot size: 1m²)			
1. Raphanus sativa	15%	Y	—
2. Polypogon monspeliensis	3%	N	FACW
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover			
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum ______ % Cover of Biotic Crust ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species	48	x 2 = 96
FAC species		x 3 =
FACU species		x 4 =
UPL species	15	x 5 = 75
Column Totals:	(A)	(B)

Prevalence Index = B/A = 75/96 = <1

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ✓ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

Cattails were present in area but have died and no new growth is apparent. Willows go up slope.

SOIL

Sampling Point: SM #3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-4	2.5 Y 5/2	100%						Silty sand
4-10	2.5 Y 6/3	100%						clayey sand

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Sediment

Depth (inches): 4"

Hydric Soil Present? Yes ___ No X

Remarks: soil pit hit hard layer near surface. layer drains quickly (and dries) when water was poured on it - layering of soils is apparent - erosion from slope

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✓ Depth (inches): ___

Water Table Present? Yes ___ No ✓ Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ___ No ✓ Depth (inches): ___

Wetland Hydrology Present? Yes ___ No ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Soil hard layer appears to be associated with sediment from erosion of slope - willows present on slope

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa C. Pen City/County: San Diego Sampling Date: 15-May-12

Applicant/Owner: DoD State: CA Sampling Point: SMP #4

Investigator(s): L Brown, T. Schoenwetter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): coastal dune Local relief (concave, convex, none): none Slope (%): 0%

Subregion (LRR): LRR C Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Cr Coastal Beaches NWI classification: PEM

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ✓? significantly disturbed? No Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ____
Hydric Soil Present?	Yes ____	No ✓
Wetland Hydrology Present?	Yes ____	No ✓

Is the Sampled Area within a Wetland? Yes ____ No ✓

Remarks: Willows in dune swale, large area with S. exigua and S. lasiolepis. Scirpus and cattails nearby but overtaken by Raphanus sativa.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 0)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 3M²)			
1. Salix exigua	30%	Y	FACW
2. Salix laevigata	40%	Y	FACW
3.			
4.			
5.			
= Total Cover	70%		
Herb Stratum (Plot size: ______)			
1. Salix exigua	10%	Y	FACW
2.			
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover	10%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

* 90% litter

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

✓ Dominance Test is >50%

__ Prevalence Index is ≤3.0[1]

__ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks: Dead cattails on outer edge of willow canopy. Castor bean nearby under willow canopy.

SOIL

Sampling Point: SM#4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-3"	10YR 3/2	100%						Sandy loam
3-8	2.5Y 4/3	100%						fine sand
9-25	10YR 4/3	100%						loamy fine sand

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes ___ No ✓

Remarks: 0-3" has a lot of organic material and litter. Some organic matter is broken down + no longer recognizable organic layer gritty, not greasy, no redox features

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✓ Depth (inches): ___

Water Table Present? Yes ___ No ✓ Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ___ No ✓ Depth (inches): ___

Wetland Hydrology Present? Yes ___ No ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: No indications that surface water remains in swale. Soils are slightly moist after 8" but not wet or saturated.

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa West City/County: SAN DIEGO Sampling Date: 15 May 2012

Applicant/Owner: MCB Camp Pendleton Department of Defense State: CA Sampling Point: SMP#3

Investigator(s): L. Brown T. Schoenuettler Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Dune swale at Base of Bluff Local relief (concave, convex, none): none Slope (%): 0-1%

Subregion (LRR): LRRC Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: CR Coastal Beaches NWI classification: PEM

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? modified Are "Normal Circumstances" present? Yes ______ No ______

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ______	Is the Sampled Area within a Wetland? Yes ______ No X
Hydric Soil Present?	Yes X	No ______	
Wetland Hydrology Present?	Yes ______	No X	

Remarks: Vegetation and soil characteristics indicate a wetland; however, hydrology does not. Hydrology may have originally been formed as a result of previous agricultural practices above. Due to the topography and sandy soils, hydrology is highly likely to change.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
		= Total Cover	
Sapling/Shrub Stratum (Plot size: 3M²)			
1. Baccharis pilularis	5%	Y	—
2. Salix exigua	1%	Y	FACW
3.			
4.			
5.			
	6%	= Total Cover	
Herb Stratum (Plot size: 1M²)			
1. Ambrosia psilostachya	5	N	FACU
2. Raphanus sativus	10	N	—
3. Ricinus communis	5	N	FACU
4. Typha latifolia	10	N	OBL
5. Nasturtium officinale	50	Y	OBL
6.			
7.			
8.			
	80	= Total Cover	
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
Litter is ~ 20%		= Total Cover	

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- Y Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ______

Remarks:

SOIL

Sampling Point: ____________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-5	10yr 3/1							loamy sand
5-14	2.5y 4/2							sand
14-25	2.5y 4/2							sand

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- X Depleted Below Dark Surface (A11) ?
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ____________ Question of weather organic in layer B is sufficiently decomposed to be leached from the surface.

Depth (inches): ____________

Hydric Soil Present? Yes X No ____

Remarks: 0-5" a lot of organic matter and roots.
6-14" darker clumps that appear to be inclusions of organic matter
14-" distinct black line that is not organic possible sediment deposition from fire on mesa.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ____ No X Depth (inches): ____

Water Table Present? Yes ____ No X Depth (inches): ____

Saturation Present? (includes capillary fringe) Yes ____ No X Depth (inches): ____

Wetland Hydrology Present? Yes ____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Soil is moist throughout layers but not saturated

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa West City/County: SAN DIEGO Sampling Date: 15-May-2012

Applicant/Owner: Department of Defence State: CA Sampling Point: SM Pit 6

Investigator(s): L. Brown T. Schienwetter Section, Township, Range: ____

Landform (hillslope, terrace, etc.): Base of Bluff Local relief (concave, convex, none): none Slope (%): 0–1%

Subregion (LRR): LRR C Lat: ____ Long: ____ Datum: ____

Soil Map Unit Name: Cr – Coastal beaches NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N – modified significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No			
Hydrophytic Vegetation Present?		✓	Is the Sampled Area within a Wetland?	Yes ____	No ✓
Hydric Soil Present?	✓				
Wetland Hydrology Present?		✓			

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 3M²)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 1M²)			
1. Scirpus americanus	5	Y	FACW
2. Raphanus sativus	5	Y	
3. Solanum xantii	1	N	FAC
4.			
5.			
6.			
7.			
8.			
= Total Cover	8		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
Litter is 80% of scirpus			
= Total Cover			

% Bare Ground in Herb Stratum: 0 % Cover of Biotic Crust: 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species	5	x 2 = 10
FAC species	1	x 3 = 3
FACU species		x 4 =
UPL species	5	x 5 = 25
Column Totals:	11 (A)	38 (B)

Prevalence Index = B/A = 38/11 = 3.4

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No X

Remarks:

Litter is 90% of ground surface, all dead scirpus

SOIL

Sampling Point: ____________

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-4	10yr 3/1							Loamy Sand
4-12	2.5y 4/2							Sand

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- X Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ____________
Depth (inches): ____________

Hydric Soil Present? Yes X No ______

Remarks: Horizontal striations

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ____ No X Depth (inches): ____________
Water Table Present? Yes ____ No X Depth (inches): ____________
Saturation Present? (includes capillary fringe) Yes ____ No X Depth (inches): ____________

Wetland Hydrology Present? Yes ______ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa West City/County: San Diego Sampling Date: 15 MAY 2012

Applicant/Owner: Department of Defence State: CA Sampling Point: SM PIT 7

Investigator(s): L. Brown J. Schnenwetter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Dune swale flat Local relief (concave, convex, none): Flat None Slope (%): 0

Subregion (LRR): LRRC Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: CR Coastal Beaches NWI classification: PEM

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes ____ No ____

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ____
Hydric Soil Present?	Yes ____	No X
Wetland Hydrology Present?	Yes ____	No X

Is the Sampled Area within a Wetland? Yes ____ No X

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 1M²)			
1. Jaumea carnosa	95	Y	OBL
2. Distichlis spicata	2	N	FAC
3. Helitropium curassavicum	3	N	FACU
4.			
5.			
6.			
7.			
8.			
= Total Cover	100		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum ____ % Cover of Biotic Crust ____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ✓ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ____

Remarks:

SOIL

Sampling Point: Pit 7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-6	2.5Y 4/2	100					sand	Lots of roots
6-15	2.5Y 4/3	100					sand	
15-24	2.5Y 4/2	100					sand	living roots

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes ______ No X

Remarks: Living roots present throughout layers soils moist but not saturated

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ______

Water Table Present? Yes ______ No X Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ______ No X Depth (inches): ______

Wetland Hydrology Present? Yes ______ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Soils are moist in lower level but not wet or saturated

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa C. Pen City/County: San Diego Sampling Date: 16-May-12

Applicant/Owner: Dept of Defense State: CA Sampling Point: SM Pit 8

Investigator(s): L. Brown, T. Schlenwetter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave Slope (%): 1%

Subregion (LRR): LRRC Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: DaC - Diablo Clay NWI classification: PEM/SSR

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? No Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ___	Is the Sampled Area within a Wetland? Yes ___ No ✓
Hydric Soil Present?	Yes X	No ___	
Wetland Hydrology Present?	Yes ___	No X	

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 0)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 3M²)			
1. Baccharis pilularis	40	Y	✓
2. Salix lasiolepsis	20	Y	FACW
3.			
4.			
5.			
= Total Cover	60		
Herb Stratum (Plot size: 1M²)			
1. Anemopsis californica	75	Y	OBL
2. Typha latifolia	1	N	OBL
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover	75		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 66% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___	x 1 = ___
FACW species	___	x 2 = ___
FAC species	___	x 3 = ___
FACU species	___	x 4 = ___
UPL species	___	x 5 = ___
Column Totals:	___ (A)	___ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

✓ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks:

SOIL

Sampling Point: Pit 8

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-3	2.5y 3/1						Sandy loam	A lot of organic debris
3-11	10yr 3/2							cobble

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- X Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes X No ___

Remarks: 0-3 lots of orgaic material, partically decomposed & dark
3-11 a lot of large cobble in soil

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___

Water Table Present? Yes ___ No X Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): ___

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa C. Pen City/County: San Diego Sampling Date: 16 May 2012

Applicant/Owner: Department of Defence State: CA Sampling Point: SM P49

Investigator(s): L. Brown T. Schoenwetter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): convex Slope (%): 1

Subregion (LRR): LRRC Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: DaC Diablo Clay NWI classification: PEM SSR

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? No Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ____
Hydric Soil Present?	Yes X	No ____
Wetland Hydrology Present?	Yes X	No ____

Is the Sampled Area within a Wetland? Yes X No ____

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 3M²)			
1. Baccharis pilularis	5	Y	
2.			
3.			
4.			
5.			
= Total Cover	5		
Herb Stratum (Plot size: 1M²)			
1. Typha latifolia	40	Y	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover	40		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum ______ % Cover of Biotic Crust ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	40	x 1 = 40
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species	5	x 5 = 25
Column Totals:	45 (A)	65 (B)

Prevalence Index = B/A = 65/45 = 1.4

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ✓ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ____

Remarks: Litter 40% cover

SOIL

Sampling Point: Pit 9

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-8	10yr 3/2						sandy clay	soils moist not saturated

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- X Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ___
Depth (inches): ___

Hydric Soil Present? Yes X No ___

Remarks: 6-8 inches rhizo Redox concentrations ~ 1% Difficult to dig due to Cobbles w/i 1" of surface.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- X Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:
Surface Water Present? Yes ___ No ___ Depth (inches): ___
Water Table Present? Yes ___ No ___ Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ___ No ___ Depth (inches): ___

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: 6-8 inches, oxidized rhizospheres present only few Most living roots don't have oxidized rhizospheres

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa City/County: San Diego Sampling Date: 16-May-12

Applicant/Owner: Dept of Defense State: CA Sampling Point: Pit 18

Investigator(s): L Brown, T. Schoenwetter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): flood plain Local relief (concave, convex, none): flat-none Slope (%): 0%

Subregion (LRR): LRR C Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: DrC - Diablo Clay NWI classification: PEM/SSR

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? No Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ______
Hydric Soil Present?	Yes ✓	No ______
Wetland Hydrology Present?	Yes ______	No ✓

Is the Sampled Area within a Wetland? Yes ______ No ✓

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 0)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 3M)			
1. Baccharis pilularis	10%	Y	–
2.			
3.			
4.			
5.			
= Total Cover	10%		
Herb Stratum (Plot size: 1M)			
1. Juncus canosa	95%	Y	OBL
2. Typha ~~sp~~	5%	N	OBL
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover	100%		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	95	x 1 = 95
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species	10	x 5 = 50
Column Totals:	105 (A)	145 (B)

Prevalence Index = B/A = 145/105 =

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ✓ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

SOIL Sampling Point: SM PIT 10

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 2/2	100%						loam
2-11	10YR 4/2	100%						Clay loam

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ___
Depth (inches): ___

(borderline = wetland boundary)

Hydric Soil Present? Yes X No ___

Remarks: 0-2 - lot of organic material, inverts worms (typically not present when saturated). OM is roots + leaves, still distinguishable. Cobbles and rocks below 2".

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:
Surface Water Present? Yes ___ No ✓ Depth (inches): ___
Water Table Present? Yes ___ No ✓ Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ___ No ✓ Depth (inches): ___

Wetland Hydrology Present? Yes ___ No ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: No hydro indicators

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa - C. Pen City/County: San Diego Sampling Date: 16-May-12

Applicant/Owner: Dept of Defense State: CA Sampling Point: SMPit 11

Investigator(s): L Brown, T. Schoenwetter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Swale Local relief (concave, convex, none): None Slope (%): 0%

Subregion (LRR): LRR C / Beaches Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Cr Coastal Beaches NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ____	Is the Sampled Area within a Wetland? Yes ____ No ✓
Hydric Soil Present?	Yes ____	No ✓	
Wetland Hydrology Present?	Yes ____	No ✓	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 0)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
		= Total Cover	
Sapling/Shrub Stratum (Plot size: 3m²)			
1. Baccharis pilularis	2%	Y	—
2.			
3.			
4.			
5.			
		= Total Cover	
Herb Stratum (Plot size: ______)			
1. Heliotropium curassavicum	10%	N	OBL
2. Distichlis spicata	90%	Y	FAC
3. Cakile maritima	2%	N	FAC
4.			
5.			
6.			
7.			
8.			
	100%	= Total Cover	
Woody Vine Stratum (Plot size: 0)			
1.			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	10	x 1 = 10
FACW species		x 2 =
FAC species	92	x 3 = 276
FACU species		x 4 =
UPL species	2	x 5 = 10
Column Totals:	104 (A)	296 (B)

Prevalence Index = B/A = 296/104 = 2.11

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ✓ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks:

SOIL

Sampling Point: 1Pit 1B

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-3	10YR 3/2	100%					fine	Fine Sand
								Sa Sand
3-20	2.5Y 4/2	100%						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) No
- ___ Sandy Gleyed Matrix (S4) No
- ___ Sandy Redox (S5) No
- ___ Stripped Matrix (S6) No
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes ___ No ✓

Remarks: 0-3 - lots of roots, no indicators of anaerobic conditions

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✓ Depth (inches): ___

Water Table Present? Yes ___ No ✓ Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ___ No ✓ Depth (inches): ___

Wetland Hydrology Present? Yes ___ No ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: 3-20" - Soils moist but not wet or saturated
No wetland hydrology indicators.

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa C Pen City/County: San Diego Sampling Date: 16-May 12

Applicant/Owner: Dept of Defense State: CA Sampling Point: SM-V12

Investigator(s): L Brown, J. Schoenwalder Section, Township, Range: ______

Landform (hillslope, terrace, etc.): base of slope Local relief (concave, convex, none): flat Slope (%): 0-1%

Subregion (LRR): LRR C Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Cr- Coastal beaches NWI classification: PEM

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ✓, or Hydrology ✓ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ______	Is the Sampled Area within a Wetland?	Yes ______ No ✓
Hydric Soil Present?	Yes ______ No ✓		
Wetland Hydrology Present?	Yes ______ No ✓		

Remarks: Base of slope where erosion has occured in past. Ag field on mesa was formerly irrigated.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 0)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1. Salix lasiolepis	20%	Y	FACW
2.			
3.			
4.			
5.			
= Total Cover	20%		
Herb Stratum (Plot size: ______)			
1. Pluchea sericea	60	Y	FACW
2. Heliotropium curassavicum	40	Y	FACW
3. Ambrosia psilostachya	10	N	FACU
4. Raphanus sativa	5	N	—
5.			
6.			
7.			
8.			
= Total Cover	90		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

10% litter

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

✓ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ______

Remarks:

SOIL

Sampling Point: Sm Pit 12

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-7	2.5Y 4/2	100%						loamy Sand
7-24	10YR 3/2							Sandy loam

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4) No
- ___ Sandy Redox (S5) No
- ___ Stripped Matrix (S6) No
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ______
Depth (inches): ______

Sandy Soils

Hydric Soil Present? Yes ___ No ✓

Remarks: 0-7 fine roots and fibrous organic matter in layer
7-24 - Soils have about 10% concentration of more clayey Material in matrix, indistinct. Lots of om on surface (sticks, leaves, not decomposed)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✓ Depth (inches): ______
Water Table Present? Yes ___ No ✓ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ___ No ✓ Depth (inches): ______

Wetland Hydrology Present? Yes ___ No ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa C. Pen City/County: San Diego Sampling Date: 16-May 12
Applicant/Owner: Dept of Defense State: CA Sampling Point: SM Pit 13
Investigator(s): L Brown, T Schoenwetter Section, Township, Range: ____
Landform (hillslope, terrace, etc.): Swale Local relief (concave, convex, none): Concave Slope (%): 0-1%
Subregion (LRR): LRR C Lat: ____ Long: ____ Datum: ____
Soil Map Unit Name: Cr Coastal Beaches NWI classification: PEM
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)
Are Vegetation ____, Soil ✓, or Hydrology ✓ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland? Yes ____ No ✓
Hydric Soil Present?	Yes ____ No ✓	
Wetland Hydrology Present?	Yes ____ No ✓	

Remarks: base of slope, mesa above was previously irrigated Ag lowest spot selected for pit location, with cattail resprouts edge of eroded slope.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 0)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 0)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 1m²)			
1. Typha latifolia	10%	Y	OBL
2. Heliotropium curassavicum	10%	Y	FACU
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover	20%		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			

80% litter
% Bare Ground in Herb Stratum: 0 % Cover of Biotic Crust ____

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 1 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 50% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	10	x 1 = 10
FACW species		x 2 =
FAC species		x 3 =
FACU species	10	x 4 = 40
UPL species		x 5 =
Column Totals:	20 (A)	50 (B)

Prevalence Index = B/A = 50/20 = 2.5

Hydrophytic Vegetation Indicators:
__ Dominance Test is >50%
✓ Prevalence Index is ≤3.0[1]
__ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ✓ No ____

Remarks: litter is mostly Raphanus (?) and some dead cattails, cattails are regrowing. No upland spp at this spot.

SOIL

Sampling Point: Sm Pit 13

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
1-3"	10YR 3/2	100%						loamy clay
~~3-12~~								sandy clay
3-12	10YR 4/2	100%						
12-26	2.5Y 4/3	100%						fine sand, w/ some clay inclusions and some coarser sand inclusions, more coarse near bottom

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) No
- ___ Sandy Gleyed Matrix (S4) No
- ___ Sandy Redox (S5) No
- ___ Stripped Matrix (S6) No
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3) No
- ___ Redox Dark Surface (F6) No
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

No visible redox features

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ______
Depth (inches): ______

Hydric Soil Present? Yes ___ No ✓

Remarks: 0-3" lots of living roots and organic matter, also worms and inverts and holes (indicates not saturated). 3-12 - living roots, 12-26 soils are moist (increases near bottom)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✓ Depth (inches): ______
Water Table Present? Yes ___ No ✓ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ___ No ✓ Depth (inches): ______

Wetland Hydrology Present? Yes ___ No ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: bottom part of pit has moist soils (not saturated) wettest we have found so far.

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa West City/County: San Diego Sampling Date: 6/11/2012
Applicant/Owner: DON State: ____ Sampling Point: SM Pit 14
Investigator(s): Joel Degner, Tara Schoenwetter Section, Township, Range: ____
Landform (hillslope, terrace, etc.): base of bluff Local relief (concave, convex, none): none Slope (%): 0
Subregion (LRR): LRR C Lat: ____ Long: ____ Datum: ____
Soil Map Unit Name: Diablo Clay NWI classification: PEM/SSR
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)
Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ____	Is the Sampled Area within a Wetland? Yes X No ____
Hydric Soil Present?	Yes X No ____	
Wetland Hydrology Present?	Yes X No ____	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 1M)			
1. Typha latifolia	25	Y	OBL
2. Anemopsis californica	40	Y	OBL
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover			
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust ____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%
___ Prevalence Index is ≤3.0[1]
___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ____

Remarks: Typha litter 80%

SOIL

Sampling Point: Pit 14

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-4	10YR 2/2	100					Sandy loamy clay	organic debris
4-8	7.5YR 3/2	85	7.5 5/1	15	D	M	sandy clay loam	live roots
8-16	10YR 4/6						Coarse Sand	
16-19	10YR 4/6	95	10YR 2/2	5	C	M	Clay	clay deposits w/ sand

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- X Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______________________

Depth (inches): ______________

Hydric Soil Present? Yes X No ______

Remarks: At 16-19" there is black maganese concretions with different colors.
Top layer of organic matter is somewhat greasy with a little staining.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- X Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): ____________

Water Table Present? Yes _____ No X Depth (inches): ____________

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): ____________

Wetland Hydrology Present? Yes X No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa West City/County: San Diego Sampling Date: 6/1/2012

Applicant/Owner: DOD State: ______ Sampling Point: SM Pit 15

Investigator(s): Tara Schoenwetter, Joel Degner Section, Township, Range: ______

Landform (hillslope, terrace, etc.): base of slope, edge of estuary Local relief (concave, convex, none): none Slope (%): 1

Subregion (LRR): LRR C Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Diablo Clay NWI classification: PEM/SSR

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ______ (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes X No ______	Is the Sampled Area within a Wetland?	Yes X No ______
Hydric Soil Present? Yes X No ______		
Wetland Hydrology Present? Yes X No ______		

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	______ = Total Cover		
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
	______ = Total Cover		
Herb Stratum (Plot size: 1M)			
1. Juncus balticus	30	Y	OBL
2. Anemopsis californica	3	N	OBL
3. Polypogon monospeliensis	5	N	FACW
4. Distichlis spicata	2	N	FAC
5.			
6.			
7.			
8.			
	40 = Total Cover		
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
	______ = Total Cover		

% Bare Ground in Herb Stratum 60 % Cover of Biotic Crust 60

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ______

Remarks:

SOIL

Sampling Point: PIT 15

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-20	7.5YR 5/1	100					sandy clay loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes X No ___

Remarks: Salt crust on 1st half inch, Oxidized rhizospheres

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- X Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ______

Water Table Present? Yes ___ No X Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): ______

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa West City/County: San Diego Sampling Date: 6/1/2012

Applicant/Owner: DOD State: CA Sampling Point: SM Pit 16

Investigator(s): Joel Degner Tara Schoenwetter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): base of slope Local relief (concave, convex, none): none Slope (%): 3

Subregion (LRR): LRRC Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Diablo clay NWI classification: PEM/SSR

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	Is the Sampled Area within a Wetland?	Yes ___ No X
Hydric Soil Present?	Yes X No ___		
Wetland Hydrology Present?	Yes ___ No X		

Remarks: Pit is at the base of slope. Water runoff from over 50yrs of agriculture may be resposible for positive vegetation and soils present. There is subsurface flow from agriculture field and in time without a water source the area may revert back to being a non-wetland. Redox features in soil.

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 1m)			
1. Isocoma menziesii	80		FAC
2.			
3.			
4.			
5.			
= Total Cover	80		
Herb Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover			
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

debris 20% (litter)

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes X No ___

Remarks:

SOIL

Sampling Point: Pit 16

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-20	10yr 5/2						Sandy Clay loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes X No ___

Remarks: 1st half inch is organic debris

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___

Water Table Present? Yes ___ No X Depth (inches): ___

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): ___

Wetland Hydrology Present? Yes ___ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa West - CP City/County: San Diego Sampling Date: 14-May-12

Applicant/Owner: Dept of Defense State: CA Sampling Point: VP #1

Investigator(s): L. Brown Section, Township, Range: ____

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): Concave Slope (%): 0-1

Subregion (LRR): LRR C Lat: ____ Long: ____ Datum: ____

Soil Map Unit Name: Marine terrace NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ✓, Soil ✓, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ____	No X	Is the Sampled Area within a Wetland? Yes ____ No X
Hydric Soil Present?	Yes X	No ____	
Wetland Hydrology Present?	Yes X	No ____	

Remarks: Seasonal pond, rut in dirt road with tire tracks LoD is High, no vegetation in road.

LoD = level of disturbance

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover			
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 100% % Cover of Biotic Crust ____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 0 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No X

Remarks: No vegetation. Nearby veg is Baccharis pilularis, Artemesia californica, Foeniculum vulgare and Brassica nigra.

SOIL

Sampling Point: VP #1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- X Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ___
Depth (inches): ___

Hydric Soil Present? Yes X No ___

Remarks: small area, compacted soils, some fine sediment in one area on surface, some gravel, mostly sand. Tire ruts indicate some clay present.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- X Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✓ Depth (inches): ___
Water Table Present? Yes ___ No ✓ Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ___ No ✓ Depth (inches): ___

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Dry at time of survey.

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa - C. Pen City/County: San Diego Sampling Date: 14-May-12

Applicant/Owner: Dept. of Defense State: CA Sampling Point: VP #2

Investigator(s): L. Brown Section, Township, Range: ______

Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): Concave Slope (%): 0-1%

Subregion (LRR): LRR C Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Marine terrace NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ______ (If no, explain in Remarks.)

Are Vegetation ✓, Soil ✓, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ______ No ✓		
Hydric Soil Present? Yes ✓ No ______	Is the Sampled Area within a Wetland?	Yes ______ No ✓
Wetland Hydrology Present? Yes ✓ No ______		

Remarks: VP in dirt road, tire tracks, no plant cover, Level of Disturbance is high

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover			
Woody Vine Stratum (Plot size: ______)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 100% % Cover of Biotic Crust ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 0 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ______ No ✓

Remarks: No veg in pond, nearby is Baccharis pilularis and Artemesia californica dominated, Isomeris (bladder pod)

SOIL

Sampling Point: VP #2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- X Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ___
Depth (inches): ___

Hydric Soil Present? Yes X No ___

Remarks: Sand and clay with gravel and Cobble.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- X Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- X Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): ___
Water Table Present? Yes ___ No X Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): ___

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Dry at time of survey

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa C. Pen City/County: San Diego Sampling Date: 14-May-12

Applicant/Owner: Dept of Defense State: CA Sampling Point: VP #3

Investigator(s): L. Brown, Section, Township, Range:

Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): concave Slope (%): 0-1%

Subregion (LRR): LRR C Lat: Long: Datum:

Soil Map Unit Name: Diablo clay NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ✓, Soil ✓, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___ No ✓	Is the Sampled Area within a Wetland? Yes ___ No ___
Hydric Soil Present?	Yes ✓ No ___	
Wetland Hydrology Present?	Yes ✓ No ___	

Remarks: Edge of ag field, veg and soils are disturbed. Tire Ruts and compacted soils, 40D is high

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: 0)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 3m)			
1. Baccharis pilularis (small)	5%	Y	—
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 1 m^2)			
1. Matricaria discoidea	10	Y	FACU
2. Sonchus asper	2	N	FAC
3. Spergularia bocconii	5	N	—
4. Cotula coronopifolia	1	N	OBL
5. Lepidium didymum	10	Y	—
6.			
7.			
8.			
= Total Cover	35		
Woody Vine Stratum (Plot size: 0)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 70% % Cover of Biotic Crust ___

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No ✓

Remarks: Dominated by upland weedy spp. and a few seedlings of Baccaris pilulares.

SOIL

Sampling Point: VP#3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ✓ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ___
Depth (inches): ___

Hydric Soil Present? Yes ✓ No ___

Remarks: Soils are hard, clayey, tire ruts/from tractor no gravel or cobbles, maybe some sand

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ✓ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ✓ Depth (inches): ___
Water Table Present? Yes ___ No ✓ Depth (inches): ___
Saturation Present? (includes capillary fringe) Yes ___ No ✓ Depth (inches): ___

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Dry at time of survey, crust appears to be sediment and not biotic

5/14/2012

VP4

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: STUART MESA WEST   City/County: San Diego   Sampling Date: 14-May-12
Applicant/Owner: MCB CAMP PENDLETON   State: CA   Sampling Point: VP ~~#~~4
Investigator(s): TS LB   Section, Township, Range: ___
Landform (hillslope, terrace, etc.): Terrace   Local relief (concave, convex, none): concave   Slope (%): 0-1%
Subregion (LRR): LRRC   Lat: ___   Long: ___   Datum: ___
Soil Map Unit Name: ___   NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)
Are Vegetation Y, Soil Y, or Hydrology Y significantly disturbed?   Are "Normal Circumstances" present? Yes X No ___
Are Vegetation N, Soil N, or Hydrology N naturally problematic?   (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No ✓
Hydric Soil Present?	Yes ✓	No ___
Wetland Hydrology Present?	Yes ✓	No ___

Is the Sampled Area within a Wetland? Yes ___ No ✓

Remarks: mostly bare, some vegetation on one side (part of ag field) LOD is High, ruts in road and ag field.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ___)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ___)			
1. Baccharis pilularis	1	Yes	–
2. Artemisia californica	2	Yes	–
3.			
4.			
5.			
= Total Cover	3		
Herb Stratum (Plot size: 1m²)			
1. Solanum xantii?	10	Yes	FAC
2. Conyza canadensis	3	No	FACU
3. Pseudognaphalium luteo album	1	No	FAC
4. Hirschfeldia incana	1	No	–
5. Salsola australis	10	Yes	–
6. Anagallis arvensis	1	No	FAC
7. Sonchus asper	1	No	FAC
8.			
= Total Cover	25		
Woody Vine Stratum (Plot size: ___)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 75   % Cover of Biotic Crust 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 25% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	___	x 1 = ___
FACW species	___	x 2 = ___
FAC species	13	x 3 = 39
FACU species	___	x 4 = ___
UPL species	17	x 5 = 85
Column Totals:	30 (A)	124 (B)

Prevalence Index = B/A = 124/30 = 4.1

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No ✓

Remarks: Heliotrope in buffer area

SOIL

Sampling Point: VP#4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- X Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______________

Depth (inches): ______________

Hydric Soil Present? Yes ✓ No ______

Remarks: Soils are a sandy clay. The soil is very compacted with some sand on the surface. There is some gravel at the edge of the birm.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- X Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- X Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ______ No X Depth (inches): ______

Water Table Present? Yes ______ No X Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ______ No X Depth (inches): ______

Wetland Hydrology Present? Yes ✓ No ______

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Dry at time of survey

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa CP City/County: San Diego Sampling Date: 14-May-12

Applicant/Owner: Dept of Defense State: CA Sampling Point: VP #5

Investigator(s): L Brown, T. Schoenwetter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): convex Slope (%): 0-1%

Subregion (LRR): LRRC Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Marine terrace NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ✓, Soil ✓, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ____ No ✓	Is the Sampled Area within a Wetland? Yes ____ No ✓
Hydric Soil Present?	Yes ✓ No ____	
Wetland Hydrology Present?	Yes ✓ No ____	

Remarks: Pool is rut (long) along road, edge of ag field, compacted soils, disturbed veg
LOD = High, disturbance, mowing, trash

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 0)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
		= Total Cover	
Sapling/Shrub Stratum (Plot size: 3M)			
1. Baccharis pilularis	10%	Y	–
2.			
3.			
4.			
5.			
	10%	= Total Cover	
Herb Stratum (Plot size: 1M)			
1. Salsola australis	30%	Y	–
2. Conyza canadensis	10	Y	FACU
3. Foeniculum vulgare	5	N	–
4. Lepidium didymum	5	N	–
5. Pseudognaphalium luteoalbum	5	N	FAC
6.			
7.			
8.			
	40%	= Total Cover	
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum 60% % Cover of Biotic Crust ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No ✓

Remarks: Plot around deepest part of long VP. Veg has been cut (mowed). Road is part of VP buffer. Heliotropium curassavicum on other edge of road.

SOIL

Sampling Point: VP #5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- X Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ______
Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks: soil is very hard, compacted, sand on surface, little gravel

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- X Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- X Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______
Water Table Present? Yes ___ No ___ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ___ No ___ Depth (inches): ______

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Dry at time of survey

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa CP City/County: San Diego Sampling Date: 14-May-12
Applicant/Owner: Dept. of Defense State: CA Sampling Point: VP #6
Investigator(s): L. Brown, T. Schoenwetter Section, Township, Range: ____
Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): Concave Slope (%): 0-1%
Subregion (LRR): LRR C Lat: ____ Long: ____ Datum: ____
Soil Map Unit Name: Marine terrace NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)
Are Vegetation ✓, Soil ✓, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ____ No ✓		Is the Sampled Area within a Wetland? Yes ____ No ✓
Hydric Soil Present? Yes ✓ No ____		
Wetland Hydrology Present? Yes ✓ No ____		

Remarks: VP is on edge of ag field, tire rut is deepest part, LOD = High

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 0)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 3m²)			
1. Baccharis pilularis	20%	Y	—
2.			
3.			
4.			
5.			
= Total Cover	20		
Herb Stratum (Plot size: 1m²)			
1. Foeniculum vulgare	10%	Y	—
2. Conyza canadensis	20%	Y	FACU
3. Pseudognaphalium leucocephalum	3	N	FAC
4. Salsola tragus	5	N	
5. Heterotheca grandiflora	3	N	—
6. Matricaria discoidea	2	N	FACU
7. Sonchus asper	1%	N	FAC
8. Heliotropium curassavicum	1%	N	FACU
= Total Cover	40%		
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 50 % Cover of Biotic Crust ____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No ✓

Remarks: Veg plot at center of pool (deepest part)
Total veg cover ~ 60% — other spp - Lepidium didymus, Hirschfeldia incana.

SOIL

Sampling Point: VP #6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ✓ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks: Hard, Clayey soils with sand and very little gravels. very compacted! Road is part of pool + deepest part is in tire rut btwn road & ag field

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ✓ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ✓ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______

Water Table Present? Yes ___ No ___ Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ___ No ___ Depth (inches): ______

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Dry at time of survey

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa - C-Pen City/County: San Diego Sampling Date: 15-May-12

Applicant/Owner: DoD State: CA Sampling Point: VP#7

Investigator(s): L. Brown, T. Shoenwetter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): none Slope (%): 0

Subregion (LRR): LRRC Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Marine Terrace NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ✓, or Hydrology ✓ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ___	No ✓
Hydric Soil Present?	Yes ✓	No ___
Wetland Hydrology Present?	Yes ✓	No ___

Is the Sampled Area within a Wetland? Yes ___ No ✓

Remarks: Vernal pool includes tire ruts through areas of compacted soils. FS not found in this pool

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 0)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: 0)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: 1 m^2)			
1. Lepidium didymum	65%	Y	—
2. Polypogon monspeliensis	5	N	FACW
3. Conyza canadensis	5	N	FACU
4. Cotula coronopifolia	3	N	OBL
5. Hirschfeldia incana	1/2	N	—
6.			
7.			
8.			
= Total Cover			
Woody Vine Stratum (Plot size: 0)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 30% % Cover of Biotic Crust ______

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ___ No ✓

Remarks: Other species in VP buffer include Spergularia bocconi, Chenopodium, Melilotus indica, Sonchus, Erodium, Anagallis arvensis

No VP indicators, no spp specific to clay soils

SOIL

Sampling Point: VP #7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- X Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ______
Depth (inches): ______

Hydric Soil Present? Yes ✓ No ___

Remarks:
Soils are clayey, some sand and small gravel nearby, no cobbles

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- X Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- X Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No ___ Depth (inches): ______
Water Table Present? Yes ___ No ___ Depth (inches): ______
Saturation Present? (includes capillary fringe) Yes ___ No ___ Depth (inches): ______

Wetland Hydrology Present? Yes ✓ No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Stuart Mesa C Pen City/County: San Diego Sampling Date: 15-May-12

Applicant/Owner: Dept. of Defence State: CA Sampling Point: VP # 8

Investigator(s): L. Brown, T. Shoemwetter Section, Township, Range: ______

Landform (hillslope, terrace, etc.): LRR C Local relief (concave, convex, none): Concave Slope (%): 0%

Subregion (LRR): LRRC Lat: ______ Long: ______ Datum: ______

Soil Map Unit Name: Marine terrace NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ____ (If no, explain in Remarks.)

Are Vegetation ✓, Soil ✓, or Hydrology ✓ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? No (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ____ No ✓	Is the Sampled Area within a Wetland? Yes ____ No ✓	
Hydric Soil Present? Yes ✓ No ____		
Wetland Hydrology Present? Yes ____ No ✓		

Remarks: VP in access area to field, small depression lots of tire tracks, No FS found at this pool

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
= Total Cover			
Woody Vine Stratum (Plot size: ____)			
1.			
2.			
= Total Cover			

% Bare Ground in Herb Stratum ____ % Cover of Biotic Crust ____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ____ (A)

Total Number of Dominant Species Across All Strata: ____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No ✓

Remarks: Not vegetated

SOIL

Sampling Point: VP #8

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (LRR C)
- ___ 1 cm Muck (A9) (LRR D)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
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- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ✓ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (LRR C)
- ___ 2 cm Muck (A10) (LRR B)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):
Type: ____________
Depth (inches): ____________

Hydric Soil Present? Yes ✓ No ______

Remarks: Soils are sandy on top of compacted soils Some gravel on edge of pool, few cobbles.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (Nonriverine)
- ___ Sediment Deposits (B2) (Nonriverine)
- ___ Drift Deposits (B3) (Nonriverine)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (Riverine)
- ___ Sediment Deposits (B2) (Riverine)
- ___ Drift Deposits (B3) (Riverine)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No ✓ Depth (inches): ________
Water Table Present? Yes _____ No ✓ Depth (inches): ________
Saturation Present? (includes capillary fringe) Yes _____ No ✓ Depth (inches): ________

Wetland Hydrology Present? Yes ______ No ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: No cracks in surface, no sed, mark observed. May be not visible because of frequent traffic to access adjacent field (foot + vehicle).

Attachment C

Representative Photos

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Photograph 1 is the southwestern portion of the survey area and depicts an area of palustrine emergent marsh dominated by cattails and wild radish.

Photograph 2 is Pit 1, which met the wetland criteria for hydric soils because of the darker layer (chroma of 1) within the top 3 inches (7.6 centimeters) of the soil pit. The soils from 3 to 21 inches (53 centimeters) were very sandy and dry with no positive indicators for wetland hydrology.

Photograph 3 is near a landslide from the bluff dominated by willows. Pit 5 was located at the transition between the willows and the emergent marsh vegetation.

Photograph 4 shows the layering of the soils indicting multiple deposition events may have occurred over time. The darker lines may be from organic matter, although the soil texture indicated some of the darker lines may be from inorganic sources (e.g., ash from a fire or other disturbance from the top of the bluff).

Photograph 5 is the swale in the foredunes between the two berms that parallel the shore. This swale area is dominated by low growing wetland plants such as fleshy jaumea, salt grass, and heliotrope.

Photograph 6 is Pit 7; none of the wetland pits dug in the swale area met the criteria for hydric oils or wetland hydrology.

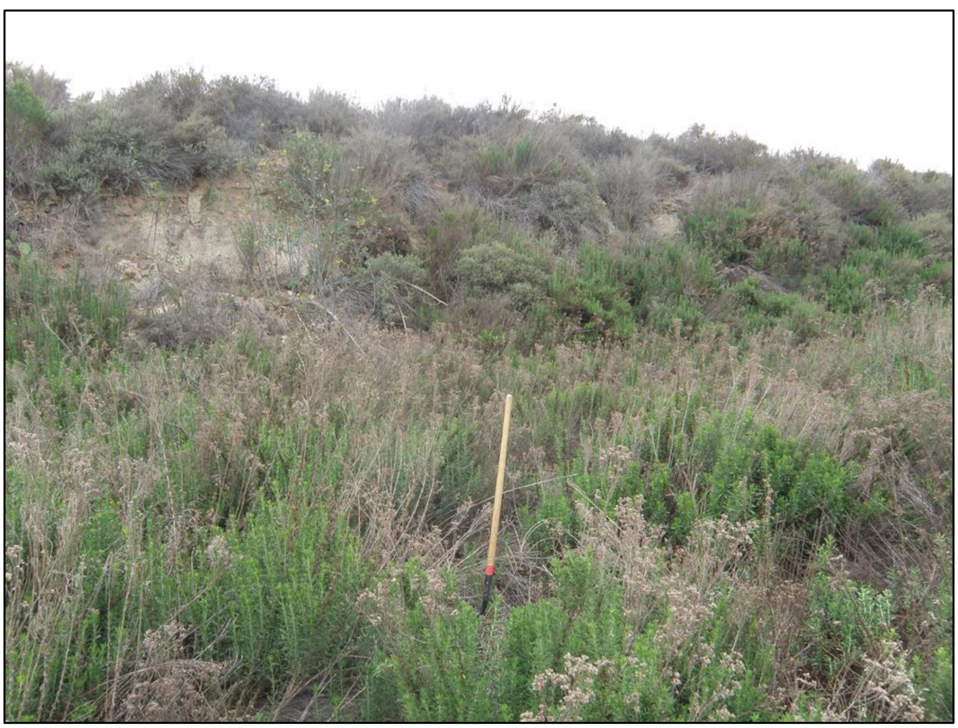
Photograph 7 is near Pit 8 in an area dominated by yerba mansa. The large patch of cattails is visible in the background as well as dense willow forest.

Photograph 8 is Pit 8. The pit was difficult to dig because of a layer of rocks underneath the top layer of sand. The rocks are worn and may indicate that sometime in the past the river flowed in this area. Pit 8 did meet the hydric soils criteria because the top 3 inches (7.6 centimeters) had a chroma of 1, possibly due to the prevalence of organic matter underneath the vegetation. There were no positive indicators for wetland hydrology at Pit 8.

Photograph 9 is soil from Pit 9, which was dug on the boundary of a dense cattail patch. The same rocks that were found at Pit 8 were also found at Pit 9 making it difficult to dig. However, oxidized rhizospheres (i.e., root channels) were observed within the top 8 inches (20.3 centimeters) of the soil pit, a positive indicator for wetland hydrology; Pit 9 met all three criteria for jurisdictional wetlands.

Photograph 10 is an overview of the southeastern portion of the survey area, the north floodplain of the Santa Margarita River and estuary.

Photograph 11, is Pit 14. The top 4 inches (10.2 centimeters) of the soil is clearly darker than the lower layers and has indications of containing decomposed organic material. A salt crust was observed in this area, a positive indicator for wetland hydrology; Pit 14 met all three criteria for jurisdictional wetlands.



In Photograph 12, the shovel depicts the location of Pit 16 on the edge of the slope and dominated by coast goldenbush. The shrub dominated areas were determined to be outside the jurisdictional wetland boundary.

Photograph 13 is seasonal basins (or vernal pools) #1 and 2. These basins are a depression in a dirt road with no vegetation, although they do hold water for a period of time.

Photograph 14 is seasonal basin #3, which consists of tire ruts within a disturbed area. Although wetland plant species were present in this basin, upland plant species were dominant.

Photograph 15 is seasonal basin #7, which is within a large, disturbed flat area at the northeast portion of the survey area. Although wetland plant species were present in basin #7, upland plant species were dominant.

Photograph 16 is the northernmost edge of the survey area. Diegan coastal scrub vegetation borders the existing road in this area and Cockleburr Creek is just to the north, outside the survey area.

Attachment D

Surveyor Information

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Leidos (formally SAIC) biologists Lauren Brown (botanist, wetlands specialist) and Tara Schoenwetter (botanist, vernal pool and wildlife biologist) conducted surveys from 14 to 16 May 2012. Additional data were collected by Tara Schoenwetter and Joel Degner (water resources specialist) on 1 June 2012. The surveys were conducted in conjunction with the rare plant surveys (Leidos 2014). All results were reviewed by Trevor Pattison (wetland specialist).

Appendix G

California Coastal Commission Negative Determination Concurrence Letter

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STATE OF CALIFORNIA – NATURAL RESOURCES AGENCY

EDMUND G. BROWN, JR., *GOVERNOR*

CALIFORNIA COASTAL COMMISSION

45 FREMONT, SUITE 2000
SAN FRANCISCO, CA 94105-2219
VOICE (415) 904-5200
FAX (415) 904-5400
TDD (415) 597-5885

January 14, 2016

B. Battista
Head, Environmental Planning
MCIW – Marine Corps Base
Box 555008
Camp Pendleton, CA 92055

Subject: Negative Determination ND-0040-15 (Conversion of Stuart Mesa West Agricultural Fields, Camp Pendleton, San Diego County)

Dear Mr. Battista:

The Coastal Commission staff has reviewed the above-referenced negative determination. The Marine Corps proposes to convert 304 acres of fallow agricultural land located within Stuart Mesa West to a military training area. The project site is located at the southern end of Camp Pendleton, between Interstate 5 and White Beach and north of the Santa Margarita River. The site was leased for agricultural use for decades until the expiration of the most recent lease in January 2011. The Marine Corps did not renew the lease as it had determined that the land was needed for future military training operations. Subsequently, the site was disked and mowed to allow for soil sampling, repair, and maintenance activities in preparation for non-agricultural land uses. The Marine Corps states that:

> *The proposed conversion . . . would accommodate combined land, air, and sea training operations needed to support USMC requirements under 10 USC § 5063. Construction of the new access roads, general site improvements, and proposed training operations is needed because MCB Camp Pendleton lacks a dedicated training area that can accommodate all three types of training operations required for MAGTFs* [Marine Air-Ground Task Force].

Training activities at the project site would include amphibious assault vehicle landings, infantry and mechanized formation operations, rotary wing and tilt-rotor aircraft operations, and logistics support. The proposed site improvements to support the planned training operations would be constructed over a six-month period and include:

- Site grading to remove remaining agricultural vegetation and quarterly mowing to prevent re-growth of vegetation that would hinder training activities.
- Grading two 25-foot-wide and 400-foot-long dirt access roads between White Beach and the upland training area.
- Rough-grading of a 3,170-foot-long access road at the southern edge of the training area.

The Marine Corps reports that there are approximately 13,500 acres of land within Camp Pendleton (including the 304-acre project site) that are designated as prime farmland by the U.S. Department of Agriculture. The Marine Corps further states that:

> *Projects are subject to federal Farmland Protection Policy Act requirements if they would irreversibly convert farmland (directly or indirectly) to non-agricultural uses and are completed by a federal agency or with assistance from a federal agency. While conversion of former agricultural lands (Prime Farmland) would occur as a result of . . .* [the proposed project], *lands on MCB Camp Pendleton are not subject to the Farmland Protection Policy Act because acquisition or use of farmland by a federal agency for national defense purposes is exempt* [from Farmland Protection Policy Act requirements].

The *MCB Camp Pendleton 2030 Base Master Plan (USMC 2010b)* identifies agricultural lands that are not being leased as potential development and expansion areas. The proposed training area would be sited, designed, and constructed consistent with the guidelines presented in the *Base Master Plan* and proposed development would be contained within existing military designations at Camp Pendleton. The proposed land conversion and training area development follows previous Marine Corps conversions of former agricultural land on Stuart Mesa. In February 2009 the Executive Director concurred with negative determination ND-060-08 for construction of military family housing on a 390-acre parcel of land formerly leased for agricultural operations east of Interstate 5. In October 2015 the Executive Director concurred with ND-0031-15 for construction of a ground-based solar photovoltaic system on a 194-acre portion of the aforementioned 390-acre parcel. Additionally, in December 2010 the Executive Director concurred with ND-039-09 for establishment of the Sierra Training Area in an area previously leased to agricultural operators located east of San Mateo Creek at the north end of Camp Pendleton. In these actions, the Executive Director concurred that the proposed conversions and new land uses would not adversely affect coastal resources.

The negative determination states that:

> *The proposed new training area would be available for operations 24 hours per day and year-round. However, training activities (i.e., amphibious landings and use of new beach access roads) on sandy beach areas within the project site and aircraft operations would be restricted per the Riparian and Estuarine Programmatic Conservation Plan and associated Riparian Biological Opinion (USFWS 1995).*

The provisions of the *Conservation Plan* and *Biological Opinion* include numerous measures (e.g., restrictions on foot traffic, vehicle traffic, aircraft operations) to protect fenced or posted nesting areas of listed species in upland areas and sandy beaches, and to protect riparian and biological resources in the Santa Margarita River Management Zone.

The project site is located entirely within the restricted boundary of Marine Corps Base Camp Pendleton, and therefore the proposed land use conversion and military training operations will not affect public access to the shoreline at this location. Future public views across the project area towards the Pacific Ocean from Interstate 5 may occasionally include military vehicles, aircraft, and other indications of training operations, but currently viewing such activity from Interstate 5 within Camp Pendleton is not uncommon. While no environmentally sensitive habitat (ESHA) or listed species are present on the subject parcel, the adjacent sandy beach and the Santa Margarita River corridor do contain ESHA and support a number of listed species, including the California least tern, Western snowy plover, coastal California gnatcatcher, and Ridgway's rail. The Marine Corps states that any potential effects on sensitive habitats and listed species will be minimized and/or mitigated through avoidance and conservation measures coordinated with the U.S. Fish and Wildlife Service under the *Programmatic Activities and Conservation Plans in Riparian and Beach/Estuarine Ecosystems on Marine Corps Base Camp Pendleton Biological Opinion (October 30, 1995).* Storm water best management practices will be incorporated into the design and construction of roads and site improvements, and will be implemented during training operations in order to protect coastal water quality to the maximum extent practicable.

Under the federal consistency regulations (15 CFR §930.35), a negative determination can be submitted for an activity "which is the same as or similar to activities for which consistency determinations have been prepared in the past." The proposed agricultural land conversion and military training area development is similar to previous consistency and negative determinations concurred with by the Commission and Executive Director for land use changes and redevelopment at Camp Pendleton. In conclusion, the Commission staff **agrees** that the proposed land use conversion and development of a military training operation at Stuart Mesa West on Marine Corps Base Camp Pendleton will not adversely affect coastal resources. We therefore **concur** with your negative determination made pursuant to 15 CFR 930.35 of the NOAA implementing regulations. Please contact Larry Simon at (415) 904-5288 should you have any questions regarding this matter.

Sincerely,

(for) CHARLES LESTER
Executive Director

cc: CCC – San Diego Coast District
Matthew Lorne, MCB Camp Pendleton

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Appendix H

Stuart Mesa West Agricultural Fields Human Health and Ecological Risk Assessment

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Naval Facilities Engineering Command
NAVFAC SOUTHWEST

Stuart Mesa West Agricultural Fields Human Health and Ecological Risk Assessment

MARINE CORPS BASE CAMP PENDLETON, CALIFORNIA

June 13, 2012

Prepared for
NAVAL FACILITIES ENGINEERING COMMAND - SOUTHWEST DIVISION
1220 Pacific Highway, San Diego, CA 92132-5190

Prepared by

PARSONS
100 West Walnut Street, Pasadena, California 91124

Prepared under
Contract Number N62473-09-D-1212

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ABBREVIATIONS AND ACRONYMS

ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
BHC	benzene hexachloride
Cal EPA	California Environmental Protection Agency
chRD	Child-Specific Reference Dose
CHHSLs	California Human Health Screening Levels
COPC	chemical of potential concern
CSM	conceptual site model
DDD	p,p'-Dichlorodiphenyldichloroethane
DDE	p,p'-Dichlorodiphenyldichloroethene
DDT	p,p'-Dichlorodiphenyltrichloroethane
DTSC	California Department of Toxic Substances Control
E	exposure
EPC	exposure point concentration
HEAST	Health Effects Assessment Tables
HHERA	human health and ecological risk assessment
HI	hazard index
HQ	hazard quotient
IED	improvised explosive device
IRIS	Integrated Risk Information System
IUR	Inhalation unit risk
MCB	Marine Corps Base
MCTSSA	Marine Corps Tactical Systems Support Activity
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram per day
mg/m^3	milligrams per meters cubed
MOUT	military operations in urban terrain
MRL	minimal risk levels
NAVFAC SW	Naval Facilities Engineering Command, Southwest
OAF	oral absorption factor
OCP	organochlorine pesticide
OEHHA	Office of Environmental Health Hazard Assessment
Parsosn	Parsons, Inc.
PEF	particulate emissions factor
PM_{10}	particulate matter 10 microns or less in diameter
PPRTVs	Provisional Peer Reviewed Toxicity Values
RME	reasonable maximum exposure
RfC	reference concentration
RfD	reference dose
RG	remedial goal
RSLs	Regional Screening Levels
SMWAF	Stuart Mesa West Agricultural Fields
SOW	scope of work
SF	slope factor
TR	target risk
UCL	upper confidence limit
USEPA	United States Environmental Protection Agency
VOC	volatile organic compounds

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INTRODUCTION

This report presents the results of a human health and ecological risk assessment (HHERA) for the Stuart Mesa West Agricultural Fields (SMWAF) at the Marine Corps Base Camp Pendleton, California (MCB Camp Pendleton or the Base) (Figure 1). This document was prepared by Parsons, Inc. (Parsons) for the Naval Facilities Engineering Command, Southwest (NAVFAC SW).

The purpose of this HHERA is to assess the potential risks to human and ecological receptors at the SMWAF. This risk assessment is consistent with the United States Environmental Protection Agency (USEPA 1989, 1996, 1997a, 1998, 2002, 2004, 2009, and 2012a) and California Department of Toxic Substances Control (DTSC) (1999, 2011) guidance.

1.0 SITE BACKGROUND

Stuart Mesa West Agricultural Fields is an area of approximately 202 acres bordered on the northeast by I-5, on the southwest by the Pacific Ocean, on the south and southeast by the Santa Margarita River, and by the Marine Corps Tactical Systems Support Facility (MCTSSA) on the west and northwest (Figure 1). The Stuart Mesa West Agricultural Fields have been used for growing tomatoes and strawberries and other agricultural uses for at least 70 years.

At present, SMWAF is an actively managed agricultural operation. Due to the disturbance related to agricultural activities, only those species that are tolerant of human activities are assumed to be present; i.e., it is not assumed that there is any wildlife at the site. However, the beach immediately to the west of the site is habitat for the California least tern (*Sterna antillarum browni*) and the western snowy plover (*Charadrius alexandrinus nivosus*) (Naval Facilities Engineering Command Southwest 2010), federally listed endangered and threatened species, respectively. For the foreseeable future, the SMWAF will be used as a military base.

2.0 SAMPLING ACTIVITIES AND RESULTS

2.1 SAMPLE COLLECTION

Soil samples were collected from SMWAF by SDV in September and October of 2011. Surface samples (i.e., 0.5 to 1.0 foot below ground surface [ft bgs]) were collected from the center of each of 802 ¼ acre grids (Figure 2). All samples were analyzed for organochlorine pesticides (OCPs) by Method 8081A.

2.2 ANALYTICAL RESULTS

All of the analytical data was validated. Data validation classified the data through the use of several qualifiers. Data without qualifiers were considered appropriate for risk assessment purposes; i.e., these data met the criteria prescribed in the modified contract task order (N62473-09-D-1212-0029). Following USEPA guidance (1989, 1992a), data with J qualifiers were used for risk assessment purposes. U and UJ qualified data were considered to be below laboratory detection limits (non-detect) but usable for risk assessment purposes. NJ qualified data were treated as detections but may be false positives (USEPA 2008). R qualified data were excluded from this risk assessment (USEPA 1989, 1992a). The validated analytical results are shown in Table 1.

All OCPs were detected at least once, with the exception of heptachlor, which was not detected. Summary statistics for the chemicals detected in soils (including the frequency of detection, the minimum and maximum detected values, and the UCL_{95}) are presented in Table 2. Detailed statistical analysis of the data (i.e., output from ProUCL [USEPA 2010]) is provided in Appendix A.

3.0 HUMAN HEALTH SCREENING EVALUATION

3.1 INTRODUCTION

The evaluation of human health effects consists of five steps: (1) identifying chemicals of potential concern (COPCs); (2) identifying potentially complete exposure pathways based on the conceptual site model; (3) assessing the toxicity of the COPCs; (4) assessing the potential for exposures; and (5) estimating the potential health risks from assumed exposures to the COPCs. Each of these steps is described below. The findings of the human health screening evaluation are summarized at the end of this section of the report.

3.2 CHEMICALS OF POTENTIAL CONCERN

All of the OCPs that were detected were selected as COPCs and were evaluated in the risk assessment. The detected OCPs include the following:

- Aldrin
- BHC (benzene hexachloride), alpha
- BHC, beta
- BHC, gamma (Lindane)
- BHC, delta
- Chlordane, alpha
- Chlordane, gamma (or trans-chlordane)
- DDD (p,p'-dichlorodiphenyldichloroethane)
- DDE (p,p'-dichlorodiphenyldichloroethene)
- DDT (p,p'-dichlorodiphenyltrichloroethane)
- Dieldrin
- Endosulfan I (or alpha-endosulfan)
- Endosulfan II (or beta-endosulfan)
- Endosulfan sulfate
- Endrin
- Endrin aldehyde
- Endrin ketone
- Heptachlor epoxide
- Methoxychlor
- Toxaphene

3.3 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) provides a description of the links between contaminant sources at a site, the chemicals detected at the site, the mechanisms by which chemical transport or migration may occur in the environment, and the receptors potentially exposed to environmental media at the site. A CSM that identifies the potential sources, mechanisms of transport, environmental media of concern, and exposure routes for current and future human receptors is shown in Figure 3.

The site history and background, as well as the identified environmental concerns, are discussed in Section 1.0. Only one potential source of contamination has been identified for SMWAF: past agricultural uses.

For the foreseeable future, the site will be used for military purposes. Although the exact use has not yet been determined, the potential uses include residential, industrial, and a military training area. Three types of military training activities may occur at the site:

1. Maneuver training - consists of the movements and positioning of troops, vehicles, and equipment, along with simulated gunfire, but with no digging.

2. MOUT (military operations in urban terrain) training - consists of classes held in outdoor facilities and convoy operations conducted on roadways designed to train personnel in the identification of improvised explosive devices (IEDs) and countermeasures, but with no digging.

3. Heavy equipment/engineering training - heavy equipment training activities, including digging, grading, piling soils, and building berms.

Although the site may be used for training purposes, it is assumed that the staff performing the training may be present longer than the trainees themselves. Therefore, both the trainers and the trainees were selected for evaluation. If the site is used for industrial purposes, maneuver training, or MOUT training, infrastructure will be required at the site. Therefore, construction workers were also selected for evaluation.

Overall, six receptors were selected for evaluation in this report: residents, industrial workers, construction workers, maneuver trainers, MOUT trainers, and heavy equipment/engineering trainers.

3.3.1 Soil Exposure Pathways

Currently, the site consists of cultivated fields with a limited number of structures and unpaved roads. Since chemicals have been detected in soils at the site, the potential exists for humans to be exposed to the chemicals in soils through direct dermal contact with soil and by incidental soil ingestion. In the future, some of the site may be covered by buildings, asphalt, or concrete. However, some of the site is likely to remain unpaved. Construction workers and heavy equipment trainers are also expected to use earth moving equipment that would expose soils at the site. Therefore, exposures were evaluated for incidental soil ingestion and dermal contact with all soils at the site.

3.3.2 Air Exposure Pathways

None of the chemicals detected in soils at the site are classified by the USEPA (2002, 2012a) as volatile organic chemicals (VOCs). Therefore, receptors at the site were not assumed to be exposed to volatiles emitted from soils by inhalation.

Wind erosion of soil particulates, vehicular traffic on the unpaved roads at the site, as well as soil tilling, could potentially result in the aerial suspension of the chemicals detected in soils at the site as dust. Therefore, it was assumed that receptors at the site could potentially be exposed to chemicals in soils by the inhalation of airborne dusts.

3.3.3 Summary of Selected Exposure Pathways

For the purpose of this evaluation, it was assumed that receptors at the site could potentially be exposed to chemicals by direct dermal contact with soil, incidental soil ingestion, and the inhalation of airborne dusts. These potentially complete exposure pathways are shown in the CSM (Figure 3).

3.4 TOXICITY VALUES

The toxicity assessment characterizes the relationship between the magnitude of exposure to a COPC and the nature and magnitude of adverse health effects that may result from such exposure. For risk assessment purposes, adverse health effects are classified into two broad categories: carcinogens and noncarcinogens. Since both carcinogens and noncarcinogens were detected at the site, toxicity values are presented below for both types of adverse health effects. Toxicity values are generally developed based on the nonthreshold approach (i.e., any level of exposure results in increased risks) for carcinogenic effects and the threshold approach (i.e., exposures below the threshold do not result in increased risks) for noncarcinogenic effects. Toxicity values used in risk assessments may be based on epidemiological studies, short-term human studies, and subchronic or chronic animal studies.

3.4.1 Carcinogenic Effects

Certain chemicals are regulated as carcinogens based on the likelihood that exposure could potentially cause cancer in humans. Estimates of the carcinogenicity for these chemicals are presented as cancer potency factors (or Slope Factors [SFs]) and Inhalation Unit Risks (IURs). The SF/IUR defines the upper-bound (i.e., 95%) cancer risk due to constant lifetime exposure to the carcinogen. Typically, carcinogenic SFs and IURs are developed assuming that there is no safe dose; i.e., any amount of exposure results in an increase in the risk of cancer. However, if there is a threshold for carcinogenicity, actual risks could be zero at doses below the threshold.

Two sets of SFs and IURs were compiled, one based preferentially on USEPA toxicity values, and one based preferentially on California EPA toxicity values. The first set of cancer toxicity values (referred to as "USEPA") was compiled following USEPA (2003, 2012a) guidance and used the following hierarchy of sources:

1) USEPA's (2012b) Integrated Risk Information System (IRIS)

2) USEPA's (2012c) Provisional Peer Reviewed Toxicity Values (PPRTVs)

3) Office of Environmental Health Hazard Assessment (OEHHA) (2012) Toxicity Criteria Database

4) USEPA's (2012c) PPRTV appendix screening toxicity values

5) USEPA's (1997b) Health Effects Assessment Summary Tables (HEAST)

The second set of cancer toxicity values (referred to as "California modified") was compiled using the following hierarchy of sources:

1) OEHHA's (2012) Toxicity Criteria Database

2) USEPA's (2012b) IRIS

3) USEPA's (2012c) PPRTVs

4) USEPA's (2012c) PPRTV appendix screening toxicity values

5) USEPA's (1997b) HEAST

For the California modified toxicity values, route-to-route extrapolations were used to calculate IURs from SFs for chemicals with an SF but without an IUR (DTSC 1999). However, route-to-route extrapolations were not used to calculate SFs for chemicals with an IUR but without an SF, as this is not advised under current guidance (DTSC 1999, USEPA 2009). Additionally, it should be noted that route-to-route extrapolations were not used for the USEPA toxicity values as this is not used under current USEPA (1989, 2009) guidance. Tables 3 and 4 present the SFs and IURs used in this evaluation.

3.4.2 Noncarcinogenic Effects

Noncarcinogenic effects were evaluated using reference doses (RfDs) and reference concentrations (RfCs). RfDs/RfCs are health-based criteria based on the assumption that thresholds exist for noncarcinogenic effects (e.g., liver or kidney damage). In general, the RfD/RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a threshold above which noncarcinogenic adverse effects may occur from a lifetime of exposure (USEPA 1989). RfDs are expressed as acceptable daily doses in milligrams of compound per kilogram of body weight per day (mg/kg-day). For inhalation exposures, the RfC is used instead of an RfD. The RfC is calculated using the same assumptions described above for the RfD but is expressed as milligrams per meters cubed (mg/m^3).

For the purpose of assessing risks associated with noncarcinogenic effects, the USEPA evaluates the potential for noncarcinogenic effects by comparing an exposure level over a specified time period (e.g., lifetime) with a RfD/RfC derived for a similar exposure period. This ratio of exposure (E) to toxicity (RfD/RfC) is called a hazard quotient (HQ). The noncancer HQ assumes that there is a level of exposure (i.e., the RfD/RfC) below which it is unlikely that even sensitive populations will experience adverse health effects; i.e., there is a threshold below which exposures are tolerated without adverse effects. If the exposure level exceeds the RfD/RfC (i.e., if the HQ is greater than 1), adverse noncancer effects may occur. In general, the greater the value of the HQ above 1, the greater the level of concern (USEPA 1989).

As for carcinogens, two sets of chronic RfDs/RfCs were compiled for noncarcinogens. The first set of noncancer toxicity values (referred to as "USEPA") was compiled following USEPA (2003, 2012a) guidance and used the following hierarchy of sources:

1) USEPA's (2012b) IRIS

2) USEPA's (2012c) PPRTVs

3) Agency for Toxic Substances and Disease Registry's (ATSDR 2012) minimal risk levels (MRLs)

4) OEHHA's (2008, 2009) reference exposure levels and child-specific reference doses

5) USEPA's (2012c) PPRTV appendix screening toxicity values

6) USEPA's (1997b) HEAST

The second set of noncancer toxicity values (referred to as "California modified") was compiled using the following hierarchy of sources:

1) OEHHA's (2008, 2009) reference exposure levels and child-specific reference doses

2) USEPA's (2012b) IRIS

3) USEPA's (2012c) PPRTVs

4) ATSDR's (2012) MRLs

5) USEPA's (2012c) PPRTV appendix screening toxicity values

6) USEPA's (1997b) HEAST

For the California modified toxicity values, route-to-route extrapolations were used to approximate RfCs (DTSC 1999) for chemicals with oral RfDs but without RfCs. However, route-to-route extrapolations were not used for chemicals with RfCs to approximate oral RfDs, as this is not advised under current DTSC (1999) guidance. Additionally, it should be noted that route-to-route extrapolations were not used for the USEPA toxicity values as this is not used under current USEPA (1989, 2009) guidance. Tables 3 and 4 present the RfDs/RfCs used in this risk evaluation.

3.5 ESTIMATION OF CHEMICAL INTAKE

Potential chemical exposures at the site were estimated using a set of exposure models defined by USEPA (1989, 1996, 2004, 2009) guidance. Exposures were evaluated for all of the complete exposure pathways identified at the site (see Section 3.3); i.e., incidental soil ingestion, dermal contact with soil, and the inhalation of dusts. The equations and exposure parameters used to estimate exposures for each exposure pathway are provided in Table 5.

For residents, exposures to carcinogens were estimated for exposure as a child then an adult (i.e., 30 years of exposure) whereas for noncarcinogens, exposures were estimated for children only (i.e., 6 years). Although counter-intuitive, this results in a more protective risk assessment for noncarcinogens. For military trainers, risks were estimated for two separate exposure durations as follows: 1) 5 years, or the maximum duration of a single enlistment, and 2) 20 years, the maximum duration of a career in the Marine Corps.

The exposure parameters used in this risk assessment are generally defaults from USEPA and DTSC. This is likely to lead to an over estimate of soil ingestion and exposure to dusts, as discussed in more detail in the Uncertainty Analysis (Section 5). The exposure duration and frequency for the military trainers are based on site-specific information from MCB Camp Pendleton.

3.5.1 Exposure Point Concentrations

For industrial and construction workers, as well as military trainers, who are assumed to be exposed to soils across the entire site, the reasonable maximum exposure (RME) was used as the exposure point concentration (EPC) for all COPCs. This assumption is discussed further in Section 6.0. The RME was calculated as the lesser of the maximum detected concentration and the 95% upper confidence limit (UCL; USEPA 1992b). UCLs were calculated using ProUCL v4.1.01 (USEPA 2010) using all soil samples collected at the site. A standard residential lot is generally assumed to be 0.25 acres. As the soil samples were collected from 0.25 acre grids, the maximum detected concentration at the site provides a health-protective estimate of residential exposures and was, therefore, used as the EPC for residents. The maximum detected concentration, UCL, and RME for each COPC are shown in Table 2.

3.5.2 Fate and Transport Modeling

For direct contact with soils, the soil analytical results may be used directly to evaluate exposures. However, to evaluate exposures to chemicals in dusts, it is necessary to model the migration of chemicals to the atmosphere. This section of the report describes the fate and transport models used to estimate EPCs for nonvolatiles in outdoor dusts.

Chemical concentrations in air were estimated for the nonvolatile chemicals that can sorb to soils and become airborne dust through wind erosion. Receptors at the site may then be exposed to chemicals in dust through the inhalation of respirable dust. Respirable dust particles are composed of particulate matter 10 microns or less in diameter (PM_{10}). The airborne dust (PM_{10}) chemical exposure point concentrations were estimated as follows:

$$C_a = \frac{C_s}{PEF}$$

where:

C_a = chemical concentration in dust (PM_{10}) in milligrams per cubic meter (mg/m^3).
C_s = chemical concentration in soil (mg/kg).
PEF = particulate emissions factor in cubic meters per kilogram (m^3/kg).

For the purposes of this risk assessment, the DTSC (2011) default PEFs for residents/industrial workers (1.316×10^9 m^3/kg) and construction workers (1×10^6 m^3/kg) were used. The default construction worker PEF provides a health-protective assessment of inhalation exposures to dusts generated at the site as the default PEF assumes a very high level of dust generation. The estimated airborne dust concentrations are shown in Table 2.

3.6 RISK CHARACTERIZATION

3.6.1 Risk Estimation Procedures

Separate procedures were used to estimate cancer and noncancer health effects. Also, separate procedures were used to estimate risks from direct exposures to soil (i.e., dermal contact and soil ingestion) and from indirect exposures via the inhalation of airborne dust. Each of these procedures is described below. Risks were calculated using both the USEPA and California modified toxicity values.

3.6.1.1 Cancer Risk Estimation Procedures

For carcinogens, risks were estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen (i.e., incremental or excess individual lifetime cancer risk). Carcinogenic risk probabilities were estimated by multiplying the exposure level calculated for each exposure route by the corresponding cancer toxicity value (i.e., SF or IUR) (USEPA 1989, 2004, 2009) as follows:

$$Risk_{oral} = Exposure_{oral} \times SF$$
$$Risk_{dermal} = Exposure_{dermal} \times SF_d$$
$$Risk_{inhalation} = Exposure_{inhalation} \times IUR$$

where:

Risk	= Incremental or excess individual lifetime cancer risk for each COPC (unitless).
$Exposure_{oral,dermal}$	= Oral and dermal exposure for each COPC (mg/kg-day).
$Exposure_{inhalation}$	= Inhalation exposure for each COPC (mg/m^3).
IUR	= Chemical specific inhalation unit risk factor ($(mg/m^3)^{-1}$).
OAF	= Oral absorption factor (unitless).
SF	= Route and chemical specific slope factor ($(mg/kg\text{-}day)^{-1}$).
SF_d	= SF/OAF.

Risk probabilities are assumed to be additive for all COPCs across all exposure pathways to estimate a total excess cancer risk. After summing all of the risks, the total excess cancer risk estimates are then compared to the point of departure of 10^{-6} (DTSC 1999, USEPA 1990). In general, total risks greater than 10^{-4} (e.g., 10^{-3} or 10^{-2}) require action; risks between 10^{-6} and 10^{-4} are in the risk management range and require the stakeholders to discuss and decide whether the risk estimates are acceptable; risks less than 10^{-6} (e.g., 10^{-7} and 10^{-8}) are unconditionally acceptable (USEPA 1990).

3.6.1.2 Noncancer Risk Estimation Procedures

For exposure to noncarcinogens, adverse effects are not assumed to occur below a certain threshold (i.e., the RfD/RfC). The potential for adverse noncarcinogenic effects (i.e., the hazard quotient or HQ) was estimated by dividing the exposure level calculated for each exposure route by the corresponding noncancer toxicity value (i.e., RfD/RfC) (USEPA 1989, 2004, 2009) as follows:

$$HQ_{oral} = Exposure_{dermal}/RfD$$
$$HQ_{dermal} = Exposure_{dermal}/RfD_d$$
$$HQ_{inhalation} = Exposure_{inhalation}/RfC$$

where:

HQ	= Hazard quotient for each COPC (unitless).
$Exposure_{oral,dermal}$	= Oral and dermal exposure for each COPC (mg/kg-day).
$Exposure_{inhalation}$	= Inhalation exposure for each COPC (mg/m^3).
OAF	= Oral absorption factor (unitless).
RfD	= Route and chemical reference dose (mg/kg-day).
RfD_d	= RfD x OAF.
RfC	= Chemical specific inhalation reference concentration (mg/m^3).

OEHHA (2009) provides child-specific RfDs for some chemicals, which are usually more protective than generic RfDs. When noncancer hazards were calculated using the California modified toxicity values, child-specific RfDs were used preferentially, if available.

As stated above, noncancer hazards for residents were estimated assuming exposure only as a child as this results in a more protective risk assessment.

After summing all of the HQs for all COPCs across all exposure pathways, the sum is then compared to the DTSC (1999) and USEPA (1990) acceptable hazard level. This summation is called a hazard index (HI). A hazard index of 1 is used as a benchmark level to indicate whether adverse health effects are likely to occur as a result of exposures to COPCs at the site. Hazard indexes greater than 1 indicate that adverse noncarcinogenic health effects may occur whereas, hazard indexes less than 1 indicate that adverse noncarcinogenic health effects are unlikely to occur, and both DTSC and USEPA consider HIs less than one as acceptable.

3.6.2 Site-Specific Cancer Risk and Noncancer Hazard Estimates

The risks from assumed exposures are presented in Tables 6 through 23. A summary of the risks and non-cancer hazards for each receptor is shown below.

	USEPA		California Modified	
Receptor	**Risk**	**Hazard**	**Risk**	**Hazard**
Resident	4.E-05	1	4.E-05	4
Industrial worker	1.E-06	0.01	1.E-06	0.008
Construction worker	2.E-07	0.05	2.E-07	0.03
Military trainers with 5 year exposure duration				
Maneuver	3.E-07	0.01	2.E-07	0.008
MOUT	1.E-07	0.005	8.E-08	0.003
Heavy Equipment	2.E-07	0.003	2.E-07	0.002
Military trainers with 20 year exposure duration				
Maneuver	1.E-06	0.06	9.E-07	0.03
MOUT	4.E-07	0.02	3.E-07	0.01
Heavy Equipment	1.E-06	0.01	8.E-07	0.007

The risk and non-cancer hazards are discussed below for each receptor.

Residents

Total excess cancer risks for assumed residential exposures to soil (through incidental ingestion of soil, dermal contact with soil, and the inhalation of outdoor dusts) were estimated using the EPCs shown in Table 2. This results in total risk estimates of approximately 4 x 10^{-5} using both USEPA and California Environmental Protection Agency (Cal EPA) modified toxicity values (Tables 6 and 7). While these estimates exceed the point of departure of 1 x 10^{-6}, they are within the USEPA (1990) target risk range of 1 x 10^{-6} to 1 x 10^{-4}.

Assumed exposures to p,p'-dichlorodiphenyldichloroethene (DDE), p,p'-dichlorodiphenyl trichloroethane (DDT), dieldrin, heptachlor epoxide, and toxaphene resulted in risks greater than

1 x 10^{-6}, though the majority of the risk estimate (62 to 64%) was due to assumed exposures to toxaphene. Both DDT and DDE occur at concentrations greater than that which would cause a residential risk of 1 x 10^{-6} (i.e., 1.62 mg/kg) in 6 grids; i.e., CC-20, DD-20, EE-20, FF-20, K-16, and K-17, though DDE also occurs above 1.62 mg/kg in grids GG-12 and LL-21. Dieldrin occurs at concentrations greater than that which would cause a residential risk of 1 x 10^{-6} (i.e., 0.03 mg/kg) in 352 of the 802 grids sampled at the site, with a maximum detected concentration of 0.18 mg/kg at FF-20. Heptachlor epoxide occurs at concentrations greater than that which would cause a residential risk of 1 x 10^{-6} (i.e., 0.1 mg/kg) in two grids; i.e., DD-20 and FF-20. Lastly, toxaphene occurs at concentrations greater than that which would cause a residential risk of 1 x 10^{-6} (i.e., 0.46 mg/kg) in 734 of the 802 grids sampled at the site, with a maximum detected concentration of 12 mg/kg at K-17. Toxaphene occurs in the adjacent cells at concentrations of 1.2 to 5.5 mg/kg (or approximately 2 to 10 times lower concentrations). In general, this indicates that areas of highest elevated cancer risks for residents at the site are a) along the border with I-5 (i.e., grids CC-20, DD-20, EE-20, FF-20, LL-21), b) at grids KK-16/KK-17, and c) at grid GG-12, although much of the site has concentrations of dieldrin and toxaphene above concentrations that would result in a risk estimate of 1 x 10^{-6} for residential exposures.

Assumed residential exposures resulted in a total HI of 1 using USEPA toxicity values and 4 using Cal EPA modified toxicity values (Tables 6 and 7). Only the hazard quotient for assumed exposures to methoxychlor was greater than one when calculated using Cal EPA modified toxicity values. The sum of all of the remaining COPCs did not exceed one when using either USEPA or Cal EPA modified toxicity values. The highest concentration of methoxychlor (3.5 mg/kg) was detected at grid K-16. The next highest concentration was 0.77 mg/kg, which would not result in an hazard quotient greater than one for child exposures. Thus, noncancer hazards greater than one from assumed residential exposures to methoxychlor seem to be limited in extent to grid K-16.

Industrial Workers

Total excess cancer risks for assumed industrial worker exposures to soil were estimated using the EPCs shown in Table 2. As noted in Section 3.5.1, industrial workers were assumed to be equally exposed to soils across the entire site, and hence the RME was used as the EPC for this exposure scenario. This results in total risk estimates of approximately 1 x 10^{-6} using both USEPA and Cal EPA modified toxicity values (Tables 8 and 9). These risk estimates do not exceed the point of departure of 1 x 10^{-6}.

Assumed industrial worker exposures resulted in a total HI of 0.01 using USEPA toxicity values and 0.008 using Cal EPA modified toxicity values (Tables 8 and 9). These estimates are below the threshold value of 1; i.e., the benchmark level of concern for noncarcinogenic effects. This indicates that assumed exposures to COPCs at the site are unlikely to result in adverse noncarcinogenic health effects for industrial workers.

Construction Workers

Total excess cancer risks for assumed construction worker exposures to soil were estimated using the EPCs shown in Table 2. As noted in Section 3.5.1, construction workers were assumed to be equally exposed to soils across the entire site, and hence the RME was used as the EPC for this exposure scenario. This results in total risk estimates of approximately 2 x 10^{-7}

using both USEPA and Cal EPA modified toxicity values (Tables 10 and 11). This is below both the point of departure of 1 x 10^{-6} and the USEPA (1990) target risk range of 1 x 10^{-6} to 1 x 10^{-4}.

Assumed construction worker exposures resulted in a total HI of 0.05 using USEPA toxicity values and 0.03 using Cal EPA modified toxicity values (Tables 10 and 11). These estimates are below the threshold value of 1; i.e., the benchmark level of concern for noncarcinogenic effects. This indicates that assumed exposures to COPCs at the site are unlikely to result in adverse noncarcinogenic health effects for construction workers.

Maneuver Trainers

Total excess cancer risks for assumed maneuver trainer exposures to soil were estimated using the EPCs shown in Table 2. As noted in Section 3.5.1, maneuver trainers were assumed to be equally exposed to soils across the entire site, and hence the RME was used as the EPC for this exposure scenario. This results in maximum total risk estimate of 1 x 10^{-6}, regardless of whether maneuver trainers are assumed to be present at the site for either 5 year or 20 years and regardless of whether USEPA or Cal EPA modified toxicity values are used to assess exposures (Tables 12 through 15). These estimates do not exceed the point of departure of 1 x 10^{-6}.

Assumed maneuver trainer exposures resulted in a maximum total HI of 0.06, regardless of whether maneuver trainers are assumed to be present at the site for either 5 year or 20 years and regardless of whether USEPA or Cal EPA modified toxicity values are used to assess exposures (Tables 12 through 15). These estimates are below the threshold value of 1; i.e., the benchmark level of concern for noncarcinogenic effects. This indicates that assumed exposures to COPCs at the site are unlikely to result in adverse noncarcinogenic health effects for maneuver trainers.

MOUT Trainers

Total excess cancer risks for assumed MOUT trainer exposures to soil were estimated using the EPCs shown in Table 2. As noted in Section 3.5.1, MOUT trainers were assumed to be equally exposed to soils across the entire site, and hence the RME was used as the EPC for this exposure scenario. This results in maximum total risk estimate of approximately 4 x 10^{-7}, regardless of whether maneuver trainers are assumed to be present at the site for either 5 year or 20 years and regardless of whether USEPA or Cal EPA modified toxicity values are used to assess exposures (Tables 16 through 19). These risk estimates are below the point of departure of 1 x 10^{-6}.

Assumed MOUT trainer exposures resulted in a maximum total HI of 0.02 regardless of whether maneuver trainers are assumed to be present at the site for either 5 year or 20 years and regardless of whether USEPA or Cal EPA modified toxicity values are used to assess exposures (Tables 16 through 19). These estimates are below the threshold value of 1; i.e., the benchmark level of concern for noncarcinogenic effects. This indicates that assumed exposures to COPCs at the site are unlikely to result in adverse noncarcinogenic health effects for MOUT trainers.

Heavy Equipment/Engineering Trainers

Total excess cancer risks for assumed heavy equipment/engineering trainer exposures to soil were estimated using the EPCs shown in Table 2. As noted in Section 3.5.1, heavy equipment/engineering trainers were assumed to be equally exposed to soils across the entire site, and hence the RME was used as the EPC for this exposure scenario. This results in maximum total risk estimates of approximately 1 x 10^{-6}, regardless of whether maneuver trainers are assumed to be present at the site for either 5 year or 20 years and regardless of whether USEPA or Cal EPA modified toxicity values are used to assess exposures (Tables 20 through 23). These estimates do not exceed the point of departure of 1 x 10^{-6}.

Assumed heavy equipment/engineering trainer exposures resulted in a maximum total HI of 0.01, regardless of whether maneuver trainers are assumed to be present at the site for either 5 year or 20 years and regardless of whether USEPA or Cal EPA modified toxicity values are used to assess exposures (Tables 20 through 23). These estimates are below the threshold value of 1; i.e., the benchmark level of concern for noncarcinogenic effects. This indicates that assumed exposures to COPCs at the site are unlikely to result in adverse noncarcinogenic health effects for heavy equipment/engineering trainers.

4.0 ABBREVIATED ECOLOGICAL EVALUATION

At present, there are no ecological receptors at the site as it is an actively managed agricultural field. After being developed, the site will be an actively managed industrial area. Therefore, under both current and future site conditions, it is not anticipated that there will be any ecological receptors at the site other than invasive species that are highly tolerant of human disturbance.

The beach immediately to the west of the site is habitat for the California least tern (*Sterna antillarum browni*) and the western snowy plover (*Charadrius alexandrinus nivosus*) (Naval Facilities Engineering Command Southwest 2010), federally listed endangered and threatened species, respectively. Neither of these species are expected to forage or nest at the site. The California least tern feeds mainly on fishes (but also on shrimp and other invertebrates) in shallow-water habitats, including bays, lagoons, estuaries, rivers, streams, marshes, sloughs, ponds, and reservoirs. The California least tern also prefers to nest on bare or sparsely vegetated sand or dried mudflats along coasts or rivers (Thompson et al. 1997). Similarly, the snowy plover forages on beaches, tide flats, river mouths, lagoon margins, salt flats, and salt ponds; and nests on sandy coastal beaches, barrier islands, barren shores of inland saline lakes, river bars, agricultural wastewater ponds, reservoir margins, coastal dredge spoils, and salt evaporation ponds (Page et al. 2009). Thus, it is unlikely that either species would feed or nest at the site and, therefore, neither species is assumed to be exposed to the COPCs in soils at SMWAF.

5.0 UNCERTAINTY ANALYSIS

This section presents an evaluation of several potential sources of uncertainty in the risk estimates. Uncertainty may have been introduced into the risk calculations as a result of:

- Use of the default DTSC construction worker PEF
- Use of surrogate toxicity values and route-to-route extrapolation
- The cancer toxicity values used for toxaphene
- Assumed soil ingestion rates

- Not assessing the risks from toxaphene degradation products
- Exposure durations for military receptors

The PEFs used here are the default dust emission rates from DTSC (2011), which tend to be conservative. Notably, the PEF for construction workers of $1x10^6$ m^3/kg assumes a dust concentration of 1,000 $\mu g/m^3$, which violates both the National Ambient Air Quality Criterion of 150 $\mu g/m^3$ and the California Ambient Air Quality Standard of 50 $\mu g/m^3$. Thus, it is unlikely that construction workers would be exposed to the levels of dust assumed here. Although, as the risk estimates show, this does not result in unacceptable risks to construction workers at this site.

Toxicity values were not available for all of the COPCs assessed here. For some chemicals, surrogate toxicity values were used. Additionally, inhalation toxicity values were not available for all COPCs evaluated here. For those, route-to-route extrapolations for oral toxicity values were used for the risk evaluations performed using California modified toxicity values. The use of surrogates and route-to-route extrapolations adds a degree of uncertainty to the risk estimates.

The existing USEPA cancer slope factor (SF) for toxaphene in the IRIS database (USEPA 2012b) was developed in 1991. California EPA (Cal EPA) developed its own SF in 2003, using the same studies as USEPA. Goodman et al. (2000) re-evaluated the pathological data reported in the original two studies using more recent USEPA protocols for the identification of carcinogenic lesions and the derivation of SFs, which resulted in an SF that is ten times lower. If Goodman et al. (2000) are correct, then the risks presented here from assumed exposures to toxaphene may have been overestimated by approximately a factor of 10.

The USEPA (2011) has recently released an updated version of the Exposure Factors Handbook, which contains revised soil ingestion rates. The soil ingestion rates used in this risk assessment, and recommended by DTSC (2011), were 100 mg/day for adult residents and industrial workers and 200 mg/day for children ages 0 to 6. However, the current edition of the Exposure Factors Handbook (USEPA 2011) recommends soil ingestion rates of 83.3 mg/day for adults (i.e., weighted average for ages 6 to 30) and 93.3 for children (i.e., weighted average for ages 0 to 6, assuming recommendation for children from 6 weeks to 1 year is representative of children less than 6 weeks of age). Thus, the soil ingestion rates used here may have overestimated the risks to residents and industrial workers. USEPA (2011) does not discuss soil ingestion rates for construction workers.

Toxaphene was measured in soils using USEPA Method 8081A. This method measures the concentration of technical toxaphene. However, there are approximately 800 toxaphene congeners (Simon and Manning 2004, Parlar 2006). Of these congeners, the majority are environmentally unstable. Toxaphene has a half-life of 10 to 14 years under aerobic conditions (e.g., exposed soils) and a shorter half-life under anaerobic conditions in the subsurface (USEPA 2005). Since the use of toxaphene was banned in 1990, only half of what was applied is likely to remain in surface soil, with less remaining in subsurface soil. However, the degradation of toxaphene generates chemicals that are not currently quantified using USEPA Method 8081A. Therefore, USEPA has developed Method 8276 to analyze for the degradation products of toxaphene. However, there are no toxicity values from USEPA or Cal EPA for toxaphene degradation products, although toxicity values are available in the scientific literature (Simon and Manning 2006). Nonetheless, it is possible that toxaphene degradation products are present in soils at the site and assumed exposures to these chemicals, and their associated risks, have not been quantified. Therefore, the risks at the site may have been underestimated.

The MOUT, maneuver, and heavy equipment trainers were assumed to be present at the site for either 5 or 20 years. Five years is the maximum duration of a single enlistment in the Marine Corps while 20 years in the maximum duration of a career in the Marine Corps. While an individual may be present at the site longer than a single enlistment, it is unlikely that an individual would be present longer than 20 years. Further, it should be noted that the trainees are likely to be present at the site for a maximum of 5 years.

The industrial and construction workers, as well as the military trainers (i.e., MOUT, maneuver, and heavy equipment trainers) were assumed to be equally exposed to soils across the entire site during the exposure duration. If, however, these receptors were exposed to soils at only a portion of the site, then the risk estimates for these exposure scenarios may be overestimated or underestimated, depending on the COPC concentrations on the portion of the site used. Refer to Section 7.0 regarding risk-based screening levels.

Altogether, these potential sources of uncertainty in the risk estimates may need to be considered in determining recommended actions for the site.

6.0 RISK SUMMARY

A human health risk evaluation was conducted for residents, industrial workers, construction workers, maneuver trainers, MOUT trainers, and heavy equipment/engineering trainers to the COPCs (i.e., organochlorine pesticides) in soils at SMWAF. Two types of potential health effects were evaluated from these receptors exposures at the site, including: 1) carcinogenic effects and 2) noncarcinogenic hazards.

Assumed exposures to the COPCs in soils at the site by industrial and construction workers, as well as the military trainers (MOUT, maneuver, and heavy equipment trainers) evaluated here do not result in carcinogenic risk estimates that exceed the point of departure of 1×10^{-6}, regardless of whether USEPA or Cal Modified toxicity values are used to assess exposures or whether military trainers were assumed to be present at the site for 5 or 20 years. Similarly, noncarcinogenic hazards do not exceed 1, the benchmark level of concern, for both the workers and trainers evaluated here. This conclusion is based on the assumption that the workers and trainers at the site would be equally exposed to soils across the entire site during the exposure duration. If these receptors were exposed to soils at only a portion of the site, then the risk estimates for these exposure scenarios may be overestimated or underestimated, depending on the COPC concentrations on the portion of the site used. Refer to Section 7.0 regarding risk-based screening levels.

For potential residents, the risk estimate from assumed exposures to the COPCs in soils at the site is 4×10^{-5}, regardless of whether USEPA or Cal Modified toxicity values are used. Although these risk estimates exceed the point of departure of 1×10^{-6}, they are within the USEPA target risk range of 1×10^{-6} to 1×10^{-4}. The risk estimates are largely (>60%) due to assumed exposures to toxaphene, which occurs above levels that would cause a residential risk of 1×10^{-6} throughout most of the site. The maximum detected concentration of toxaphene of 12 mg/kg occurs at grid K-17, which is adjacent to the maximum detected concentration of 18 mg/kg in grid K-15 at MCTSSA. Assumed exposures to DDE, DDT, dieldrin, and heptachlor epoxide also resulted in residential risks greater than 1×10^{-6}. Residential exposures also resulted in a hazard index greater than the threshold value of 1, indicating that adverse noncancer effects may occur, from assumed exposures to methoxychlor. In general, the areas with the highest cancer risks and noncancer hazards for residents at the site are a) along the border with I-5 (i.e., grids CC-20, DD-20, EE-20, FF-20, LL-21), b) at grids KK-16/KK-17, and c) at grid GG-12, although much of the site has concentrations of dieldrin and toxaphene above concentrations that would result in a risk estimate of 1×10^{-6} for residential exposures.

At present, there are no ecological receptors at the site as it is an actively managed agricultural field. After being developed, the site will be an actively managed industrial area. Therefore, under both current and future site conditions, it is not anticipated that there will be any ecological receptors at the site other than invasive species that are highly tolerant of human disturbance. Although two federally listed birds (i.e., the California least tern and the snowy plover) inhabit the beach to the west of the site, neither bird is likely to feed or nest at the site and, thus, neither bird is likely to be exposed to the COPCs at the site.

7.0 RISK BASED SCREENING LEVELS

Risk based Screening Levels (RBSLs) were derived for all of the detected chemicals shown in Table 2. The RBSLs were derived using the exposure parameters shown in Table 5 combined with the USEPA toxicity values shown in Table 3 and the Cal Modified toxicity values shown in Table 4.

To derive the RBSLs the equations used to calculate the risk and hazard estimates were re-arranged to solve for the concentration in soil while specifying the target risk (TR) of 1 x 10-6 and target hazard quotient (THQ) of 1. The equations used to calculate the RBSLs are the same as are used by USEPA (2012a) and are shown in Table 24. Separate RBSLs are calculated for the ingestion, dermal, and inhalation pathways. A RBSL protective of all three pathways is calculated using the following formula:

$$RG = \frac{1}{\frac{1}{RG_{ingestion}} + \frac{1}{RG_{dermal}} + \frac{1}{RG_{inhalation}}}$$

Separate RBSLs protective of cancer and noncancer effects were calculated using both USEPA and Cal Modified toxicity values for each receptor. The lowest value for each receptor is presented in Table 25, with both a 5-year and 20-year exposure duration shown for the maneuver trainers, MOUT trainers, and heavy equipment/engineering trainers. The complete set of RBSLs for each receptor is presented in Appendix B.

The RBSLs for residents are generally similar to USEPA's (2012a) residential Regional Screening Levels (RSLs) and California's (OEHHA 2010) Human Health Screening Levels, with the following exceptions:

- Endrin
- Endrin aldehyde
- Endrin ketone
- Methoxychlor

The difference between the RSLs and California Human Health Screening Levels (CHHSLs) for endrin, endrin aldehyde, and endrin ketone are due to the use of a lower oral absorption factor here than were used by USEPA (2012a) and OEHHA (2010). Before the RBSLs for these three chemicals are used for decision making, the oral absorption factor may need to be evaluated more closely. However, the residential HQs from assumed exposures to these three pesticides were all well below one and, therefore, no remedial decisions will be based on the RBSLs for endrin, endrin aldehyde, or endrin ketone at this site.

In contrast, assumed residential exposures to methoxychlor has resulted in an HQ of approximately 3 using California modified toxicity values. This is due to California's child-specific RfD for methoxychlor of $2x10^{-5}$ mg/kg-day (OEHHA 2009), which is 250 times lower than the RfD for adults from USEPA (2012b) of $5x10^{-3}$ mg/kg-day. Thus, the residential RBSL protective of residents calculated here is also approximately 250 times lower than the RSL and CHHSL.

Note that the RBSLs can be used to evaluate potential exposures, but should not be used as soil cleanup goals for potential workers and trainers. The use of the RBSLs as cleanup goals for workers and trainers is likely to be overly conservative as the RBSLs assume that the receptor is exposed to only a single sample location for the entire exposure duration (e.g., in the case of MOUT trainers, 250 days per year for either 5 or 20 years), whereas these receptors are more likely to be equally exposed to soils across the entire site. Thus, the RBSLs should be compared to the UCL for all samples from the area that workers and/or trainers are assumed to use instead of being compared to a single sample. Nonetheless, comparing the RBSLs to each sample provides the Navy with additional information that can be used to evaluate potential ways to utilize the land at the SMWAF. For this reason, Plate 1 was developed to show how the analytical results from each sample location compare to the RBSLs for each receptor, using the 5-year exposure duration for maneuver trainers, MOUT trainers, and heavy equipment/engineering trainers. The 5-year exposure duration was used for generating Plate 1 because it is considered more representative of actual exposure durations than the 20-year exposure assumption.

As noted above, it is not realistic to assume that a given receptor would be exposed to only one location at the site for the entire exposure duration, and hence taking action (e.g., restricting usage or removing soils) in those locations that exceed an RBSL may be overly conservative, since an actual receptor would likely be exposed to a large portion of the site. However, Plate 1 can be used to identify those sampling locations with the highest COPC concentrations and to make decisions to possibly address certain areas, if receptors might be selectively exposed to areas having higher COPC concentrations. Alternatively, the plate could be used for the purpose of ensuring future use of the site is not focused only in those locations having concentrations exceeding RBSLs for a given receptor type.

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TABLES

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

			Organochlorine Pesticides (Method 8081)																			
Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-AM19	0	mg/kg	<0.0067	<0.0041	<0.0062	<0.0067	<0.0042	<0.0053	<0.0024	0.008J	0.14	0.055	<0.0026	<0.0029	0.011J	<0.0049	<0.0028	0.011J	<0.0035	<0.0045	0.049J	0.35
SMWAF-AM20	0	mg/kg	<0.0066	<0.004	<0.0061	<0.0066	<0.0041	<0.0052	<0.0023	<0.0034	0.042	0.025	<0.0026	<0.0029	<0.0045	<0.0048	<0.0028	<0.0055	<0.0035	<0.0044	<0.0083	<0.1
SMWAF-AM21	0	mg/kg	<0.013	<0.0076	0.017J	<0.013	<0.0077	<0.0098	<0.0044	0.05	0.46	0.2	<0.0049	<0.0054	0.061	<0.0091	<0.0052	0.047	0.027J	<0.0083	0.18J	1.1
SMWAF-AM22	0	mg/kg	<0.0064	<0.0039	<0.0058	<0.0064	<0.0039	<0.005	<0.0022	0.0065J	0.13	0.052	<0.0025	<0.0028	0.013J	<0.0046	<0.0026	0.014J	<0.0033	<0.0042	0.058J	0.4
SMWAF-AM23	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.0043J	0.079	0.035	<0.0025	<0.0027	0.0097J	<0.0046	<0.0026	0.01J	<0.0033	<0.0042	<0.0079	0.31
SMWAF-AL18	0	mg/kg	<0.0073	<0.0045	<0.0067	<0.0073	<0.0045	<0.0057	<0.0026	<0.0038	0.13	0.1	<0.0029	<0.0032	0.042	<0.0053	<0.0031	0.041	0.043	<0.0049	0.16	1.3
SMWAF-AL19	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.02J	0.17	0.12	<0.0025	<0.0027	0.046	<0.0046	<0.0026	0.048	0.045	<0.0042	0.19	1.4
SMWAF-AL20	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	<0.0033	0.21	0.15	<0.0025	<0.0027	0.055	<0.0046	<0.0026	0.059	0.058	<0.0042	<0.0079	1.7
SMWAF-AL21	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.004	<0.005	<0.0022	0.032	0.23	0.17	<0.0025	<0.0028	0.063	<0.0047	<0.0027	0.072	0.073	<0.0043	0.27	2.1
SMWAF-AL22	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.019J	0.17	0.13	<0.0025	<0.0027	0.047	<0.0046	<0.0026	0.052	0.049	<0.0042	0.19	1.4
SMWAF-AL23	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.015J	0.15	0.11	<0.0025	<0.0027	0.046	<0.0046	<0.0026	0.042	0.039	<0.0042	<0.0079	1.2
SMWAF-AK17	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.022	0.19	0.14	<0.0025	<0.0027	0.049	<0.0046	<0.0026	0.055	0.054	<0.0042	0.21	1.5
SMWAF-AK18	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.02J	0.18	0.14	<0.0024	<0.0027	0.05	<0.0045	<0.0026	0.052	0.053	<0.0041	0.2	1.5
SMWAF-AK19	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.021	0.18	0.14	<0.0025	<0.0027	0.049	<0.0046	<0.0026	0.058	0.059	<0.0042	0.22	1.6
SMWAF-AK20	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.022	0.18	0.15	<0.0024	<0.0027	0.049	<0.0045	<0.0026	0.058	0.061	<0.0041	0.23	1.7
SMWAF-AK21	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	<0.0032	0.17	0.14	<0.0025	<0.0027	0.047	<0.0045	<0.0026	0.053	0.055	<0.0042	0.21	1.5
SMWAF-AK22	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.021	0.16	0.13	<0.0025	<0.0027	0.046	<0.0046	<0.0026	0.054	0.055	<0.0042	0.21	1.5
SMWAF-AK23	0	mg/kg	<0.012	<0.0076	<0.011	<0.012	<0.0077	<0.0097	<0.0043	0.02J	0.14	0.12	<0.0049	<0.0054	0.051	<0.009	<0.0052	0.051	0.052	<0.0083	0.2J	1.5
SMWAF-AJ17	0	mg/kg	<0.0067	<0.0041	<0.0061	<0.0067	<0.0041	<0.0053	0.0036J	0.023	0.18	0.14	<0.0026	<0.0029	0.053	<0.0049	<0.0028	0.056	0.057	<0.0045	0.21	1.5
SMWAF-AJ18	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0048	<0.0022	<0.0032	0.2	0.15	<0.0024	<0.0027	0.054	<0.0045	<0.0026	0.057	0.059	<0.0041	0.22	1.6
SMWAF-AJ19	0	mg/kg	<0.0064	<0.0039	<0.0058	<0.0064	<0.0039	<0.005	<0.0022	0.023	0.18	0.14	<0.0025	<0.0028	0.051	<0.0046	<0.0026	0.059	0.059	<0.0042	0.22	1.6
SMWAF-AJ20	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.019J	0.14	0.12	<0.0025	<0.0027	0.042	<0.0045	<0.0026	0.049	0.051	<0.0042	0.19	1.4
SMWAF-AJ21	0	mg/kg	<0.0067	<0.0041	<0.0061	<0.0067	<0.0041	<0.0052	<0.0023	<0.0034	0.21	0.16	<0.0026	<0.0029	0.054	<0.0048	<0.0028	0.063	0.066	<0.0044	0.25	1.8
SMWAF-AJ22	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	<0.0033	0.15	0.11	<0.0025	<0.0027	0.045	<0.0046	<0.0026	0.05	0.049	<0.0042	0.19	1.4
SMWAF-AJ23	0	mg/kg	<0.0073	<0.0044	<0.0067	<0.0073	<0.0045	<0.0057	<0.0026	<0.0038	0.16	0.13	<0.0029	<0.0032	0.05	<0.0053	<0.003	0.055	0.057	<0.0049	0.22	1.6
SMWAF-AI17	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.018J	0.17	0.13	<0.0025	<0.0027	0.051	<0.0046	<0.0026	0.053	0.05	<0.0042	0.21	1.4
SMWAF-AI18	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.025	0.23	0.18	<0.0025	<0.0027	0.066	<0.0045	<0.0026	0.065	0.063	<0.0042	0.25	1.8
SMWAF-AI19	0	mg/kg	<0.0066	<0.004	<0.0061	<0.0066	<0.0041	<0.0052	<0.0023	0.021J	0.17	0.13	<0.0026	<0.0029	0.049	<0.0048	<0.0028	0.054	0.054	<0.0044	0.21	1.5
SMWAF-AI20	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.022	0.17	0.13	<0.0025	<0.0027	0.048	<0.0046	<0.0026	0.057	0.056	<0.0042	0.21	1.5
SMWAF-AI21	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.024	0.16	0.14	<0.0025	<0.0027	0.054	<0.0046	<0.0026	0.061	0.062	<0.0042	0.23	1.7
SMWAF-AI22	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	<0.0033	0.15	0.15	<0.0025	<0.0027	0.051	<0.0046	<0.0026	0.06	0.064	<0.0042	0.23	1.7
SMWAF-AI23	0	mg/kg	<0.013	<0.0076	<0.011	<0.013	<0.0077	<0.0098	<0.0044	<0.0065	0.18	0.21	<0.0049	<0.0054	0.062	<0.0091	<0.0052	0.068	0.069	<0.0084	0.26	1.9
SMWAF-AH16	0	mg/kg	<0.0078	<0.0047	<0.0072	<0.0078	<0.0048	<0.0061	<0.0027	0.006J	0.04	0.034	<0.0031	<0.0034	0.023J	<0.0057	0.0097J	0.014J	<0.0041	<0.0052	<0.0098	0.39
SMWAF-AH17	0	mg/kg	<0.0064	<0.0039	<0.0058	<0.0064	<0.0039	<0.005	<0.0022	0.014J	0.13	0.1	<0.0025	<0.0028	0.038	<0.0046	<0.0027	0.039	0.036	<0.0042	0.15	1.1
SMWAF-AH18	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0048	<0.0022	0.021	0.16	0.18	<0.0024	<0.0027	0.049	<0.0045	<0.0026	0.056	0.054	<0.0041	0.21	1.5
SMWAF-AH19	0	mg/kg	<0.0077	<0.0047	<0.0071J	<0.0077J	<0.0047	<0.006J	<0.0027	0.014J	0.12J	0.091	<0.003J	<0.0033	0.033	<0.0056J	<0.0032	0.035	0.039	<0.0051	0.15	1
SMWAF-AH20	0	mg/kg	<0.0062	<0.0038	<0.0057J	<0.0062J	<0.0039	<0.0049J	<0.0022	0.02J	0.15J	0.12	<0.0024J	<0.0027	0.046	<0.0045J	<0.0026	0.049	0.05	<0.0042	0.19	1.4
SMWAF-AH21	0	mg/kg	<0.0074	<0.0045	<0.0068J	<0.0074J	<0.0046	<0.0058J	<0.0026	0.013J	0.1J	0.083	<0.0029J	<0.0032	0.032	<0.0054J	<0.0031	0.034	0.034	<0.005	0.13	0.95
SMWAF-AH22	0	mg/kg	<0.0075	<0.0046	<0.0069J	<0.0075J	<0.0046	<0.0059J	<0.0026	0.005J	0.11J	0.07	<0.0029J	<0.0033	0.022J	<0.0055J	<0.0031	0.025	0.035	<0.005	0.13	0.82
SMWAF-AH23	0	mg/kg	<0.0063	<0.0038	<0.0058J	<0.0063J	<0.0039	<0.0049J	<0.0022	0.02J	0.16J	0.13	<0.0025J	<0.0027	0.048	<0.0046J	<0.0026	0.052	0.049	<0.0042	0.2	1.4
SMWAF-AG16	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.027	0.15	0.16	<0.0025	<0.0027	0.043	<0.0046	<0.0026	0.1	0.0065J	<0.0042	0.03J	1.3
SMWAF-AG17	0	mg/kg	<0.013	<0.0077	<0.012	<0.013	<0.0078	<0.01	<0.0044	0.052	0.15	0.59	<0.005	<0.0055	0.057	<0.0092	<0.0053	0.14	0.012J	<0.0085	0.13J	1.9
SMWAF-AG18	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.031	0.18	0.24	<0.0025	<0.0027	0.054	<0.0046	<0.0026	0.14	0.01J	<0.0042	0.068J	1.8
SMWAF-AG19	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.0039	<0.005	<0.0022	0.029	0.15	0.2	<0.0025	<0.0028	0.051	<0.0046	<0.0027	0.13	0.0094J	<0.0043	0.05J	1.6
SMWAF-AG20	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.026	0.16	0.2	<0.0025	<0.0027	0.049	<0.0046	<0.0026	0.13	0.009J	<0.0042	0.058J	1.6
SMWAF-AG21	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.031	0.17	0.23	<0.0024	<0.0027	0.056	<0.0045	<0.0026	0.14	0.0099J	<0.0041	0.075J	1.8
SMWAF-AG22	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.031	0.17	0.23	<0.0025	<0.0027	0.058	<0.0046	<0.0026	0.15	0.011J	<0.0042	0.08J	1.8
SMWAF-AG23	0	mg/kg	<0.0067	<0.0041J	<0.0061J	<0.0067J	<0.0041	<0.0052J	<0.0023J	0.0075J	0.065J	0.057J	<0.0026	<0.0029J	0.021J	<0.0049J	<0.0028	0.021J	0.024J	<0.0045J	0.092J	0.64

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

			Organochlorine Pesticides (Method 8081)																			
Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-AF16	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.004	<0.005	<0.0023	0.027	0.14	0.17	0.007J	<0.0028	0.045	<0.0047	<0.0027	0.1	0.0066J	<0.0043	0.04J	**1.3**
SMWAF-AF17	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.0039	<0.005	<0.0022	0.017J	0.093	0.12	<0.0025	<0.0028	0.03	<0.0046	<0.0027	0.074	0.0062J	<0.0043	0.032J	**0.91**
SMWAF-AF18	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.024	0.14	0.18	0.0071J	<0.0027	0.041	<0.0045	<0.0026	0.11	0.0076J	<0.0042	0.052J	**1.3**
SMWAF-AF19	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.026	0.15	0.18	0.0086J	<0.0027	0.048	<0.0046	<0.0026	0.12	0.0087J	<0.0042	0.065J	**1.4**
SMWAF-AF20	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.028	0.15	0.2	0.0095J	<0.0027	0.05	<0.0046	<0.0026	0.13	0.0093J	<0.0042	0.068J	**1.6**
SMWAF-AF21	0	mg/kg	<0.0075	<0.0046	<0.0069	<0.0075	<0.0046	<0.0059	<0.0026	0.034	0.19	0.24	0.012J	<0.0032	0.061	<0.0054	<0.0031	0.15	0.011J	<0.005	0.085J	**1.9**
SMWAF-AF22	0	mg/kg	<0.0063	<0.0039	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.029	0.17	0.22	0.009J	<0.0027	0.055	<0.0046	<0.0026	0.14	0.0098J	<0.0042	0.074J	**1.7**
SMWAF-AF23	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.028	0.12	0.12J	0.0053J	<0.0027	0.039	<0.0045J	<0.0026	0.089	0.0063J	<0.0042	0.027J	**1.1**
SMWAF-AE16	0	mg/kg	<0.0026	<0.0016	<0.0024	<0.0026	<0.0016	<0.002	<0.00091	0.028J	0.16J	0.21J	<0.001	<0.0011	0.05J	<0.0019	<0.0011	0.12J	0.0097J	<0.0017	0.048J	**1.6J**
SMWAF-AE17	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.0039	<0.005	<0.0022	0.026	0.14	0.18	<0.0025	<0.0028	0.046	<0.0046	<0.0027	0.12	0.009J	<0.0043	0.058J	**1.4**
SMWAF-AE18	0	mg/kg	<0.0064	<0.0039	<0.0058	<0.0064	<0.0039	<0.005	<0.0022	0.026	0.15	0.19	<0.0025	<0.0028	0.045	<0.0046	<0.0027	0.12	0.008J	<0.0042	0.053J	**1.5**
SMWAF-AE19	0	mg/kg	<0.0068	<0.0041	<0.0062	<0.0068	<0.0042	<0.0053	<0.0024	0.024	0.13	0.18	<0.0027	<0.0029	0.044	<0.0049	<0.0028	0.12	0.0078J	<0.0045	0.053J	**1.4**
SMWAF-AE20	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.029	0.16	0.2	<0.0025	<0.0027	0.054	<0.0046	<0.0026	0.14	0.0085J	<0.0042	0.063J	**1.7**
SMWAF-AE21	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.025	0.12	0.18	0.0079J	<0.0027	0.044	<0.0046	<0.0026	0.11	0.0084J	<0.0042	0.069J	**1.4**
SMWAF-AE22	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.03	0.16	0.22	<0.0025	<0.0027	0.057	<0.0046	<0.0026	0.14	<0.0033	<0.0042	0.084J	**1.8**
SMWAF-AE23	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.023	0.11	0.2	<0.0025	<0.0027	0.035	<0.0045	<0.0026	0.088	<0.0033	<0.0042	0.035J	**1.1**
SMWAF-AD16	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.0039	<0.005	<0.0022	0.026	0.13	0.16	0.0055J	<0.0028	0.042	<0.0046	<0.0027	0.1	0.0071J	<0.0043	0.038J	**1.3**
SMWAF-AD17	0	mg/kg	<0.0069	<0.0042	<0.0063	<0.0069	<0.0043	<0.0054	<0.0024	0.021J	0.11	0.14	0.0032J	<0.003	0.037	<0.005	<0.0029	0.089	0.0072J	<0.0046	0.052J	**1.1**
SMWAF-AD18	0	mg/kg	<0.0065	<0.004	<0.006	<0.0065	<0.004	<0.0051	<0.0023	0.026	0.13	0.18	0.007J	<0.0028	0.042	<0.0047	<0.0027	0.11	0.0082J	<0.0043	0.044J	**1.4**
SMWAF-AD19	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.024	0.13	0.18	0.0053J	<0.0027	0.044	<0.0046	<0.0026	0.12	0.0076J	<0.0042	0.054J	**1.4**
SMWAF-AD20	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.028	0.14	0.2	0.0043J	<0.0027	0.05	<0.0045	<0.0026	0.13	0.01J	<0.0042	0.075J	**1.6**
SMWAF-AD21	0	mg/kg	<0.0063	<0.0039	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.023	0.13	0.17	0.0068J	<0.0027	0.042	<0.0046	<0.0026	0.11	0.0076J	<0.0042	0.058J	**1.3**
SMWAF-AD22	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.029	0.14	0.2	0.0026J	<0.0027	0.051	<0.0045	<0.0026	0.13	0.0099J	<0.0042	0.074J	**1.6**
SMWAF-AD23	0	mg/kg	<0.007	<0.0042	<0.0064	<0.007	<0.0043	<0.0055	<0.0024	0.0085J	0.04	0.053	<0.0027	<0.003	0.015J	<0.0051	<0.0029	0.037	<0.0037	<0.0047	0.018J	**0.46**
SMWAF-AC16	0	mg/kg	<0.0068	<0.0041	<0.0062	<0.0068	<0.0042	<0.0053	<0.0024	0.022J	0.18	0.15	<0.0027	<0.0029	0.05	<0.0049	<0.0028	0.057	0.046	<0.0045	0.22	**1.3**
SMWAF-AC17	0	mg/kg	<0.0076	<0.0046	<0.0069	<0.0076	<0.0047	<0.0059	<0.0027	0.02J	0.19	0.17	<0.003	<0.0033	0.052	<0.0055	<0.0032	0.062	0.056	<0.0051	0.25	**1.5**
SMWAF-AC18	0	mg/kg	<0.0065	<0.004	<0.006	<0.0065	<0.004	<0.0051	<0.0023	0.023	0.23	0.19	<0.0026	<0.0028	0.061	<0.0047	<0.0027	0.064	0.051	<0.0044	0.26	**1.5**
SMWAF-AC19	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.004	<0.005	<0.0022	0.0097J	0.099	0.07	<0.0025	<0.0028	0.026	<0.0047	<0.0027	0.028	0.021	<0.0043	0.11	**0.63**
SMWAF-AC20	0	mg/kg	<0.0074	<0.0045	<0.0068	<0.0074	<0.0046	<0.0058	<0.0026	0.017J	0.092	0.12	<0.0029	<0.0032	0.029	<0.0054	<0.0031	0.077	0.005J	<0.0049	0.042J	**0.94**
SMWAF-AC21	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.022	0.12	0.16	<0.0025	<0.0027	0.037	<0.0046	<0.0026	0.093	0.0063J	<0.0042	0.054J	**1.2**
SMWAF-AC22	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.019J	0.13	0.12	0.012J	<0.0027	0.032J	<0.0046	<0.0026	0.045	0.043	<0.0042	0.22	**1.4**
SMWAF-AC23	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.016J	0.12	0.13	<0.0024	<0.0027	0.032	<0.0045	<0.0026	0.042	0.04	<0.0041	0.22	**1.4**
SMWAF-AB16	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.004	<0.005	<0.0023	0.026	0.14J	0.17J	0.026	<0.0028	0.044	<0.0047J	<0.0027	0.11	<0.0034	<0.0043	0.044J	**1.3**
SMWAF-AB17	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.022	0.13	0.13	0.013J	<0.0027	0.039	<0.0045	<0.0026	0.053	0.051	<0.0042	0.2	**1.3**
SMWAF-AB18	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.017J	0.13	0.12	0.0096J	<0.0027	0.035	<0.0046	<0.0026	0.044	0.041	<0.0042	0.17	**1.1**
SMWAF-AB19	0	mg/kg	<0.0025	<0.0015	<0.0023	<0.0025	<0.0016	<0.002	<0.00089	0.013J	0.12J	0.14J	<0.00099	<0.0011	0.031J	<0.0018	<0.0011	0.088J	<0.0013	<0.0017	0.042J	**1J**
SMWAF-AB20	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.032	0.14	0.36J	<0.0025	<0.0027	0.043	<0.0045	<0.0026	0.11	<0.0033	<0.0042	0.064J	**1.4**
SMWAF-AB21	0	mg/kg	<0.0069	<0.0042	<0.0064	<0.0069	<0.0043	<0.0054	<0.0024	0.021J	0.14	0.13	<0.0027	<0.003	0.034	<0.005	<0.0029	0.046	0.043	<0.0046	0.23	**1.5**
SMWAF-AB22	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.02J	0.14	0.13	0.014J	<0.0027	0.033	<0.0045	<0.0026	0.046	0.044	<0.0041	0.24	**1.5**
SMWAF-AB23	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.021	0.15	0.14	<0.0024	<0.0027	0.037	<0.0045	<0.0026	0.051	0.047	<0.0042	0.25	**1.6**
SMWAF-A16	0	mg/kg	<0.0065	<0.0039	<0.0059	<0.0065	<0.004	<0.0051	<0.0023	0.013	0.11	0.081	<0.0025	<0.0028	0.031	<0.0047	<0.0027	0.031	0.023	<0.0043	0.12	**0.75**
SMWAF-A17	0	mg/kg	<0.0063	<0.0039	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.016	0.12	0.096	<0.0025	<0.0027	0.032	<0.0046	<0.0026	0.042	0.039	<0.0042	0.15	**1**
SMWAF-A18	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	<0.0033	0.12	0.1	<0.0025	<0.0027	0.034	<0.0046	<0.0026	0.042	0.04	<0.0042	0.16	**1.1**
SMWAF-A19	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.013	0.095	0.082	<0.0025	<0.0027	0.026	<0.0046	<0.0026	0.034	0.032	<0.0042	0.13	**0.87**
SMWAF-A20	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0039	<0.0049	<0.0022	0.019	0.14	0.11	<0.0024	<0.0027	0.037	<0.0045	<0.0026	0.049	0.046	<0.0042	0.18	**1.2**
SMWAF-A21	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.02	0.16	0.12	<0.0025	<0.0027	0.039	<0.0046	<0.0026	0.051	0.049	<0.0042	0.19	**1.3**
SMWAF-A22	0	mg/kg	<0.0069	<0.0042	<0.0063	<0.0069	<0.0042	<0.0054	<0.0024	0.019	0.16	0.11	<0.0027	<0.003	0.04	<0.005	<0.0029	0.049	0.047	<0.0046	0.19	**1.3**
SMWAF-A23	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.018	0.14	0.1	<0.0025	<0.0027	0.038	<0.0046	<0.0026	0.044J	0.042J	<0.0042	0.17J	**1.2**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

			Organochlorine Pesticides (Method 8081)																			
Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		mg/kg	0.029	0.077	0.27	0.27	0.52	1.6	1.6	2	1.4	1.7	0.03	370	370	370	18	18	18	0.053	310	0.44
Industrial RSL		mg/kg	0.1	0.27	0.96	0.96	2.1	6.5	6.5	7.2	5.1	7	0.11	3700	3700	3700	180	180	180	0.19	3100	1.6
Resident RBSL		mg/kg	0.02	0.09	0.31	0.13	0.50	0.42	0.42	2.29	1.62	1.62	0.02	364	364	364	1.51	1.51	1.51	0.05	1.37	0.44
Industrial Worker RBSL		mg/kg	0.05	0.31	1.09	0.44	1.66	1.40	1.40	7.59	5.36	5.36	0.05	2865	2865	2865	5.29	5.29	5.29	0.15	2388	1.22
Maneuver Trainer RBSL		mg/kg	0.25	1.55	5.42	8.22	2.19	6.95	6.95	37.67	26.59	26.59	0.270	2843	2843	2843	5.24	5.24	5.24	0.73	2369	6.03
Heavy Equipment/Engineering RBSL		mg/kg	0.28	1.82	6.38	9.60	0.21	8.13	8.13	43.99	31.05	31.05	0.298	13003	13003	13003	22.09	22.09	22.09	0.83	10835	6.84
Construction Worker RBSL		mg/kg	0.34	2.19	7.65	0.26	11.52	2.97	2.97	52.79	37.26	37.26	0.36	780	780	780	1.33	1.33	1.33	0.99	650	8.20
MOUT Trainer RBSL		mg/kg	0.67	4.06	14.22	21.57	5.75	18.26	18.26	98.88	69.80	69.80	0.710	7462	7462	7462	13.77	13.77	13.77	1.91	6218	15.83
SMWAF-B16	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.0039	<0.005	<0.0022	0.0078J	0.16	0.1	<0.0025	<0.0028	0.037	<0.0046	<0.0027	0.037	0.034	<0.0043	0.17	1
SMWAF-B17	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.0039	<0.005	<0.0022	0.017J	0.13	0.1	<0.0025	<0.0028	0.036	<0.0046	<0.0027	0.045J	0.042	<0.0043	0.17J	1.2
SMWAF-B18	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.018J	0.13	0.11	<0.0025	<0.0027	0.037	<0.0046	<0.0026	0.047	0.045	<0.0042	0.18	1.2
SMWAF-B19	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	<0.0033	0.12	0.097	<0.0025	<0.0027	0.034	<0.0046	<0.0026	0.044	0.042	<0.0042	0.17	1.1
SMWAF-B20	0	mg/kg	<0.0063	<0.0039	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.022	0.14	0.12	<0.0025	<0.0027	0.044	<0.0046	<0.0026	0.059	0.057	<0.0042	0.21	1.5
SMWAF-B21	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.018J	0.13	0.11	<0.0025	<0.0027	0.036	<0.0045	<0.0026	0.047	0.047	<0.0042	0.19	1.3
SMWAF-B22	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.016J	0.11	0.093	<0.0025	<0.0027	0.033	<0.0046	<0.0026	0.042	0.043	<0.0042	0.16	1.1
SMWAF-B23	0	mg/kg	<0.0071	<0.0043	<0.0065	<0.0071	<0.0044	<0.0056	<0.0025	0.012J	0.082	0.069	<0.0028	<0.0031	0.025	<0.0052	<0.003	0.028	0.033	<0.0047	0.12	0.83
SMWAF-C16	0	mg/kg	<0.00032	<0.00019	0.0011J	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.14	0.12	<0.00022	<0.00059	0.028	<0.00035	<0.00016	0.035J	<0.00043	<0.00045	<0.00075	0.79J
SMWAF-C17	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.12	0.1	<0.00022	<0.0006	0.026	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	0.96J
SMWAF-C18	0	mg/kg	<0.00033	0.00027J	0.00098	<0.00026	<0.00018	<0.0006	<0.00017	<0.00024	0.13	0.12	<0.00023	<0.00061	0.033	<0.00036	<0.00017	<0.00041	<0.00044	<0.00046	<0.00076	1.2J
SMWAF-C19	0	mg/kg	<0.00032	0.00024J	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.12	0.093	<0.00022	<0.00059	0.026	<0.00035	<0.00016	<0.00041	<0.00043	<0.00045	<0.00075	0.98J
SMWAF-C20	0	mg/kg	<0.00032	0.00024J	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.11	0.075	<0.00022	<0.00059	0.027	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00075	0.98J
SMWAF-C21	0	mg/kg	<0.00032	0.00025J	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.11	0.091	<0.00022	<0.00059	0.026	<0.00035	<0.00016	<0.0004	<0.00043	<0.00045	<0.00075	0.95J
SMWAF-C22	0	mg/kg	<0.00036	0.00036	<0.00035	<0.00028	<0.0002	<0.00067	<0.00019	<0.00026	0.12	0.092	<0.00025	<0.00067	0.028	<0.0004	<0.00019	<0.00046	<0.00049	<0.0005	<0.00085	1J
SMWAF-C23	0	mg/kg	<0.00032	0.00021J	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.12	0.1	<0.00022	<0.0006	0.029	<0.00036	<0.00016	<0.00041	<0.00044	<0.00045	<0.00075	1J
SMWAF-D16	0	mg/kg	<0.00032	<0.00019	0.0013J	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.14	0.11	<0.00023	<0.0006	0.037	<0.00036	<0.00017	0.042J	<0.00044	<0.00045	<0.00076	1J
SMWAF-D17	0	mg/kg	<0.00032	<0.0002	<0.00032	<0.00026	<0.00018	<0.0006	<0.00017	<0.00023	0.11	0.095	<0.00023	<0.0006	0.032	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00076	1.1J
SMWAF-D18	0	mg/kg	<0.00032	<0.00019	0.00094J	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.12	0.098	<0.00023	<0.0006	0.028	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00076	0.87J
SMWAF-D19	0	mg/kg	<0.00032	0.00024J	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.1	0.081	<0.00023	<0.0006	0.022	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	0.82J
SMWAF-D20	0	mg/kg	<0.00034	0.00031J	0.00073J	<0.00027	<0.00019	<0.00063	<0.00017	<0.00024	0.13	0.098	<0.00024	<0.00063	0.031	<0.00038	<0.00017	<0.00043	<0.00046	<0.00047	<0.0008	1.1J
SMWAF-D21	0	mg/kg	<0.00037	0.00033J	<0.00037	<0.0003	<0.00021	<0.00069	<0.00019	<0.00027	0.13	0.11	<0.00026	<0.0007	0.028	<0.00042	<0.00019	<0.00048	<0.00051	<0.00052	<0.00088	1.1J
SMWAF-D22	0	mg/kg	<0.00032	0.00035J	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.13	0.1	<0.00022	<0.00059	0.032	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	1.2J
SMWAF-D23	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.11	0.072	<0.00022	<0.0006	0.029	<0.00036	<0.00016	<0.00041	<0.00044	<0.00045	<0.00075	1.1J
SMWAF-E16	0	mg/kg	<0.00032	<0.00019	0.00099J	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.14	0.17	<0.00022	<0.0006	0.04	<0.00036	<0.00017	0.041J	<0.00044	<0.00045	<0.00075	1.2J
SMWAF-E17	0	mg/kg	<0.00032	<0.00019	0.00036J	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.13	0.1	<0.00022	<0.00059	0.041	<0.00035	<0.00016	0.048J	<0.00043	<0.00045	<0.00075	1.3J
SMWAF-E18	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.13	0.11	<0.00023	<0.0006	0.038	<0.00036	<0.00017	0.042J	<0.00044	<0.00045	<0.00075	1.3J
SMWAF-E19	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.11	0.11	<0.00022	<0.00059	0.036	<0.00035	<0.00016	<0.00041	<0.00043	<0.00045	<0.00075	0.92J
SMWAF-E20	0	mg/kg	<0.00033	<0.0002	0.00053J	<0.00026	<0.00018	<0.00062	<0.00017	<0.00024	0.12	0.14	<0.00023	<0.00062	0.047	<0.00037	<0.00017	<0.00042	<0.00045	<0.00047	<0.00078	1.1J
SMWAF-E21	0	mg/kg	<0.00032	<0.00019	0.0011	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.12	0.15	<0.00022	<0.00059	0.048	<0.00035	<0.00016	<0.0004	<0.00043	<0.00045	<0.00075	1.2J
SMWAF-E22	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.12	0.13	<0.00023	<0.0006	0.051	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	1.2J
SMWAF-E23	0	mg/kg	<0.00032	<0.00019	0.00048J	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.1	0.12	<0.00022	<0.00059	0.045	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	1J
SMWAF-F16	0	mg/kg	<0.00037	<0.00022	0.00056J	<0.00029	<0.0002	<0.00068	<0.00019	<0.00027	0.086	0.062	<0.00026	<0.00068	0.024	<0.00041	<0.00019	0.023J	<0.0005	<0.00052	<0.00086	0.65J
SMWAF-F17	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.12	0.11	<0.00023	<0.0006	0.035	<0.00036	<0.00017	0.043J	<0.00044	<0.00045	<0.00075	1.2J
SMWAF-F18	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.12	0.094	<0.00022	<0.00059	0.032	<0.00035	<0.00016	0.036J	<0.00043	<0.00045	<0.00075	1.1J
SMWAF-F19	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.11	0.092	<0.00022	<0.00059	0.033	<0.00035	<0.00016	0.036J	<0.00043	<0.00045	<0.00075	1.2J
SMWAF-F20	0	mg/kg	<0.00032	<0.00019	0.00063J	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.12	0.093	<0.00022	<0.00059	0.032	<0.00035	<0.00016	0.038J	<0.00043	<0.00045	<0.00075	1.1J
SMWAF-F21	0	mg/kg	<0.00032	<0.00019	0.00051J	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.11	0.095	<0.00023	<0.0006	0.032	<0.00036	<0.00017	0.036J	<0.00044	<0.00045	<0.00075	1.2J
SMWAF-F22	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.12	0.1	<0.00022	<0.00059	0.035	<0.00035	<0.00016	0.038J	<0.00044	<0.00045	<0.00075	1.2J
SMWAF-F23	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.098	0.078	<0.00022	<0.00059	0.034	<0.00035	<0.00016	0.034J	<0.00043	<0.00044	<0.00074	1.3J
SMWAF-G16	0	mg/kg	<0.00033	<0.0002	0.00086	<0.00026	<0.00018	<0.00061	<0.00017	<0.00024	0.12	0.11	<0.00023	<0.00061	0.037	<0.00037	<0.00017	0.037J	<0.00045	<0.00046	<0.00077J	1.2J
SMWAF-G17	0	mg/kg	<0.00035	<0.00021	<0.00034	<0.00027	<0.00019	<0.00064	<0.00018	<0.00025	0.1	0.085	<0.00024	<0.00064	0.03	<0.00038	<0.00018	0.034J	<0.00047	<0.00048	<0.00081	1J
SMWAF-G18	0	mg/kg	<0.00032	<0.00019	0.00062J	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.12	0.11	<0.00022	<0.0006	0.035	<0.00036	<0.00017	0.04J	<0.00044	<0.00045	<0.00075	1.2J
SMWAF-G19	0	mg/kg	<0.00032	<0.00019	<0.00032	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.11	0.09	<0.00023	<0.0006	0.031	<0.00036	<0.00017	0.038J	<0.00044	<0.00045	<0.00076	1.1J
SMWAF-G20	0	mg/kg	<0.00032	<0.00019	0.00047J	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.12	0.092	<0.00022	<0.00059	0.033	<0.00035	<0.00016	0.039J	<0.00043	<0.00045	<0.00075	1.2J
SMWAF-G21	0	mg/kg	<0.00033	<0.0002	0.0004J	<0.00026	<0.00018	<0.00061	<0.00017	<0.00024	0.14	0.11	<0.00023	<0.00061	0.037	<0.00036	<0.00017	0.048J	<0.00045	<0.00046	<0.00077	1.3J
SMWAF-G22	0	mg/kg	<0.00035	<0.00021	<0.00034	<0.00028	<0.00019	<0.00065	<0.00018	<0.00025	0.094	0.077	<0.00025	<0.00065	0.029	<0.00039	<0.00018	0.036J	<0.00048	<0.00049	<0.00083	1J
SMWAF-G23	0	mg/kg	<0.00032	<0.00019	<0.00032	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.1	0.093	<0.00023	<0.0006	0.033	<0.00036	<0.00017	0.035J	<0.00044	<0.00045	<0.00076	1.1J

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

Location	Depth	Units	Organochlorine Pesticides (Method 8081) Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-H16	0	mg/kg	<0.00035	<0.00021	0.0012	<0.00028	<0.00019	<0.00065	<0.00018	<0.00025	0.13	0.11	<0.00025	<0.00066	0.038	<0.00039	<0.00018	<0.00045	<0.00048	<0.00049	<0.00083	**1.1J**
SMWAF-H17	0	mg/kg	<0.00034	<0.0002	<0.00033	<0.00027	<0.00019	<0.00063	<0.00017	<0.00024	0.13	0.12	<0.00024	<0.00063	0.032	<0.00038	<0.00017	<0.00043	<0.00046	<0.00047	<0.00079	**1.2J**
SMWAF-H18	0	mg/kg	<0.00032	<0.0002	0.0011J	<0.00026	<0.00018	<0.0006	<0.00017	<0.00023	0.12	0.081	<0.00023	<0.0006	0.031	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00076	**1.1J**
SMWAF-H19	0	mg/kg	<0.00032	0.00021J	<0.00031	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.11	0.096	<0.00023	<0.0006	0.032	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	**1.2J**
SMWAF-H20	0	mg/kg	<0.00032	0.00027J	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.11	0.096	<0.00022	<0.0006	0.026	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	**0.97**
SMWAF-H21	0	mg/kg	<0.00035	0.00025J	<0.00034	<0.00028	<0.00019	<0.00065	<0.00018	<0.00025	0.097	0.083	<0.00025	<0.00065	0.026	<0.00039	<0.00018	<0.00045	<0.00048	<0.00049	<0.00082	**0.91J**
SMWAF-H22	0	mg/kg	<0.00032	<0.0002	<0.00032	<0.00026	<0.00018	<0.0006	<0.00017	<0.00023	0.13	0.12	<0.00023	<0.0006	0.032	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00076	**1.2J**
SMWAF-H23	0	mg/kg	<0.00034	0.00027	<0.00033	<0.00027	<0.00019	<0.00063	<0.00018	<0.00025	0.1	0.071	<0.00024	<0.00063	0.028	<0.00038	<0.00018	<0.00043	<0.00046	<0.00048	<0.0008	**0.99J**
SMWAF-I16	0	mg/kg	<0.00032	<0.00019	0.0014J	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.14	0.11	<0.00022	<0.00059	0.033	<0.00035	<0.00016	<0.00041	<0.00044	<0.00045	<0.00075	**0.89J**
SMWAF-I17	0	mg/kg	<0.00032	<0.00019	0.0011J	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.13	0.082	<0.00022	<0.00059	0.02J	<0.00035	<0.00016	<0.00041	<0.00044	<0.00045	<0.00075	**0.87J**
SMWAF-I18	0	mg/kg	<0.00035	<0.00021	0.0011J	<0.00028	<0.00019	<0.00065	<0.00018	<0.00025	0.12	0.087	<0.00025	<0.00065	0.032	<0.00039	<0.00018	<0.00045	<0.00048	<0.00049	<0.00083	**0.9J**
SMWAF-I19	0	mg/kg	<0.00032	0.00031J	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.11	0.095	<0.00022	<0.00059	0.028	<0.00035	<0.00016	<0.0004	<0.00043	<0.00045	<0.00075	**0.98J**
SMWAF-I20	0	mg/kg	<0.00032	0.00026J	0.00089J	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.12	0.11	<0.00022	<0.0006	0.034	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	**1.2J**
SMWAF-I21	0	mg/kg	<0.00032	0.00023J	<0.00031	0.00025R	<0.00018	<0.00059	<0.00017	<0.00023	0.12	0.094	<0.00023	<0.0006	0.03	<0.00036J	<0.00017	<0.00041	<0.00044J	<0.00045	<0.00075J	**1.1J**
SMWAF-I22	0	mg/kg	<0.00035	<0.00021	0.00077J	<0.00028	<0.00019	<0.00066	<0.00018	<0.00026	0.11	0.14	<0.00025	<0.00066	0.056	<0.00039	<0.00018	0.054J	<0.00048	<0.0005	<0.00083	**1.3J**
SMWAF-I23	0	mg/kg	<0.00032	<0.00019	0.00086J	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.12	0.15	<0.00022	<0.00059	0.057	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**1.2J**
SMWAF-J16	0	mg/kg	<0.00032	<0.00019	0.00081J	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.14	0.12	<0.00023	<0.0006	0.03J	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	**1.2J**
SMWAF-J17	0	mg/kg	<0.00032	<0.00019	0.00086J	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.13	0.095	<0.00022	<0.00059	0.027J	<0.00035	<0.00016	<0.00041	<0.00043	<0.00045	<0.00075	**1.3J**
SMWAF-J18	0	mg/kg	<0.00033	<0.0002	0.00059J	<0.00026	<0.00018	<0.00061	<0.00017	<0.00024	0.14	0.1	<0.00023	<0.00061	0.024J	<0.00036	<0.00017	<0.00042	<0.00045	<0.00046	<0.00077	**1.3J**
SMWAF-J19	0	mg/kg	<0.00033	0.00055	0.00055J	<0.00026	<0.00018	<0.00061	<0.00017	<0.00024	0.13	0.11	<0.00023	<0.00061	0.037	<0.00037	<0.00017	<0.00042	<0.00045	<0.00046	<0.00077	**1.2J**
SMWAF-J20	0	mg/kg	<0.00032	0.00049J	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.14	0.094	<0.00022	<0.0006	0.034	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.013J	**1.3J**
SMWAF-J21	0	mg/kg	<0.00032	0.00064	0.00053J	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.14	0.12	<0.00023	<0.0006	0.04	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.035J	**1.4J**
SMWAF-J22	0	mg/kg	<0.00033	0.00055J	<0.00032	<0.00026	<0.00018	<0.00061	<0.00017	<0.00024	0.15	0.12	<0.00023	<0.00061	0.042	<0.00036	<0.00017	<0.00042	<0.00045	<0.00046	0.041J	**1.5J**
SMWAF-J23	0	mg/kg	<0.00035	<0.00021	<0.00035	<0.00028	<0.00019	<0.00065	<0.00018	<0.00025	0.085	0.06	<0.00025	<0.00066	0.028	<0.00039	<0.00018	<0.00045	<0.00048	<0.00049	0.024J	**1J**
SMWAF-K16	0	mg/kg	<0.064	<0.039	<0.059	<0.064	<0.04	<0.05	<0.022	0.21	**3**	**2.4**	<0.025	<0.028	0.16J	<0.047	<0.027	0.43	0.043J	<0.043	**3.5**	**5.5**
SMWAF-K17	0	mg/kg	<0.13	<0.078	<0.12	<0.13	<0.079	<0.1	<0.045	0.54	**5.1**	**5.6**	<0.05	<0.055	0.3J	<0.093	<0.053	0.91J	<0.067	<0.085	0.68J	**12**
SMWAF-K18	0	mg/kg	<0.012	<0.0075	<0.011	<0.012	<0.0076	<0.0097	<0.0043	0.086	0.73J	0.82J	<0.0048	<0.0054	0.09	<0.009	<0.0052	0.22	0.014J	<0.0082	0.16J	**3.3**
SMWAF-K19	0	mg/kg	<0.0076	<0.0046	<0.007	<0.0076	<0.0047	<0.0059	<0.0027	0.033	0.17	0.19	<0.003	<0.0033	0.048	<0.0055	<0.0032	0.11	0.0081J	<0.0051	0.038J	**1.6**
SMWAF-K20	0	mg/kg	<0.0071	<0.0043	<0.0066	<0.0071	<0.0044	<0.0056	<0.0025	0.013J	0.11J	0.091	<0.0028	<0.0031	0.027	<0.0052	<0.003	0.03J	<0.0038	<0.0048	0.16J	**0.96**
SMWAF-K21	0	mg/kg	<0.0065	<0.0039	<0.0059	<0.0065	<0.004	<0.0051	<0.0023	0.027	0.2	0.2	<0.0025	<0.0028	0.052	<0.0047	<0.0027	0.061	0.048	<0.0043	0.32	**1.9**
SMWAF-K22	0	mg/kg	<0.0065	<0.004	<0.006	<0.0065	<0.004	<0.0051	<0.0023	0.024	0.19	0.18	<0.0026	<0.0028	0.046	<0.0047	<0.0027	0.056	0.047	<0.0044	0.29	**1.8**
SMWAF-K23	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.022	0.17	0.16	0.0098J	<0.0027	0.044	<0.0046	<0.0026	0.051	0.039	<0.0042	0.26	**1.7**
SMWAF-L16	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.031	0.15	0.16	<0.0024	<0.0027	0.049	<0.0045	<0.0026	0.12	0.0066J	<0.0042	0.024J	**1.7**
SMWAF-L17	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.037	0.18	0.24	<0.0025	<0.0027	0.061	<0.0046	<0.0026	0.15	0.0096J	<0.0042	0.066J	**2.1**
SMWAF-L18	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.031	0.17	0.21	<0.0025	<0.0027	0.056	<0.0046	<0.0026	0.14	0.0092J	<0.0042	0.045J	**2**
SMWAF-L19	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.031	0.17	0.21	<0.0024	<0.0027	0.054	<0.0045	<0.0026	0.14	0.0091J	<0.0041	0.043J	**2**
SMWAF-L20	0	mg/kg	<0.0064	<0.0039	<0.0058	<0.0064	<0.0039	<0.005	<0.0022	0.031	0.17	0.23	<0.0025	<0.0028	0.047	<0.0046	<0.0026	0.12	0.0079J	<0.0042	0.044J	**1.7**
SMWAF-L21	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.031	0.17	0.2	<0.0025	<0.0027	0.055	<0.0046	<0.0026	0.14	0.0087J	<0.0042	0.06J	**2**
SMWAF-L22	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.017J	0.16	0.12	<0.0025	<0.0027	0.042	<0.0046	<0.0026	0.05	0.045	<0.0042	0.21	**1.6**
SMWAF-L23	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.03	0.17	0.21	<0.0024	<0.0027	0.052	<0.0045	<0.0026	0.13	0.0078J	<0.0042	0.055J	**1.9**
SMWAF-M16	0	mg/kg	<0.0067	<0.0041	<0.0061	<0.0067	<0.0041	<0.0052	<0.0023	0.019	0.19	0.14	<0.0026	<0.0029	0.065	<0.0049	<0.0028J	0.061	0.04	<0.0045	<0.0084	**1.5**
SMWAF-M17	0	mg/kg	<0.0064	<0.0039	<0.0058	<0.0064	<0.0039	<0.005	<0.0022	0.022	0.23	0.16	<0.0025	<0.0028	0.073	<0.0046	<0.0027J	0.064	0.053	<0.0043	0.28	**1.8**
SMWAF-M18	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.018J	0.18	0.13	<0.0025	<0.0027	0.057	<0.0046	<0.0026J	0.059	0.046	<0.0042	0.25	**1.5**
SMWAF-M19	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.004	<0.005	<0.0022	0.021	0.19	0.11	<0.0025	<0.0028	0.058	<0.0047	<0.0027	0.054	0.032	<0.0043	<0.008	**1.3**
SMWAF-M20	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.015J	0.16	0.11	<0.0024J	<0.0027	0.046	<0.0045	<0.0026J	0.049J	0.041	<0.0041	0.21J	**1.2**
SMWAF-M21	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.014J	0.15	0.1	<0.0024	<0.0027	0.041	<0.0045	<0.0026	0.046	0.039	<0.0042	0.19	**1.2**
SMWAF-M22	0	mg/kg	<0.0068	<0.0041	<0.0062	<0.0068	<0.0042	<0.0053	<0.0024	0.017J	0.14	0.1	<0.0027	<0.003	0.04	<0.0049	<0.0028	0.047	0.044	<0.0045	0.19	**1.2**
SMWAF-M23	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.015	0.15	0.11	<0.0025	<0.0027	0.045	<0.0045	<0.0026	0.046	0.046	<0.0042	0.2	**1.3**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

			Organochlorine Pesticides (Method 8081)																			
Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-N16	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.013J	0.13	0.084	<0.0024	<0.0027	0.042	<0.0045	<0.0026	0.041	0.029	<0.0041	0.17	**1.1**
SMWAF-N17	0	mg/kg	<0.0063J	<0.0038J	<0.0058J	<0.0063J	<0.0039J	<0.0049J	0.0033J	0.024	0.23J	0.15	<0.0025J	<0.0027	0.072	<0.0046	<0.0026	0.065	0.053	<0.0042J	0.27	**1.8**
SMWAF-N18	0	mg/kg	<0.0063J	<0.0038J	<0.0058J	<0.0063J	<0.0039J	<0.0049J	<0.0022J	0.013	0.15J	0.086	<0.0025J	<0.0027	0.05	<0.0046	<0.0026	0.044J	0.027J	<0.0042J	0.19J	**1.1**
SMWAF-N19	0	mg/kg	<0.0069J	<0.0042J	<0.0064J	<0.0069J	<0.0043J	<0.0054J	<0.0024J	0.02J	0.2J	0.12	<0.0027J	<0.003	0.059	<0.005	<0.0029	0.061	0.045	<0.0046J	0.25	**1.5**
SMWAF-N20	0	mg/kg	<0.0062J	<0.0038J	<0.0057J	<0.0062J	<0.0038J	<0.0049J	<0.0022J	0.017	0.17J	0.11	<0.0024J	<0.0027	0.05	<0.0045	<0.0026	0.055	0.044	<0.0041J	0.23	**1.4**
SMWAF-N21	0	mg/kg	<0.0062J	<0.0038J	<0.0057J	<0.0062J	<0.0039J	<0.0049J	0.003J	<0.0032	0.16J	0.1	<0.0024J	<0.0027	0.045	<0.0045	<0.0026	0.048	0.039	<0.0042J	0.21	**1.3**
SMWAF-N22	0	mg/kg	<0.0064J	<0.0039J	<0.0059J	<0.0064J	<0.0039J	<0.005J	<0.0022J	0.011J	0.15J	0.093	<0.0025J	<0.0028	0.033	<0.0046	<0.0027	0.04	0.039	<0.0043J	0.19	**1.2**
SMWAF-N23	0	mg/kg	<0.0063J	<0.0038J	<0.0058J	<0.0063J	<0.0039J	<0.0049J	<0.0022J	0.013J	0.19J	0.13	<0.0025J	<0.0027	0.066	<0.0046	<0.0026	0.049	0.046	<0.0042J	0.23	**1.5**
SMWAF-O16	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.014J	0.13	0.11	<0.0025	<0.0027	0.045	<0.0045	<0.0026	0.048	0.039	<0.0042	0.21	**1.1**
SMWAF-O17	0	mg/kg	<0.0068	<0.0041	<0.0063	<0.0068	<0.0042	<0.0053	<0.0024	0.02J	0.16	0.13	<0.0027	<0.003	0.068	<0.0049	<0.0028	0.055	0.048	<0.0045	0.24	**1.4**
SMWAF-O18	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.012J	0.12	0.085	<0.0025	<0.0027	0.037	<0.0045	<0.0026	0.039	0.033	<0.0042	0.17	**0.97**
SMWAF-O19	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0048	<0.0022	0.0075J	0.12	0.083	<0.0024	<0.0027	0.037	<0.0045	<0.0026	0.037	0.025	<0.0041	0.17	**0.84**
SMWAF-O20	0	mg/kg	<0.0062J	<0.0038J	<0.0057J	<0.0062J	<0.0038J	<0.0049J	<0.0022J	<0.0032	0.15J	0.09	<0.0024J	<0.0027	0.043	<0.0045	<0.0026	0.043J	0.034J	<0.0041J	0.19J	**1.2**
SMWAF-O21	0	mg/kg	<0.0062J	<0.0038J	<0.0057J	<0.0062J	<0.0038J	<0.0048J	<0.0022J	0.016J	0.15J	0.099	<0.0024J	<0.0027	0.042	<0.0045	<0.0026	0.046	0.039	<0.0041J	0.2	**1.2**
SMWAF-O22	0	mg/kg	<0.0062J	<0.0038J	<0.0057J	<0.0062J	<0.0038J	<0.0048J	<0.0022J	<0.0032	0.18J	0.13	<0.0024J	<0.0027	0.051	<0.0045	<0.0026	0.059	0.053	<0.0041J	0.25	**1.6**
SMWAF-P16	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.013J	0.15	0.11	<0.0024J	<0.0027	0.049	<0.0045	<0.0026J	0.051J	0.036	<0.0042	0.21J	**1.1**
SMWAF-P17	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0039	<0.0049	<0.0022	0.016J	0.11	0.11	0.0067J	<0.0027	0.037	<0.0045	<0.0026	0.041	0.037	<0.0042	0.23	**1.4**
SMWAF-P18	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.015J	0.1	0.095	0.0064J	<0.0027	0.032	<0.0045	<0.0026	0.041	0.038	<0.0042	0.23	**1.3**
SMWAF-P19	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.013	0.11	0.095	0.0066J	<0.0027	0.035	<0.0045	<0.0026	0.039	0.029	<0.0042	0.22	**1.3**
SMWAF-P20	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.016	0.11	0.11	0.0069J	<0.0027	0.034	<0.0045	<0.0026	0.043	0.04	<0.0042	0.23	**1.4**
SMWAF-P21	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.017	0.13	0.12	0.007J	<0.0027	0.034	<0.0045	<0.0026	0.047J	0.044J	<0.0042	0.26J	**1.6**
SMWAF-P22	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.018J	0.13	0.13	<0.0025	<0.0027	0.039	<0.0046	<0.0026	0.048	0.045	<0.0042	0.27	**1.6**
SMWAF-Q16	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.029	0.13	0.12	<0.0024	<0.0027	0.044	<0.0045	<0.0026	0.11	0.0038J	<0.0041	0.015J	**1.6**
SMWAF-Q17	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.025	0.14	0.16	<0.0025	<0.0027	0.045	<0.0046	<0.0026	0.11	0.0067J	<0.0042	0.046J	**1.6**
SMWAF-Q18	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.018J	0.098	0.11	<0.0024	<0.0027	0.033	<0.0045	<0.0026	0.086J	0.005J	<0.0042	0.027J	**1.2**
SMWAF-Q19	0	mg/kg	<0.0069	<0.0042	<0.0063	<0.0069	<0.0042	<0.0054	<0.0024	0.018J	0.089	0.11	<0.0027	<0.003	0.033	<0.005	<0.0029	0.081	0.005J	<0.0046	0.027J	**1.2**
SMWAF-Q20	0	mg/kg	<0.0069	<0.0042	<0.0064	<0.0069	<0.0043	<0.0054	<0.0024	0.021J	0.1	0.1	<0.0027	<0.003	0.035	<0.005	<0.0029	0.087	0.0054J	<0.0046	0.021J	**1.4**
SMWAF-Q21	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.02J	0.12	0.13	<0.0024	<0.0027	0.035	<0.0045	<0.0026	0.092	0.0055J	<0.0041	0.028J	**1.3**
SMWAF-Q22	0	mg/kg	<0.0079	<0.0048	<0.0073	<0.0079	<0.0049	<0.0062	<0.0028	0.019J	0.1	0.12	<0.0031	<0.0034	0.035	<0.0057	<0.0033	0.089	0.0055J	<0.0053	0.031J	**1.3**
SMWAF-R16	0	mg/kg	<0.0065	<0.0039	<0.0059	<0.0065	<0.004	<0.0051	<0.0023	0.035	0.18	0.2	<0.0025	<0.0028	0.056	<0.0047	<0.0027	0.14	0.009J	<0.0043	0.034J	**1.8**
SMWAF-R17	0	mg/kg	<0.0069	<0.0042	<0.0063	<0.0069	<0.0042	<0.0054	<0.0024	<0.0035	0.16J	0.14	<0.0027	<0.003	0.052	<0.005	<0.0029	0.06	0.049J	<0.0046	0.26J	**1.8**
SMWAF-R18	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.018J	0.13	0.1	<0.0024	<0.0027	0.042	<0.0045	<0.0026	0.049	0.042	<0.0042	0.21	**1.5**
SMWAF-R19	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0039	<0.0049	<0.0022	0.0092J	0.084	0.068	<0.0024	<0.0027	0.026	<0.0045	<0.0026	0.03	0.024	<0.0042	0.13	**0.9**
SMWAF-R20	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.011J	0.096	0.076	<0.0024	<0.0027	0.031	<0.0045	<0.0026	0.035J	0.025J	<0.0042	0.14J	**0.98**
SMWAF-R21	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.014J	0.13	0.098	<0.0024	<0.0027	0.038	<0.0045	<0.0026	0.046	0.036	<0.0041	0.19	**1.3**
SMWAF-R22	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0039	<0.0049	<0.0022	0.021	0.15	0.13	<0.0024	<0.0027	0.062	<0.0045	<0.0026	0.054	0.047	<0.0042	0.23	**1.7**
SMWAF-S16	0	mg/kg	<0.0047	<0.005	<0.0075	0.0038J	<0.0038	<0.0045	0.0041J	0.025J	0.17	0.17	**0.024J**	0.0049J	0.048J	0.013J	0.036J	0.057J	0.021J	<0.0027	0.062J	**2.8**
SMWAF-S17	0	mg/kg	<0.0048	<0.0051	<0.0076	0.013J	<0.0039	<0.0046	0.0023J	0.021J	0.12	0.12	**0.022J**	0.0061J	0.04J	0.0081J	0.029J	0.043J	0.018J	0.0031J	0.056J	**2.1**
SMWAF-S18	0	mg/kg	<0.0023	<0.0024	<0.0036	0.0027J	<0.0018	<0.0022	<0.00099	0.039J	0.14	0.22	<0.00099	0.0048J	0.039J	0.014J	0.0061	0.058	0.064	<0.0013	<0.014	**2**
SMWAF-S19	0	mg/kg	<0.0022	<0.0023	<0.0035	0.0027J	<0.0018	<0.0021	<0.00056	<0.0028	0.11	0.16	<0.00097	0.0041J	0.028J	0.0067J	0.031J	0.054	0.042	<0.0013	<0.014	**1.4**
SMWAF-S20	0	mg/kg	<0.0011	<0.0011	<0.0017	0.0013J	<0.00088	0.0035J	<0.0021	0.02J	0.1	0.13	<0.00047	0.0042J	0.029	0.0078J	0.0039J	0.036	0.044	0.0019J	<0.0067	**1.3**
SMWAF-S21	0	mg/kg	<0.0045	<0.0047	<0.0071	0.0042J	<0.0037	<0.0043	<0.0011	0.013J	0.11	0.095	0.017J	0.0021	0.029J	0.0064J	0.023J	0.026J	0.013J	<0.0026	0.046J	**1.8**
SMWAF-T16	0	mg/kg	<0.0045	<0.0047	<0.007	0.0041J	<0.0036	0.011J	0.0096J	0.033J	0.18	0.19	**0.028J**	0.007J	0.053J	0.015J	0.042J	0.062J	0.024J	0.0048J	0.068J	**2.8**
SMWAF-T17	0	mg/kg	<0.0023	<0.0024	<0.0035	0.0034J	<0.0018	0.0083J	<0.0041	<0.0028	0.18	0.28J	<0.00098	0.0083J	0.028J	<0.00099	0.057J	0.087NJ	0.068J	<0.0013	<0.014	**2.2**
SMWAF-T18	0	mg/kg	<0.0045	<0.0047	<0.007	<0.0034	<0.0036	<0.0043	0.0032J	0.022J	0.12	0.14	**0.021J**	0.005J	0.042J	0.014J	0.029J	0.056J	0.021J	<0.0026	0.054J	**2.3**
SMWAF-T19	0	mg/kg	<0.0022	<0.0023	<0.0035	<0.0017	<0.0018	0.0036J	0.0037J	0.016J	0.097	0.098	0.018J	0.0035J	<0.0011	0.0099J	0.021J	0.036J	0.013J	0.0024J	0.054J	**1.6**
SMWAF-T20	0	mg/kg	<0.0022	<0.0023	<0.0034	<0.0016	<0.0018	0.0034J	0.003J	0.015J	0.095	0.11	0.014J	0.0033J	<0.001	0.0059J	0.02J	0.032J	0.013J	0.0024J	0.037J	**1.5**
SMWAF-T21	0	mg/kg	<0.0043	<0.0045	<0.0068	<0.0033	<0.0035	<0.0041	0.0021J	0.017J	0.086	0.093	0.016J	0.0041J	0.031J	0.0073J	0.0039J	0.037J	0.016J	<0.0025	0.043J	**1.6**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
			Organochlorine Pesticides (Method 8081)																			
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-U16	0	mg/kg	<0.0044	<0.0046	<0.0069	0.0042J	<0.0036	<0.0042	0.0028J	0.026J	0.15	0.16	**0.029J**	0.0049J	0.045J	0.012J	0.041J	0.081J	0.02J	<0.0025	0.076J	**2.1**
SMWAF-U17	0	mg/kg	<0.0043	<0.0045	<0.0067	0.0035J	<0.0035	<0.0041	0.0054J	0.032J	0.16	0.17	**0.031J**	0.007J	0.044J	0.0098J	0.042J	0.045J	0.018J	0.0037J	0.074J	**1.9**
SMWAF-U18	0	mg/kg	<0.0043	<0.0045	<0.0067	0.0043J	<0.0035	<0.0041	0.0013J	0.019J	0.15	0.18	**0.025J**	0.0037J	<0.002	0.012J	0.033J	0.06NJ	0.018J	<0.0025	<0.027	**2.6**
SMWAF-U19	0	mg/kg	<0.0046	<0.0048	<0.0072	0.0054J	<0.0037	<0.0043	<0.0012	0.013J	0.093	0.11	0.016J	0.0026J	0.027J	0.0075J	0.022J	0.036J	0.013J	<0.0026	0.039J	**1.2J**
SMWAF-U20	0	mg/kg	<0.0022	<0.0023	<0.0035	0.0023J	<0.0018	<0.0021	0.002J	0.013J	0.075	0.076	0.013J	0.0022J	0.022J	0.0053J	0.019J	0.034J	0.01J	<0.0013	0.038J	**0.99**
SMWAF-U21	0	mg/kg	<0.0043	<0.0045	<0.0068	0.0039J	<0.0035	<0.0041	0.0012J	0.017J	0.11	0.11	**0.021J**	0.0038J	0.033J	0.0078J	0.03J	0.034J	0.014J	<0.0025	0.056J	**1.5**
SMWAF-V16	0	mg/kg	<0.0044	<0.0046	<0.0068	0.0043J	<0.0035	<0.0041	0.0031J	0.022J	0.13	0.13	**0.022J**	0.004J	0.036J	0.0056J	0.031J	0.057J	0.015J	<0.0025	0.054J	**1.6**
SMWAF-V17	0	mg/kg	<0.0042	<0.0044	<0.0066	0.0036J	<0.0034	<0.004	0.0019J	0.023J	0.15	0.15	**0.025J**	0.0044	0.042J	0.0079J	0.035J	0.073J	0.02J	<0.0024	0.064J	**2**
SMWAF-V18	0	mg/kg	<0.0044	<0.0046	<0.0069	0.0039J	<0.0036	<0.0042	0.0015J	0.02J	0.12	0.13	**0.022J**	0.004J	0.037J	0.0067J	0.031J	0.064J	0.017J	<0.0025	0.057J	**1.8**
SMWAF-V19	0	mg/kg	<0.0023	<0.0024	<0.0035	0.006J	<0.0018	0.0024J	0.0024J	0.02J	0.11	0.12	0.019J	0.0041J	0.032J	0.0076J	0.03J	0.054J	0.014J	0.0014J	0.055J	**1.6**
SMWAF-V20	0	mg/kg	<0.0022	<0.0023	<0.0034	0.0033J	<0.0018	<0.0021	0.00077J	0.012J	0.061	0.058	0.012J	0.0024J	0.019J	0.0045J	0.017J	0.019J	0.0087J	<0.0012	0.031J	**0.81**
SMWAF-V21	0	mg/kg	<0.0043	<0.0045	<0.0067	<0.0033	<0.0035	<0.0041	0.0017J	0.022J	0.13	0.17	**0.027J**	0.0043J	0.046J	0.018	0.041J	0.096NJ	0.018J	0.0029	<0.026	**2.7**
SMWAF-W16	0	mg/kg	<0.0047	<0.005	<0.0074	<0.0036	<0.0038	0.0049J	0.0043J	0.027J	0.13	0.15	**0.024J**	0.0062J	0.047J	0.012J	0.034J	0.048J	0.022J	0.0038J	0.065J	**2.5**
SMWAF-W17	0	mg/kg	<0.0022	<0.0023	<0.0034	0.0028J	<0.0018	0.011J	<0.0055	<0.0027	0.17	0.29J	<0.00095	0.0089J	0.029J	<0.00096	0.062J	0.093NJ	0.067J	<0.0012	<0.014	**2.2**
SMWAF-W18	0	mg/kg	<0.0045	<0.0047	<0.007	0.0039J	<0.0036	0.0082J	0.0054J	0.028J	0.15	0.2	**0.031J**	0.0071J	<0.0021	0.02J	0.044J	0.071J	0.025J	0.0045J	0.072J	**2.9**
SMWAF-W19	0	mg/kg	<0.0044	<0.0046	<0.0069	<0.0033	<0.0035	0.005J	0.0054J	0.024J	0.13	0.13	0.02J	0.0059J	<0.0021	0.0091J	0.032J	0.044J	0.017J	0.0035J	0.052J	**2.1**
SMWAF-W20	0	mg/kg	<0.0043	<0.0045	<0.0068	0.0038J	<0.0035	<0.0041	0.0021J	0.02J	0.12	0.15	0.016J	0.0046J	0.033J	0.01J	0.027J	0.037J	0.014J	0.0033J	0.046J	**1.7**
SMWAF-W21	0	mg/kg	<0.011	<0.012	<0.017	<0.0085	<0.009	<0.011	0.0055	0.034	1.4	0.73	**0.046**	0.041	0.051	0.039	0.047	0.081J	<0.018	0.024	0.18	**2.3**
SMWAF-X16	0	mg/kg	<0.0042	<0.0044	<0.0066	<0.0032	<0.0034	0.0051J	0.0021J	0.025J	0.14	0.17	**0.028J**	0.006J	0.048J	0.015J	0.034J	0.051J	0.025J	0.0039J	0.068J	**2.7**
SMWAF-X17	0	mg/kg	<0.0044	<0.0046	<0.0069	<0.0033	<0.0035	0.0053J	0.0044J	0.028J	0.14	0.13	**0.023J**	0.0062J	0.044J	0.01J	0.035J	0.043J	0.019J	0.004J	0.057J	**2.2**
SMWAF-X18	0	mg/kg	<0.0043	<0.0045	<0.0068	<0.0033	<0.0035	0.008J	0.0058J	0.029J	0.17	0.18	**0.027J**	0.0068J	0.052J	0.014J	0.038J	0.066J	0.023J	0.0047J	0.066J	**2.7**
SMWAF-X19	0	mg/kg	<0.0043	<0.0045	<0.0068	<0.0033	<0.0035	0.0082J	0.006J	0.028J	0.14	0.18	**0.029J**	0.008J	0.055J	0.022J	0.042J	0.058J	0.024J	0.0048J	0.073J	**3**
SMWAF-X20	0	mg/kg	<0.0045	<0.0047	<0.0071	0.0039J	<0.0036	0.0044J	0.0034J	0.023J	0.12	0.13	0.018J	0.0057J	0.039J	0.0091J	0.029J	0.039J	0.018J	0.0035J	0.049J	**2**
SMWAF-Y1	0	mg/kg	<0.021	<0.022	<0.034	<0.016	<0.017	<0.02	<0.0054	0.059J	1.1	0.66	**0.064J**	<0.0053	<0.068	0.05J	0.095J	0.095NJ	<0.035	<0.012	<0.13	**3.8J**
SMWAF-Y2	0	mg/kg	<0.0043	<0.0045	<0.0068	0.0043J	<0.0035	<0.0041	<0.0011	0.05J	0.25	0.35	**0.032J**	0.0068J	0.049J	0.021NJ	<0.0023	0.081NJ	0.086	<0.0025	0.13J	**3.1**
SMWAF-Y3	0	mg/kg	<0.00032	<0.00019	0.00096J	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.24	0.25	<0.00022	<0.00059	0.063	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**1.8**
SMWAF-Y4	0	mg/kg	<0.00032	<0.00019	0.0015	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.21	0.18	<0.00022	<0.00059	0.025	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	0.033	**1.7**
SMWAF-Y5	0	mg/kg	<0.00032	<0.00019	0.0004J	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.21	0.17	<0.00022	<0.00059	0.054	<0.00035	<0.00016	<0.0004	<0.00043	<0.00045	<0.00075	**1.6**
SMWAF-Y6	0	mg/kg	<0.00032	<0.00019	0.00093	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.19	0.16	<0.00022	<0.00059	0.048	<0.00035	<0.00016	<0.0004	<0.00043	<0.00045	0.036J	**1.6**
SMWAF-Y7	0	mg/kg	<0.00032	0.00041	<0.00031	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.16	0.13	<0.00023	<0.0006	0.04	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.03	**1.4**
SMWAF-Y8	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.14	0.1	<0.00022	<0.00059	0.04	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00075	**1.3**
SMWAF-Y9	0	mg/kg	<0.00033	<0.0002	<0.00033	<0.00026	<0.00018	<0.00062	<0.00017	<0.00024	0.13	0.098	<0.00023	<0.00062	0.039	<0.00037	<0.00017	<0.00042	<0.00046	<0.00047	0.028	**1.3**
SMWAF-Y10	0	mg/kg	<0.0021	<0.0022	<0.0034	<0.0016	<0.0017	0.0049J	0.0012J	0.015J	0.11	0.1	0.019J	0.0035J	0.03J	0.013J	0.025J	0.046J	0.015J	0.0015J	<0.013	**1.1**
SMWAF-Y11	0	mg/kg	<0.0044	<0.0046	<0.0069	<0.0033	<0.0035	<0.0042	0.0035J	0.027J	0.15	0.18	**0.034J**	0.0068J	0.051J	0.022J	0.047J	0.076J	0.023J	<0.0025	<0.027	**2.3**
SMWAF-Y12	0	mg/kg	<0.0044	<0.0046	<0.0069	<0.0034	<0.0036	<0.0042	<0.0011	0.025J	0.13	0.15	**0.03J**	0.0067J	0.047J	0.022J	0.041J	0.066J	0.022J	<0.0025	0.085J	**2.3**
SMWAF-Y13	0	mg/kg	<0.0044	<0.0046	<0.0069	<0.0033	<0.0036	<0.0042	0.0022J	0.029J	0.17	0.2	**0.033J**	0.0057J	0.061J	0.024J	0.049J	0.084J	0.027J	<0.0025	<0.027	**3.6**
SMWAF-Y14	0	mg/kg	<0.0045	<0.0048	<0.0071	<0.0035	<0.0037	<0.0043	0.003	0.021J	0.14	0.17	**0.025J**	0.005	<0.0022	0.02	0.034J	0.065NJ	0.022J	<0.0026	<0.028	**2.7**
SMWAF-Y15	0	mg/kg	<0.0043	<0.0045	<0.0067	<0.0033	<0.0035	<0.0041	<0.0011	0.025J	0.13	0.17	**0.028J**	0.0054J	0.052J	0.021J	0.044J	0.07J	0.025J	<0.0024	<0.026	**3**
SMWAF-Y16	0	mg/kg	<0.0045	<0.0047	<0.0071	0.0035J	<0.0037	<0.0043	<0.0011	0.026J	0.14	0.17	**0.03J**	0.0063J	0.052J	0.022J	0.045J	0.071J	0.024J	<0.0026	<0.028	**2.8**
SMWAF-Y17	0	mg/kg	<0.0045	<0.0047	<0.0071	<0.0034	<0.0036	<0.0043	0.0052J	0.032J	0.15	0.17	**0.033J**	0.0073J	0.054J	0.017J	0.051J	0.069J	0.025J	<0.0026	0.1J	**2.9**
SMWAF-Y18	0	mg/kg	<0.0045	<0.0047	<0.0071	0.0041J	<0.0036	<0.0043	0.0046J	0.033J	0.17	0.22	**0.034J**	0.0075J	0.06J	0.018J	0.055J	0.079J	0.027J	<0.0026	0.11J	**3.2**
SMWAF-Y19	0	mg/kg	<0.0044	<0.0046	<0.0069	<0.0034	<0.0036	<0.0042	0.0022J	0.025J	0.13	0.18	**0.028J**	0.0056J	0.05J	0.022J	0.044J	0.069J	0.022J	<0.0025	0.09J	**2.9**
SMWAF-Y20	0	mg/kg	<0.0045	<0.0047	<0.007	<0.0034	<0.0036	<0.0043	<0.0011	0.02J	0.13	0.15	0.02J	0.0035J	<0.0021	0.01J	0.0046J	0.047J	0.016J	<0.0026	0.066J	**2.1**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

			Organochlorine Pesticides (Method 8081)																			
Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-Z1	0	mg/kg	<0.011	<0.011	<0.017	<0.0083	<0.0088	<0.01	0.018J	0.028J	1.3	0.87	**0.039J**	0.016J	<0.049	0.051J	0.072J	0.084NJ	<0.018	<0.0062	<0.067	**3.3J**
SMWAF-Z2	0	mg/kg	<0.0044	<0.0046	<0.0069	0.0055J	<0.0036	0.011J	0.0015J	0.021J	0.2	0.19	**0.024J**	0.0059J	<0.039	0.016J	0.038	0.055NJ	0.015J	<0.0025	<0.027	**2.2**
SMWAF-Z3	0	mg/kg	<0.00032	0.00033J	0.0012J	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.23	0.19	<0.00022	<0.0006	0.057	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.0075	**1.9**
SMWAF-Z4	0	mg/kg	<0.00033	0.00044J	0.00055J	<0.00026	<0.00018	<0.00062	<0.00017	<0.00024	0.2	0.16	<0.00023	<0.00062	0.05	<0.00037	<0.00017	<0.00042	<0.00045	<0.00047	0.036J	**1.7**
SMWAF-Z5	0	mg/kg	<0.00032	<0.00019	0.00047J	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.2	0.15	<0.00023	<0.0006	0.051	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	**1.5**
SMWAF-Z6	0	mg/kg	<0.00034	0.00052J	0.00044J	<0.00027	<0.00019	<0.00063	<0.00017	<0.00024	0.18	0.15	<0.00024	<0.00063	0.046	<0.00038	<0.00017	<0.00043	<0.00046	<0.00047	0.033	**1.6**
SMWAF-Z7	0	mg/kg	<0.00032	0.00039J	0.00045J	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.18	0.15	<0.00023	<0.0006	0.045	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.035	**1.6**
SMWAF-Z8	0	mg/kg	<0.00031	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.14	0.1	<0.00022	<0.00058	0.039	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**1.3**
SMWAF-Z9	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.12	0.086	<0.00022	<0.0006	0.034	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.022	**1.2**
SMWAF-Z10	0	mg/kg	<0.0022	<0.0023	<0.0034	0.0061J	<0.0018	0.0057J	0.00087J	0.016J	0.12	0.13	**0.021J**	0.0032J	0.035J	0.011J	0.027	0.051J	0.018J	0.0017J	<0.013	**1.7**
SMWAF-Z11	0	mg/kg	<0.0044	<0.0046	<0.0069	<0.0033	<0.0036	<0.0042	<0.0011	<0.0054	0.17	0.29	<0.0019	0.01J	0.052J	0.025J	0.033J	0.12J	0.076	<0.0025	<0.027	**2.5**
SMWAF-Z12	0	mg/kg	<0.0022	<0.0023	<0.0035	0.0018J	<0.0018	0.0094J	<0.005	0.062	0.16	0.28J	<0.00096	0.0098J	0.051J	0.029J	<0.0012	0.11NJ	0.08J	<0.0013	<0.014	**2.4**
SMWAF-Z13	0	mg/kg	<0.0044	<0.0047	<0.007	<0.0034	<0.0036	<0.0042	0.0024J	<0.0055	0.15	0.23	<0.0019	0.0086J	0.048J	<0.0019	0.05J	0.088J	0.065J	<0.0025	<0.028	**2.2**
SMWAF-Z14	0	mg/kg	<0.0044	<0.0046	<0.007	<0.0034	<0.0036	<0.0042	0.0013J	<0.0055	0.15	0.25	<0.0019	0.0077J	0.049J	<0.0019	0.05J	0.1J	0.073J	<0.0025	<0.027	**2.5**
SMWAF-Z15	0	mg/kg	<0.0045	<0.0047	<0.007	<0.0034	<0.0036	<0.0042	0.0014J	<0.0055	0.15	0.24	<0.0019	<0.0011	0.046J	<0.0019	0.048J	0.066J	0.067J	<0.0025	<0.028	**2.3**
SMWAF-Z16	0	mg/kg	<0.0045	<0.0047	<0.007	<0.0034	<0.0036	<0.0043	<0.0011	<0.0055	0.15	0.24	<0.0019	<0.0011	0.046J	<0.002	0.048J	0.094J	0.063J	<0.0026	<0.028	**2.2**
SMWAF-Z17	0	mg/kg	<0.0045	<0.0047	<0.007	<0.0034	<0.0036	<0.0042	0.0027J	<0.0055	0.14	0.22	<0.0019	<0.0011	0.044J	<0.002	0.026J	0.089J	0.063J	<0.0025	<0.028	**2**
SMWAF-Z18	0	mg/kg	<0.0043	<0.0045	<0.0068	<0.0033	<0.0035	<0.0041	0.002J	<0.0053	0.15	0.22	<0.0019	0.0061J	0.039J	<0.0019	0.045J	0.071J	0.05J	<0.0025	<0.027	**1.8**
SMWAF-Z19	0	mg/kg	<0.0043	<0.0045	<0.0068	<0.0033	<0.0035	<0.0041	<0.0011	<0.0053	0.12	0.2	<0.0019	0.005J	0.033J	0.017J	0.035J	0.073J	0.054J	<0.0025	<0.027	**1.7**
SMWAF-Z20	0	mg/kg	<0.0045	<0.0047	<0.007	<0.0034	<0.0036	<0.0042	0.0031J	<0.0055	0.16	0.22	<0.0019	<0.0011	0.036J	<0.002	0.042J	0.06J	0.038J	<0.0025	0.089J	**1.6**
SMWAF-AA1	0	mg/kg	<0.0021	<0.0022	<0.0033	<0.0016	<0.0017	0.011J	0.0075	0.008J	0.56	0.35	0.018	0.0062J	<0.021	0.017	0.028J	0.033NJ	0.032J	0.01J	0.042J	**1.2**
SMWAF-AA2	0	mg/kg	<0.0022	<0.0023	<0.0035	0.0064	<0.0018	0.0089J	0.0037J	0.018J	0.18	0.17	**0.022**	0.0047	0.035J	0.014J	0.033J	0.054NJ	0.016J	0.0024	<0.014	**2.1**
SMWAF-AA3	0	mg/kg	<0.00032	0.00035	0.00088	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.19	0.16	<0.00023	<0.0006	0.047	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	**1.6**
SMWAF-AA4	0	mg/kg	<0.00032	0.00054	0.00087	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.17	0.14	<0.00022	<0.00059	0.042	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	0.03	**1.5**
SMWAF-AA5	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.17	0.13	<0.00022	<0.00059	0.043	<0.00035	<0.00016	<0.00041	<0.00043	<0.00045	<0.00075	**1.4**
SMWAF-AA6	0	mg/kg	<0.00032	0.00039	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.16	0.13	<0.00023	<0.0006	0.039	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.032	**1.4**
SMWAF-AA7	0	mg/kg	<0.00032	0.00046	<0.00032	<0.00026	<0.00018	<0.0006	<0.00017	<0.00023	0.13	0.11	<0.00023	<0.0006	0.037	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.026	**1.3**
SMWAF-AA8	0	mg/kg	<0.00032	<0.00019	<0.00032	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.15	0.11	<0.00023	<0.0006	0.046	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00076	**1.4**
SMWAF-AA9	0	mg/kg	<0.00034	<0.00021	<0.00034	<0.00027	<0.00019	<0.00064	<0.00018	<0.00025	0.15	0.12J	<0.00024	<0.00064	0.043	<0.00038	<0.00018	<0.00044	<0.00047	<0.00048	<0.00081	**1.5**
SMWAF-AA10	0	mg/kg	<0.0011	<0.0012	<0.0018	0.0018	<0.00091	<0.0011	0.0011	0.005	0.038	0.037	0.0067	0.0012	<0.00054	0.0039	0.0086	0.017J	0.0055	<0.00064	<0.007	**0.54**
SMWAF-AA11	0	mg/kg	<0.0021	<0.0022	<0.0034	0.0019	<0.0017	<0.002	0.0015	0.011	0.073	0.083	0.013	0.0018	<0.001	0.0077	0.017	0.035J	0.012	<0.0012	0.036	**1.1**
SMWAF-AA12	0	mg/kg	<0.0045	<0.0047	<0.007	0.0068	<0.0036	<0.0042	<0.0011	0.017	0.12	0.13	**0.023**	0.0053	0.036	0.012	0.029	0.056J	0.017	<0.0025	<0.028	**1.8**
SMWAF-AA13	0	mg/kg	<0.0022	<0.0023	<0.0035	0.0024	<0.0018	<0.0021	0.00072	0.015	0.094	0.12	0.017	0.0025	0.03	0.009	0.023	0.045J	0.014	0.0017	0.045	**1.4**
SMWAF-AA14	0	mg/kg	<0.0043	<0.0045	<0.0068	<0.0033	<0.0035	<0.0041	<0.0011	0.016	0.1	0.12	0.02	0.0039	0.035	0.013	0.025	0.049J	0.016	<0.0025	<0.027	**1.7**
SMWAF-AA15	0	mg/kg	<0.0022	<0.0023	<0.0034	<0.0017	<0.0018	<0.0021	<0.00055	<0.0027	0.16	0.26	<0.00094	0.0079	0.051	0.018	0.042	0.072	0.081	0.003	0.17	**2.7**
SMWAF-AA16	0	mg/kg	<0.0044	<0.0046	<0.0069	0.0036	<0.0035	0.01	0.0058	0.032	0.17	0.21	**0.03**	0.0084	0.062	0.022	0.044	0.065	0.027	0.0055	0.082	**3.5**
SMWAF-AA17	0	mg/kg	<0.0045	<0.0047	<0.0071	<0.0034	<0.0037	0.0065	0.0045	0.032	0.17	0.19	**0.036**	0.0076	0.061	0.02	0.046	0.086	0.03	0.0049	0.082	**3.3**
SMWAF-AA18	0	mg/kg	<0.0044	<0.0046	<0.0069	<0.0034	<0.0036	0.0092	0.0051	0.03	0.16	0.19	**0.027**	0.0074	0.055	0.017	0.043	0.058	0.026	0.0047	0.066	**3**
SMWAF-AA19	0	mg/kg	<0.0044	<0.0046	<0.0069	<0.0033	<0.0035	<0.0042	<0.0051	0.068	0.17	0.29	<0.0019	0.0099	0.033J	0.03	<0.0023	0.11NJ	0.079J	<0.0025	<0.027	**2.4**
SMWAF-AA20	0	mg/kg	<0.0043	<0.0045	<0.0068	0.011	<0.0035	0.0092	0.005	0.03	0.22	0.21	**0.028**	0.0068	0.051	0.014	0.042	0.051	0.02	0.0045	0.034	**2.7**
SMWAF-BB1	0	mg/kg	<0.023	<0.024	<0.036	<0.017	<0.018	<0.022	<0.0057	0.049J	1.2	0.78	**0.072J**	<0.0056	<0.011	0.042J	0.089J	0.074NJ	0.084J	<0.013	<0.14	**3.2J**
SMWAF-BB2	0	mg/kg	<0.0044	<0.0046	<0.0069	0.0073J	<0.0036	<0.0042	0.0036J	0.017J	0.18	0.16	**0.022J**	0.0052J	<0.036	0.014J	0.032J	0.053NJ	0.015J	<0.0025	<0.027	**2**
SMWAF-BB3	0	mg/kg	0.00048J	0.00022J	0.00048J	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.21	0.17	<0.00023	<0.0006	0.051	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	**1.7**
SMWAF-BB4	0	mg/kg	<0.00032	0.00046J	<0.00032	<0.00026	<0.00018	<0.0006	<0.00017	<0.00023	0.18	0.15	<0.00023	<0.0006	0.043	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.031	**1.5**
SMWAF-BB5	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.15	0.12	<0.00022	<0.00059	0.04	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**1.3**
SMWAF-BB6	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.13	0.092	<0.00022	<0.0006	0.032	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.032J	**1.1**
SMWAF-BB7	0	mg/kg	<0.00033	0.00023J	<0.00033	<0.00026	<0.00018	<0.00062	<0.00017	<0.00024	0.14	0.1	<0.00023	<0.00062	0.033	<0.00037	<0.00017	<0.00042	<0.00045	<0.00047	0.023	**1.2**
SMWAF-BB8	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.14	0.1	<0.00022	<0.0006	0.041	<0.00036	<0.00017	0.043	<0.00044	<0.00045	<0.00075	**1.3**
SMWAF-BB9	0	mg/kg	<0.00036	<0.00022	<0.00035	<0.00028	<0.0002	<0.00066	<0.00018	<0.00026	0.14	0.11J	<0.00025	<0.00066	0.041	<0.0004	<0.00018	<0.00045	<0.00049	<0.0005	0.034	**1.5**
SMWAF-BB10	0	mg/kg	<0.0022	<0.0023	<0.0035	0.0045J	<0.0018	<0.0021	0.00075J	0.01J	0.078	0.074	0.013J	0.0021J	<0.0011	0.0067J	0.017J	0.032J	0.011J	<0.0013	<0.014	**1.1**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

			Organochlorine Pesticides (Method 8081)																			
Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-BB11	0	mg/kg	<0.0022	<0.0023	<0.0035	<0.0017	<0.0018	<0.0021	0.00066J	0.011J	0.081	0.088	0.015J	0.0026J	0.023J	0.0085J	0.02J	0.038J	0.011J	0.0015J	<0.014	**1.2**
SMWAF-BB12	0	mg/kg	<0.0011	<0.0012	<0.0017	<0.00084	<0.00089	0.0024J	0.00043J	0.0093J	0.063	0.067	0.011J	0.0016J	0.02J	0.0077J	0.015J	0.042NJ	0.0091J	0.00088J	0.034J	**0.98**
SMWAF-BB13	0	mg/kg	<0.0022	<0.0023	<0.0034	<0.0016	<0.0017	<0.0021	0.0016J	0.0088J	0.059	0.058	0.012J	0.0021J	0.019J	0.0064J	0.015J	0.027J	0.009J	<0.0012	0.029J	**0.9**
SMWAF-BB14	0	mg/kg	<0.0022	<0.0023	<0.0035	<0.0017	<0.0018	<0.0021	0.0017J	0.009J	0.067	0.062	0.012J	0.0016J	0.02J	0.0054J	0.015J	0.028J	0.01J	<0.0013	0.031J	**0.95**
SMWAF-BB15	0	mg/kg	<0.0045	<0.0047	<0.0071	0.0036J	<0.0036	<0.0043	<0.0011	0.018J	0.13	0.13	**0.024J**	0.0031J	0.041J	0.013J	0.03J	0.057J	0.019J	<0.0026	<0.028	**1.9**
SMWAF-BB16	0	mg/kg	<0.0022	<0.0024	<0.0035	0.0019J	<0.0018	<0.0021	0.0016J	0.012J	0.071	0.081	0.014J	0.0022J	0.025J	0.011J	0.02J	0.038J	0.012J	<0.0013	0.044J	**1.2**
SMWAF-BB17	0	mg/kg	<0.0045	<0.0047	<0.007	0.0039J	<0.0036	<0.0043	0.0012J	0.022J	0.15	0.15	**0.029J**	0.004J	0.05J	0.016J	0.035J	0.072J	0.023J	<0.0026	0.074J	**2.3**
SMWAF-BB18	0	mg/kg	<0.0043	<0.0045	<0.0068	0.01J	<0.0035	<0.0041	<0.0011	0.015J	0.11	0.11	0.02J	0.0045J	0.033J	0.0098J	0.024J	0.047J	0.016J	<0.0025	0.051J	**1.6**
SMWAF-BB19	0	mg/kg	<0.0022	<0.0023	<0.0034	0.002J	<0.0018	<0.0021	0.0011J	0.015J	0.11	0.09	0.014J	0.0031J	0.023J	0.0063J	0.021J	0.041J	0.01J	<0.0012	0.039J	**1.1**
SMWAF-BB20	0	mg/kg	<0.0011	<0.0012	<0.0017	<0.00084	<0.0009	0.0034J	0.00089J	0.0086J	0.086	0.063	0.011J	0.0023J	0.015J	0.0069J	0.016J	0.024J	0.0062J	0.0015	0.026J	**0.77**
SMWAF-CC1	0	mg/kg	<0.0011	<0.0011	<0.0017	<0.00081	<0.00086	<0.001	0.0016J	0.0024J	0.091	0.044	0.003J	0.00059J	<0.0039	0.0026J	<0.00056	0.0066NJ	<0.0017	<0.00061	<0.0066	0.23J
SMWAF-CC2	0	mg/kg	<0.0043	<0.0045	<0.0068	0.0056J	<0.0035	<0.0041	0.0015J	0.014J	0.15	0.13	0.018J	0.0044J	<0.03	0.011J	0.026J	0.039NJ	0.013J	<0.0025	<0.027	**1.6**
SMWAF-CC3	0	mg/kg	<0.00032	0.0002J	0.00034J	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.19	0.15	<0.00023	<0.0006	0.043	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	**1.4**
SMWAF-CC4	0	mg/kg	<0.00032	0.00032J	0.00088J	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.19	0.15	<0.00022	<0.00059	0.044	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	0.03	**1.5**
SMWAF-CC5	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.14	0.11	<0.00023	<0.0006	0.038	<0.00036	<0.00017	0.039	<0.00044	<0.00045	<0.00075	**1.2**
SMWAF-CC6	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.16	0.12	<0.00023	<0.0006	0.042	<0.00036	<0.00017	0.042	<0.00044	<0.00045	<0.00075	**1.3**
SMWAF-CC7	0	mg/kg	<0.00032	0.00025J	<0.00032	<0.00026	<0.00018	<0.0006	<0.00017	<0.00023	0.13	0.1	<0.00023	<0.0006	0.034	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.024	**1.2**
SMWAF-CC8	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.14	0.092	<0.00022	<0.00059	0.04	<0.00035	<0.00016	0.038	<0.00043	<0.00045	<0.00075	**1.3**
SMWAF-CC9	0	mg/kg	<0.00035	<0.00021	<0.00034	<0.00027	<0.00019	<0.00064	<0.00018	<0.00025	0.15	0.1J	<0.00024	<0.00065	0.037J	<0.00039	<0.00018	<0.00044	<0.00047	<0.00049	0.0063J	**1.1**
SMWAF-CC10	0	mg/kg	<0.0043	<0.0045	<0.0067	0.0085J	<0.0034	<0.0041	0.0011J	0.015J	0.14	0.12	0.019J	0.0033J	0.033J	0.009J	0.027J	0.03J	0.015J	<0.0024	<0.026	**1.9**
SMWAF-CC11	0	mg/kg	<0.0044	<0.0047	<0.007	0.058	<0.0036	0.0083J	0.0034J	0.018J	0.16	0.15	**0.024J**	0.019J	0.04J	0.011J	0.034J	0.053J	0.018J	<0.0025	<0.028	**2.3**
SMWAF-CC12	0	mg/kg	<0.0022	<0.0023	<0.0034	0.0025J	<0.0017	0.0085J	<0.0039	0.064	0.19	0.3J	<0.00093	0.0092J	0.027J	0.027J	<0.0011	0.12NJ	0.083J	0.0046J	<0.013	**2.6**
SMWAF-CC13	0	mg/kg	<0.0043	<0.0045	<0.0068	<0.0033	<0.0035	<0.0041	<0.0011	0.016J	0.12	0.12	0.02J	0.0026J	0.036J	0.01J	0.027J	0.07J	0.017J	<0.0025	0.058J	**2.2**
SMWAF-CC14	0	mg/kg	<0.0043	<0.0045	<0.0068	<0.0033	<0.0035	<0.0041	<0.0011	0.015J	0.12	0.11	0.018J	0.0024J	0.035J	0.0088J	0.026J	0.064J	0.017J	<0.0025	0.057J	**2.2**
SMWAF-CC15	0	mg/kg	<0.0043	<0.0045	<0.0067	<0.0033	<0.0035	<0.0041	0.003J	0.016J	0.12	0.12	0.019J	0.0024J	0.037J	0.0088J	0.027J	0.047J	0.017J	<0.0025	0.06J	**2**
SMWAF-CC16	0	mg/kg	<0.0044	<0.0046	<0.0069	<0.0033	<0.0035	<0.0042	<0.0011	0.014J	0.11	0.11	0.018J	0.0024J	0.034J	0.009J	0.025J	0.045J	0.015J	<0.0025	<0.027	**2**
SMWAF-CC17	0	mg/kg	<0.0043	<0.0045	<0.0068	<0.0033	<0.0035	<0.0041	<0.0011	0.016J	0.12	0.11	0.02J	0.0027J	0.036J	0.01J	0.027J	0.047J	0.018J	<0.0025	<0.027	**2.3**
SMWAF-CC18	0	mg/kg	<0.0045	<0.0047	<0.007	0.0036J	<0.0036	<0.0042	<0.0011	0.014J	0.12	0.11	0.019J	0.0028J	0.034J	0.011J	0.025J	0.029J	0.015J	<0.0025	0.056J	**1.9**
SMWAF-CC19	0	mg/kg	<0.0043	<0.0045	<0.0068	<0.0033	<0.0035	<0.0041	0.0012J	0.018J	0.18	0.16	0.02J	0.0028J	0.036J	0.013J	0.03J	0.071J	0.016J	<0.0025	0.066J	**2.2**
SMWAF-CC20	0	mg/kg	<0.022	<0.023	<0.034	<0.017	<0.018	0.023	0.022	0.13	**4.7**	**2.3**	**0.14**	0.14	0.18	0.14	0.15	0.3J	0.24	**0.1**	0.62	**8.6**
SMWAF-DD1	0	mg/kg	<0.00044	<0.00046	<0.00069	<0.00033	<0.00035	<0.00042	0.00098J	<0.00054	0.029	0.0069J	<0.00019	<0.00011	<0.00074	0.00077J	<0.00023	0.0016NJ	<0.00071	<0.00025	<0.0027	**0.055J**
SMWAF-DD2	0	mg/kg	<0.0022	<0.0023	<0.0034	0.0054J	<0.0018	0.0063J	0.0028J	0.014J	0.16	0.16	0.018J	0.0043J	0.032J	0.012J	0.027J	0.046NJ	0.013J	0.0021J	<0.013	**1.8**
SMWAF-DD3	0	mg/kg	0.00046J	0.00025J	0.00084J	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.17	0.13	<0.00023	<0.0006	0.043	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	**1.4**
SMWAF-DD4	0	mg/kg	<0.00032	0.00043J	0.00045J	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.17	0.13	<0.00023	<0.0006	0.037	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.027	**1.3**
SMWAF-DD5	0	mg/kg	<0.00032	<0.00019	<0.00032	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.12	0.096	<0.00023	<0.0006	0.028	<0.00036	<0.00017	0.033	<0.00044	<0.00045	<0.00076	**0.95**
SMWAF-DD6	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.14	0.12	<0.00023	<0.0006	0.032	<0.00036	<0.00017	0.034	<0.00044	<0.00045	<0.00075	**1**
SMWAF-DD7	0	mg/kg	<0.00032	0.00029J	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.13	0.086	<0.00022	<0.0006	0.027	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.023	**1**
SMWAF-DD8	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.13	0.088	<0.00022	<0.0006	0.036	<0.00036	<0.00017	0.037	<0.00044	<0.00045	<0.00075	**0.99**
SMWAF-DD9	0	mg/kg	<0.00035	<0.00021	<0.00034	<0.00027	<0.00019	<0.00064	<0.00018	<0.00025	0.14	0.11J	<0.00024	<0.00064	0.038	<0.00038	<0.00018	<0.00044	<0.00047	<0.00048	0.027	**1.3**
SMWAF-DD10	0	mg/kg	0.00057J	<0.00028J	<0.00045	<0.00026J	<0.0003J	0.0023J	0.0069J	0.01J	0.13J	0.055	0.0075	0.0014J	0.017J	0.0091J	0.014J	<0.00034J	<0.00027J	0.0018J	0.029	**1.2**
SMWAF-DD11	0	mg/kg	0.0006J	<0.0003	<0.00048	<0.00028	<0.00032	0.0052	0.0035	<0.00024	0.15	0.092	0.0098	<0.00034	0.022	0.015	0.012	0.0058	0.0018J	0.0015J	0.045	**1.9**
SMWAF-DD12	0	mg/kg	<0.0025	<0.0021	<0.0066	<0.004	<0.0046	0.012J	<0.0027	0.038J	0.22	0.2	**0.048**	<0.0018	0.05	<0.0028	<0.0031	<0.0017	<0.0049	<0.0043	<0.0045	**1.7**
SMWAF-DD13	0	mg/kg	<0.0027	<0.0023	<0.0071	<0.0043	<0.005	0.013J	<0.0029	0.044	0.28	0.26	**0.037J**	<0.0019	0.057	<0.003	<0.0033	<0.0018	<0.0053	<0.0046	<0.0048	**1.9**
SMWAF-DD14	0	mg/kg	<0.0026	<0.0022	<0.007	<0.0042	<0.0049	0.012J	<0.0028	0.039J	0.25	0.21	**0.032J**	<0.0018	0.05	<0.0029	<0.0032	<0.0018	<0.0051	<0.0045	<0.0047	**1.6**
SMWAF-DD15	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	<0.0048	0.011J	<0.0027	0.034J	0.18	0.16	**0.027J**	<0.0018	0.043J	<0.0028	<0.0031	<0.0018	<0.005	<0.0044	<0.0046	**1.4**
SMWAF-DD16	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	<0.0048	0.015J	<0.0027	0.036J	0.18	0.17	**0.043**	<0.0018	0.045	<0.0028	<0.0031	<0.0018	<0.005	<0.0044	<0.0046	**1.6**
SMWAF-DD17	0	mg/kg	<0.0026	<0.0022	<0.0069	<0.0042	<0.0048	0.011J	<0.0028	0.033J	0.15	0.15	**0.04J**	<0.0018	0.042	<0.0029	<0.0032	<0.0018	<0.0051	<0.0044	<0.0047	**1.4**
SMWAF-DD18	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	<0.0048	0.01J	<0.0027	0.033J	0.17	0.19	**0.041**	<0.0018	0.043	<0.0028	<0.0031	<0.0018	<0.005	<0.0044	<0.0046	**1.5**
SMWAF-DD19	0	mg/kg	<0.0026	<0.0022	<0.0069	<0.0042	<0.0048	0.0077J	<0.0028	0.032J	0.19	0.18	**0.04**	<0.0018	0.041	<0.0029	<0.0032	<0.0018	<0.0051	<0.0044	<0.0047	**1.4**
SMWAF-DD20	0	mg/kg	<0.044	<0.047	<0.07	<0.034	<0.036	<0.042	0.025	<0.055	**5.4**	**1.7**	**0.14**	0.19	0.18	0.15	0.25	0.28J	<0.072	**0.13**	0.61	**8.7**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

			Organochlorine Pesticides (Method 8081)																			
Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-EE1	0	mg/kg	<0.00044	<0.00046	<0.00068	<0.00033	<0.00035	<0.00041	0.0016J	<0.00054	0.027	0.02	0.00068J	0.00021J	<0.0011	0.001J	<0.00023	0.0022NJ	<0.0007	<0.00025	<0.0027	0.081J
SMWAF-EE2	0	mg/kg	<0.0022	<0.0023	<0.0035	0.0056J	<0.0018	<0.0021	0.0026J	0.013J	0.14	0.13	0.015J	0.0033J	0.029J	0.0098J	0.023J	0.037NJ	0.013J	<0.0013	<0.014	**1.6**
SMWAF-EE3	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.15	0.11	<0.00022	<0.0006	0.033	<0.00036	<0.00017	0.037	<0.00044	<0.00045	<0.00075	**1.1**
SMWAF-EE4	0	mg/kg	<0.00034	<0.0002	<0.00033	<0.00027	<0.00019	<0.00063	<0.00017	<0.00024	0.12	0.089	<0.00024	<0.00063	0.029	<0.00038	<0.00017	0.031	<0.00046	<0.00047	<0.00079J	**1**
SMWAF-EE5	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.11	0.083	<0.00022	<0.00059	0.028	<0.00035	<0.00016	0.033	<0.00044	<0.00045	<0.00075	**0.97**
SMWAF-EE6	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.14	0.1	<0.00023	<0.0006	0.029	<0.00036	<0.00017	0.033	<0.00044	<0.00045	<0.00075	**1**
SMWAF-EE7	0	mg/kg	<0.00035	<0.00021	<0.00034	<0.00028	<0.00019	<0.00065	<0.00018	<0.00025	0.11	0.091	<0.00025	<0.00065	0.026	<0.00039	<0.00018	<0.00045	<0.00048	<0.00049	0.02	**1**
SMWAF-EE8	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.13	0.094	<0.00023	<0.0006	0.033	<0.00036	<0.00017	0.035	<0.00044	<0.00045	<0.00075	**1**
SMWAF-EE9	0	mg/kg	<0.00032	0.00026J	<0.00032	<0.00026	<0.00018	<0.0006	<0.00017	<0.00023	0.13	0.094	<0.00023	<0.0006	0.032	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.025	**1.2**
SMWAF-EE10	0	mg/kg	0.00055J	<0.00028	<0.00045	<0.00027	<0.0003	0.0043	0.0033	0.01	0.13	0.075	0.0072	<0.00033	0.019	0.012	0.0093	<0.00034	<0.00027	0.0014J	0.037	<0.012
SMWAF-EE11	0	mg/kg	0.00087J	<0.00031	<0.0005	<0.00029	<0.00034	0.0034	0.0025	<0.00025	0.17	0.12	0.012	<0.00036	0.022	0.013	0.014	0.0069	<0.0003	0.002J	0.048	**1.4**
SMWAF-EE12	0	mg/kg	<0.0061	<0.0056	<0.0089	<0.0052	<0.006	<0.0068	<0.0068	0.025J	1.2	0.8	0.016J	<0.0064	0.017J	0.014J	0.019J	<0.0066	<0.0053	<0.0067	<0.0071	**1.3J**
SMWAF-EE13	0	mg/kg	<0.0015	<0.0014	0.0023J	<0.0013	<0.0015	0.002J	<0.0017	0.004J	0.35	0.031	<0.0014	<0.0016	<0.0015	<0.00088	<0.0016	<0.0016	<0.0013	<0.0016	0.0037J	0.083J
SMWAF-EE14	0	mg/kg	0.0017J	<0.0014	<0.0022	0.002J	<0.0015	0.0093J	0.011	0.077	0.44	0.28	**0.039**	<0.0016	0.069	0.062	0.051	<0.0017	<0.0013	0.0091J	0.21	**6.2**
SMWAF-EE15	0	mg/kg	0.00056J	<0.00028	0.00069J	0.00039J	<0.0003	0.00077J	0.0031	0.012	0.13	0.077	0.0068	<0.00032	0.03	0.014	0.0083	<0.00033	<0.00026	0.0012J	0.038	**1.7**
SMWAF-EE16	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	<0.0047	0.0094J	<0.0027	0.032J	0.14	0.14	**0.037J**	<0.0018	0.041	<0.0028	<0.0031	<0.0017	<0.005	<0.0043	<0.0046	**1.3**
SMWAF-EE17	0	mg/kg	<0.0025	<0.0021	<0.0067	<0.004	<0.0047	0.011J	<0.0027	0.036J	0.16	0.16	**0.029J**	<0.0018	0.045	<0.0028	<0.0031	<0.0017	<0.0049	<0.0043	<0.0045	**1.5J**
SMWAF-EE18	0	mg/kg	<0.0029	<0.0025	<0.0077	<0.0046	<0.0054	0.0042J	<0.0031	0.014J	0.061	0.053	0.018J	<0.002	0.016J	<0.0032	<0.0035	<0.002	<0.0056	<0.0049	<0.0052	**0.68**
SMWAF-EE19	0	mg/kg	<0.0025	<0.0021	<0.0066	<0.004	<0.0046	0.0071J	<0.0026	0.028J	0.15	0.14	**0.036J**	<0.0017	0.036J	<0.0027	<0.003	<0.0017	<0.0049	<0.0042	<0.0045	**1.2**
SMWAF-EE20	0	mg/kg	<0.042	<0.044	<0.066	<0.032	<0.034	<0.04	<0.011	0.13	**2.9**	**2.7**	**0.11**	0.072	<0.02	0.12	<0.022	0.23J	<0.068	**0.057**	0.51	**6.9**
SMWAF-FF1	0	mg/kg	<0.00035	<0.00021	<0.00034	<0.00027	<0.00019	<0.00064	<0.00018	0.0017J	0.1	0.024	<0.00024	<0.00065	0.0036J	<0.00039	<0.00018	<0.00044	<0.00047	<0.00049	0.0049J	0.16
SMWAF-FF2	0	mg/kg	<0.00031	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	0.0029	0.053	0.033	<0.00022	<0.00058	0.0077	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	0.22
SMWAF-FF3	0	mg/kg	<0.00031	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.031	0.014	<0.00022	<0.00059	0.0038	<0.00035	<0.00016	0.0035	<0.00043	<0.00044	<0.00074	0.1
SMWAF-FF4	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.11	0.081	<0.00022	<0.00059	0.026	<0.00035	<0.00016	0.031	<0.00043	<0.00045	<0.00075	**0.85**
SMWAF-FF5	0	mg/kg	<0.00036	<0.00022	<0.00035	<0.00028	<0.0002	<0.00067	<0.00019	<0.00026	0.12	0.085	<0.00025	<0.00067	0.031	<0.0004	<0.00019	0.034	<0.00049	<0.0005	<0.00085	**1**
SMWAF-FF6	0	mg/kg	<0.00033	<0.0002	<0.00032	<0.00026	<0.00018	<0.00061	<0.00017	<0.00024	0.14	0.093	<0.00023	<0.00061	0.032	<0.00037	<0.00017	0.036	<0.00045	<0.00046	<0.00077	**1.1**
SMWAF-FF7	0	mg/kg	<0.00033	<0.0002	<0.00032	<0.00026	<0.00018	<0.00061	<0.00017	<0.00024	0.1	0.077	<0.00023	<0.00061	0.025	<0.00036	<0.00017	<0.00042	<0.00045	<0.00046	0.017J	**0.92**
SMWAF-FF8	0	mg/kg	<0.00032	0.00022	<0.00032	<0.00026	<0.00018	<0.0006	<0.00017	<0.00023	0.11	0.074	<0.00023	<0.0006	0.028	<0.00036	<0.00017	0.032	<0.00044	<0.00045	<0.00076	**0.92**
SMWAF-FF9	0	mg/kg	<0.00037	<0.00022	<0.00036	<0.00029	<0.0002	<0.00068	<0.00019	<0.00027	0.12	0.076	<0.00026	<0.00069	0.028	<0.00041	<0.00019	<0.00047	<0.0005	<0.00052	0.0095J	**0.94**
SMWAF-FF10	0	mg/kg	<0.00035	<0.00032	<0.00051	<0.0003	<0.00035	0.0027	0.0013J	<0.00026	0.088	0.043	0.0047J	<0.00037	0.01	0.0059	0.0066	<0.00039	<0.00031	0.00079J	0.021J	**0.62**
SMWAF-FF11	0	mg/kg	0.0005J	<0.00028	<0.00045	<0.00026	<0.0003	0.0048	0.0031	<0.00023	0.13	0.081	0.0084	<0.00032	0.019	0.012	0.01	<0.00033	0.001J	0.0014J	0.038	**1.1**
SMWAF-FF12	0	mg/kg	<0.0016	<0.0014	<0.0023	<0.0013	<0.0015	0.0031J	0.0041J	0.015J	0.7	0.37	0.012J	<0.0016	0.014J	0.012J	0.015J	<0.0017	<0.0014	0.0033J	0.046J	**1.2**
SMWAF-FF14	0	mg/kg	<0.0016	<0.0014	<0.0023	0.0021J	<0.0015	0.0094J	0.012	0.074	0.43	0.36	**0.04**	<0.0016	0.069	0.061	0.05	0.018J	0.0085J	0.008J	0.2	**6.6**
SMWAF-FF15	0	mg/kg	0.00056J	<0.00028	<0.00044	0.00037J	<0.0003	0.00085J	0.0028	<0.00022	0.13	0.083	0.0081	<0.00032	0.032	0.014	0.0071	<0.00033	<0.00027	0.00081J	0.044	**1.8**
SMWAF-FF16	0	mg/kg	<0.0027	<0.0023	<0.0072	<0.0043	<0.005	0.0092J	<0.0029	0.03J	0.13	0.16	**0.035J**	<0.0019	<0.0031	<0.003	<0.0033	<0.0018	<0.0053	<0.0046	<0.0049	**1.4**
SMWAF-FF17	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	<0.0047	0.0042J	<0.0027	0.014J	0.065	0.065	0.018	<0.0018	<0.0029	<0.0028	<0.0031	<0.0017	<0.005	<0.0043	<0.0046	**0.7**
SMWAF-FF18	0	mg/kg	<0.0025	<0.0022	<0.0067	<0.0041	<0.0047	0.0085J	<0.0027	0.03J	0.13	0.13	**0.024J**	<0.0018	<0.0029	<0.0028	<0.0031	<0.0017	<0.005	<0.0043	<0.0046	**1.3**
SMWAF-FF19	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	<0.0047	0.0094J	<0.0027	0.036J	0.18	0.19	**0.028J**	<0.0018	<0.0029	<0.0028	<0.0031	<0.0017	<0.005	<0.0044	<0.0046	**1.5**
SMWAF-FF20	0	mg/kg	<0.045	<0.047	<0.07	<0.034	<0.036	<0.042	0.028	0.2	**5.2**	**3.9**	**0.18**	0.12	<0.021	0.22	<0.023	0.35J	<0.072	**0.13**	0.77	**11**
SMWAF-GG1	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	0.00097J	0.092	0.016	<0.00022	<0.00059	0.0025J	<0.00035	<0.00016	<0.00041	<0.00044	<0.00045	0.0035J	0.11
SMWAF-GG2	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.085	0.034J	<0.00022	<0.0006	0.014	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	0.0018J	0.34
SMWAF-GG3	0	mg/kg	<0.00032	<0.00029	<0.00046	<0.00027	<0.00031	0.00044J	0.00036J	0.0037J	0.095	0.047	0.0022J	<0.00033	0.0085	0.005	0.002J	<0.00035	0.00049J	<0.00035	0.015J	0.41
SMWAF-GG4	0	mg/kg	<0.00031	<0.00028	<0.00044	<0.00026	<0.0003	0.0015J	<0.00034	0.0047	0.13	0.066	0.0035J	<0.00032	0.0087	0.0061	0.0042	<0.00033	<0.00027	0.00044J	0.018J	**0.51**
SMWAF-GG5	0	mg/kg	<0.00034	<0.00031	<0.00049	0.0004J	<0.00033	0.0017J	0.0018J	0.0079	0.15	0.079	0.0047	0.00056J	0.011	0.0066	0.0081	<0.00037	<0.00029	0.001J	0.017J	**0.61**
SMWAF-GG6	0	mg/kg	<0.0017	<0.0015	<0.0024	<0.0014	<0.0016	0.014	0.0085J	0.043	0.33	0.24	**0.026**	<0.0018	0.088	0.033	0.035	<0.0018	<0.0015	0.0056J	0.1J	**3.7**
SMWAF-GG7	0	mg/kg	<0.00033	0.0003	<0.00032	<0.00026	<0.00018	<0.00061	<0.00017	<0.00024	0.11	0.078	<0.00023	<0.00061	0.029	<0.00036	<0.00017	<0.00042	<0.00045	<0.00046	0.022	**0.98**
SMWAF-GG8	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.11	0.073	<0.00022	<0.0006	0.031	<0.00036	<0.00017	0.033	<0.00044	<0.00045	<0.00075	**0.92**
SMWAF-GG9	0	mg/kg	<0.00032	0.00021J	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.22J	0.2	<0.00022	<0.00059	0.039J	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	0.03J	**1.3**
SMWAF-GG10	0	mg/kg	0.0011J	<0.00028	<0.00045	<0.00026	<0.0003	0.0053	0.0057	0.011	0.13	0.064	0.008	0.0017J	0.018	0.011	0.015	0.0051	<0.00027	0.0019J	0.034	**1.4**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

			Organochlorine Pesticides (Method 8081)																			
Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-GG11	0	mg/kg	0.00063J	<0.00028	<0.00044	<0.00026	<0.0003	0.0049	0.0043	<0.00022	0.16	0.1	0.01	<0.00032	0.024	0.016	0.013	0.0065	<0.00026	0.002	0.051	**2**
SMWAF-GG12	0	mg/kg	<0.006	<0.0055	<0.0087	<0.0052	<0.0059	0.0079J	<0.0066	0.054J	**2.2**	1.2	**0.03J**	<0.0063	0.058J	0.051J	0.033J	<0.0065	<0.0052	<0.0066	0.16J	**3.9**
SMWAF-GG13	0	mg/kg	<0.0015	<0.0014	<0.0022	<0.0013	<0.0015	0.0024J	<0.0017	0.0022J	0.32	0.011J	0.0026J	<0.0016	<0.0015	<0.00089	<0.0016	<0.0017	<0.0013	<0.0017	<0.0018	<0.057
SMWAF-GG14	0	mg/kg	<0.0017	<0.0015	<0.0024	0.0026J	<0.0016	0.011	0.02	0.059	0.72	0.56	**0.074**	<0.0018	0.062	0.058	0.079	0.035	<0.0015	0.014	0.22	**5.9**
SMWAF-GG15	0	mg/kg	0.00079J	<0.00028	<0.00044	0.00039J	<0.0003	0.0027	0.0062	0.016	0.22	0.12	0.011	<0.00032	0.044	0.019	0.016	<0.00033	<0.00026	0.0017J	0.073	**1**
SMWAF-GG16	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	0.0049J	0.0095J	<0.0027	0.045	0.2	0.17	**0.026J**	<0.0018	<0.0029	<0.0028	<0.0031	<0.0017	<0.005	<0.0043	<0.0046	**1.2**
SMWAF-GG17	0	mg/kg	<0.0026	<0.0022	<0.007	<0.0042	0.006J	0.013J	<0.0028	0.034J	0.21	0.19	**0.03J**	<0.0018	0.044	<0.0029	<0.0032	<0.0018	<0.0051	<0.0045	<0.0047	**2.5**
SMWAF-GG18	0	mg/kg	<0.0025	<0.0022	<0.0067	<0.004	<0.0047	0.0097J	<0.0027	0.035J	0.22	0.21J	**0.028J**	<0.0018	0.027J	<0.0028	<0.0031J	<0.0017	<0.0049	<0.0043	<0.0045	**1.4**
SMWAF-GG19	0	mg/kg	<0.0025	<0.0021	<0.0067	<0.004	<0.0046	0.013J	<0.0027	0.044	0.23	0.2J	**0.035J**	<0.0018	<0.0029	<0.0028	<0.0031	<0.0017	<0.0049	<0.0043	<0.0045	**1.4**
SMWAF-GG20	0	mg/kg	<0.0052	<0.0054	<0.0081	<0.0039	<0.0042	0.0051	0.0054	0.049	0.53	0.45	**0.03**	0.013	<0.0025	0.029	<0.0027J	0.08J	0.073	0.0081	0.16	**2.2**
SMWAF-HH1	0	mg/kg	<0.00038	<0.00023	<0.00037	<0.0003	<0.00021	<0.00071	<0.0002	<0.00027	0.16	0.044	<0.00027	<0.00071	0.016	<0.00042	<0.0002	<0.00048	<0.00052	<0.00053	0.017J	**0.62**
SMWAF-HH2	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.1	0.049	<0.00022	<0.00059	0.017	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	0.0038J	**0.56**
SMWAF-HH3	0	mg/kg	<0.00031	<0.00028	<0.00045	<0.00026	<0.0003	0.00082J	0.00059J	0.0035J	0.092	0.04	0.0032J	<0.00032	0.0073	0.0047	0.0037J	<0.00033	<0.00027	<0.00034	0.019J	0.25
SMWAF-HH4	0	mg/kg	<0.00031	<0.00028	<0.00045	<0.00027	<0.00031	0.0011J	<0.00034	0.0099	0.078	0.036	0.0027J	<0.00033	0.007	0.0049	0.0032J	<0.00034	<0.00027	<0.00034	0.018J	0.24
SMWAF-HH5	0	mg/kg	<0.0003	<0.00027	<0.00044	<0.00026	<0.0003	0.00095J	0.00087J	0.011	<0.00025	0.006	0.0019J	<0.00032	0.0063	0.0057	0.0041	<0.00033	<0.00026	<0.00033	0.017J	0.22
SMWAF-HH6	0	mg/kg	<0.0003	<0.00028	<0.00044	<0.00026	<0.0003	0.00071J	<0.00034	0.0077	0.067	0.032	0.0021J	<0.00032	0.0052	0.0046	0.0024J	<0.00033	<0.00026	<0.00033	0.015J	**0.53**
SMWAF-HH7	0	mg/kg	<0.00032	<0.00029	<0.00046	<0.00027	<0.00031	0.00082J	<0.00035	0.0085	0.066	0.035	0.0022J	<0.00034	0.0066	0.0046	0.0044	<0.00035	<0.00028	<0.00035	0.014J	0.18
SMWAF-HH8	0	mg/kg	<0.00031	<0.00028	<0.00045	<0.00026	<0.0003	0.00085J	0.00081J	0.0048	0.09	0.046	0.0035J	<0.00032	0.01	0.0057	0.0071	<0.00034	<0.00027	0.00052J	0.015J	**0.47**
SMWAF-HH9	0	mg/kg	0.00038J	<0.00031	<0.0005	<0.00029	<0.00034	0.0018J	0.001J	0.0063	0.12	0.083	0.0051	<0.00036	0.015	0.0088	0.0065	<0.00037	<0.0003	0.00067J	0.026	**0.74**
SMWAF-HH10	0	mg/kg	0.00046J	<0.00033	<0.00053	<0.00031	<0.00036	0.00093J	0.0006J	<0.00027	0.13	0.071	0.0042J	<0.00039	0.013	0.0081	0.0047J	<0.0004	<0.00032	0.0006J	0.022J	**0.7**
SMWAF-HH11	0	mg/kg	0.00055J	<0.00028	<0.00044	<0.00026	<0.0003	0.0016J	0.0014J	0.0083	0.17	0.097	0.0066	<0.00032	0.019	0.011	0.0088	<0.00033	<0.00027	0.00087J	0.03	**0.94**
SMWAF-HH12	0	mg/kg	0.00079J	<0.00028	<0.00045	<0.00026	<0.0003	0.0022	0.0014J	0.0071	0.17	0.093	0.0063	<0.00033	0.018	0.0097	0.0082	<0.00034	<0.00027	0.00083J	0.038	**0.86**
SMWAF-HH13	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0024	0.0044J	<0.0014	0.016J	0.13	0.1	0.018J	<0.0009	0.022	<0.0014	<0.0016	<0.00087	<0.0025	<0.0022	<0.0023	**0.68**
SMWAF-HH14	0	mg/kg	<0.0012	<0.0011	<0.0033	<0.002	<0.0023	0.0052J	<0.0013	0.021	0.15	0.11	**0.021**	<0.00086	0.026	<0.0014	<0.0015	<0.00084	<0.0024	<0.0021	<0.0022	**0.82**
SMWAF-HH15	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0023	0.0054J	<0.0013	0.017J	0.12	0.097	**0.021**	<0.00089	0.023	<0.0014	<0.0015	<0.00087	<0.0025	<0.0022	<0.0023	**0.78**
SMWAF-HH16	0	mg/kg	<0.0025	<0.0022	<0.0067	<0.004	<0.0047	0.0048J	<0.0027	0.02J	0.13	0.11	**0.024J**	<0.0018	0.027J	<0.0028	<0.0031J	<0.0017	<0.0049	<0.0043	<0.0045	**0.73**
SMWAF-HH17	0	mg/kg	<0.0024	<0.0021	<0.0065	<0.0039	<0.0045	0.0043J	<0.0026	0.02J	0.15	0.11	**0.023J**	<0.0017	0.028J	<0.0027	<0.003J	<0.0017	<0.0048	<0.0041	<0.0044	**0.84**
SMWAF-HH18	0	mg/kg	<0.0026	<0.0022	<0.0069	<0.0042	<0.0048	<0.0034	<0.0028	0.02J	0.14	0.11J	**0.024J**	<0.0018	0.036J	<0.0029	<0.0032J	<0.0018	<0.0051	<0.0044	<0.0047	**0.74**
SMWAF-HH19	0	mg/kg	<0.0025	<0.0021	<0.0067	<0.004	<0.0046	0.0064J	<0.0027	0.021J	0.14	0.12J	**0.027**	<0.0018	0.031J	<0.0028	<0.0031J	<0.0017	<0.0049	<0.0043	<0.0045	**0.94**
SMWAF-HH20	0	mg/kg	<0.0025	<0.0021	<0.0065	<0.0039	<0.0045	0.0091J	<0.0026	0.027J	0.19	0.17J	**0.029J**	<0.0017	<0.0028	<0.0027	<0.003J	<0.0017	<0.0048	<0.0042	<0.0044	**2.2**
SMWAF-II1	0	mg/kg	<0.00031	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00022	0.16	0.062	<0.00022	<0.00058	0.013	<0.00035	<0.00016	<0.0004	<0.00042	<0.00044	0.012J	**0.48**
SMWAF-II2	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.15	0.077	<0.00022	<0.00059	0.027	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**0.82**
SMWAF-II3	0	mg/kg	0.00031J	<0.00027	<0.00044	<0.00026	<0.0003	0.0026	0.0031	0.0048	0.098	0.032	0.0042	<0.00032	0.0087	0.0046	0.0069	<0.00033	<0.00026	0.00063J	0.014J	0.41
SMWAF-II4	0	mg/kg	<0.00031	<0.00028	<0.00045	<0.00026	<0.0003	0.0021	0.0019J	<0.00023	0.098	0.04	0.0038J	<0.00032	0.0098	0.0055	0.0048	<0.00033	<0.00027	0.00052J	0.016J	**0.47**
SMWAF-II5	0	mg/kg	<0.0003	<0.00028	<0.00044	<0.00026	<0.0003	0.0016J	0.001J	<0.00022	0.077	0.027	0.0031J	<0.00032	0.0064	0.0036J	0.0051	<0.00033	<0.00026	0.00062J	0.011J	0.35
SMWAF-II6	0	mg/kg	<0.0003	<0.00027	<0.00044	<0.00026	<0.0003	0.0012J	0.0012J	0.0029J	0.067	0.024	0.0026J	<0.00032	0.005	0.003J	0.0026J	<0.00033	<0.00026	0.00041J	0.011J	0.31
SMWAF-II7	0	mg/kg	<0.0003	<0.00028	<0.00044	<0.00026	<0.0003	0.001J	0.0012J	0.0024J	0.042	0.016	0.0019J	<0.00032	0.0039J	0.0024J	0.002J	<0.00033	<0.00027	<0.00033	0.0076J	0.22J
SMWAF-II8	0	mg/kg	<0.00052	<0.00044	<0.0014	<0.00083	<0.00096	<0.00067	<0.00055	<0.0011	0.036	0.022	0.0017J	<0.00036	<0.00059	0.0038J	<0.00063	<0.00035	0.0013J	<0.00088	0.0035J	0.25
SMWAF-II9	0	mg/kg	<0.001	<0.00088	<0.0027	<0.0017	<0.0019	<0.0013	<0.0011	<0.0022	0.056	0.033	0.0033J	<0.00072	<0.0012	0.0038J	<0.0013	<0.0007	0.0024J	<0.0018	0.0054J	0.43
SMWAF-II10	0	mg/kg	<0.001	<0.00087	<0.0027	<0.0016	<0.0019	<0.0013	<0.0011	<0.0022	0.096	0.054	0.0058J	<0.00071	<0.0012	0.0075J	<0.0012	<0.00069	0.0039J	<0.0017	0.0099J	**0.72**
SMWAF-II11	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.0021	<0.0024	<0.0017	<0.0014	<0.0028	0.11	0.058	0.0051J	<0.00091	<0.0015	<0.0014	<0.0016	<0.00088	0.0038J	<0.0022	<0.0023	**0.7**
SMWAF-II12	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0024	<0.0016	<0.0014	<0.0028	0.13	0.07	0.0068J	<0.0009	<0.0015	0.0085J	<0.0016	<0.00087	0.0047J	<0.0022	0.012J	**0.75**
SMWAF-II13	0	mg/kg	<0.0012	<0.001	<0.0032	<0.0019	<0.0022	<0.0016	<0.0013	<0.0026	0.14	0.07	0.0069J	<0.00085	<0.0014	0.0099J	<0.0015	<0.00082	0.0048J	<0.0021	0.011J	**0.82**
SMWAF-II14	0	mg/kg	<0.001	<0.00088	<0.0027	<0.0017	<0.0019	<0.0013	<0.0011	<0.0022	0.085	0.052	0.0045J	<0.00072	<0.0012	0.0052J	<0.0013	<0.0007	0.003J	<0.0018	0.0075J	**0.5**
SMWAF-II15	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.0021	<0.0024	<0.0017	<0.0014	<0.0028	0.13	0.074	0.0055J	<0.00091	<0.0015	0.0066J	<0.0016	<0.00088	0.004J	<0.0022	0.01J	**0.68**
SMWAF-II16	0	mg/kg	<0.0025	<0.0021	<0.0066	<0.004	<0.0046	0.0045J	<0.0026	0.021J	0.16	0.11	**0.026J**	<0.0017	0.028J	<0.0027	<0.003J	<0.0017	<0.0048	<0.0042	<0.0044	**0.9**
SMWAF-II17	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	<0.0047	0.0053J	<0.0027	0.021J	0.17	0.12	**0.026J**	<0.0018	0.029J	<0.0028	<0.0031J	<0.0017	<0.005	<0.0043	<0.0046	**0.95**
SMWAF-II18	0	mg/kg	<0.0028	<0.0024	<0.0074	<0.0045	<0.0052	0.0041J	<0.003	0.015J	0.11	0.082	0.016	<0.002	0.021J	<0.0031	<0.0034J	<0.0019	<0.0054	<0.0047	<0.005	**0.67**
SMWAF-II19	0	mg/kg	<0.0026	<0.0022	<0.0069	<0.0042	<0.0048	<0.0033	<0.0028	0.017J	0.13	0.13	0.018	<0.0018	0.024J	<0.0029	<0.0032J	<0.0018	<0.0051J	<0.0044	<0.0047	**0.68**
SMWAF-II20	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	<0.0048	0.0042J	<0.0027	0.018J	0.14	0.1	**0.023**	<0.0018	0.025J	<0.0028	<0.0031J	<0.0018	<0.005	<0.0044	<0.0046	**0.73**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

Location	Depth	Units	Organochlorine Pesticides (Method 8081) Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-JJ1	0	mg/kg	<0.00034	<0.00031	<0.00049	<0.00029	<0.00033	0.0023	0.0026	<0.00025	0.29	0.05	0.0094	<0.00036	0.011	0.0088	0.013	<0.00037	<0.00029	0.0012J	0.031	**1.1**
SMWAF-JJ2	0	mg/kg	0.00053J	<0.00028	<0.00044	<0.00026	<0.0003	0.002	0.0036	0.0096	0.17	0.074	0.0074	<0.00032	0.026	0.011	0.0097	<0.00033	<0.00026	0.0012J	0.032	**1.3**
SMWAF-JJ3	0	mg/kg	0.001J	<0.00027	<0.00044	<0.00026	<0.0003	0.003	0.0018J	<0.00022	0.17	0.088	0.01	<0.00032	0.021	0.012	0.016	0.0056	<0.00026	0.0017J	0.036	**1.1**
SMWAF-JJ4	0	mg/kg	0.00035J	<0.00028	<0.00045	<0.00027	<0.0003	0.0007J	0.00055J	<0.00023	0.13	0.063	0.0046	<0.00033	0.018	0.0086	0.005	<0.00034	<0.00027	0.00066J	0.023	**1.1**
SMWAF-JJ5	0	mg/kg	<0.0003	<0.00027	<0.00044	<0.00026	<0.0003	0.0007J	<0.00033	0.0033J	0.079	0.035	0.0034J	<0.00032	0.0076	0.0047	0.0038J	<0.00033	<0.00026	0.00044J	0.014J	0.43
SMWAF-JJ6	0	mg/kg	0.00051J	<0.00028	<0.00044	<0.00026	<0.0003	0.0027	0.0031	0.0048	0.089	0.03	0.004J	0.00064J	0.0079	0.0046	0.0065	<0.00033	<0.00026	0.00062J	0.015J	0.42
SMWAF-JJ7	0	mg/kg	<0.0003	<0.00027	<0.00044	<0.00026	<0.0003	0.0013J	0.00062J	<0.00022	0.066	0.027	0.0028J	<0.00032	0.0061	0.0039J	0.0033J	<0.00033	<0.00026	0.00038J	0.012J	0.36
SMWAF-JJ8	0	mg/kg	<0.0013	<0.0011	<0.0033	<0.002	<0.0023	<0.0016	<0.0013	0.0066J	0.06	0.046	0.0087J	<0.00089	0.009J	<0.0014	<0.0015	<0.00086	<0.0025	<0.0021	<0.0023	0.38
SMWAF-JJ9	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0024	<0.0016	<0.0014	0.0072J	0.059	0.045	0.0092J	<0.0009	0.01NJ	<0.0014	<0.0016	<0.00087	<0.0025	<0.0022	<0.0023	0.4
SMWAF-JJ10	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.0021	<0.0024	0.0064J	<0.0014	0.016J	0.12	0.087	0.019J	<0.00091	0.02J	<0.0014	<0.0016	<0.00088	<0.0025	<0.0022	<0.0023	**0.63**
SMWAF-JJ11	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0024	0.0028J	<0.0013	0.011J	0.078	0.066	0.013	<0.00089	0.014J	<0.0014	<0.0015	<0.00087	<0.0025	<0.0022	<0.0023	**0.49**
SMWAF-JJ12	0	mg/kg	<0.0013	<0.0011	<0.0033	<0.002	<0.0023	0.0046J	<0.0013	0.017J	0.14	0.11	0.018J	<0.00088	0.022	<0.0014	<0.0015	<0.00085	<0.0024	<0.0021	<0.0022	**0.77**
SMWAF-JJ13	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0024	0.0062J	<0.0014	0.02J	0.16	0.13	**0.023**	<0.0009	0.026	<0.0014	<0.0016	<0.00087	<0.0025	<0.0022	<0.0023	**0.86**
SMWAF-JJ14	0	mg/kg	<0.0012	<0.001	<0.0032	<0.0019	<0.0022	<0.0016	<0.0013	0.0032J	0.032	0.025	0.0047J	<0.00085	0.0038J	<0.0013	<0.0015	<0.00083	<0.0024	<0.0021	<0.0022	0.21
SMWAF-JJ15	0	mg/kg	<0.0024	<0.0021	<0.0065	<0.0039	<0.0045	0.0053J	<0.0026	0.018J	0.19	0.15	**0.024J**	<0.0017	0.024J	<0.0027	<0.003	<0.0017	<0.0048	<0.0042	<0.0044	**0.95**
SMWAF-JJ16	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	<0.0048	0.0054J	<0.0027	0.019J	0.16	0.12	**0.022J**	<0.0018	0.026J	<0.0028	<0.0031	<0.0018	<0.005	<0.0044	<0.0046	**0.93**
SMWAF-JJ17	0	mg/kg	<0.0026	<0.0022	<0.007	<0.0042	<0.0049	0.0057J	<0.0028	0.019J	0.17	0.12	0.02J	<0.0018	0.026J	<0.0029	<0.0032	<0.0018	<0.0051	<0.0045	<0.0047	**0.92**
SMWAF-JJ18	0	mg/kg	<0.0024	<0.0021	<0.0064	<0.0039	<0.0045	0.0049J	<0.0026	0.017J	0.16	0.13	**0.022J**	<0.0017	0.024J	<0.0027	<0.003	<0.0017	<0.0047	<0.0041	<0.0043	**0.81**
SMWAF-JJ19	0	mg/kg	<0.0026	<0.0022	<0.0069	<0.0041	<0.0048	0.0048J	<0.0028	0.016J	0.13	0.1	**0.021J**	<0.0018	0.022J	<0.0029	<0.0032	<0.0018	<0.0051	<0.0044	<0.0047	**0.74**
SMWAF-JJ20	0	mg/kg	<0.0027	<0.0023	<0.0072	<0.0043	<0.005	0.0045J	<0.0029	0.015J	0.12	0.094	0.02J	<0.0019	0.021J	<0.003	<0.0033	<0.0018	<0.0053	<0.0046	<0.0049	**0.75**
SMWAF-KK2	0	mg/kg	0.00091J	<0.00029	<0.00047	<0.00027	<0.00031	0.0014J	0.0022	<0.00023	0.16	0.079	0.008	<0.00034	0.016	0.01	0.011	0.0045	<0.00028	0.0013J	0.032	**0.92**
SMWAF-KK3	0	mg/kg	0.00072J	<0.00029	<0.00046	0.0007J	<0.00031	0.0018J	0.0019J	0.011	0.18	0.092	0.0082	<0.00034	0.025	0.016	0.01	<0.00035	<0.00028	0.0011J	0.053	**1.7**
SMWAF-KK4	0	mg/kg	0.00084J	<0.0003	<0.00048	<0.00028	<0.00033	0.0014J	0.0018J	0.013	0.21	0.16	0.0083	<0.00035	0.029	0.017	0.011	<0.00036	<0.00029	0.0012J	0.058	**1.3**
SMWAF-KK5	0	mg/kg	0.00088J	<0.00027	<0.00044	<0.00026	<0.0003	0.0025	0.0015J	0.0082J	0.14	0.076J	0.0063	0.00097J	0.023J	0.011	0.0083	<0.00033J	0.00087J	0.0009J	0.042J	**1.3**
SMWAF-KK6	0	mg/kg	0.00092J	<0.00029	<0.00045	<0.00027	<0.00031	0.0014J	0.0017J	0.0082	0.13	0.063	0.0059	0.0012J	0.02	0.011	0.0081	<0.00034	<0.00027	0.00099J	0.028	**1.2**
SMWAF-KK7	0	mg/kg	<0.00029	<0.00024	<0.00076	<0.00046	<0.00053	<0.00037	<0.0003	<0.00062	0.02	0.01	0.0013J	<0.0002	<0.00033	0.00093J	<0.00035	<0.00019	0.00073J	<0.00049	0.0019J	0.14
SMWAF-KK8	0	mg/kg	<0.001	<0.00086	<0.0027	<0.0016	<0.0019	<0.0013	<0.0011	<0.0022	0.087	0.037	0.0044J	<0.00071	<0.0012	0.0063J	<0.0012	<0.00069	0.0025J	<0.0017	0.0074J	**0.53**
SMWAF-KK9	0	mg/kg	<0.0011	<0.00092	<0.0029	<0.0017	<0.002	<0.0014	<0.0011	<0.0024	0.035	0.019	0.0016J	<0.00076	<0.0012	0.0017J	<0.0013	<0.00074	<0.0021	<0.0018	0.0022J	0.22
SMWAF-KK10	0	mg/kg	<0.001	<0.00088	<0.0027	<0.0016	<0.0019	<0.0013	<0.0011	<0.0022	0.078	0.042	0.0035J	<0.00072	<0.0012	0.0066J	<0.0013	<0.0007	0.0024J	<0.0017	0.0065J	**0.51**
SMWAF-KK11	0	mg/kg	<0.001	<0.00088	<0.0027	<0.0016	<0.0019	<0.0013	<0.0011	<0.0022	0.07	0.039	0.0033J	<0.00072	<0.0012	0.0049J	<0.0013	<0.0007	0.0025J	<0.0017	0.0055J	0.41
SMWAF-KK12	0	mg/kg	<0.001	<0.00087	<0.0027	<0.0016	<0.0019	<0.0013	<0.0011	<0.0022	0.082	0.047	0.0036J	<0.00072	<0.0012	0.0056J	<0.0012	<0.0007	0.0032J	<0.0017	0.007J	**0.5**
SMWAF-KK13	0	mg/kg	<0.001	<0.00086	<0.0027	<0.0016	<0.0019	<0.0013	<0.0011	<0.0022	0.097	0.059	0.0048J	<0.00071	<0.0012	0.0093J	0.0022J	<0.00069	0.0035J	<0.0017	0.009J	**0.61**
SMWAF-KK14	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0023	<0.0016	<0.0013	<0.0028	0.11	0.059	0.0055J	<0.00089	<0.0014	0.0071J	<0.0015	<0.00086	0.0037J	<0.0022	0.01J	**0.62**
SMWAF-KK15	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.0021	<0.0024	<0.0017	<0.0014	<0.0028	0.15	0.086	0.0056J	<0.0009	<0.0015	0.0096J	<0.0016	<0.00088	0.0046J	<0.0022	<0.0023	**0.83**
SMWAF-KK16	0	mg/kg	<0.0024	<0.0021	<0.0064	<0.0039	<0.0045	0.0057J	<0.0026	0.018J	0.15	0.12	**0.023J**	<0.0017	0.025J	<0.0027	<0.003	<0.0017	<0.0047	<0.0041	<0.0044	**0.86**
SMWAF-KK17	0	mg/kg	<0.0025	<0.0021	<0.0066	<0.004	<0.0046	0.0049J	<0.0027	0.019J	0.15	0.11	**0.024J**	<0.0018	0.025J	<0.0028	<0.0031	<0.0017	<0.0049	<0.0042	<0.0045	**0.91**
SMWAF-KK18	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	<0.0048	0.0053J	<0.0027	0.019J	0.17	0.12	**0.024J**	<0.0018	0.025J	<0.0028	<0.0031	<0.0018	<0.005	<0.0044	<0.0046	**0.88**
SMWAF-KK19	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	<0.0047	<0.0033	<0.0027	0.015J	0.13	0.094	0.02J	<0.0018	<0.0029	<0.0028	<0.0031	<0.0017	<0.005	<0.0043	<0.0046	**0.68**
SMWAF-KK20	0	mg/kg	<0.0027	<0.0023	<0.0072	<0.0043	<0.005	<0.0035	<0.0029	0.011J	0.091	0.07	0.013J	<0.0019	<0.0031	<0.003	<0.0033	<0.0018	<0.0053	<0.0046	<0.0049	**0.57**
SMWAF-LL2	0	mg/kg	0.00055J	<0.00028	<0.00044	<0.00026J	<0.0003	0.0032	0.0029	<0.00022	0.16	0.086	0.009	<0.00032	0.031J	0.014J	0.016	0.005J	0.0015J	0.0013J	0.038	**1.6**
SMWAF-LL3	0	mg/kg	0.00065J	<0.00028	<0.00044	0.00057J	<0.0003	0.0022	0.0031	0.011	0.18	0.091	0.0083	0.0013J	0.03	0.013	0.011	<0.00033	<0.00026	0.00094J	0.036	**1.6**
SMWAF-LL4	0	mg/kg	0.00087J	<0.00029	<0.00047	0.00039J	<0.00032	0.0018J	0.0029	0.011	0.18	0.09	0.0079	<0.00034	0.029	0.015	0.01	<0.00035	<0.00028	0.0012J	0.038	**1.6**
SMWAF-LL5	0	mg/kg	<0.0012	<0.0011	<0.0033	<0.002	<0.0023	0.004J	<0.0013	0.014J	0.1	0.078	0.018	<0.00088	0.019J	<0.0014	<0.0015	<0.00085	<0.0024	<0.0021	<0.0022	**0.6**
SMWAF-LL6	0	mg/kg	<0.0025	<0.0021	<0.0065	<0.0039	<0.0046	0.0076J	<0.0026	0.027J	0.2	0.15	**0.039**	<0.0017	0.035J	<0.0027	<0.003	<0.0017	<0.0048	<0.0042	<0.0044	**1.2**
SMWAF-LL7	0	mg/kg	<0.0024	<0.0021	<0.0064	<0.0039	<0.0045	0.0064J	<0.0026	0.024J	0.19	0.14	**0.033J**	<0.0017	0.03J	<0.0027	<0.003	<0.0017	<0.0047	<0.0041	<0.0044	**1.1**
SMWAF-LL8	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.0021	<0.0024	0.0066J	<0.0014	0.02	0.14	0.1	**0.026**	<0.0009	0.027	<0.0014	<0.0016	<0.00088	<0.0025	<0.0022	<0.0023	**0.81**
SMWAF-LL9	0	mg/kg	<0.0013	<0.0011	<0.0033	<0.002	<0.0023	0.0046J	<0.0013	0.015J	0.12	0.085	0.019	<0.00088	0.02	<0.0014	<0.0015	<0.00086	<0.0025	<0.0021	<0.0023	**0.68**
SMWAF-LL10	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0023	0.005J	<0.0013	0.014J	0.11	0.081	0.018	<0.00089	0.019J	<0.0014	<0.0015	<0.00086	<0.0025	<0.0022	<0.0023	**0.67**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

			Organochlorine Pesticides (Method 8081)																			
Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-LL11	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.0021	<0.0024	0.0042J	<0.0014	0.014J	0.12	0.08	0.018	<0.00091	0.019J	<0.0014	<0.0016	<0.00088	<0.0025	<0.0022	<0.0023	**0.59**
SMWAF-LL12	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0023	0.0039J	<0.0013	0.013J	0.1	0.07	0.014	<0.00089	0.016J	<0.0014	<0.0015	<0.00087	<0.0025	<0.0022	<0.0023	**0.55**
SMWAF-LL13	0	mg/kg	<0.0012	<0.001	<0.0032	<0.0019	<0.0023	0.0027J	<0.0013	0.011J	0.093	0.067	0.014	<0.00086	0.015J	<0.0013	<0.0015	<0.00083	<0.0024	<0.0021	<0.0022	**0.49**
SMWAF-LL14	0	mg/kg	<0.0012	<0.001	<0.0032	<0.0019	<0.0022	0.0029J	<0.0013	0.013J	0.1	0.073	0.014J	<0.00084	0.016J	<0.0013	0.0078J	<0.00082	<0.0023	<0.002	<0.0022	**0.58**
SMWAF-LL15	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.0021	<0.0024	0.0028J	<0.0014	0.009J	0.08	0.063	0.012J	<0.00091	0.012J	<0.0014	<0.0016	<0.00088	<0.0025	<0.0022	<0.0023	**0.48**
SMWAF-LL16	0	mg/kg	<0.0024	<0.002	<0.0063	<0.0038	<0.0044	0.0033J	<0.0025	0.016	0.12	0.086	**0.021**	<0.0017	0.029J	<0.0026J	<0.0029J	<0.0016	<0.0046J	<0.004	<0.0043	**0.61**
SMWAF-LL17	0	mg/kg	<0.00059	<0.00051	<0.0016	<0.00095	<0.0011	0.0013J	<0.00063	0.0068J	0.045	0.034	0.0061	<0.00042	0.006J	<0.00065	<0.00072J	<0.0004	<0.0012	<0.001	<0.0011	0.25
SMWAF-LL18	0	mg/kg	<0.0005J	<0.00043J	<0.0013J	<0.0008J	<0.00093J	<0.00064J	<0.00053J	0.0036J	0.03J	0.023J	0.0047J	<0.00035J	0.0053J	<0.00055J	<0.00061J	<0.00034J	<0.00098J	<0.00085J	<0.0009J	0.15J
SMWAF-LL19	0	mg/kg	<0.0025	<0.0021	<0.0066	<0.004	<0.0046	0.0044J	<0.0026	0.017J	0.14	0.11	**0.023J**	<0.0017	0.024J	<0.0027	<0.003	<0.0017	<0.0048	<0.0042	<0.0045	**0.84**
SMWAF-LL20	0	mg/kg	<0.00059	<0.0005	<0.0016	<0.00094	<0.0011	0.0017J	<0.00063	0.0069J	0.044	0.031	0.0083J	<0.00041	0.012	<0.00065	<0.00072J	<0.0004	<0.0011	<0.001	<0.0011	0.3
SMWAF-LL21	0	mg/kg	<0.011	<0.012	<0.017	<0.0084	<0.0089	<0.011	0.0063	0.049	**1.8**	0.89	**0.042**	0.029	<0.0053	0.018	<0.0058	0.13J	<0.018	<0.0063	0.17	**3**
SMWAF-MM2	0	mg/kg	0.00033J	<0.0003	<0.00047	<0.00028	<0.00032	0.0012J	0.0012J	0.005	0.11	0.056	0.0053	<0.00034	0.019	0.0075	0.0096	<0.00035	<0.00028	0.0006J	0.022	**0.64**
SMWAF-MM3	0	mg/kg	0.00045J	<0.00028	<0.00044	<0.00026	<0.0003	0.0017J	0.0015J	0.0074	0.17	0.087	0.0076	<0.00032	0.029	0.012	0.0093	<0.00033	<0.00027	0.00083J	0.034	**1**
SMWAF-MM4	0	mg/kg	<0.0024	<0.0021	<0.0064	<0.0039	<0.0045	<0.0031	<0.0026	<0.0053	0.17	0.096	0.016J	<0.0017	<0.0028	0.013J	<0.003	<0.0016	0.0061J	<0.0041	0.016J	**1.1**
SMWAF-MM5	0	mg/kg	<0.0025	<0.0021	<0.0066	<0.004	<0.0046	<0.0032	<0.0026	<0.0054	0.19	0.11	0.018J	<0.0017	<0.0028	0.013J	<0.003	<0.0017	0.0063J	<0.0042	0.016J	**1.1**
SMWAF-MM6	0	mg/kg	<0.0011	<0.00096	<0.003	<0.0018	<0.0021	<0.0015	<0.0012	<0.0025	0.074	0.04	0.008J	<0.00079	<0.0013	0.0047J	<0.0014	<0.00077	0.0027J	<0.0019	0.0067J	**0.52**
SMWAF-MM7	0	mg/kg	<0.0014	<0.0012	<0.0036	<0.0022	<0.0025	0.0064J	<0.0014	0.021J	0.14	0.099	**0.032**	<0.00095	0.029	<0.0015	<0.0017	<0.00092	<0.0026	<0.0023	<0.0024	**0.89**
SMWAF-MM8	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0024	0.0076J	<0.0014	0.026	0.17	0.12	**0.039**	<0.00089	0.036	<0.0014	<0.0016	<0.00087	<0.0025	<0.0022	<0.0023	**1.2**
SMWAF-MM9	0	mg/kg	<0.0015	<0.0013	<0.004	<0.0024	<0.0028	0.0035	<0.0016	0.011J	0.069	0.042	0.016	<0.0011	0.014J	<0.0017	<0.0018	<0.001	<0.0029	<0.0026	<0.0027	**0.5**
SMWAF-MM10	0	mg/kg	<0.0012	<0.0011	<0.0033	<0.002	<0.0023	0.0078J	<0.0013	0.022	0.16	0.1	**0.03**	<0.00087	0.03	<0.0014	<0.0015	<0.00084	<0.0024	<0.0021	<0.0022	**0.94**
SMWAF-MM11	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0024	0.005J	<0.0014	0.015J	0.13	0.078	0.019J	<0.0009	0.022	<0.0014	<0.0016	<0.00087	<0.0025	<0.0022	<0.0023	**0.69**
SMWAF-MM12	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.0021	<0.0024	0.004J	<0.0014	0.014J	0.11	0.069	0.019	<0.00091	0.019J	<0.0014	<0.0016J	<0.00088	<0.0025	<0.0022	<0.0023	**0.68**
SMWAF-MM13	0	mg/kg	<0.0013	<0.0011	<0.0035	<0.0021	<0.0024	0.0037J	<0.0014	0.011J	0.088	0.056	0.015J	<0.00092	0.016J	<0.0014	<0.0016J	<0.0009	<0.0026	<0.0022	<0.0024	**0.53**
SMWAF-MM14	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.0021	<0.0024	0.0031J	<0.0014	0.01J	0.087	0.053	0.015J	<0.00091	0.014J	<0.0014	<0.0016J	<0.00088	<0.0025	<0.0022	<0.0023	**0.49**
SMWAF-MM15	0	mg/kg	<0.0013	<0.0011	<0.0033	<0.002	<0.0023	0.0033J	<0.0013	0.0098J	0.079	0.051	0.014J	<0.00088	0.014J	<0.0014	<0.0015J	<0.00085	<0.0024	<0.0021	<0.0022	**0.49**
SMWAF-MM16	0	mg/kg	<0.0024	<0.002	<0.0063	<0.0038	<0.0044	0.0034J	<0.0025	0.0077J	0.063	0.053	0.011J	<0.0017	0.017J	<0.0026J	<0.0029	<0.0016	<0.0047J	<0.0041	<0.0043	0.41J
SMWAF-MM17	0	mg/kg	<0.00047	<0.0004	<0.0012	<0.00075	<0.00087	<0.00061	<0.0005	0.0049J	0.036	0.026	0.0058J	<0.00033	0.0087	<0.00052	<0.00057	<0.00032	<0.00092	<0.0008	<0.00085	0.17
SMWAF-MM18	0	mg/kg	<0.0025	<0.0022	<0.0067	<0.004	<0.0047	<0.0032	<0.0027	0.0076J	0.069	0.055	0.0097J	<0.0018	0.019J	<0.0028J	<0.0031	<0.0017	<0.0049J	<0.0043	<0.0045	**0.45J**
SMWAF-MM19	0	mg/kg	<0.0025	<0.0021	<0.0065	<0.0039	<0.0045	<0.0032	<0.0026	0.013J	0.1	0.084	0.015J	<0.0017	0.018J	<0.0027	<0.003	<0.0017	<0.0048	<0.0042	<0.0044	**0.59**
SMWAF-MM20	0	mg/kg	<0.0026	<0.0022	<0.007	<0.0042	<0.0049	<0.0034	<0.0028	<0.0057	0.11	0.085	0.018	<0.0018	0.018J	<0.0029	<0.0032	<0.0018	<0.0051	<0.0045	<0.0047	**0.62**
SMWAF-MM21	0	mg/kg	<0.0024	<0.0021	<0.0064	<0.0039	<0.0045	0.0064J	<0.0026	0.023J	0.19	0.14	**0.032J**	<0.0017	<0.0028	<0.0027	<0.003	<0.0017	<0.0047	<0.0041	<0.0044	**0.9**
SMWAF-NN3	0	mg/kg	0.00044J	<0.00028	<0.00044	<0.00026	<0.0003	0.0017J	0.00096J	<0.00022	0.12	0.057	0.006	<0.00032	0.012	0.008	0.008	<0.00033	<0.00027	0.00079J	0.026	**0.75**
SMWAF-NN4	0	mg/kg	<0.0013	<0.0011	<0.0033	<0.002	<0.0023	0.0069J	<0.0013	0.02J	0.14	0.11	**0.029**	<0.00088	0.027	<0.0014	<0.0015	<0.00086	<0.0025	<0.0021	<0.0023	**0.85**
SMWAF-NN5	0	mg/kg	<0.0024	<0.0021	<0.0064	<0.0039	<0.0045	0.0088J	<0.0026	0.025J	0.21	0.17	**0.038**	<0.0017	0.033J	<0.0027	<0.003	<0.0017	<0.0047	<0.0041	<0.0044	**1.1**
SMWAF-NN6	0	mg/kg	<0.0024	<0.0021	<0.0064	<0.0039	<0.0045	0.009J	<0.0026	0.029J	0.22	0.18	**0.043**	<0.0017	0.037J	<0.0027	<0.003	<0.0017	<0.0047	<0.0041	<0.0043	**1.2**
SMWAF-NN7	0	mg/kg	<0.0025	<0.0021	<0.0065	<0.0039	<0.0046	0.011J	<0.0026	0.033J	0.22	0.14	**0.047**	<0.0017	0.039	<0.0027	<0.003	<0.0017	<0.0048	<0.0042	<0.0044	**1.2**
SMWAF-NN8	0	mg/kg	<0.0025	<0.0021	<0.0065	<0.0039	<0.0046	0.0078J	<0.0026	0.028J	0.19	0.15	**0.043**	<0.0017	0.037J	<0.0027	<0.003	<0.0017	<0.0048	<0.0042	<0.0044	**1.2**
SMWAF-NN9	0	mg/kg	<0.0013	<0.0011	<0.0033	<0.002	<0.0023	0.0084J	<0.0013	0.028J	0.16	0.13	**0.039**	<0.00088	0.037	<0.0014	<0.0015	<0.00086	<0.0025	<0.0021	<0.0023	**1.1**
SMWAF-NN10	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.0021	<0.0024	0.0084J	<0.0014	0.03	0.17	0.14	**0.039**	<0.00091	0.04	<0.0014	<0.0016	<0.00089	<0.0025	<0.0022	<0.0023	**1.2**
SMWAF-NN11	0	mg/kg	<0.0024	<0.0021	<0.0064	<0.0039	<0.0045	0.01J	<0.0026	0.032J	0.19	0.15	**0.045**	<0.0017	0.04	<0.0027	<0.0029	<0.0016	<0.0047	<0.0041	<0.0043	**1.3**
SMWAF-NN12	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	<0.0047	0.0078J	<0.0027	0.027J	0.17	0.13	**0.039**	<0.0018	0.034J	<0.0028	<0.0031	<0.0017	<0.005	<0.0043	<0.0046	**1.2**
SMWAF-NN13	0	mg/kg	<0.0024	<0.002	<0.0063	<0.0038	<0.0044	0.0068J	<0.0025	0.022J	0.17	0.12	**0.032**	<0.0017	0.028J	<0.0026	<0.0029	<0.0016	<0.0046	<0.004	<0.0042	**0.99**
SMWAF-NN14	0	mg/kg	<0.0012	<0.001	<0.0032	<0.002	<0.0023	0.0042J	<0.0013	0.017J	0.13	0.093	**0.023**	<0.00086	0.023	<0.0013	<0.0015	<0.00084	<0.0024	<0.0021	<0.0022	**0.75**
SMWAF-NN15	0	mg/kg	<0.0012	<0.0011	<0.0033	<0.002	<0.0023	0.0041J	<0.0013	0.014J	0.1	0.075	0.018	<0.00087	0.018J	<0.0014	<0.0015	<0.00085	<0.0024	<0.0021	<0.0022	**0.58**
SMWAF-NN16	0	mg/kg	<0.0025	<0.0022	<0.0067	<0.0041	<0.0047	<0.0033	<0.0027	<0.0055	0.079	0.057	0.014J	<0.0018	<0.0029	<0.0028	<0.0031J	<0.0017	<0.0049	<0.0043	<0.0046	**0.5J**
SMWAF-NN17	0	mg/kg	<0.00051	<0.00043	<0.0013	<0.00081	<0.00094	0.00086J	<0.00054	0.0053J	0.038	0.027	0.0053J	<0.00036	0.0096	<0.00056	<0.00062J	<0.00035	<0.00099	<0.00086	<0.00091	0.2J
SMWAF-NN18	0	mg/kg	<0.00051	<0.00044	<0.0014	<0.00082	<0.00095	<0.00066	<0.00054	0.0038J	0.029	0.022	0.0048	<0.00036	0.0078J	<0.00056	<0.00063J	<0.00035	<0.001	<0.00087	<0.00092	0.23
SMWAF-NN19	0	mg/kg	<0.00052	<0.00044	<0.0014	<0.00082	<0.00095	0.0012J	<0.00055	0.0058J	0.039	0.032	0.0072J	<0.00036	0.011	<0.00057	<0.00063J	<0.00035	<0.001	<0.00088	<0.00092	0.24
SMWAF-NN20	0	mg/kg	<0.0025	<0.0021	<0.0066	<0.004	<0.0046	<0.0032	<0.0027	<0.0055	0.054	0.046	0.0071J	<0.0018	<0.0029	<0.0028	<0.0031J	<0.0017	<0.0049	<0.0043	<0.0045	0.41J
SMWAF-NN21	0	mg/kg	<0.0025	<0.0021	<0.0066	<0.004	<0.0046	<0.0032	<0.0027	0.0089J	0.087	0.068	0.013J	<0.0018	<0.0029	<0.0028	<0.0031J	<0.0017	<0.0049	<0.0043	<0.0045	**0.58**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

			Organochlorine Pesticides (Method 8081)																			
Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		mg/kg	0.029	0.077	0.27	0.27	0.52	1.6	1.6	2	1.4	1.7	0.03	370	370	370	18	18	18	0.053	310	0.44
Industrial RSL		mg/kg	0.1	0.27	0.96	0.96	2.1	6.5	6.5	7.2	5.1	7	0.11	3700	3700	3700	180	180	180	0.19	3100	1.6
Resident RBSL		mg/kg	0.02	0.09	0.31	0.13	0.50	0.42	0.42	2.29	1.62	1.62	0.02	364	364	364	1.51	1.51	1.51	0.05	1.37	0.44
Industrial Worker RBSL		mg/kg	0.05	0.31	1.09	0.44	1.66	1.40	1.40	7.59	5.36	5.36	0.05	2865	2865	2865	5.29	5.29	5.29	0.15	2388	1.22
Maneuver Trainer RBSL		mg/kg	0.25	1.55	5.42	8.22	2.19	6.95	6.95	37.67	26.59	26.59	0.270	2843	2843	2843	5.24	5.24	5.24	0.73	2369	6.03
Heavy Equipment/Engineering RBSL		mg/kg	0.28	1.82	6.38	9.60	0.21	8.13	8.13	43.99	31.05	31.05	0.298	13003	13003	13003	22.09	22.09	22.09	0.83	10835	6.84
Construction Worker RBSL		mg/kg	0.34	2.19	7.65	0.26	11.52	2.97	2.97	52.79	37.26	37.26	0.36	780	780	780	1.33	1.33	1.33	0.99	650	8.20
MOUT Trainer RBSL		mg/kg	0.67	4.06	14.22	21.57	5.75	18.26	18.26	98.88	69.80	69.80	0.710	7462	7462	7462	13.77	13.77	13.77	1.91	6218	15.83
SMWAF-OO3	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0023	0.0063J	<0.0013	0.021	0.12	0.086	**0.025**	<0.00089	0.025NJ	<0.0014	<0.0015	<0.00086	<0.0025	<0.0022	<0.0023	**0.76**
SMWAF-OO4	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0024	0.0064J	<0.0014	0.022	0.14	0.11	**0.031**	<0.00089	0.029	<0.0014	<0.0016	<0.00087	<0.0025	<0.0022	<0.0023	**0.93**
SMWAF-OO5	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0024	0.0058J	<0.0014	0.022	0.15	0.11	**0.031**	<0.0009	0.029	<0.0014	<0.0016J	<0.00087	<0.0025	<0.0022	<0.0023	**0.92**
SMWAF-OO6	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0023	0.0055J	<0.0013	0.019J	0.13	0.1	**0.03**	<0.00089	0.026	<0.0014	<0.0015J	<0.00086	<0.0025	<0.0022	<0.0023	**0.84**
SMWAF-OO7	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0023	0.0049J	<0.0013	0.019	0.13	0.096	**0.029**	<0.00089	0.026	<0.0014	<0.0015J	<0.00086	<0.0025	<0.0022	<0.0023	**0.8**
SMWAF-OO8	0	mg/kg	<0.00029	<0.00025	<0.00078	<0.00047	<0.00054	0.0013J	<0.00031	0.0043J	0.028	0.02	0.0066	<0.00021	0.0054J	<0.00032	<0.00036	<0.0002	<0.00057	<0.0005	<0.00053	0.18
SMWAF-OO9	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.002	<0.0024	0.0059J	<0.0013	0.023	0.14	0.11	**0.032**	<0.00089	0.031	<0.0014	<0.0016J	<0.00087	<0.0025	<0.0022	<0.0023	**0.96**
SMWAF-OO10	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.0021	<0.0024	0.0061J	<0.0014	0.021J	0.14	0.091	**0.032**	<0.00091	0.029	<0.0014	<0.0016J	<0.00089	<0.0025	<0.0022	<0.0023	**0.91**
SMWAF-OO11	0	mg/kg	<0.0013	<0.0011	<0.0033	<0.002	<0.0023	0.0072J	<0.0013	0.024	0.15	0.098	**0.034**	<0.00088	0.033	<0.0014	<0.0015J	<0.00085	<0.0024	<0.0021	<0.0022	**1.1**
SMWAF-OO12	0	mg/kg	<0.0013	<0.0011	<0.0033	<0.002	<0.0023	0.008J	<0.0013	0.025	0.16	0.1	**0.037**	<0.00088	0.034	<0.0014	<0.0015J	<0.00085	<0.0024	<0.0021	<0.0022	**1.1**
SMWAF-OO13	0	mg/kg	<0.0013	<0.0011	<0.0034	<0.0021	<0.0024	0.0071J	<0.0014	0.022	0.14	0.093	**0.032**	<0.00091	0.031	<0.0014	<0.0016J	<0.00088	<0.0025	<0.0022	<0.0023	**0.98**
SMWAF-OO14	0	mg/kg	<0.00029	<0.00025	<0.00077	<0.00047	<0.00054	0.0014J	<0.00031	0.0043J	0.027	0.017	0.0054	<0.0002	0.0055	<0.00032	<0.00036J	<0.0002	<0.00057	<0.00049	<0.00052	0.19
SMWAF-OO15	0	mg/kg	<0.0012	<0.001	<0.0032	<0.002	<0.0023	0.0039J	<0.0013	0.015J	0.1	0.057	0.019	<0.00086	0.02	<0.0014	<0.0015J	<0.00084	<0.0024	<0.0021	<0.0022	**0.59**
SMWAF-OO16	0	mg/kg	<0.0024	<0.0021	<0.0065	<0.0039	<0.0045	<0.0031	<0.0026	0.0084J	0.073	0.055	0.012J	<0.0017	<0.0028	<0.0027	<0.003J	<0.0017	<0.0048	<0.0042	<0.0044	**0.47J**
SMWAF-OO17	0	mg/kg	<0.0024	<0.002	<0.0063	<0.0038	<0.0044	0.0033J	<0.0025	0.012J	0.096	0.071	0.016	<0.0017	<0.0027	<0.0026	<0.0029J	<0.0016	<0.0047	<0.0041	<0.0043	**0.63**
SMWAF-OO18	0	mg/kg	<0.0024	<0.0021	<0.0064	<0.0039	<0.0045	<0.0031	<0.0026	0.009J	0.079	0.056	0.014J	<0.0017	<0.0028	<0.0027	<0.003J	<0.0017	<0.0047	<0.0041	<0.0043	**0.52**
SMWAF-OO19	0	mg/kg	<0.0025	<0.0022	<0.0067	<0.0041	<0.0047	<0.0033	<0.0027	<0.0055	0.053	0.04J	0.0076J	<0.0018	<0.0029	<0.0028	<0.0031J	<0.0017	<0.005	<0.0043	<0.0046	**0.45J**
SMWAF-OO20	0	mg/kg	<0.0026	<0.0022	<0.0068	<0.0041	<0.0047	<0.0033	<0.0027	<0.0056	0.051	0.04J	0.0085J	<0.0018	<0.0029	<0.0028	<0.0031	<0.0017	<0.005	<0.0043	<0.0046	0.41J
SMWAF-OO21	0	mg/kg	<0.0025	<0.0022	<0.0067	<0.004	<0.0047	<0.0033	<0.0027	<0.0055	0.055	0.042	0.0098J	<0.0018	<0.0029	<0.0028	<0.0031	<0.0017	<0.0049	<0.0043	<0.0045	**0.49J**
SMWAF-OO22	0	mg/kg	<0.0043	<0.0045	<0.0068	<0.0033	<0.0035	<0.0041	0.0042J	<0.0054	1.4	0.25	**0.032NJ**	0.028J	0.026J	0.018	0.027J	0.043NJ	<0.007	0.024J	0.088NJ	**1.2**
SMWAF-PP4	0	mg/kg	<0.00032	<0.00019	0.00041J	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.12	0.1	<0.00022	<0.00059	0.043	<0.00035	<0.00016	<0.00041	<0.00044	<0.00045	<0.00075	**0.8J**
SMWAF-PP5	0	mg/kg	<0.00035	<0.00021	<0.00034	<0.00027	<0.00019	<0.00064	<0.00018	<0.00025	0.072	0.067	<0.00024	<0.00064	0.026	<0.00038	<0.00018	<0.00044	<0.00047	<0.00049	<0.00081	**0.57J**
SMWAF-PP6	0	mg/kg	<0.00039	<0.00024	<0.00038	<0.00031	<0.00021	<0.00072	<0.0002	<0.00028	0.087	0.078	<0.00027	<0.00073	0.033	<0.00043	<0.0002	<0.0005	<0.00053	<0.00055	<0.00092	**0.7J**
SMWAF-PP7	0	mg/kg	0.0019	<0.00022	<0.00036	<0.00029	<0.0002	<0.00068	<0.00019	<0.00027	0.089	0.076	<0.00026	<0.00069	0.028	<0.00041	<0.00019	<0.00047	<0.0005	<0.00052	<0.00087	**0.69J**
SMWAF-PP8	0	mg/kg	<0.00035	<0.00021	<0.00034	<0.00028	<0.00019	<0.00065	<0.00018	<0.00025	0.087	0.071	<0.00025	<0.00065	0.031	<0.00039	<0.00018	<0.00045	<0.00048	<0.00049	<0.00082	**0.67J**
SMWAF-PP9	0	mg/kg	<0.00034	<0.0002	<0.00033	<0.00026	<0.00018	<0.00062	<0.00017	<0.00024	0.081	0.067	<0.00024	<0.00062	0.024	<0.00037	<0.00017	<0.00043	<0.00046	<0.00047	<0.00079	**0.61J**
SMWAF-PP10	0	mg/kg	<0.00035	<0.00021	<0.00035	<0.00028	<0.00019	<0.00065	<0.00018	<0.00025	0.071	0.03	<0.00025	<0.00066	0.017	<0.00039	<0.00018	<0.00045	<0.00048	<0.00049	<0.00083	**0.5J**
SMWAF-PP11	0	mg/kg	<0.00035	<0.00021	<0.00035	<0.00028	<0.00019	<0.00066	<0.00018	<0.00026	0.12	0.099	<0.00025	<0.00066	0.033	<0.00039	<0.00018	0.03J	<0.00048	<0.0005	<0.00083	**0.76J**
SMWAF-PP12	0	mg/kg	<0.00033	<0.0002	<0.00032	<0.00026	<0.00018	<0.00061	<0.00017	<0.00024	0.067	0.054	<0.00023	<0.00061	0.022	<0.00036	<0.00017	0.022J	<0.00045	<0.00046	<0.00077	**0.51J**
SMWAF-PP13	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.092	0.074	<0.00022	<0.00059	0.028	<0.00035	<0.00016	0.029J	<0.00043	<0.00044	<0.00074	**0.67J**
SMWAF-PP14	0	mg/kg	<0.00035	<0.00021	<0.00034	<0.00027	<0.00019	<0.00064	<0.00018	<0.00025	0.081	0.063	<0.00024	<0.00065	0.041	<0.00039	<0.00018	0.023J	<0.00047	<0.00049	<0.00082	1J
SMWAF-PP15	0	mg/kg	<0.00033	<0.0002	<0.00032	<0.00026	<0.00018	<0.0006	<0.00017	<0.00024	0.11	0.073	<0.00023	<0.00061	0.036	<0.00036	<0.00017	0.033J	<0.00044	<0.00046	<0.00076	**0.7J**
SMWAF-PP16	0	mg/kg	<0.00031	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.081	0.039	<0.00022	<0.00059	0.014	<0.00035	<0.00016	0.012J	<0.00043J	<0.00044	<0.00074	0.4J
SMWAF-PP17	0	mg/kg	<0.00033	<0.0002	<0.00033	<0.00026	<0.00018	<0.00062	<0.00017	<0.00024	0.084	0.041	<0.00024	<0.00062	0.022	<0.00037	<0.00017	<0.00043	<0.00046J	<0.00047	<0.00079	**0.6J**
SMWAF-PP18	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.067	0.032J	<0.00022	<0.00059	0.01	<0.00035	<0.00016	<0.0004	<0.00043J	<0.00044	<0.00074	0.35J
SMWAF-PP19	0	mg/kg	<0.00031	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.058	0.028J	<0.00022	<0.00058	0.011J	<0.00035	<0.00016	<0.0004	<0.00043J	<0.00044	<0.00074	0.4J
SMWAF-PP20	0	mg/kg	<0.00033	<0.0002	<0.00032	<0.00026	<0.00018	<0.00061	<0.00017	<0.00024	0.039	0.028	<0.00023	<0.00061	0.0082	<0.00037	<0.00017	<0.00042	<0.00045J	<0.00046	<0.00078	0.28J
SMWAF-PP21	0	mg/kg	<0.00037	<0.00022	<0.00036	<0.00029	<0.0002	<0.00069	<0.00019	<0.00027	0.032	0.023	<0.00026	<0.00069	0.0064	<0.00041	<0.00019	<0.00047	<0.0005J	<0.00052	<0.00087	0.22J
SMWAF-PP22	0	mg/kg	<0.00037	<0.00022	<0.00036	<0.00029	<0.0002	<0.00068	<0.00019	<0.00026	0.036	0.026	<0.00026	<0.00068	0.0079	<0.00041	<0.00019	<0.00046	<0.0005J	<0.00051	<0.00086	0.25J
SMWAF-QQ5	0	mg/kg	<0.00032	<0.00019	0.001	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.16	0.1	0.012J	<0.00059	0.039	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**1.2J**
SMWAF-QQ6	0	mg/kg	<0.00032	<0.00019	0.00065J	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.13	0.074	0.01J	<0.00059	0.034	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**0.95J**
SMWAF-QQ7	0	mg/kg	<0.00035	<0.00021	0.0004J	<0.00028	<0.00019	<0.00064	<0.00018	<0.00025	0.097	0.057	0.01J	<0.00065	0.028	<0.00039	<0.00018	<0.00044	<0.00047	<0.00049	<0.00082	**0.87J**
SMWAF-QQ8	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.12	0.075	0.012J	<0.00059	0.031	<0.00035	<0.00016	<0.0004	<0.00043	<0.00045	<0.00075	**0.97J**
SMWAF-QQ9	0	mg/kg	<0.00032	<0.0002	<0.00032	<0.00026	<0.00018	<0.0006	<0.00017	<0.00023	0.092	0.05	0.011	<0.0006	0.025	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00076	**0.79J**
SMWAF-QQ10	0	mg/kg	<0.00035	<0.00021	<0.00035	<0.00028	<0.00019	<0.00065	<0.00018	<0.00026	0.076	0.044	0.0086J	<0.00066	0.021	<0.00039	<0.00018	<0.00045	<0.00048	<0.0005	<0.00083	**0.67J**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

			Organochlorine Pesticides (Method 8081)																			
Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-QQ11	0	mg/kg	<0.00035	<0.00021	<0.00034	<0.00027	<0.00019	<0.00064	<0.00018	<0.00025	0.071	0.034	0.0073	<0.00064	0.02	<0.00038	<0.00018	<0.00044	<0.00047	<0.00048	<0.00081	**0.6J**
SMWAF-QQ12	0	mg/kg	<0.00033	<0.0002	<0.00033	<0.00026	<0.00018	<0.00062	<0.00017	<0.00024	0.084	0.036	0.0099J	<0.00062	0.024	<0.00037	<0.00017	<0.00042	<0.00045	<0.00047	<0.00078	**0.76J**
SMWAF-QQ13	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.1	0.055	0.0099J	<0.00059	0.026	<0.00035	<0.00016	<0.0004	<0.00043	<0.00045	<0.00075	**0.86J**
SMWAF-QQ14	0	mg/kg	<0.00035	<0.00021	<0.00034	<0.00028	<0.00019	<0.00065	<0.00018	<0.00025	0.11	0.062	0.011J	<0.00066	0.03	<0.00039	<0.00018	<0.00045	<0.00048	<0.00049	<0.00083	**0.96J**
SMWAF-QQ15	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.12	0.064	0.013J	<0.0006	0.033	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	**1.1J**
SMWAF-QQ16	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.11	0.056	<0.00022	<0.00059	0.028	<0.00035	<0.00016	<0.0004	<0.00043J	<0.00045	<0.00075J	**0.84J**
SMWAF-QQ17	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.11	0.054	0.0074J	<0.00059	0.027	<0.00035	<0.00016	<0.0004	<0.00043	<0.00045	<0.00075J	**0.74J**
SMWAF-QQ18	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.1	0.06	<0.00022	<0.00059	0.025	<0.00035	<0.00016	<0.00041	<0.00043	<0.00045	<0.00075J	**0.69J**
SMWAF-QQ19	0	mg/kg	<0.00035	<0.00021	<0.00034	<0.00028	<0.00019	<0.00065	<0.00018	<0.00025	0.079	0.042	<0.00025	<0.00066	0.019	<0.00039	<0.00018	<0.00045	<0.00048	<0.00049	<0.00083J	**0.56J**
SMWAF-QQ20	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.063	0.038	<0.00022	<0.00059	0.017	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074J	**0.5J**
SMWAF-QQ21	0	mg/kg	<0.00036	<0.00022	<0.00036	<0.00029	<0.0002	<0.00068	<0.00019	<0.00026	0.039	0.027	<0.00026	<0.00068	0.0094	<0.00041	<0.00019	<0.00046	<0.0005J	<0.00051J	<0.00086J	0.3J
SMWAF-QQ22	0	mg/kg	<0.00036	<0.00022	<0.00035	<0.00028	<0.0002	<0.00067	<0.00019	<0.00026	0.025	0.015	<0.00025	<0.00067	0.0048	<0.0004	<0.00019	<0.00046	<0.00049J	<0.0005	<0.00085	0.16J
SMWAF-RR5	0	mg/kg	<0.0022	<0.0023	<0.0035	<0.0017	<0.0018	0.0077	<0.00056	<0.0028	0.28	0.3	**0.04**	0.012	0.048	0.016	0.06	0.073J	0.071	0.0055	0.16	**2.6**
SMWAF-RR6	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.12	0.08	<0.00022	<0.00059	0.031	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**0.98J**
SMWAF-RR7	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.12	0.067	<0.00022	<0.00059	0.029	<0.00035	<0.00016	<0.00041	<0.00044	<0.00045	<0.00075	**0.92J**
SMWAF-RR8	0	mg/kg	<0.00033	<0.0002	<0.00033	<0.00026	<0.00018	<0.00062	<0.00017	<0.00024	0.12	0.08	<0.00023	<0.00062	0.029	<0.00037	<0.00017	<0.00042	<0.00045	<0.00047	<0.00078	**0.96J**
SMWAF-RR9	0	mg/kg	<0.00031	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.12	0.08	0.012J	<0.00059	0.029	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074J	**1J**
SMWAF-RR10	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.12	0.058	0.019	<0.00059	0.027	<0.00035	<0.00016	<0.00041	<0.00043	<0.00045	<0.00075J	**0.86J**
SMWAF-RR11	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.11	0.053	**0.026**	<0.00059	0.029	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00075J	**0.92J**
SMWAF-RR12	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.089	0.044	0.017	<0.00059	0.021	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074J	**0.67J**
SMWAF-RR13	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.068	0.03	0.013	<0.00059	0.016	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00075J	**0.51J**
SMWAF-RR14	0	mg/kg	<0.00036	<0.00022	<0.00035	<0.00028	<0.0002	<0.00066	<0.00018	<0.00026	0.056	0.035	0.0094	<0.00067	0.013	<0.0004	<0.00018	<0.00045	<0.00049	<0.0005	<0.00084J	0.44J
SMWAF-RR15	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.085	0.041	0.013	<0.00059	0.019	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074J	**0.59J**
SMWAF-RR16	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.092	0.047	0.0076J	<0.0006	0.022	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075J	**0.7J**
SMWAF-RR17	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.12	0.057	<0.00022	<0.00059	0.027	<0.00035	<0.00016	0.034J	<0.00044	<0.00045	<0.00075J	**0.75J**
SMWAF-RR18	0	mg/kg	<0.00031	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.11	0.062	<0.00022	<0.00058	0.028	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074J	**0.9J**
SMWAF-RR19	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.11	0.062	<0.00023	<0.0006	0.031	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075J	**0.93J**
SMWAF-RR20	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.099	0.056	<0.00022	<0.00059	0.026	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00075J	**0.72J**
SMWAF-RR21	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.075	0.035	<0.00022	<0.00059	0.019	<0.00035	<0.00016	<0.0004	<0.00043	<0.00045	<0.00075J	**0.58J**
SMWAF-RR22	0	mg/kg	<0.00031	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.043	0.026	<0.00022	<0.00059	0.013	<0.00035	<0.00016	0.018J	<0.00043	<0.00044	<0.00074	0.38J
SMWAF-RR23	0	mg/kg	<0.00036	<0.00022	<0.00035	<0.00028	<0.0002	<0.00067	<0.00019	<0.00026	0.045	0.026	<0.00025	<0.00067	0.014	<0.0004	<0.00019	<0.00046	<0.00049	<0.0005	<0.00084	0.33J
SMWAF-SS6	0	mg/kg	<0.0011	<0.0012	<0.0018	<0.00085	<0.00091	0.0029	<0.00028	<0.0014	0.13	0.12	0.015	0.0046	0.019	0.0079	0.022	0.032J	0.03	0.0022	0.065	**0.98**
SMWAF-SS7	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.096	0.048	<0.00022	<0.00059	0.023	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**0.75J**
SMWAF-SS8	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.11	0.074	<0.00022	<0.00059	0.027	<0.00035	<0.00016	<0.0004	<0.00043	<0.00045	<0.00075	**0.93J**
SMWAF-SS9	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.085	0.052	<0.00022	<0.00059	0.025	<0.00035	<0.00016	<0.0004	<0.00043	<0.00045	<0.00075	**0.82J**
SMWAF-SS10	0	mg/kg	<0.00034	<0.00021	<0.00034	<0.00027	<0.00019	<0.00063	<0.00018	<0.00025	0.095	0.051	**0.023**	<0.00064	0.03	<0.00038	<0.00018	<0.00044	<0.00047	<0.00048	<0.0008	**0.92J**
SMWAF-SS11	0	mg/kg	<0.00032	<0.00019	<0.00032	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.093	0.068	0.0079	<0.0006	0.024	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00076	**0.78J**
SMWAF-SS12	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.096	0.062	0.0058J	<0.00059	0.021	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**0.81J**
SMWAF-SS13	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.068	0.035	0.015J	<0.0006	0.019	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	**0.61J**
SMWAF-SS14	0	mg/kg	<0.00034	<0.00021	<0.00034	<0.00027	<0.00019	<0.00064	<0.00018	<0.00025	0.12	0.071	<0.00024	<0.00064	0.03	<0.00038	<0.00018	<0.00044	<0.00047	<0.00048	<0.00081	**0.97J**
SMWAF-SS15	0	mg/kg	<0.00032	<0.00019	<0.00032	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.054	0.03	<0.00023	<0.0006	0.014	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00076	0.41J
SMWAF-SS16	0	mg/kg	<0.00034	<0.0002	<0.00033	<0.00027	<0.00018	<0.00062	<0.00017	<0.00024	0.059	0.035	<0.00024	<0.00063	0.016	<0.00037	<0.00017	<0.00043	<0.00046	<0.00047	<0.00079	**0.47J**
SMWAF-SS17	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.084	0.078	<0.00022	<0.00059	0.022	<0.00035	<0.00016	<0.0004	<0.00043	<0.00045	<0.00075	**0.6J**
SMWAF-SS18	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.1	0.057	<0.00022	<0.00059	0.025	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**0.69J**
SMWAF-SS19	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.11	0.063	<0.00022	<0.00059	0.033	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**0.97J**
SMWAF-SS20	0	mg/kg	<0.00033	<0.0002	<0.00032	<0.00026	<0.00018	<0.00061	<0.00017	<0.00024	0.11	0.061	<0.00023	<0.00061	0.033	<0.00036	<0.00017	<0.00042	<0.00045	<0.00046	<0.00077	**0.96J**
SMWAF-SS21	0	mg/kg	<0.00034	<0.0002	<0.00033	<0.00027	<0.00019	<0.00063	<0.00017	<0.00024	0.12	0.064	<0.00024	<0.00063	0.037	<0.00038	<0.00017	<0.00043	<0.00046	<0.00047	<0.00079	**1J**
SMWAF-SS22	0	mg/kg	<0.00034	<0.0002	<0.00033	<0.00027	<0.00018	<0.00062	<0.00017	<0.00024	0.1	0.055	<0.00024	<0.00063	0.034	<0.00037	<0.00017	<0.00043	<0.00046	<0.00047	<0.00079	**0.84J**
SMWAF-SS23	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.073	0.048	<0.00022	<0.00059	0.023	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**0.64J**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

			Organochlorine Pesticides (Method 8081)																			
Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-TT7	0	mg/kg	<0.0022	<0.0023	<0.0034	0.0026	<0.0018	0.0073	0.0041	<0.0027	0.19	0.2	**0.031**	0.0093	0.039	<0.00096	0.049	0.048J	0.046	0.0038	0.11	**2**
SMWAF-TT8	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.096	0.057	<0.00022	<0.00059	0.022	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	**0.61J**
SMWAF-TT9	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.098	0.056	<0.00022	<0.00059	0.022	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00075	**0.62J**
SMWAF-TT10	0	mg/kg	<0.00034	<0.0002	<0.00033	<0.00027	<0.00019	<0.00063	<0.00018	<0.00024	0.091	0.05	<0.00024	<0.00063	0.022	<0.00038	<0.00018	<0.00043	<0.00046	<0.00048	<0.0008	**0.63J**
SMWAF-TT11	0	mg/kg	<0.00033	<0.0002	<0.00033	<0.00026	<0.00018	<0.00062	<0.00017	<0.00024	0.1	0.057	<0.00023	<0.00062	0.026	<0.00037	<0.00017	<0.00042	<0.00045	<0.00047	<0.00078	**0.74J**
SMWAF-TT12	0	mg/kg	<0.00031	<0.00019	<0.0003	<0.00025	<0.00017	<0.00058	<0.00016	<0.00022	0.11	0.054	<0.00022	<0.00058	0.023	<0.00035	<0.00016	0.033J	<0.00042	<0.00044	<0.00073J	**0.72J**
SMWAF-TT13	0	mg/kg	<0.00032	<0.0002	<0.00032	<0.00026	<0.00018	<0.0006	<0.00017	<0.00023	0.11	0.067	<0.00023	<0.0006	0.028	<0.00036	<0.00017	0.035J	<0.00044	<0.00045	<0.00076J	**0.84J**
SMWAF-TT14	0	mg/kg	<0.00032	<0.00019	<0.00032	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.091	0.05	0.0098J	<0.0006	0.024	<0.00036	<0.00017	<0.00041	<0.00044J	<0.00045	<0.00076	**0.81J**
SMWAF-TT15	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00016	<0.00023	0.091	0.049	0.0084J	<0.00059	0.021	<0.00035	<0.00016	<0.00041	<0.00043J	<0.00045	<0.00075	**0.71J**
SMWAF-TT16	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00058	<0.00016	<0.00023	0.076	0.053	0.0081J	<0.00059	0.019	<0.00035	<0.00016	<0.0004	<0.00043J	<0.00044	<0.00074	**0.63J**
SMWAF-TT17	0	mg/kg	<0.00033	<0.0002	<0.00033	<0.00026	<0.00018	<0.00062	<0.00017	<0.00024	0.065	0.043	<0.00023	<0.00062	0.015	<0.00037	<0.00017	<0.00042	<0.00046J	<0.00047	<0.00079	**0.53J**
SMWAF-TT18	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.092	0.14	<0.00022	<0.00059	0.019	<0.00035	<0.00016	<0.0004	<0.00043J	<0.00045	<0.00075	**0.62J**
SMWAF-TT19	0	mg/kg	<0.00032	<0.00019	<0.00032	<0.00025	<0.00018	<0.0006	<0.00017	<0.00023	0.085	0.068	<0.00023	<0.0006	0.024	<0.00036	<0.00017	<0.00041	<0.00044J	<0.00045	<0.00076	**0.85J**
SMWAF-TT20	0	mg/kg	<0.00033	<0.0002	<0.00032	<0.00026	<0.00018	<0.00061	<0.00017	<0.00024	0.067	0.038J	<0.00023	<0.00061	0.02	<0.00036	<0.00017	<0.00042	<0.00045J	<0.00046	<0.00077	**0.66J**
SMWAF-TT21	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.088	0.046J	<0.00022	<0.00059	0.023	<0.00035	<0.00016	<0.0004	<0.00043J	<0.00044	<0.00074	**0.78J**
SMWAF-TT22	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.1	0.075	<0.00022	<0.00059	0.031	<0.00035	<0.00016	<0.0004	<0.00043J	<0.00044	<0.00074	**0.97J**
SMWAF-TT23	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.09	0.054J	<0.00022	<0.00059	0.027	<0.00035	<0.00016	<0.0004	<0.00043J	<0.00045	<0.00075	**0.75J**
SMWAF-UU8	0	mg/kg	<0.0011	<0.0011	<0.0017	0.002	<0.00086	<0.001	<0.00027	0.025	0.11	0.12	<0.00046	0.0038	0.02	0.0043	0.0046	0.038J	0.026	0.0023	0.06	**1**
SMWAF-UU9	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00017	<0.00059	<0.00016	<0.00023	0.095	0.036	<0.00022	<0.00059	0.022	<0.00035	<0.00016	<0.0004	<0.00043	<0.00044	<0.00074	0.44J
SMWAF-UU10	0	mg/kg	<0.00032	<0.00019	<0.00031	<0.00025	<0.00018	<0.00059	<0.00017	<0.00023	0.097	0.054	<0.00022	<0.0006	0.021	<0.00036	<0.00017	<0.00041	<0.00044	<0.00045	<0.00075	**0.6J**
SMWAF-UU11	0	mg/kg	<0.00034	<0.0002	<0.00033	<0.00027	<0.00019	<0.00063	<0.00018	<0.00024	0.079	0.044	<0.00024	<0.00063	0.02	<0.00038	<0.00018	<0.00043	<0.00046	<0.00048	<0.0008	**0.56J**
SMWAF-UU12	0	mg/kg	<0.00033	<0.0002	<0.00033	<0.00026	<0.00018	<0.00062	<0.00017	<0.00024	0.1	0.056	<0.00023	<0.00062	0.027	<0.00037	<0.00017	<0.00042	<0.00046	<0.00047	<0.00079	**0.73J**
SMWAF-UU13	0	mg/kg	<0.0062	<0.0038J	<0.0057	<0.0062	<0.0039	<0.0049	<0.0022	<0.0032	0.16J	0.094	<0.0024	<0.0027	0.033	<0.0045	<0.0026	0.044J	0.032	<0.0042	<0.0078	**1.1**
SMWAF-UU14	0	mg/kg	<0.0068	<0.0041	<0.0062	<0.0068	<0.0042	<0.0053	<0.0024	0.012J	0.13	0.091	<0.0027	<0.0029	0.041	<0.0049	<0.0028	0.051J	0.028J	<0.0045	<0.0085	**1.3**
SMWAF-UU15	0	mg/kg	<0.0068	<0.0042J	<0.0063	<0.0068	<0.0042	<0.0053	<0.0024	0.03	0.17	0.09	<0.0027	<0.003	0.041	<0.0049	<0.0028	0.053	0.032	<0.0046	<0.0085	**1.2**
SMWAF-UU16	0	mg/kg	<0.0064	<0.0039J	<0.0058	<0.0064	<0.0039	<0.005	<0.0022	<0.0033	0.15	0.079	<0.0025	<0.0028	0.041	<0.0046	<0.0027	0.049	0.027	<0.0042	<0.008	**1**
SMWAF-UU17	0	mg/kg	<0.0063	<0.0038J	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.024	0.13	0.067	<0.0024	<0.0027	0.031	<0.0045	<0.0026	0.04	0.025	<0.0042	<0.0078	**0.92**
SMWAF-UU18	0	mg/kg	<0.0067	<0.0041J	<0.0062	<0.0067	<0.0042	<0.0053	<0.0024	0.021J	0.12	0.064	<0.0026	<0.0029	0.028	<0.0049	<0.0028	0.035	0.024	<0.0045	<0.0084	**0.85**
SMWAF-UU19	0	mg/kg	<0.0067	<0.0041	<0.0062	<0.0067	<0.0041	<0.0053	<0.0024	0.012J	0.094	0.069	<0.0026	<0.0029	0.025	<0.0049	<0.0028	0.039	0.027	<0.0045	0.18	**1**
SMWAF-UU20	0	mg/kg	<0.0063	<0.0038J	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.028	0.13	0.069	<0.0025	<0.0027	0.036	<0.0045	<0.0026	0.046	0.033	<0.0042	<0.0078	**1.1**
SMWAF-UU21	0	mg/kg	<0.0028	<0.0017J	<0.0025	<0.0028	<0.0017	<0.0022	<0.00097	0.024	0.099	0.061	<0.0011	<0.0012	0.03	<0.002	<0.0012	0.039	0.029	<0.0019	0.17J	**0.97**
SMWAF-UU22	0	mg/kg	<0.0068	<0.0041J	<0.0062	<0.0068	<0.0042	<0.0053	<0.0024	0.034	0.16	0.088	<0.0027	<0.0029	0.047	<0.0049	<0.0028	0.056	0.036	<0.0045	<0.0085	**1.4**
SMWAF-UU23	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.029	0.14	0.13	<0.0025	<0.0027	0.047	<0.0046	<0.0026	0.13	0.0076J	<0.0042	0.037J	**1.6**
SMWAF-UU24	0	mg/kg	<0.0022	<0.0023	<0.0035	0.0034	<0.0018	0.0066J	0.0035J	<0.0028	0.13	0.16J	**0.025NJ**	0.0072J	0.037J	<0.00098	0.029	0.044NJ	0.042J	0.0022	0.089NJ	**1.7**
SMWAF-VV9	0	mg/kg	<0.0065	<0.0039	<0.0059	<0.0065	<0.004	<0.0051	<0.0023	0.038	0.12	0.11	<0.0025	<0.0028	0.024	<0.0047	<0.0027	0.072	0.0059J	<0.0043	0.024J	**0.97**
SMWAF-VV10	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.02J	0.13	0.12	<0.0025	<0.0027	0.031	<0.0046	<0.0026	0.083	0.0053J	<0.0042	0.03J	**1.1**
SMWAF-VV11	0	mg/kg	<0.0062	<0.0038	<0.0057J	<0.0062J	<0.0039J	<0.0049	<0.0022J	0.016J	0.14	0.097	<0.0024J	<0.0027J	0.037	<0.0045J	<0.0026J	0.047	0.03	<0.0042J	<0.0078J	**1.1**
SMWAF-VV12	0	mg/kg	<0.0064	<0.0039	<0.0058J	<0.0064J	<0.0039J	<0.005	<0.0022J	0.016J	0.15	0.1	<0.0025J	<0.0028J	0.038	<0.0046J	<0.0027J	0.046	0.029	<0.0042J	<0.008J	**1.1**
SMWAF-VV13	0	mg/kg	<0.0064	<0.0039	<0.0058J	<0.0064J	<0.0039J	<0.005	<0.0022J	0.015J	0.16	0.11	<0.0025J	<0.0028J	0.045	<0.0046J	<0.0027J	0.046	0.029	<0.0042J	<0.008J	**1.2**
SMWAF-VV14	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.021	0.14	0.12	0.0056J	<0.0027	0.033	<0.0045	<0.0026	0.09	0.0055J	<0.0042	0.021J	**1.2**
SMWAF-VV15	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.023	0.15	0.11	<0.0024	<0.0027	0.033	<0.0045	<0.0026	0.086	0.0048J	<0.0042	0.016J	**1.1**
SMWAF-VV16	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.011J	0.16	0.14	<0.0024	<0.0027	0.042	<0.0045	<0.0026	0.11	0.0072J	<0.0041	0.026J	**1.4**
SMWAF-VV17	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.025	0.14	0.12	<0.0024	<0.0027	0.037	<0.0045	<0.0026	0.098	0.0057J	<0.0041	0.021J	**1.2**
SMWAF-VV18	0	mg/kg	<0.0063	<0.0039	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	<0.0033	0.13	0.12	<0.0025	<0.0027	0.039	<0.0046	0.023	0.13J	0.0084J	<0.0042	<0.0079	**1.3**
SMWAF-VV19	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.024	0.12	0.12	<0.0024	<0.0027	0.037	<0.0045	<0.0026	0.096	0.0059J	<0.0042	0.034J	**1.2**
SMWAF-VV20	0	mg/kg	<0.0069	<0.0042	<0.0063	<0.0069	<0.0042	<0.0054	<0.0024	0.012J	0.08	0.056	<0.0027	<0.003	0.021J	<0.005	<0.0029	0.056	<0.0036	<0.0046	<0.0086	**0.67**
SMWAF-VV21	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.0039	<0.005	<0.0022	0.02J	0.1	0.095	<0.0025	<0.0028	0.032	<0.0046	<0.0027	0.085	0.0058J	<0.0043	0.024J	**1.1**
SMWAF-VV22	0	mg/kg	<0.0068	<0.0042	<0.0063	<0.0068	<0.0042	<0.0054	<0.0024	0.029	0.14	0.13	0.0078J	<0.003	0.046	<0.005	<0.0029	0.12	0.0079J	<0.0046	0.031J	**1.5**
SMWAF-VV23	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0039	<0.0049	<0.0022	0.025	0.12	0.12	0.0065J	<0.0027	0.04	<0.0045	<0.0026	0.11	0.0064J	<0.0042	0.027J	**1.3**
SMWAF-VV24	0	mg/kg	<0.0022	<0.0023	<0.0034	0.0037	<0.0017	0.0052	0.0026	0.04	0.12	0.15	**0.023**	0.0065	0.041	<0.00095	<0.0011	0.061J	0.04	0.0019	0.085	**1.5**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

			Organochlorine Pesticides (Method 8081)																			
Location	Depth	Units	Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-WW11	0	mg/kg	<0.0068	<0.0041	<0.0063	<0.0068J	<0.0042	<0.0053	<0.0024	0.017J	0.2	0.13	<0.0027	<0.003	0.026	<0.0049	<0.0028	0.066	<0.0036	<0.0045	0.022J	**0.96**
SMWAF-WW12	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062J	<0.0038	<0.0049	<0.0022	0.019J	0.12	0.1	<0.0024	<0.0027	0.028	<0.0045	<0.0026	0.073	0.0043J	<0.0041	0.015J	**0.97**
SMWAF-WW13	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062J	<0.0038	<0.0048	<0.0022	0.019J	0.13	0.11	<0.0024	<0.0027	0.026	<0.0045	<0.0026	0.069	0.004J	<0.0041	0.015J	**0.94**
SMWAF-WW14	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062J	<0.0038	<0.0049	<0.0022	0.016J	0.15	0.12	<0.0024	<0.0027	0.033	<0.0045	<0.0026	0.087	0.0051J	<0.0041	0.017J	**1.1**
SMWAF-WW15	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062J	<0.0038	<0.0049	<0.0022	0.018J	0.15	0.12	<0.0024	<0.0027	0.033	<0.0045	<0.0026	0.09	0.0055J	<0.0041	0.018J	**1.2**
SMWAF-WW16	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.012J	0.14	0.098	<0.0025	<0.0027	0.036	<0.0046	<0.0026	0.049J	0.03J	<0.0042	0.18J	**1.2**
SMWAF-WW17	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063J	<0.0039	<0.0049	<0.0022	0.019J	0.16	0.13	<0.0025	<0.0027	0.041	<0.0045	<0.0026	0.11	0.006	<0.0042	0.02J	**1.3**
SMWAF-WW18	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.027	0.13	0.1	<0.0024	<0.0027	0.036	<0.0045	<0.0026	0.094	0.0063	<0.0042	0.02J	**1.4**
SMWAF-WW19	0	mg/kg	<0.0068	<0.0041	<0.0062	<0.0068	<0.0042	<0.0053	<0.0024	0.036	0.14	0.13	<0.0027	<0.0029	0.04	<0.0049	<0.0028	0.11	0.0063J	<0.0045	0.022J	**1.4**
SMWAF-WW20	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.014J	0.074	0.057	<0.0025	<0.0027	0.022	<0.0046	<0.0026	0.059	0.0035J	<0.0042	0.011J	**0.8**
SMWAF-WW21	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0048	<0.0022	0.016J	0.079	0.072	<0.0024	<0.0027	0.025	<0.0045	<0.0026	0.068	0.0045J	<0.0041	0.016J	**0.85**
SMWAF-WW22	0	mg/kg	<0.0064	<0.0039	<0.0058	<0.0064	<0.0039	<0.005	<0.0022	0.021	0.1	0.1	<0.0025	<0.0028	0.036	<0.0046	<0.0026	0.098	0.0063J	<0.0042	0.026J	**1.2**
SMWAF-WW23	0	mg/kg	<0.0064	<0.0039	<0.0058	<0.0064	<0.0039	<0.005	<0.0022	0.023	0.12	0.12	<0.0025	<0.0028	0.042	<0.0046	<0.0027	0.12	0.0068J	<0.0042	0.041J	**1.5**
SMWAF-WW24	0	mg/kg	<0.0022	<0.0023	<0.0034	0.0032	<0.0017	0.0056	<0.00055	<0.0027	0.13	0.16	**0.023**	0.0058	0.036	0.0099	<0.0011	0.048J	0.048	0.0019	0.11	**1.8**
SMWAF-WW25	0	mg/kg	<0.0022	<0.0023	<0.0035	<0.0017	<0.0018	0.0047	0.0021	0.026	0.32	0.38	**0.032**	0.011	0.048	0.017	0.039	0.083J	0.076	0.0047	0.18	**2.8**
SMWAF-XX13	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.012J	0.12	0.091	<0.0024	<0.0027	0.033	<0.0045	<0.0026	0.039J	0.024J	<0.0041	0.14J	**0.89**
SMWAF-XX14	0	mg/kg	<0.0064	<0.0039	<0.0058	<0.0064J	<0.0039	<0.005	<0.0022	0.019J	0.12	0.11	<0.0025	<0.0028	0.028	<0.0046	<0.0027	0.074	0.0051J	<0.0043	0.016J	**0.99**
SMWAF-XX15	0	mg/kg	<0.0066	<0.004	<0.0061	<0.0066J	<0.0041	<0.0052	<0.0023	0.0099J	0.058	0.046	<0.0026	<0.0029	0.013	<0.0048	<0.0028	0.034	<0.0035	<0.0044	<0.0083	**0.45**
SMWAF-XX16	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.017J	0.15	0.12	<0.0025	<0.0027	0.032	<0.0045	<0.0026	0.085	0.005J	<0.0042	0.017J	**1.1**
SMWAF-XX17	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.019	0.12	0.076	<0.0025	<0.0027	0.029	<0.0046	<0.0026	0.037	0.022	<0.0042	<0.0079	**0.83**
SMWAF-XX18	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.022	0.13	0.077	<0.0024	<0.0027	0.033	<0.0045	<0.0026	0.041	0.024	<0.0041	<0.0078	**0.92**
SMWAF-XX19	0	mg/kg	<0.0068	<0.0042	<0.0063	<0.0068	<0.0042	<0.0053	<0.0024	0.02J	0.12	0.071	<0.0027	<0.003	0.036	<0.005	<0.0028	0.041	0.023	<0.0046	<0.0085	**0.91**
SMWAF-XX20	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.0039	<0.005	<0.0022	<0.0033	0.1	0.058	<0.0025	<0.0028	0.031	<0.0046	<0.0027	0.037	0.019J	<0.0043	<0.008	**0.78**
SMWAF-XX21	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.012J	0.068	0.04	<0.0024	<0.0027	0.018J	<0.0045	<0.0026	0.022	0.014J	<0.0042	<0.0078	**0.54**
SMWAF-XX22	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.012J	0.06	0.041	<0.0024	<0.0027	0.018J	<0.0045	<0.0026	0.023	0.017J	<0.0042	<0.0078	**0.57**
SMWAF-XX23	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.023	0.097	0.065	<0.0025	<0.0027	0.03	<0.0046	<0.0026	0.039	0.028	<0.0042	<0.0079	**0.97**
SMWAF-XX24	0	mg/kg	<0.0022	<0.0023	<0.0035	0.003	<0.0018	0.0028	0.0012	<0.0028	0.12	0.16	**0.023**	0.0056	0.033	0.01	<0.0012	0.071J	0.049	<0.0013	0.1	**1.7**
SMWAF-XX25	0	mg/kg	<0.0023	<0.0024	<0.0036	0.0049	<0.0019	0.0067	<0.00058	0.013	0.13	0.16	0.02	0.0072	0.033	0.0072	<0.0012	0.043J	0.043	0.0025	0.093	**1.6**
SMWAF-YY15	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.017J	0.12	0.098	<0.0025	<0.0027	0.025	<0.0046	<0.0026	0.071	0.0033J	<0.0042	0.015J	**0.93**
SMWAF-YY16	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.004	<0.0051	<0.0023	0.018J	0.13	0.11	<0.0025	<0.0028	0.028	<0.0047	<0.0027	0.075	0.0047J	<0.0043	0.02J	**0.97**
SMWAF-YY17	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.004	<0.005	<0.0022	0.017J	0.12	0.095	<0.0025	<0.0028	0.026	<0.0046	<0.0027	0.071	0.004J	<0.0043	0.013J	**0.93**
SMWAF-YY18	0	mg/kg	<0.0066	<0.004	<0.0061	<0.0066	<0.0041	<0.0052	<0.0023	0.015J	0.11	0.084	<0.0026	<0.0029	0.023	<0.0048	<0.0028	0.063	<0.0035	<0.0044	<0.0083	**0.81**
SMWAF-YY19	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.0071J	0.049	0.041	<0.0025	<0.0027	0.011J	<0.0045	<0.0026	0.03	<0.0033	<0.0042	<0.0078	0.36
SMWAF-YY20	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.019J	0.11	0.099	<0.0025	<0.0027	0.028	<0.0046	<0.0026	0.077	0.0049J	<0.0042	0.015J	**1**
SMWAF-YY21	0	mg/kg	<0.0063	<0.0039	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.013J	0.078	0.07	<0.0025	<0.0027	0.02J	<0.0046	<0.0026	0.056	0.0033J	<0.0042	0.014J	**0.73**
SMWAF-YY22	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.011J	0.07	0.064	<0.0025	<0.0027	0.018J	<0.0046	<0.0026	0.049	<0.0033	<0.0042	0.017J	**0.65**
SMWAF-YY23	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.004	<0.005	<0.0022	0.017J	0.1	0.098	<0.0025	<0.0028	0.028	<0.0047	<0.0027	0.075	0.0046J	<0.0043	0.022J	**0.97**
SMWAF-YY24	0	mg/kg	<0.0013	<0.0014	<0.0021	0.0037	<0.0011	0.0049	0.0011	0.029	0.11	0.13	0.018	0.0044	0.025	0.0063	0.0042	0.038J	0.038	0.0027	0.081	**1.3**
SMWAF-YY25	0	mg/kg	<0.0011	<0.0012	<0.0018	0.0037J	<0.00091	0.0054	<0.00028	0.035	0.13	0.15	**0.021**	0.0047	0.029	<0.00049	0.0055	0.039	0.041	0.0028	0.091	**1.5**
SMWAF-ZZ16	0	mg/kg	<0.0013	<0.0014	<0.0021	<0.001J	<0.0011	0.0041	<0.00033	<0.0016	0.11	0.1	0.013	0.0031	0.019	<0.00058	0.021	0.026	0.025	0.0026	0.062	**0.99**
SMWAF-ZZ17	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.0039	<0.005	<0.0022	<0.0033	0.15	0.14	<0.0025	<0.0028	0.027	<0.0046	<0.0027	0.1J	0.007J	<0.0043	<0.008	**1.1**
SMWAF-ZZ18	0	mg/kg	<0.0063	<0.0039	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.018J	0.12	0.1	<0.0025	<0.0027	0.027	<0.0046	<0.0026	0.075	0.0044J	<0.0042	0.015J	**1**
SMWAF-ZZ19	0	mg/kg	<0.0063	<0.0039	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.019J	0.15	0.13	<0.0025	<0.0027	0.031	<0.0046	<0.0026	0.087	0.0042J	<0.0042	0.015J	**1.1**
SMWAF-ZZ20	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.004	<0.005	<0.0022	0.022	0.13	0.1	<0.0025	<0.0028	0.024	<0.0046	<0.0027	0.08	0.0058J	<0.0043	<0.008	**0.99**
SMWAF-ZZ21	0	mg/kg	<0.0065	<0.0039	<0.0059	<0.0065	<0.004	<0.0051	<0.0023	0.023	0.13	0.1	<0.0025	<0.0028	0.03	<0.0047	<0.0027	0.084	0.0053J	<0.0043	<0.0081	**1**
SMWAF-ZZ22	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.014J	0.089	0.068	<0.0025	<0.0027	0.021	<0.0045	<0.0026	0.058	0.0041J	<0.0042	<0.0078	**0.67**
SMWAF-ZZ23	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	0.016J	0.1	0.077	<0.0024	<0.0027	0.022	<0.0045	<0.0026	0.064	0.0042J	<0.0041	0.016J	**0.76**
SMWAF-ZZ24	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	<0.0032J	0.15J	0.14	**0.026J**	<0.0027	0.04	<0.0045	<0.0026J	0.12J	0.0086J	<0.0042	<0.0078	**1.3**
SMWAF-ZZ25	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.018J	0.16	0.13	0.018J	<0.0027	0.041	<0.0046	<0.0026	0.11	0.0084J	<0.0042	0.033J	**1.4**
SMWAF-ZZ26	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.039	0.28	0.18	**0.038**	<0.0027	0.052	<0.0046	<0.0026	0.13	0.0074J	<0.0042	0.043J	**1.6**

Table 1
Stuart Mesa West Agricultural Fields
Organochlorine Pesticides Detected in Soil Samples
MCB Camp Pendleton, California

Location	Depth	Units	Organochlorine Pesticides (Method 8081) Aldrin	BHC, alpha	BHC, beta	BHC, delta	BHC, gamma (Lindane)	Chlordane, alpha	Chlordane, gamma	4,4-DDD	4,4-DDE	4,4-DDT	Dieldrin	Endosulfan, alpha	Endosulfan, beta	Endosulfan sulfate	Endrin	Endrin aldehyde	Endrin ketone	Heptachlor epoxide	Methoxychlor	Toxaphene
Residential RSL		**mg/kg**	**0.029**	**0.077**	**0.27**	**0.27**	**0.52**	**1.6**	**1.6**	**2**	**1.4**	**1.7**	**0.03**	**370**	**370**	**370**	**18**	**18**	**18**	**0.053**	**310**	**0.44**
Industrial RSL		**mg/kg**	**0.1**	**0.27**	**0.96**	**0.96**	**2.1**	**6.5**	**6.5**	**7.2**	**5.1**	**7**	**0.11**	**3700**	**3700**	**3700**	**180**	**180**	**180**	**0.19**	**3100**	**1.6**
Resident RBSL		**mg/kg**	**0.02**	**0.09**	**0.31**	**0.13**	**0.50**	**0.42**	**0.42**	**2.29**	**1.62**	**1.62**	**0.02**	**364**	**364**	**364**	**1.51**	**1.51**	**1.51**	**0.05**	**1.37**	**0.44**
Industrial Worker RBSL		**mg/kg**	**0.05**	**0.31**	**1.09**	**0.44**	**1.66**	**1.40**	**1.40**	**7.59**	**5.36**	**5.36**	**0.05**	**2865**	**2865**	**2865**	**5.29**	**5.29**	**5.29**	**0.15**	**2388**	**1.22**
Maneuver Trainer RBSL		**mg/kg**	**0.25**	**1.55**	**5.42**	**8.22**	**2.19**	**6.95**	**6.95**	**37.67**	**26.59**	**26.59**	**0.270**	**2843**	**2843**	**2843**	**5.24**	**5.24**	**5.24**	**0.73**	**2369**	**6.03**
Heavy Equipment/Engineering RBSL		**mg/kg**	**0.28**	**1.82**	**6.38**	**9.60**	**0.21**	**8.13**	**8.13**	**43.99**	**31.05**	**31.05**	**0.298**	**13003**	**13003**	**13003**	**22.09**	**22.09**	**22.09**	**0.83**	**10835**	**6.84**
Construction Worker RBSL		**mg/kg**	**0.34**	**2.19**	**7.65**	**0.26**	**11.52**	**2.97**	**2.97**	**52.79**	**37.26**	**37.26**	**0.36**	**780**	**780**	**780**	**1.33**	**1.33**	**1.33**	**0.99**	**650**	**8.20**
MOUT Trainer RBSL		**mg/kg**	**0.67**	**4.06**	**14.22**	**21.57**	**5.75**	**18.26**	**18.26**	**98.88**	**69.80**	**69.80**	**0.710**	**7462**	**7462**	**7462**	**13.77**	**13.77**	**13.77**	**1.91**	**6218**	**15.83**
SMWAF-AAA17	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.013	0.18	0.11	<0.0024	<0.0027	0.044	<0.0045	<0.0026	0.044	0.026	<0.0042	<0.0078	**1.1**
SMWAF-AAA18	0	mg/kg	<0.0064	<0.0039	<0.0058	<0.0064	<0.0039	<0.005	<0.0022	0.013	0.18	0.12	<0.0025	<0.0028	0.037	<0.0046	<0.0026	0.047	0.029	<0.0042	<0.0079	**1.1**
SMWAF-AAA19	0	mg/kg	<0.0064	<0.0039	<0.0058	<0.0064	<0.0039	<0.005	<0.0022	<0.0033	0.18	0.16J	<0.0025	<0.0028	0.039	<0.0046	<0.0027	0.12J	0.0078J	<0.0042	<0.008	**1.3**
SMWAF-AAA20	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.005	<0.0022	0.014	0.17	0.1	<0.0025	<0.0027	0.037	<0.0046	<0.0026	0.044	0.025	<0.0042	<0.0079	**0.98**
SMWAF-AAA21	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.014	0.17	0.099	<0.0025	<0.0027	0.036	<0.0046	<0.0026	0.047	0.029	<0.0042	<0.0079	**1.1**
SMWAF-AAA22	0	mg/kg	<0.0064	<0.0039	<0.0058	<0.0064	<0.0039	<0.005	<0.0022	<0.0033	0.12	0.08	<0.0025	<0.0028	0.028	<0.0046	<0.0027	0.037	0.024	<0.0042	<0.008	**0.86**
SMWAF-AAA23	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	<0.0033	0.1	0.064	<0.0025	<0.0027	0.027	<0.0046	<0.0026	0.032	0.018J	<0.0042	<0.0079	**0.7**
SMWAF-AAA24	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	<0.0022	<0.0032	0.11	0.066	0.0094J	<0.0027	0.027	<0.0045	<0.0026	0.033	0.02J	<0.0041	<0.0078	**0.75**
SMWAF-AAA25	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0039	<0.0049	<0.0022	0.0057J	0.13	0.084	0.011J	<0.0027	0.032	<0.0045	<0.0026	0.04	0.026	<0.0042	<0.0078	**0.95**
SMWAF-AAA26	0	mg/kg	<0.0064	<0.0039	<0.0058	<0.0064	<0.0039	<0.005	<0.0022	<0.0033	0.12	0.11	<0.0025	<0.0028	0.029	<0.0046	<0.0027	0.089J	0.0051J	<0.0043	0.018J	**0.96**
SMWAF-BBB18	0	mg/kg	<0.0062	<0.0038	<0.0057	<0.0062	<0.0038	<0.0049	0.0032J	0.01J	0.17	0.11	<0.0024	<0.0027	0.037	<0.0045	<0.0026	0.039	0.022	<0.0041	<0.0078	**0.99**
SMWAF-BBB19	0	mg/kg	<0.0072	<0.0044	<0.0066	<0.0072	<0.0044	<0.0056	<0.0025	0.0077J	0.1	0.066	<0.0028	<0.0031	0.021J	<0.0052	<0.003	0.028	0.017J	<0.0048	<0.0089	**0.67**
SMWAF-BBB20	0	mg/kg	<0.0064	<0.0039	<0.0059	<0.0064	<0.004	<0.005	<0.0023	0.01J	0.14	0.098	<0.0025	<0.0028	0.029	<0.0047	<0.0027	0.041	0.024	<0.0043	<0.0081	**0.96**
SMWAF-BBB21	0	mg/kg	<0.0067	<0.0041	<0.0061	<0.0067	<0.0041	<0.0052	<0.0023	0.0089J	0.14	0.096	<0.0026	<0.0029	0.031	<0.0049	<0.0028	0.035	0.021J	<0.0045	<0.0084	**0.89**
SMWAF-BBB22	0	mg/kg	<0.0065	<0.004	<0.006	<0.0065	<0.004	<0.0051	<0.0023	<0.0034J	0.099J	0.077J	<0.0025J	<0.0028	0.021J	<0.0047J	<0.0027	0.059J	0.0049J	<0.0043	0.018J	**0.71**
SMWAF-BBB23	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.011J	0.12	0.088	<0.0025	<0.0027	0.026	<0.0045	<0.0026	0.041	0.027	<0.0042	0.15	**0.99**
SMWAF-BBB24	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.022	0.11	0.098	<0.0024	<0.0027	0.027	<0.0045	<0.0026	0.08	0.0059J	<0.0042	0.022J	**0.95**
SMWAF-BBB25	0	mg/kg	<0.0063	<0.0038	<0.0057	<0.0063	<0.0039	<0.0049	<0.0022	0.021	0.12	0.093	<0.0025	<0.0027	0.028	<0.0045	<0.0026	0.076	0.0051J	<0.0042	0.023J	**0.92**
SMWAF-BBB26	0	mg/kg	<0.0063	<0.0038	<0.0058	<0.0063	<0.0039	<0.0049	<0.0022	0.018J	0.12	0.095	<0.0025	<0.0027	0.028	<0.0046	<0.0026	0.076	0.0054J	<0.0042	<0.0079	**0.91**
SMWAF-CCC19	0	mg/kg	<0.011	<0.011	<0.017	<0.0082J	<0.0088	<0.01	<0.0027	0.04	0.54	0.34	**0.027**	0.02	<0.0052	0.016	<0.0057	0.049	<0.018	<0.0062	0.11	**1.7**
SMWAF-CCC20	0	mg/kg	<0.0023	<0.0024	<0.0037	<0.0018	<0.0019	0.0064J	0.0014J	0.036	0.18	0.18J	0.018NJ	0.0054J	0.025J	0.0083J	0.005J	0.038NJ	0.039J	0.0045J	0.093NJ	**1.4**
SMWAF-CCC21	0	mg/kg	<0.0013	<0.0014	<0.002	<0.00099J	<0.001	0.0044	<0.00033	<0.0016	0.15	0.15	0.013	0.0046	0.022	0.0066	0.022	0.032	0.03	0.0049	0.076	**1.2**
SMWAF-CCC22	0	mg/kg	<0.0022	<0.0023	<0.0035	<0.0017J	<0.0018	0.0043	<0.0027	0.019	0.19	0.16	0.018	0.0069	0.026	<0.00097	0.0057	0.034	0.032	0.0033	0.074	**1.3**
SMWAF-CCC23	0	mg/kg	<0.0023	<0.0024	<0.0036	0.0023J	<0.0018	0.0055	<0.00057	<0.0028	0.15	0.16	0.018	0.0066	0.023	<0.00099	0.028	0.04	0.037	0.0034	0.085	**1.4**
SMWAF-CCC24	0	mg/kg	<0.0022	<0.0023	<0.0034	<0.0017J	<0.0018	0.0064	<0.0014	0.036	0.16	0.17	0.018	0.007	0.027	0.0084	0.006	0.038	0.04	0.0035	0.099	**1.5**
SMWAF-CCC25	0	mg/kg	<0.0043	<0.0045	<0.0067	<0.0033J	<0.0035	<0.0041	<0.0011	<0.0053	0.16	0.15	0.013	0.0058	0.018	0.0057	0.017	0.028	0.025	<0.0024	0.062	**0.97**
SMWAF-CCC26	0	mg/kg	<0.011	<0.012	<0.017	<0.0085J	<0.009	<0.011	<0.0028	<0.014	0.3	0.19	0.015	<0.0027	<0.0053	<0.0049	<0.0058	0.024	<0.018	<0.0063	<0.069	<1.1
SMWAF-CCC27	0	mg/kg	<0.0052	<0.0055	<0.0082	<0.004J	<0.0042	<0.005	<0.0013	<0.0065	0.16	0.075	0.0065	<0.0013	<0.0025	<0.0023	0.0065	0.0098	<0.0085	<0.003	<0.032	<0.5

mg/kg = milligrams per kilogram
ft bgs = feet below ground surface
RSL = Regional Screening Levels for Chemical Contaminants at Superfund Sites, November, 2011.
RBSL = Risked Based Screening Level
J = estimated value
NJ = tentatively identified compound
<0.00061 = not detected at indicated value
5-YR = 5-Year Exposure
20-YR = 20-Year Exposure
Explanation of Color Coding

1.1	Concentration above RBSL for Residential, but below RBSLs for Industrial Workers, Maneuver Trainer, Heavy Equipment/Engineering, MOUT Trainer, and Construction Worker
1.3	Concentration above RBSLs for Residential and Industrial Workers, but below RBSLs for Maneuver Trainer, Heavy Equipment/Engineering, MOUT Trainer, and Construction Worker
6.2	Concentration above RBSLs for Residential, Industrial Worker, and Maneuver Trainer, but below RBSLs for Heavy Equipment/Engineering, MOUT Trainer, and Construction Worker
6.9	Concentration above RBSLs for Residential, Industrial Worker, Maneuver Trainer, and Heavy Equipment/Engineering, but below RBSLs for MOUT Trainer and Construction Worker
11	Concentration above RBSLs for Residential, Industrial Worker, Maneuver Trainer, Heavy Equipment/Engineering, and Construction Worker, but below RBSL for MOUT Trainer

Note: Color codes in table heading show which chemicals are above the indicated RBSLs

Table 2
Summary Statistics and Exposure Point Concentrations for Chemicals Detected in Grid Soil Samples[1]
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

Chemical	N	ND	%ND	MinD (mg/kg)	MaxD (mg/kg)	ProUCLDistr[2]	ProUCL UCL[3] (mg/kg)	Exposure Point Concentrations: Soil (mg/kg) Residents	Soil (mg/kg) Workers/Trainers[4,5]	Air (mg/m^3) Residents	Air (mg/m^3) Workers/Trainers[4]	Air (mg/m^3) Construction/Heavy Equip.[5]
Aldrin	802	768	96%	0.00031	0.0019	95% KM (t) UCL	3.70E-04	1.90E-03	3.70E-04	1.44E-12	2.81E-13	3.70E-10
BHC, alpha	802	759	95%	0.0002	0.00064	95% KM (t) UCL	2.28E-04	6.40E-04	2.28E-04	4.86E-13	1.73E-13	2.28E-10
BHC, beta	802	749	93%	0.00034	0.017	95% KM (t) UCL	4.89E-04	1.70E-02	4.89E-04	1.29E-11	3.71E-13	4.89E-10
BHC, gamma	802	800	100%	0.0049	0.006	95% KM (t) UCL	4.90E-03	6.00E-03	4.90E-03	4.56E-12	3.72E-12	4.90E-09
BHC, delta	801	731	91%	0.00037	0.058	95% KM (t) UCL	1.04E-03	5.80E-02	1.04E-03	4.41E-11	7.90E-13	1.04E-09
Chlordane, alpha	802	600	75%	0.00044	0.023	95% KM (t) UCL	2.10E-03	2.30E-02	2.10E-03	1.75E-11	1.60E-12	2.10E-09
Chlordane, gamma	802	665	83%	0.00036	0.028	95% KM (t) UCL	1.11E-03	2.80E-02	1.11E-03	2.13E-11	8.43E-13	1.11E-09
DDD	802	319	40%	0.00097	0.54	95% KM (BCA) UCL	1.63E-02	5.40E-01	1.63E-02	4.10E-10	1.24E-11	1.63E-08
DDE	802	1	0%	0.02	5.4	95% KM (BCA) UCL	2.02E-01	5.40E+00	2.02E-01	4.10E-09	1.53E-10	2.02E-07
DDT	802	0	0%	0.006	5.6	95% Chebyshev UCL	1.87E-01	5.60E+00	1.87E-01	4.26E-09	1.42E-10	1.87E-07
Dieldrin	802	435	54%	0.00068	0.18	95% KM (t) UCL	1.01E-02	1.80E-01	1.01E-02	1.37E-10	7.67E-12	1.01E-08
Endosulfan I	802	672	84%	0.00021	0.19	95% KM (t) UCL	2.39E-03	1.90E-01	2.39E-03	1.44E-10	1.82E-12	2.39E-09
Endosulfan II	802	69	9%	0.0025	0.3	95% KM (BCA) UCL	3.27E-02	3.00E-01	3.27E-02	2.28E-10	2.48E-11	3.27E-08
Endosulfan sulfate	802	615	77%	0.00077	0.22	95% KM (t) UCL	5.12E-03	2.20E-01	5.12E-03	1.67E-10	3.89E-12	5.12E-09
Endrin	802	629	78%	0.002	0.25	95% KM (t) UCL	8.32E-03	2.50E-01	8.32E-03	1.90E-10	6.32E-12	8.32E-09
Endrin aldehyde	802	360	45%	0.0016	0.91	95% KM (t) UCL	3.95E-02	9.10E-01	3.95E-02	6.91E-10	3.00E-11	3.95E-08
Endrin ketone	802	426	53%	0.00049	0.24	95% KM (t) UCL	1.41E-02	2.40E-01	1.41E-02	1.82E-10	1.07E-11	1.41E-08
Heptachlor	802	802	100%	-	-	-	-	-	-	-	-	-
Heptachlor epoxide	802	701	87%	0.00038	0.13	95% KM (BCA) UCL	1.90E-03	1.30E-01	1.90E-03	9.88E-11	1.44E-12	1.90E-09
Methoxychlor	802	407	51%	0.0018	3.5	95% KM (BCA) UCL	6.17E-02	3.50E+00	6.17E-02	2.66E-09	4.69E-11	6.17E-08
Toxaphene	802	5	1%	0.055	12.00	95% KM (BCA) UCL	1.32E+00	1.20E+01	1.32E+00	9.12E-09	1.00E-09	1.32E-06

Notes:

1 - This only includes the data collected in September and October 2011.
2 - The method and distribution used by ProUCL (USEPA 2010) to calculate the recommended UCL
3 - The 1st recommended UCL from ProUCL (USEPA 2010)
4 - Includes maneuver and MOUT trainers
5 - Includes heavy equipment/engineer trainers

Definitions:

N Total number of samples analyzed
ND Number of non-detects
%ND Percentage of nondetects
MinD Minimum detected value
MaxD Maximum detected value
UCL Upper confidence limit

Table 3
USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

	Cancer Potency Values				Noncarcinogenic Effects					
COPC	**SF (mg/kg-day)$^{-1}$**	**IUR (µg/m^3)**	**Source**	**Date**	**RfD (mg/kg-day)**	**RfC (mg/m^3)**	**Source**	**Date**	**ABS[3] (unitless)**	**OAF[3] (unitless)**
Aldrin	1.70E+01	4.90E-03	IRIS	Jan-12	3.00E-05	-	IRIS	Jan-12	0.1	0.5
BHC, alpha	6.30E+00	1.80E-03	IRIS	Jan-12	8.00E-03	-	ATSDR	Jan-12	0.04	1
BHC, beta	1.80E+00	5.30E-04	IRIS	Jan-12	-	-	-	-	0.04	1
BHC, gamma	1.10E+00	3.10E-04	OEHHA	Jan-12	3.00E-04	-	IRIS	Jan-12	0.04	1
BHC, delta	1.80E+00	5.10E-04	IRIS;1	Jan-12	-	-	-	-	0.04	1
Chlordane, alpha	3.50E-01	1.00E-04	IRIS	Jan-12	5.00E-04	7.00E-04	IRIS	Jan-12	0.04	1
Chlordane, gamma	3.50E-01	1.00E-04	IRIS	Jan-12	5.00E-04	7.00E-04	IRIS	Jan-12	0.04	1
DDD	2.40E-01	6.90E-05	IRIS/OEHHA	Jan-12	5.00E-04	-	IRIS;2	Jan-12	0.03	1
DDE	3.40E-01	9.70E-05	IRIS/OEHHA	Jan-12	5.00E-04	-	IRIS;2	Jan-12	0.03	1
DDT	3.40E-01	9.70E-05	IRIS	Jan-12	5.00E-04	-	IRIS	Jan-12	0.03	1
Dieldrin	1.60E+01	4.60E-03	IRIS	Jan-12	5.00E-05	-	IRIS	Jan-12	0.1	0.5
Endosulfan I	-	-	-	-	6.00E-03	-	IRIS	Jan-12	0.1	1
Endosulfan II	-	-	-	-	6.00E-03	-	IRIS	Jan-12	0.1	1
Endosulfan sulfate	-	-	-	-	6.00E-03	-	IRIS	Jan-12	0.1	1
Endrin	-	-	-	-	3.00E-04	-	IRIS	Jan-12	0.1	0.02
Endrin aldehyde	-	-	-	-	3.00E-04	-	IRIS	Jan-12	0.1	0.02
Endrin ketone	-	-	-	-	3.00E-04	-	IRIS	Jan-12	0.1	0.02
Heptachlor	4.50E+00	1.30E-03	IRIS	Jan-12	5.00E-04	-	IRIS	Jan-12	0.1	1
Heptachlor epoxide	9.10E+00	2.60E-03	IRIS	Jan-12	1.30E-05	-	IRIS	Jan-12	0.1	1
Methoxychlor	-	-	-	-	5.00E-03	-	IRIS	Jan-12	0.1	1
Toxaphene	1.10E+00	3.20E-04	IRIS	Jan-12	-	-	-	-	0.1	1

Notes:
1 - No toxicity data. Technical BHC used as a surrogate
2 - No toxicity data. DDT used as a surrogate, as per DTSC (1999) guidance.
3 - From USEPA (2004) and Bast and Borges (1996), with USEPA (2004) given priority

Definitions:
ABS - Dermal absorption factor
IUR - Inhalation unit risk
OAF - Oral absorption factor
RfC - Reference concentration
RfD - Reference dose
SF - Slope factor

Table 4
California Modified Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Cancer Potency Values				Noncarcinogenic Effects						ABS[4] (unitless)	OAF[5] (unitless)
	SF $(mg/kg\text{-}day)^{-1}$	IUR $(\mu g/m^3)$	Source	Date	RfD (mg/kg-day)	RfC (mg/m^3)	Source	chRD (mg/kg-day)	chRD Source	chRD Date		
Aldrin	1.70E+01	4.90E-03	OEHHA	Jan-12	3.00E-05	1.05E-04	IRIS;2	-	-	Jan-12	0.05	0.5
BHC, alpha	2.70E+00	7.70E-04	OEHHA	Jan-12	8.00E-03	2.80E-02	ATSDR;2	-	-	Jan-12	0.05	1
BHC, beta	1.50E+00	4.30E-04	OEHHA	Jan-12	-	-	-	-	-	-	0.05	1
BHC, gamma	1.10E+00	3.10E-04	OEHHA	Jan-12	3.00E-04	1.05E-03	IRIS;2	-	-	Jan-12	0.05	1
BHC, delta	4.00E+00	1.10E+00	OEHHA;1	Jan-12	-	-	-	-	-	-	0.05	1
Chlordane, alpha	1.30E+00	3.40E-04	OEHHA	Jan-12	5.00E-04	7.00E-04	IRIS	3.30E-05	OEHHA	Jan-12	0.05	1
Chlordane, gamma	1.30E+00	3.40E-04	OEHHA	Jan-12	5.00E-04	7.00E-04	IRIS	3.30E-05	OEHHA	Jan-12	0.05	1
DDD	2.40E-01	6.90E-05	OEHHA	Jan-12	5.00E-04	1.75E-03	IRIS;2,3	-	-	Jan-12	0.05	1
DDE	3.40E-01	9.70E-05	OEHHA	Jan-12	5.00E-04	1.75E-03	IRIS;2,3	-	-	Jan-12	0.05	1
DDT	3.40E-01	9.70E-05	OEHHA	Jan-12	5.00E-04	1.75E-03	IRIS;2	-	-	Jan-12	0.05	1
Dieldrin	1.60E+01	4.60E-03	OEHHA	Jan-12	5.00E-05	1.75E-04	IRIS;2	-	-	Jan-12	0.05	0.5
Endosulfan I	-	-	-	-	6.00E-03	2.10E-02	IRIS;2	-	-	Jan-12	0.05	1
Endosulfan II	-	-	-	-	6.00E-03	2.10E-02	IRIS;2	-	-	Jan-12	0.05	1
Endosulfan sulfate	-	-	-	-	6.00E-03	2.10E-02	IRIS;2	-	-	Jan-12	0.05	1
Endrin	-	-	-	-	3.00E-04	1.05E-03	IRIS;2	-	-	Jan-12	0.05	0.02
Endrin aldehyde	-	-	-	-	3.00E-04	1.05E-03	IRIS;2	-	-	Jan-12	0.05	0.02
Endrin ketone	-	-	-	-	3.00E-04	1.05E-03	IRIS;2	-	-	Jan-12	0.05	0.02
Heptachlor	4.10E+00	1.30E-03	OEHHA/IRIS	Jan-12	5.00E-04	1.75E-03	IRIS;2	3.00E-05	OEHHA	Jan-12	0.05	1
Heptachlor epoxide	5.50E+00	2.60E-03	OEHHA/IRIS	Jan-12	1.30E-05	4.55E-05	IRIS;2	1.30E-05	OEHHA	Jan-12	0.05	1
Methoxychlor	-	-	-	-	5.00E-03	1.75E-02	IRIS;2	2.00E-05	OEHHA	Jan-12	0.05	1
Toxaphene	1.20E+00	3.40E-04	Cal EPA	Jan-12	-	-	-	-	-	-	0.05	1

Notes:

1 - No toxicity data. Technical BHC used as a surrogate
2 - No inhalation toxicity data. RfD converted to RfC.
3 - No toxicity data. DDT used as a surrogate, as per DTSC (1999) guidance.
4 - From DTSC (1999).
5 - From USEPA (2004) and Bast and Borges (1996), with USEPA (2004) given priority

Definitions:

ABS - Dermal absorption factor
chRD - Child reference dose
IUR - Inhalation unit risk
OAF - Oral absorption factor
RfC - Reference concentration
RfD - Reference dose
SF - Slope factor

Table 5
Exposure Equations and Factors
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

Exposure from soil ingestion (mg/kg-day) (USEPA 1989):

$$\text{Exposure} = \frac{C_s \times IR \times CF \times EF \times ED}{BW \times AT}$$

Exposure from dermal contact with soil (mg/kg-day) (USEPA 1989, 2004):

$$\text{Exposure} = \frac{C_s \times AF \times ABS \times CF \times SA \times EF \times ED}{BW \times AT}$$

Exposure to dusts (mg/m^3) (USEPA 2009):

$$\text{Exposure} = \frac{C_a \times EF \times ED \times ET}{AT}$$

Variable	Parameter		Value		Source
ABS	Absorption fraction		chemical-specific	unitless	See Tables 4-5
AF	Soil Adherence Factor				
		Resident - adult	0.07	mg/cm^2-day	DTSC (2011), USEPA (2002, 2004)
		Resident - child	0.2	mg/cm^2-day	DTSC (2011), USEPA (2002, 2004)
		Industrial worker	0.2	mg/cm^2-day	DTSC (2011), USEPA (2002, 2004)
		Construction worker	0.8	mg/cm^2-day	DTSC (2011)
		Maneuver/MOUT traineer	0.2	mg/cm^2-day	Assumed equivalent to industrial worker
		Heavy equipment/engineering trainer	0.8	mg/cm^2-day	Assumed equivalent to construction worker
AT	Averaging time				
		Carcinogens	25,550	days	DTSC (2011), USEPA (1989)
		Noncarcinogens			
		Resident - child	2,190	days	ED x 365; DTSC (2011), USEPA (1989)
		Industrial worker	9,125	days	ED x 365; DTSC (2011), USEPA (1989)
		Construction worker	365	days	ED x 365; DTSC (2011), USEPA (1989)
		Maneuver/MOUT traineer	1,825	days	ED x 365; DTSC (2011), USEPA (1989)
		Heavy equipment/engineering trainer	7,300	days	ED x 365; DTSC (2011), USEPA (1989)
BW	Body weight				
		Resident - adult	70	kg	DTSC (2011), USEPA (1989, 2002)
		Resident - child	15	kg	DTSC (2011), USEPA (1989, 2002)
		Industrial worker	70	kg	DTSC (2011), USEPA (1989, 2002)
		Construction worker	70	kg	DTSC (2011), USEPA (1989, 2002)
		Maneuver/MOUT traineer	70	kg	DTSC (2011), USEPA (1989, 2002)
		Heavy equipment/engineering trainer	70	kg	DTSC (2011), USEPA (1989, 2002)
C_a	Concentration in air (dust)		chemical-specific	mg/m^3	See Table 6
C_s	Concentration in soil		chemical-specific	mg/kg	See Table 6
CF	Conversion factor		1.E-06	kg/mg	
ED	Exposure duration				
		Resident - adult	24	yrs	DTSC (2011), USEPA (1989, 2002)
		Resident - child	6	yrs	DTSC (2011), USEPA (1989, 2002)
		Industrial worker	25	yrs	DTSC (2011), USEPA (1989)
		Construction worker	1	yr	DTSC (2011)
		Military trainers	5	yrs	Maximum duration of single enlistment
		Military trainers	20	yrs	Maximum career duation
EF	Exposure frequency				
		Resident	350	days/yr	DTSC (2011), USEPA (1989, 2002)
		Industrial worker	250	days/yr	DTSC (2011), USEPA (2002)
		Construction worker	250	days/yr	DTSC (2011)
		Maneuver trainer	252	days/yr	Site-specific
		MOUT trainer	96	days/yr	Site-specific
		Heavy equipment/engineering trainer	60	days/yr	Site-specific
ET	Exposure time (i.e., fraction of day spent at the site)				
		Resident	1	Unitless	USEPA (2009)
		Industrial worker	0.33	Unitless	USEPA (2009)
		Construction worker	0.33	Unitless	USEPA (2009)
		Maneuver/MOUT traineer	0.33	Unitless	Assume at site 8 hrs/day
		Heavy equipment/engineering trainer	0.33	Unitless	Assume at site 8 hrs/day

Table 5
Exposure Equations and Factors
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

IR	Soil ingestion rate				
		Resident - adult	100	mg/day	DTSC (2011), USEPA (1989, 2002)
		Resident - child	200	mg/day	DTSC (2011), USEPA (1989, 2002)
		Industrial worker	100	mg/day	DTSC (2011), USEPA (1989, 2002)
		Construction worker	330	mg/day	DTSC (2011), USEPA (2002)
		Maneuver/MOUT traineer	100	mg/day	Assumed equivalent to industrial worker
		Heavy equipment/engineering trainer	330	mg/day	Assumed equivalent to construction worker
PEF	Particulate emission factor				
		Resident	1.316E+09	m^3/kg	DTSC (2011)
		Industrial worker	1.316E+09	m^3/kg	DTSC (2011)
		Construction worker	1.00E+06	m^3/kg	DTSC (2011)
		Maneuver/MOUT traineer	1.316E+09	m^3/kg	Assumed equivalent to industrial worker
		Heavy equipment/engineering trainer	1.00E+06	m^3/kg	Assumed equivalent to construction worker
SA	Skin surface area				
		Resident - adult	5,700	cm^2	DTSC (2011), USEPA (2002, 2004)
		Resident - child	2,900	cm^2	DTSC (2011)
		Industrial worker	5,700	cm^2	DTSC (2011)
		Construction worker	5,700	cm^2	DTSC (2011)
		Maneuver/MOUT traineer	5,700	cm^2	Assumed equivalent to industrial worker
		Heavy equipment/engineering trainer	5,700	cm^2	Assumed equivalent to construction worker

Table 6
Residents
Cancer Risks and Noncancer Hazards - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Risk Probabilities				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	5.06E-08	3.26E-08	2.91E-12	8.32E-08	0%
BHC, alpha	6.31E-09	8.15E-10	3.60E-13	7.13E-09	0%
BHC, beta	4.79E-08	6.18E-09	2.81E-12	5.41E-08	0%
BHC, gamma	1.03E-08	1.33E-09	5.81E-13	1.17E-08	0%
BHC, delta	1.63E-07	2.11E-08	9.24E-12	1.85E-07	0%
Chlordane, alpha	1.26E-08	1.63E-09	7.18E-13	1.42E-08	0%
Chlordane, gamma	1.53E-08	1.98E-09	8.74E-13	1.73E-08	0%
DDD	2.03E-07	1.96E-08	1.16E-11	2.23E-07	1%
DDE	2.87E-06	2.78E-07	1.64E-10	3.15E-06	7%
DDT	2.98E-06	2.89E-07	1.70E-10	3.27E-06	7%
Dieldrin	4.51E-06	2.91E-06	2.59E-10	7.42E-06	17%
Endosulfan I	-	-	-	-	-
Endosulfan II	-	-	-	-	-
Endosulfan sulfate	-	-	-	-	-
Endrin	-	-	-	-	-
Endrin aldehyde	-	-	-	-	-
Endrin ketone	-	-	-	-	-
Heptachlor	-	-	-	-	-
Heptachlor epoxide	1.85E-06	5.98E-07	1.06E-10	2.45E-06	6%
Toxaphene	2.07E-05	6.67E-06	1.20E-09	2.73E-05	62%
Summation	3E-05	1E-05	2E-09	4E-05	

COPC	Hazard Index (HI)				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	8.10E-04	4.70E-04	-	1.28E-03	0%
BHC, alpha	1.02E-06	1.19E-07	-	1.14E-06	0%
BHC, beta	-	-	-	-	-
BHC, gamma	2.56E-04	2.97E-05	-	2.85E-04	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	5.88E-04	6.82E-05	2.39E-08	6.56E-04	0%
Chlordane, gamma	7.16E-04	8.31E-05	2.91E-08	7.99E-04	0%
DDD	1.38E-02	1.20E-03	-	1.50E-02	1%
DDE	1.38E-01	1.20E-02	-	1.50E-01	10%
DDT	1.43E-01	1.25E-02	-	1.56E-01	10%
Dieldrin	4.60E-02	2.67E-02	-	7.27E-02	5%
Endosulfan I	4.05E-04	1.17E-04	-	5.22E-04	0%
Endosulfan II	6.39E-04	1.85E-04	-	8.25E-04	0%
Endosulfan sulfate	4.69E-04	1.36E-04	-	6.05E-04	0%
Endrin	1.07E-02	1.54E-01	-	1.65E-01	11%
Endrin aldehyde	3.88E-02	5.62E-01	-	6.01E-01	40%
Endrin ketone	1.02E-02	1.48E-01	-	1.59E-01	11%
Heptachlor epoxide	1.28E-01	3.71E-02	-	1.65E-01	11%
Methoxychlor	8.95E-03	2.60E-03	-	1.15E-02	1%
Toxaphene	-	-	-	-	-
Summation	0.5	1	5E-08	1	

Table 7
Residents
Cancer Risks and Noncancer Hazards - Cal EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Risk Probabilities				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	5.06E-08	1.63E-08	2.91E-12	6.69E-08	0%
BHC, alpha	2.71E-09	4.36E-10	1.54E-13	3.14E-09	0%
BHC, beta	3.99E-08	6.44E-09	2.28E-12	4.64E-08	0%
BHC, gamma	1.03E-08	1.67E-09	5.81E-13	1.20E-08	0%
BHC, delta	3.63E-07	5.86E-08	1.99E-08	4.42E-07	1%
Chlordane, alpha	4.68E-08	7.55E-09	2.44E-12	5.44E-08	0%
Chlordane, gamma	5.70E-08	9.19E-09	2.97E-12	6.62E-08	0%
DDD	2.03E-07	3.27E-08	1.16E-11	2.36E-07	1%
DDE	2.87E-06	4.64E-07	1.64E-10	3.34E-06	8%
DDT	2.98E-06	4.81E-07	1.70E-10	3.46E-06	8%
Dieldrin	4.51E-06	1.45E-06	2.59E-10	5.96E-06	14%
Endosulfan I	-	-	-	-	-
Endosulfan II	-	-	-	-	-
Endosulfan sulfate	-	-	-	-	-
Endrin	-	-	-	-	-
Endrin aldehyde	-	-	-	-	-
Endrin ketone	-	-	-	-	-
Heptachlor epoxide	1.12E-06	1.81E-07	1.06E-10	1.30E-06	3%
Methoxychlor	-	-	-	-	-
Toxaphene	2.25E-05	3.64E-06	1.27E-09	2.62E-05	64%
Summation	3E-05	6E-06	2E-08	4E-05	

COPC	Hazard Index (HI)				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	8.10E-04	2.35E-04	1.32E-08	1.04E-03	0%
BHC, alpha	1.02E-06	1.48E-07	1.67E-11	1.17E-06	0%
BHC, beta	-	-	-	-	-
BHC, gamma	2.56E-04	3.71E-05	4.16E-09	2.93E-04	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	8.91E-03	1.29E-03	2.39E-08	1.02E-02	0%
Chlordane, gamma	1.08E-02	1.57E-03	2.91E-08	1.24E-02	0%
DDD	1.38E-02	2.00E-03	2.25E-07	1.58E-02	0%
DDE	1.38E-01	2.00E-02	2.25E-06	1.58E-01	4%
DDT	1.43E-01	2.08E-02	2.33E-06	1.64E-01	5%
Dieldrin	4.60E-02	1.33E-02	7.49E-07	5.94E-02	2%
Endosulfan I	4.05E-04	5.87E-05	6.59E-09	4.64E-04	0%
Endosulfan II	6.39E-04	9.27E-05	1.04E-08	7.32E-04	0%
Endosulfan sulfate	4.69E-04	6.80E-05	7.63E-09	5.37E-04	0%
Endrin	1.07E-02	7.72E-02	1.73E-07	8.79E-02	2%
Endrin aldehyde	3.88E-02	2.81E-01	6.31E-07	3.20E-01	9%
Endrin ketone	1.02E-02	7.42E-02	1.67E-07	8.44E-02	2%
Heptachlor epoxide	1.28E-01	1.85E-02	2.08E-06	1.46E-01	4%
Methoxychlor	2.24E+00	3.24E-01	1.46E-07	2.56E+00	71%
Toxaphene	-	-	-	-	-
Summation	3	0.8	9E-06	4	

Table 8
Industrial Workers
Cancer Risks and Noncancer Hazards - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

	Risk Probabilities				
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Total**	**%Contribution**
Aldrin	2.20E-09	5.00E-09	1.12E-13	7.20E-09	1%
BHC, alpha	5.01E-10	2.29E-10	2.54E-14	7.30E-10	0%
BHC, beta	3.07E-10	1.40E-10	1.60E-14	4.47E-10	0%
BHC, gamma	1.88E-09	8.59E-10	9.41E-14	2.74E-09	0%
BHC, delta	6.54E-10	2.98E-10	3.29E-14	9.53E-10	0%
Chlordane, alpha	2.57E-10	1.17E-10	1.30E-14	3.74E-10	0%
Chlordane, gamma	1.36E-10	6.19E-11	6.88E-15	1.98E-10	0%
DDD	1.37E-09	4.68E-10	6.97E-14	1.83E-09	0%
DDE	2.40E-08	8.21E-09	1.21E-12	3.22E-08	2%
DDT	2.22E-08	7.60E-09	1.12E-12	2.98E-08	2%
Dieldrin	5.65E-08	1.29E-07	2.88E-12	1.85E-07	14%
Endosulfan I	-	-	-	-	-
Endosulfan II	-	-	-	-	-
Endosulfan sulfate	-	-	-	-	-
Endrin	-	-	-	-	-
Endrin aldehyde	-	-	-	-	-
Endrin ketone	-	-	-	-	-
Heptachlor epoxide	6.04E-09	6.89E-09	3.06E-13	1.29E-08	1%
Methoxychlor	-	-	-	-	-
Toxaphene	5.07E-07	5.78E-07	2.62E-11	1.09E-06	80%
Summation	6E-07	7E-07	3E-11	1E-06	

	Hazard Index (HI)				
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Total**	**%Contribution**
Aldrin	1.21E-05	2.75E-05	-	3.95E-05	0%
BHC, alpha	2.79E-08	1.27E-08	-	4.06E-08	0%
BHC, beta	-	-	-	-	-
BHC, gamma	1.60E-05	7.29E-06	-	2.33E-05	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	4.11E-06	1.87E-06	5.20E-10	5.98E-06	0%
Chlordane, gamma	2.17E-06	9.91E-07	2.75E-10	3.16E-06	0%
DDD	3.19E-05	1.09E-05	-	4.28E-05	0%
DDE	3.95E-04	1.35E-04	-	5.30E-04	4%
DDT	3.66E-04	1.25E-04	-	4.91E-04	4%
Dieldrin	1.98E-04	4.51E-04	-	6.48E-04	5%
Endosulfan I	3.90E-07	4.44E-07	-	8.34E-07	0%
Endosulfan II	5.33E-06	6.08E-06	-	1.14E-05	0%
Endosulfan sulfate	8.35E-07	9.52E-07	-	1.79E-06	0%
Endrin	2.71E-05	1.55E-03	-	1.57E-03	11%
Endrin aldehyde	1.29E-04	7.34E-03	-	7.47E-03	54%
Endrin ketone	4.60E-05	2.62E-03	-	2.67E-03	19%
Heptachlor epoxide	1.43E-04	1.63E-04	-	3.06E-04	2%
Methoxychlor	1.21E-05	1.38E-05	-	2.58E-05	0%
Toxaphene	-	-	-	-	-
Summation	0.001	0.01	8E-10	0.01	

Table 9
Industrial Workers
Cancer Risks and Noncancer Hazards - Cal EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Risk Probabilities				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	2.20E-09	2.50E-09	1.12E-13	4.70E-09	0%
BHC, alpha	2.15E-10	1.22E-10	1.09E-14	3.37E-10	0%
BHC, beta	2.56E-10	1.46E-10	1.30E-14	4.02E-10	0%
BHC, gamma	1.88E-09	1.07E-09	9.41E-14	2.96E-09	0%
BHC, delta	1.45E-09	8.29E-10	7.09E-11	2.35E-09	0%
Chlordane, alpha	9.54E-10	5.44E-10	4.42E-14	1.50E-09	0%
Chlordane, gamma	5.04E-10	2.87E-10	2.34E-14	7.92E-10	0%
DDD	1.37E-09	7.79E-10	6.97E-14	2.15E-09	0%
DDE	2.40E-08	1.37E-08	1.21E-12	3.77E-08	3%
DDT	2.22E-08	1.27E-08	1.12E-12	3.49E-08	3%
Dieldrin	5.65E-08	6.44E-08	2.88E-12	1.21E-07	11%
Endosulfan I	-	-	-	-	-
Endosulfan II	-	-	-	-	-
Endosulfan sulfate	-	-	-	-	-
Endrin	-	-	-	-	-
Endrin aldehyde	-	-	-	-	-
Endrin ketone	-	-	-	-	-
Heptachlor epoxide	3.65E-09	2.08E-09	3.06E-13	5.73E-09	1%
Methoxychlor	-	-	-	-	-
Toxaphene	5.54E-07	3.16E-07	2.78E-11	8.69E-07	80%
Summation	7E-07	4E-07	1E-10	1E-06	

COPC	Hazard Index (HI)				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	1.21E-05	1.37E-05	6.11E-10	2.58E-05	0%
BHC, alpha	2.79E-08	1.59E-08	1.41E-12	4.37E-08	0%
BHC, beta	-	-	-	-	-
BHC, gamma	1.60E-05	9.11E-06	8.10E-10	2.51E-05	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	4.11E-06	2.34E-06	5.20E-10	6.45E-06	0%
Chlordane, gamma	2.17E-06	1.24E-06	2.75E-10	3.41E-06	0%
DDD	3.19E-05	1.82E-05	1.62E-09	5.01E-05	1%
DDE	3.95E-04	2.25E-04	2.00E-08	6.21E-04	8%
DDT	3.66E-04	2.09E-04	1.85E-08	5.75E-04	7%
Dieldrin	1.98E-04	2.25E-04	1.00E-08	4.23E-04	5%
Endosulfan I	3.90E-07	2.22E-07	1.97E-11	6.12E-07	0%
Endosulfan II	5.33E-06	3.04E-06	2.70E-10	8.37E-06	0%
Endosulfan sulfate	8.35E-07	4.76E-07	4.23E-11	1.31E-06	0%
Endrin	2.71E-05	7.73E-04	1.37E-09	8.01E-04	10%
Endrin aldehyde	1.29E-04	3.67E-03	6.53E-09	3.80E-03	48%
Endrin ketone	4.60E-05	1.31E-03	2.33E-09	1.36E-03	17%
Heptachlor epoxide	1.43E-04	8.15E-05	7.24E-09	2.25E-04	3%
Methoxychlor	1.21E-05	6.88E-06	6.12E-10	1.90E-05	0%
Toxaphene	-	-	-	-	-
Summation	0.001	0.007	7E-08	0.008	

Table 10
Construction Workers
Cancer Risks and Noncancer Hazards - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

	Risk Probabilities				
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Total**	**%Contribution**
Aldrin	2.90E-10	8.01E-10	5.91E-12	1.10E-09	1%
BHC, alpha	6.62E-11	3.66E-11	1.34E-12	1.04E-10	0%
BHC, beta	4.06E-11	2.24E-11	8.45E-13	6.38E-11	0%
BHC, gamma	2.49E-10	1.37E-10	4.95E-12	3.91E-10	0%
BHC, delta	8.64E-11	4.77E-11	1.73E-12	1.36E-10	0%
Chlordane, alpha	3.39E-11	1.87E-11	6.85E-13	5.33E-11	0%
Chlordane, gamma	1.79E-11	9.91E-12	3.62E-13	2.82E-11	0%
DDD	1.80E-10	7.48E-11	3.67E-12	2.59E-10	0%
DDE	3.17E-09	1.31E-09	6.39E-11	4.55E-09	2%
DDT	2.93E-09	1.22E-09	5.92E-11	4.21E-09	2%
Dieldrin	7.45E-09	2.06E-08	1.52E-10	2.82E-08	14%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	7.98E-10	1.10E-09	1.61E-11	1.92E-09	1%
Methoxychlor	-		-	-	-
Toxaphene	6.70E-08	9.26E-08	1.38E-09	1.61E-07	80%
Summation	8E-08	1E-07	2E-09	2E-07	

	Hazard Index (HI)				
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Total**	**%Contribution**
Aldrin	3.98E-05	1.10E-04	-	1.50E-04	0%
BHC, alpha	9.19E-08	5.08E-08	-	1.43E-07	0%
BHC, beta	-	-	-	-	-
BHC, gamma	5.27E-05	2.92E-05	-	8.19E-05	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	1.36E-05	7.50E-06	6.85E-07	2.17E-05	0%
Chlordane, gamma	7.17E-06	3.96E-06	3.62E-07	1.15E-05	0%
DDD	1.05E-04	4.36E-05	-	1.49E-04	0%
DDE	1.30E-03	5.41E-04	-	1.85E-03	3%
DDT	1.21E-03	5.01E-04	-	1.71E-03	3%
Dieldrin	6.52E-04	1.80E-03	-	2.45E-03	5%
Endosulfan I	1.29E-06	1.78E-06	-	3.06E-06	0%
Endosulfan II	1.76E-05	2.43E-05	-	4.19E-05	0%
Endosulfan sulfate	2.76E-06	3.81E-06	-	6.56E-06	0%
Endrin	8.95E-05	6.19E-03	-	6.28E-03	12%
Endrin aldehyde	4.25E-04	2.94E-02	-	2.98E-02	55%
Endrin ketone	1.52E-04	1.05E-02	-	1.06E-02	20%
Heptachlor epoxide	4.72E-04	6.52E-04	-	1.12E-03	2%
Methoxychlor	3.98E-05	5.51E-05	-	9.49E-05	0%
Toxaphene	-	-	-	-	-
Summation	0.005	0.05	1E-06	0.05	

Table 11
Construction Workers
Cancer Risks and Noncancer Hazards - Cal EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Risk Probabilities				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	2.90E-10	4.00E-10	5.91E-12	6.96E-10	0%
BHC, alpha	2.84E-11	1.96E-11	5.72E-13	4.85E-11	0%
BHC, beta	3.38E-11	2.34E-11	6.85E-13	5.78E-11	0%
BHC, gamma	2.49E-10	1.72E-10	4.95E-12	4.25E-10	0%
BHC, delta	1.92E-10	1.33E-10	3.73E-09	4.06E-09	3%
Chlordane, alpha	1.26E-10	8.70E-11	2.33E-12	2.15E-10	0%
Chlordane, gamma	6.66E-11	4.60E-11	1.23E-12	1.14E-10	0%
DDD	1.80E-10	1.25E-10	3.67E-12	3.09E-10	0%
DDE	3.17E-09	2.19E-09	6.39E-11	5.42E-09	3%
DDT	2.93E-09	2.03E-09	5.92E-11	5.02E-09	3%
Dieldrin	7.45E-09	1.03E-08	1.52E-10	1.79E-08	11%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	4.82E-10	3.33E-10	1.61E-11	8.31E-10	1%
Methoxychlor	-		-	-	-
Toxaphene	7.31E-08	5.05E-08	1.46E-09	1.25E-07	78%
Summation	9E-08	7E-08	6E-09	2E-07	

COPC	Hazard Index (HI)				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	3.98E-05	5.50E-05	8.03E-07	9.55E-05	0%
BHC, alpha	9.19E-08	6.35E-08	1.86E-09	1.57E-07	0%
BHC, beta	-	-	-	-	-
BHC, gamma	5.27E-05	3.64E-05	1.07E-06	9.02E-05	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	1.36E-05	9.37E-06	6.85E-07	2.36E-05	0%
Chlordane, gamma	7.17E-06	4.95E-06	3.62E-07	1.25E-05	0%
DDD	1.05E-04	7.27E-05	2.13E-06	1.80E-04	1%
DDE	1.30E-03	9.01E-04	2.64E-05	2.23E-03	7%
DDT	1.21E-03	8.34E-04	2.44E-05	2.07E-03	7%
Dieldrin	6.52E-04	9.01E-04	1.32E-05	1.57E-03	5%
Endosulfan I	1.29E-06	8.89E-07	2.60E-08	2.20E-06	0%
Endosulfan II	1.76E-05	1.22E-05	3.56E-07	3.01E-05	0%
Endosulfan sulfate	2.76E-06	1.90E-06	5.57E-08	4.71E-06	0%
Endrin	8.95E-05	3.09E-03	1.81E-06	3.18E-03	10%
Endrin aldehyde	4.25E-04	1.47E-02	8.59E-06	1.51E-02	49%
Endrin ketone	1.52E-04	5.24E-03	3.07E-06	5.40E-03	17%
Heptachlor epoxide	4.72E-04	3.26E-04	9.53E-06	8.08E-04	3%
Methoxychlor	3.98E-05	2.75E-05	8.05E-07	6.82E-05	0%
Toxaphene	-	-	-	-	-
Summation	0.005	0.03	9E-05	0.03	

Table 12
Maneuver Trainers (5 year exposure duration)
Cancer Risks and Noncancer Hazards - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Risk Probabilities Ingestion	Dermal	Inhalation	Total	%Contribution
Aldrin	4.43E-10	1.01E-09	2.26E-14	1.45E-09	1%
BHC, alpha	1.01E-10	4.61E-11	5.12E-15	1.47E-10	0%
BHC, beta	6.20E-11	2.83E-11	3.23E-15	9.02E-11	0%
BHC, gamma	3.80E-10	1.73E-10	1.90E-14	5.53E-10	0%
BHC, delta	1.32E-10	6.01E-11	6.63E-15	1.92E-10	0%
Chlordane, alpha	5.18E-11	2.36E-11	2.62E-15	7.54E-11	0%
Chlordane, gamma	2.74E-11	1.25E-11	1.39E-15	3.99E-11	0%
DDD	2.76E-10	9.43E-11	1.40E-14	3.70E-10	0%
DDE	4.84E-09	1.65E-09	2.45E-13	6.49E-09	2%
DDT	4.48E-09	1.53E-09	2.27E-13	6.01E-09	2%
Dieldrin	1.14E-08	2.60E-08	5.80E-13	3.73E-08	14%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	1.22E-09	1.39E-09	6.17E-14	2.61E-09	1%
Methoxychlor	-		-	-	-
Toxaphene	1.02E-07	1.17E-07	5.28E-12	2.19E-07	80%
Summation	1E-07	1E-07	6E-12	3E-07	

COPC	Hazard Index (HI) Ingestion	Dermal	Inhalation	Total	%Contribution
Aldrin	1.21E-05	2.77E-05	-	3.98E-05	0%
BHC, alpha	2.81E-08	1.28E-08	-	4.09E-08	0%
BHC, beta	-	-	-	-	-
BHC, gamma	1.61E-05	7.35E-06	-	2.35E-05	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	4.14E-06	1.89E-06	5.25E-10	6.03E-06	0%
Chlordane, gamma	2.19E-06	9.98E-07	2.77E-10	3.19E-06	0%
DDD	3.22E-05	1.10E-05	-	4.31E-05	0%
DDE	3.98E-04	1.36E-04	-	5.35E-04	4%
DDT	3.69E-04	1.26E-04	-	4.95E-04	4%
Dieldrin	1.99E-04	4.54E-04	-	6.53E-04	5%
Endosulfan I	3.93E-07	4.48E-07	-	8.41E-07	0%
Endosulfan II	5.38E-06	6.13E-06	-	1.15E-05	0%
Endosulfan sulfate	8.42E-07	9.59E-07	-	1.80E-06	0%
Endrin	2.74E-05	1.56E-03	-	1.59E-03	11%
Endrin aldehyde	1.30E-04	7.40E-03	-	7.53E-03	54%
Endrin ketone	4.64E-05	2.64E-03	-	2.69E-03	19%
Heptachlor epoxide	1.44E-04	1.64E-04	-	3.08E-04	2%
Methoxychlor	1.22E-05	1.39E-05	-	2.60E-05	0%
Toxaphene	-	-	-	-	-
Summation	0.001	0.01	8E-10	0.01	

Table 13
Maneuver Trainers (20 year exposure duration)
Cancer Risks and Noncancer Hazards - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Risk Probabilities Ingestion	Dermal	Inhalation	Total	%Contribution
Aldrin	1.77E-09	4.04E-09	9.05E-14	5.81E-09	1%
BHC, alpha	4.04E-10	1.84E-10	2.05E-14	5.89E-10	0%
BHC, beta	2.48E-10	1.13E-10	1.29E-14	3.61E-10	0%
BHC, gamma	1.52E-09	6.93E-10	7.59E-14	2.21E-09	0%
BHC, delta	5.28E-10	2.41E-10	2.65E-14	7.68E-10	0%
Chlordane, alpha	2.07E-10	9.44E-11	1.05E-14	3.02E-10	0%
Chlordane, gamma	1.09E-10	4.99E-11	5.55E-15	1.59E-10	0%
DDD	1.10E-09	3.77E-10	5.62E-14	1.48E-09	0%
DDE	1.94E-08	6.62E-09	9.79E-13	2.60E-08	2%
DDT	1.79E-08	6.13E-09	9.06E-13	2.40E-08	2%
Dieldrin	4.55E-08	1.04E-07	2.32E-12	1.49E-07	14%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	4.87E-09	5.55E-09	2.47E-13	1.04E-08	1%
Methoxychlor	-		-	-	-
Toxaphene	4.09E-07	4.66E-07	2.11E-11	8.76E-07	80%
Summation	5E-07	6E-07	3E-11	1E-06	

COPC	Hazard Index (HI) Ingestion	Dermal	Inhalation	Total	%Contribution
Aldrin	4.86E-05	1.11E-04	-	1.59E-04	0%
BHC, alpha	1.12E-07	5.12E-08	-	1.64E-07	0%
BHC, beta	-	-	-	-	-
BHC, gamma	6.44E-05	2.94E-05	-	9.38E-05	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	1.66E-05	7.56E-06	2.10E-09	2.41E-05	0%
Chlordane, gamma	8.76E-06	3.99E-06	1.11E-09	1.28E-05	0%
DDD	1.29E-04	4.40E-05	-	1.73E-04	0%
DDE	1.59E-03	5.45E-04	-	2.14E-03	4%
DDT	1.48E-03	5.05E-04	-	1.98E-03	4%
Dieldrin	7.97E-04	1.82E-03	-	2.61E-03	5%
Endosulfan I	1.57E-06	1.79E-06	-	3.36E-06	0%
Endosulfan II	2.15E-05	2.45E-05	-	4.60E-05	0%
Endosulfan sulfate	3.37E-06	3.84E-06	-	7.20E-06	0%
Endrin	1.09E-04	6.24E-03	-	6.35E-03	11%
Endrin aldehyde	5.19E-04	2.96E-02	-	3.01E-02	54%
Endrin ketone	1.85E-04	1.06E-02	-	1.08E-02	19%
Heptachlor epoxide	5.77E-04	6.57E-04	-	1.23E-03	2%
Methoxychlor	4.87E-05	5.55E-05	-	1.04E-04	0%
Toxaphene	-	-	-	-	-
Summation	0.006	0.05	3E-09	0.06	

Table 14
Maneuver Trainers (5 year exposure duration)
Cancer Risks and Noncancer Hazards - Cal EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

	Risk Probabilities				
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Total**	**%Contribution**
Aldrin	4.43E-10	5.04E-10	2.26E-14	9.47E-10	0%
BHC, alpha	4.33E-11	2.47E-11	2.19E-15	6.80E-11	0%
BHC, beta	5.16E-11	2.94E-11	2.62E-15	8.11E-11	0%
BHC, gamma	3.80E-10	2.16E-10	1.90E-14	5.96E-10	0%
BHC, delta	2.93E-10	1.67E-10	1.43E-11	4.74E-10	0%
Chlordane, alpha	1.92E-10	1.10E-10	8.92E-15	3.02E-10	0%
Chlordane, gamma	1.02E-10	5.79E-11	4.71E-15	1.60E-10	0%
DDD	2.76E-10	1.57E-10	1.40E-14	4.33E-10	0%
DDE	4.84E-09	2.76E-09	2.45E-13	7.60E-09	3%
DDT	4.48E-09	2.55E-09	2.27E-13	7.03E-09	3%
Dieldrin	1.14E-08	1.30E-08	5.80E-13	2.44E-08	11%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	7.36E-10	4.20E-10	6.17E-14	1.16E-09	1%
Methoxychlor	-		-	-	-
Toxaphene	1.12E-07	6.36E-08	5.61E-12	1.75E-07	80%
Summation	1E-07	8E-08	2E-11	2E-07	

	Hazard Index (HI)				
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Total**	**%Contribution**
Aldrin	1.21E-05	1.38E-05	6.15E-10	2.60E-05	0%
BHC, alpha	2.81E-08	1.60E-08	1.42E-12	4.41E-08	0%
BHC, beta	-	-	-	-	-
BHC, gamma	1.61E-05	9.18E-06	8.16E-10	2.53E-05	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	4.14E-06	2.36E-06	5.25E-10	6.50E-06	0%
Chlordane, gamma	2.19E-06	1.25E-06	2.77E-10	3.44E-06	0%
DDD	3.22E-05	1.83E-05	1.63E-09	5.05E-05	1%
DDE	3.98E-04	2.27E-04	2.02E-08	6.26E-04	8%
DDT	3.69E-04	2.10E-04	1.87E-08	5.79E-04	7%
Dieldrin	1.99E-04	2.27E-04	1.01E-08	4.26E-04	5%
Endosulfan I	3.93E-07	2.24E-07	1.99E-11	6.17E-07	0%
Endosulfan II	5.38E-06	3.06E-06	2.72E-10	8.44E-06	0%
Endosulfan sulfate	8.42E-07	4.80E-07	4.26E-11	1.32E-06	0%
Endrin	2.74E-05	7.80E-04	1.39E-09	8.07E-04	10%
Endrin aldehyde	1.30E-04	3.70E-03	6.58E-09	3.83E-03	48%
Endrin ketone	4.64E-05	1.32E-03	2.35E-09	1.37E-03	17%
Heptachlor epoxide	1.44E-04	8.22E-05	7.30E-09	2.26E-04	3%
Methoxychlor	1.22E-05	6.94E-06	6.17E-10	1.91E-05	0%
Toxaphene	-	-	-	-	-
Summation	0.001	0.007	7E-08	0.008	

Table 15
Maneuver Trainers (20 year exposure duration)
Cancer Risks and Noncancer Hazards - Cal EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Risk Probabilities				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	1.77E-09	2.02E-09	9.05E-14	3.79E-09	0%
BHC, alpha	1.73E-10	9.88E-11	8.76E-15	2.72E-10	0%
BHC, beta	2.07E-10	1.18E-10	1.05E-14	3.24E-10	0%
BHC, gamma	1.52E-09	8.66E-10	7.59E-14	2.38E-09	0%
BHC, delta	1.17E-09	6.68E-10	5.72E-11	1.90E-09	0%
Chlordane, alpha	7.69E-10	4.39E-10	3.57E-14	1.21E-09	0%
Chlordane, gamma	4.07E-10	2.32E-10	1.89E-14	6.38E-10	0%
DDD	1.10E-09	6.28E-10	5.62E-14	1.73E-09	0%
DDE	1.94E-08	1.10E-08	9.79E-13	3.04E-08	3%
DDT	1.79E-08	1.02E-08	9.06E-13	2.81E-08	3%
Dieldrin	4.55E-08	5.19E-08	2.32E-12	9.75E-08	11%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	2.94E-09	1.68E-09	2.47E-13	4.62E-09	1%
Methoxychlor	-		-	-	-
Toxaphene	4.46E-07	2.54E-07	2.24E-11	7.01E-07	80%
Summation	5E-07	3E-07	8E-11	9E-07	

COPC	Hazard Index (HI)				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	4.86E-05	5.54E-05	2.46E-09	1.04E-04	0%
BHC, alpha	1.12E-07	6.40E-08	5.69E-12	1.76E-07	0%
BHC, beta	-	-	-	-	-
BHC, gamma	6.44E-05	3.67E-05	3.26E-09	1.01E-04	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	1.66E-05	9.44E-06	2.10E-09	2.60E-05	0%
Chlordane, gamma	8.76E-06	4.99E-06	1.11E-09	1.38E-05	0%
DDD	1.29E-04	7.33E-05	6.52E-09	2.02E-04	1%
DDE	1.59E-03	9.09E-04	8.07E-08	2.50E-03	8%
DDT	1.48E-03	8.41E-04	7.47E-08	2.32E-03	7%
Dieldrin	7.97E-04	9.09E-04	4.04E-08	1.71E-03	5%
Endosulfan I	1.57E-06	8.96E-07	7.96E-11	2.47E-06	0%
Endosulfan II	2.15E-05	1.23E-05	1.09E-09	3.38E-05	0%
Endosulfan sulfate	3.37E-06	1.92E-06	1.71E-10	5.29E-06	0%
Endrin	1.09E-04	3.12E-03	5.54E-09	3.23E-03	10%
Endrin aldehyde	5.19E-04	1.48E-02	2.63E-08	1.53E-02	48%
Endrin ketone	1.85E-04	5.28E-03	9.39E-09	5.47E-03	17%
Heptachlor epoxide	5.77E-04	3.29E-04	2.92E-08	9.05E-04	3%
Methoxychlor	4.87E-05	2.77E-05	2.47E-09	7.64E-05	0%
Toxaphene	-	-	-	-	-
Summation	0.006	0.03	3E-07	0.03	

Table 16
MOUT Trainers (5 year exposure duration)
Cancer Risks and Noncancer Hazards - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Risk Probabilities				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	1.69E-10	3.84E-10	8.62E-15	5.53E-10	1%
BHC, alpha	3.85E-11	1.76E-11	1.95E-15	5.61E-11	0%
BHC, beta	2.36E-11	1.08E-11	1.23E-15	3.44E-11	0%
BHC, gamma	1.45E-10	6.60E-11	7.23E-15	2.11E-10	0%
BHC, delta	5.02E-11	2.29E-11	2.52E-15	7.32E-11	0%
Chlordane, alpha	1.97E-11	9.00E-12	9.99E-16	2.87E-11	0%
Chlordane, gamma	1.04E-11	4.75E-12	5.28E-16	1.52E-11	0%
DDD	1.05E-10	3.59E-11	5.35E-15	1.41E-10	0%
DDE	1.84E-09	6.30E-10	9.32E-14	2.47E-09	2%
DDT	1.71E-09	5.84E-10	8.63E-14	2.29E-09	2%
Dieldrin	4.34E-09	9.89E-09	2.21E-13	1.42E-08	14%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	4.64E-10	5.29E-10	2.35E-14	9.93E-10	1%
Methoxychlor	-		-	-	-
Toxaphene	3.90E-08	4.44E-08	2.01E-12	8.34E-08	80%
Summation	5E-08	6E-08	2E-12	1E-07	

COPC	Hazard Index (HI)				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	4.63E-06	1.06E-05	-	1.52E-05	0%
BHC, alpha	1.07E-08	4.88E-09	-	1.56E-08	0%
BHC, beta	-	-	-	-	-
BHC, gamma	6.14E-06	2.80E-06	-	8.94E-06	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	1.58E-06	7.20E-07	2.00E-10	2.30E-06	0%
Chlordane, gamma	8.34E-07	3.80E-07	1.06E-10	1.21E-06	0%
DDD	1.22E-05	4.19E-06	-	1.64E-05	0%
DDE	1.52E-04	5.19E-05	-	2.04E-04	4%
DDT	1.41E-04	4.81E-05	-	1.89E-04	4%
Dieldrin	7.59E-05	1.73E-04	-	2.49E-04	5%
Endosulfan I	1.50E-07	1.71E-07	-	3.20E-07	0%
Endosulfan II	2.05E-06	2.33E-06	-	4.38E-06	0%
Endosulfan sulfate	3.21E-07	3.66E-07	-	6.86E-07	0%
Endrin	1.04E-05	5.94E-04	-	6.04E-04	11%
Endrin aldehyde	4.95E-05	2.82E-03	-	2.87E-03	54%
Endrin ketone	1.77E-05	1.01E-03	-	1.02E-03	19%
Heptachlor epoxide	5.49E-05	6.26E-05	-	1.18E-04	2%
Methoxychlor	4.64E-06	5.29E-06	-	9.92E-06	0%
Toxaphene	-	-	-	-	-
Summation	5E-04	0.005	3E-10	0.005	

Table 17
MOUT Trainers (20 year exposure duration)
Cancer Risks and Noncancer Hazards - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Risk Probabilities				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	6.74E-10	1.54E-09	3.45E-14	2.21E-09	1%
BHC, alpha	1.54E-10	7.02E-11	7.80E-15	2.24E-10	0%
BHC, beta	9.44E-11	4.30E-11	4.93E-15	1.37E-10	0%
BHC, gamma	5.79E-10	2.64E-10	2.89E-14	8.43E-10	0%
BHC, delta	2.01E-10	9.16E-11	1.01E-14	2.93E-10	0%
Chlordane, alpha	7.89E-11	3.60E-11	4.00E-15	1.15E-10	0%
Chlordane, gamma	4.17E-11	1.90E-11	2.11E-15	6.07E-11	0%
DDD	4.20E-10	1.44E-10	2.14E-14	5.64E-10	0%
DDE	7.37E-09	2.52E-09	3.73E-13	9.89E-09	2%
DDT	6.83E-09	2.33E-09	3.45E-13	9.16E-09	2%
Dieldrin	1.73E-08	3.96E-08	8.84E-13	5.69E-08	14%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	1.86E-09	2.12E-09	9.40E-14	3.97E-09	1%
Methoxychlor	-		-	-	-
Toxaphene	1.56E-07	1.78E-07	8.04E-12	3.34E-07	80%
Summation	2E-07	2E-07	1E-11	4E-07	

COPC	Hazard Index (HI)				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	1.85E-05	4.22E-05	-	6.07E-05	0%
BHC, alpha	4.28E-08	1.95E-08	-	6.23E-08	0%
BHC, beta	-	-	-	-	-
BHC, gamma	2.45E-05	1.12E-05	-	3.57E-05	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	6.31E-06	2.88E-06	7.99E-10	9.19E-06	0%
Chlordane, gamma	3.34E-06	1.52E-06	4.23E-10	4.86E-06	0%
DDD	4.90E-05	1.68E-05	-	6.58E-05	0%
DDE	6.07E-04	2.08E-04	-	8.15E-04	4%
DDT	5.62E-04	1.92E-04	-	7.54E-04	4%
Dieldrin	3.04E-04	6.92E-04	-	9.96E-04	5%
Endosulfan I	5.99E-07	6.82E-07	-	1.28E-06	0%
Endosulfan II	8.19E-06	9.34E-06	-	1.75E-05	0%
Endosulfan sulfate	1.28E-06	1.46E-06	-	2.74E-06	0%
Endrin	4.17E-05	2.38E-03	-	2.42E-03	11%
Endrin aldehyde	1.98E-04	1.13E-02	-	1.15E-02	54%
Endrin ketone	7.06E-05	4.03E-03	-	4.10E-03	19%
Heptachlor epoxide	2.20E-04	2.50E-04	-	4.70E-04	2%
Methoxychlor	1.85E-05	2.11E-05	-	3.97E-05	0%
Toxaphene	-	-	-	-	-
Summation	2E-03	0.02	1E-09	0.02	

Table 18
MOUT Trainers (5 year exposure duration)
Cancer Risks and Noncancer Hazards - Cal EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Risk Probabilities				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	1.69E-10	1.92E-10	8.62E-15	3.61E-10	0%
BHC, alpha	1.65E-11	9.41E-12	8.35E-16	2.59E-11	0%
BHC, beta	1.97E-11	1.12E-11	1.00E-15	3.09E-11	0%
BHC, gamma	1.45E-10	8.25E-11	7.23E-15	2.27E-10	0%
BHC, delta	1.12E-10	6.36E-11	5.44E-12	1.81E-10	0%
Chlordane, alpha	7.33E-11	4.18E-11	3.40E-15	1.15E-10	0%
Chlordane, gamma	3.87E-11	2.21E-11	1.80E-15	6.08E-11	0%
DDD	1.05E-10	5.98E-11	5.35E-15	1.65E-10	0%
DDE	1.84E-09	1.05E-09	9.32E-14	2.89E-09	3%
DDT	1.71E-09	9.73E-10	8.63E-14	2.68E-09	3%
Dieldrin	4.34E-09	4.94E-09	2.21E-13	9.28E-09	11%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	2.80E-10	1.60E-10	2.35E-14	4.40E-10	1%
Methoxychlor	-		-	-	-
Toxaphene	4.25E-08	2.42E-08	2.14E-12	6.67E-08	80%
Summation	5E-08	3E-08	8E-12	8E-08	

COPC	Hazard Index (HI)				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	4.63E-06	5.28E-06	2.34E-10	9.90E-06	0%
BHC, alpha	1.07E-08	6.10E-09	5.42E-13	1.68E-08	0%
BHC, beta	-	-	-	-	-
BHC, gamma	6.14E-06	3.50E-06	3.11E-10	9.64E-06	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	1.58E-06	9.00E-07	2.00E-10	2.48E-06	0%
Chlordane, gamma	8.34E-07	4.75E-07	1.06E-10	1.31E-06	0%
DDD	1.22E-05	6.98E-06	6.21E-10	1.92E-05	1%
DDE	1.52E-04	8.65E-05	7.69E-09	2.38E-04	8%
DDT	1.41E-04	8.01E-05	7.12E-09	2.21E-04	7%
Dieldrin	7.59E-05	8.65E-05	3.84E-09	1.62E-04	5%
Endosulfan I	1.50E-07	8.53E-08	7.58E-12	2.35E-07	0%
Endosulfan II	2.05E-06	1.17E-06	1.04E-10	3.22E-06	0%
Endosulfan sulfate	3.21E-07	1.83E-07	1.62E-11	5.03E-07	0%
Endrin	1.04E-05	2.97E-04	5.28E-10	3.07E-04	10%
Endrin aldehyde	4.95E-05	1.41E-03	2.51E-09	1.46E-03	48%
Endrin ketone	1.77E-05	5.03E-04	8.95E-10	5.21E-04	17%
Heptachlor epoxide	5.49E-05	3.13E-05	2.78E-09	8.62E-05	3%
Methoxychlor	4.64E-06	2.64E-06	2.35E-10	7.28E-06	0%
Toxaphene	-	-	-	-	-
Summation	5E-04	0.003	3E-08	0.003	

Table 19
MOUT Trainers (20 year exposure duration)
Cancer Risks and Noncancer Hazards - Cal EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Risk Probabilities				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	6.74E-10	7.69E-10	3.45E-14	1.44E-09	0%
BHC, alpha	6.60E-11	3.76E-11	3.34E-15	1.04E-10	0%
BHC, beta	7.87E-11	4.48E-11	4.00E-15	1.24E-10	0%
BHC, gamma	5.79E-10	3.30E-10	2.89E-14	9.08E-10	0%
BHC, delta	4.47E-10	2.55E-10	2.18E-11	7.23E-10	0%
Chlordane, alpha	2.93E-10	1.67E-10	1.36E-14	4.60E-10	0%
Chlordane, gamma	1.55E-10	8.83E-11	7.18E-15	2.43E-10	0%
DDD	4.20E-10	2.39E-10	2.14E-14	6.59E-10	0%
DDE	7.37E-09	4.20E-09	3.73E-13	1.16E-08	3%
DDT	6.83E-09	3.89E-09	3.45E-13	1.07E-08	3%
Dieldrin	1.73E-08	1.98E-08	8.84E-13	3.71E-08	11%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	1.12E-09	6.39E-10	9.40E-14	1.76E-09	1%
Methoxychlor	-		-	-	-
Toxaphene	1.70E-07	9.69E-08	8.54E-12	2.67E-07	80%
Summation	2E-07	1E-07	3E-11	3E-07	

COPC	Hazard Index (HI)				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	1.85E-05	2.11E-05	9.38E-10	3.96E-05	0%
BHC, alpha	4.28E-08	2.44E-08	2.17E-12	6.72E-08	0%
BHC, beta	-	-	-	-	-
BHC, gamma	2.45E-05	1.40E-05	1.24E-09	3.85E-05	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	6.31E-06	3.60E-06	7.99E-10	9.91E-06	0%
Chlordane, gamma	3.34E-06	1.90E-06	4.23E-10	5.24E-06	0%
DDD	4.90E-05	2.79E-05	2.48E-09	7.69E-05	1%
DDE	6.07E-04	3.46E-04	3.08E-08	9.53E-04	8%
DDT	5.62E-04	3.20E-04	2.85E-08	8.83E-04	7%
Dieldrin	3.04E-04	3.46E-04	1.54E-08	6.50E-04	5%
Endosulfan I	5.99E-07	3.41E-07	3.03E-11	9.40E-07	0%
Endosulfan II	8.19E-06	4.67E-06	4.15E-10	1.29E-05	0%
Endosulfan sulfate	1.28E-06	7.31E-07	6.50E-11	2.01E-06	0%
Endrin	4.17E-05	1.19E-03	2.11E-09	1.23E-03	10%
Endrin aldehyde	1.98E-04	5.64E-03	1.00E-08	5.84E-03	48%
Endrin ketone	7.06E-05	2.01E-03	3.58E-09	2.08E-03	17%
Heptachlor epoxide	2.20E-04	1.25E-04	1.11E-08	3.45E-04	3%
Methoxychlor	1.85E-05	1.06E-05	9.40E-10	2.91E-05	0%
Toxaphene	-	-	-	-	-
Summation	2E-03	0.01	1E-07	0.01	

Table 20
Heavy Equipment/Engineering Trainers (5 year exposure duration)
Cancer Risks and Noncancer Hazards - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

	Risk Probabilities				
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Total**	**%Contribution**
Aldrin	3.48E-10	9.61E-10	7.09E-12	1.32E-09	1%
BHC, alpha	7.94E-11	4.39E-11	1.60E-12	1.25E-10	0%
BHC, beta	4.87E-11	2.69E-11	1.01E-12	7.66E-11	0%
BHC, gamma	2.98E-10	1.65E-10	5.95E-12	4.69E-10	0%
BHC, delta	1.04E-10	5.73E-11	2.08E-12	1.63E-10	0%
Chlordane, alpha	4.07E-11	2.25E-11	8.22E-13	6.40E-11	0%
Chlordane, gamma	2.15E-11	1.19E-11	4.34E-13	3.38E-11	0%
DDD	2.17E-10	8.98E-11	4.40E-12	3.11E-10	0%
DDE	3.80E-09	1.58E-09	7.67E-11	5.45E-09	2%
DDT	3.52E-09	1.46E-09	7.10E-11	5.05E-09	2%
Dieldrin	8.95E-09	2.47E-08	1.82E-10	3.38E-08	14%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	9.57E-10	1.32E-09	1.93E-11	2.30E-09	1%
Methoxychlor	-		-	-	-
Toxaphene	8.04E-08	1.11E-07	1.65E-09	1.93E-07	80%
Summation	1E-07	1E-07	2E-09	2E-07	

	Hazard Index (HI)				
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Total**	**%Contribution**
Aldrin	2.39E-06	6.59E-06	-	8.98E-06	0%
BHC, alpha	5.52E-09	3.05E-09	-	8.56E-09	0%
BHC, beta	-	-	-	-	-
BHC, gamma	3.16E-06	1.75E-06	-	4.91E-06	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	8.14E-07	4.50E-07	4.11E-08	1.30E-06	0%
Chlordane, gamma	4.30E-07	2.38E-07	2.17E-08	6.90E-07	0%
DDD	6.32E-06	2.62E-06	-	8.93E-06	0%
DDE	7.83E-05	3.24E-05	-	1.11E-04	3%
DDT	7.25E-05	3.00E-05	-	1.02E-04	3%
Dieldrin	3.91E-05	1.08E-04	-	1.47E-04	5%
Endosulfan I	7.72E-08	1.07E-07	-	1.84E-07	0%
Endosulfan II	1.06E-06	1.46E-06	-	2.51E-06	0%
Endosulfan sulfate	1.65E-07	2.28E-07	-	3.94E-07	0%
Endrin	5.37E-06	3.71E-04	-	3.77E-04	12%
Endrin aldehyde	2.55E-05	1.76E-03	-	1.79E-03	55%
Endrin ketone	9.11E-06	6.29E-04	-	6.38E-04	20%
Heptachlor epoxide	2.83E-05	3.91E-05	-	6.74E-05	2%
Methoxychlor	2.39E-06	3.30E-06	-	5.69E-06	0%
Toxaphene	-	-	-	-	-
Summation	0.000	0.00	6E-08	0.00	

Table 21
Heavy Equipment/Engineering Trainers (20 year exposure duration)
Cancer Risks and Noncancer Hazards - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Risk Probabilities				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	1.39E-09	3.84E-09	2.83E-11	5.26E-09	1%
BHC, alpha	3.18E-10	1.76E-10	6.42E-12	5.00E-10	0%
BHC, beta	1.95E-10	1.08E-10	4.05E-12	3.06E-10	0%
BHC, gamma	1.19E-09	6.60E-10	2.38E-11	1.88E-09	0%
BHC, delta	4.14E-10	2.29E-10	8.30E-12	6.52E-10	0%
Chlordane, alpha	1.63E-10	9.00E-11	3.29E-12	2.56E-10	0%
Chlordane, gamma	8.60E-11	4.75E-11	1.74E-12	1.35E-10	0%
DDD	8.66E-10	3.59E-10	1.76E-11	1.24E-09	0%
DDE	1.52E-08	6.30E-09	3.07E-10	2.18E-08	2%
DDT	1.41E-08	5.84E-09	2.84E-10	2.02E-08	2%
Dieldrin	3.58E-08	9.89E-08	7.27E-10	1.35E-07	14%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	3.83E-09	5.29E-09	7.73E-11	9.20E-09	1%
Methoxychlor	-		-	-	-
Toxaphene	3.21E-07	4.44E-07	6.61E-09	7.72E-07	80%
Summation	4E-07	6E-07	8E-09	1E-06	

COPC	Hazard Index (HI)				%Contribution
	Ingestion	Dermal	Inhalation	Total	
Aldrin	9.54E-06	2.64E-05	-	3.59E-05	0%
BHC, alpha	2.21E-08	1.22E-08	-	3.43E-08	0%
BHC, beta	-	-	-	-	-
BHC, gamma	1.27E-05	7.00E-06	-	1.97E-05	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	3.25E-06	1.80E-06	1.64E-07	5.22E-06	0%
Chlordane, gamma	1.72E-06	9.51E-07	8.69E-08	2.76E-06	0%
DDD	2.53E-05	1.05E-05	-	3.57E-05	0%
DDE	3.13E-04	1.30E-04	-	4.43E-04	3%
DDT	2.90E-04	1.20E-04	-	4.10E-04	3%
Dieldrin	1.57E-04	4.33E-04	-	5.89E-04	5%
Endosulfan I	3.09E-07	4.27E-07	-	7.35E-07	0%
Endosulfan II	4.22E-06	5.84E-06	-	1.01E-05	0%
Endosulfan sulfate	6.61E-07	9.14E-07	-	1.58E-06	0%
Endrin	2.15E-05	1.48E-03	-	1.51E-03	12%
Endrin aldehyde	1.02E-04	7.05E-03	-	7.15E-03	55%
Endrin ketone	3.64E-05	2.52E-03	-	2.55E-03	20%
Heptachlor epoxide	1.13E-04	1.57E-04	-	2.70E-04	2%
Methoxychlor	9.56E-06	1.32E-05	-	2.28E-05	0%
Toxaphene	-	-	-	-	-
Summation	0.001	0.01	3E-07	0.01	

Table 22
Heavy Equipment/Engineering Trainers (5 year exposure duration)
Cancer Risks and Noncancer Hazards - Cal EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

	Risk Probabilities				
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Total**	**%Contribution**
Aldrin	3.48E-10	4.80E-10	7.09E-12	8.35E-10	0%
BHC, alpha	3.40E-11	2.35E-11	6.86E-13	5.82E-11	0%
BHC, beta	4.06E-11	2.80E-11	8.22E-13	6.94E-11	0%
BHC, gamma	2.98E-10	2.06E-10	5.95E-12	5.10E-10	0%
BHC, delta	2.30E-10	1.59E-10	4.48E-09	4.87E-09	3%
Chlordane, alpha	1.51E-10	1.04E-10	2.79E-12	2.58E-10	0%
Chlordane, gamma	7.99E-11	5.52E-11	1.48E-12	1.37E-10	0%
DDD	2.17E-10	1.50E-10	4.40E-12	3.71E-10	0%
DDE	3.80E-09	2.63E-09	7.67E-11	6.50E-09	3%
DDT	3.52E-09	2.43E-09	7.10E-11	6.02E-09	3%
Dieldrin	8.95E-09	1.24E-08	1.82E-10	2.15E-08	11%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	5.78E-10	4.00E-10	1.93E-11	9.97E-10	1%
Methoxychlor	-		-	-	-
Toxaphene	8.77E-08	6.06E-08	1.76E-09	1.50E-07	78%
Summation	1E-07	8E-08	7E-09	2E-07	

	Hazard Index (HI)				
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Total**	**%Contribution**
Aldrin	2.39E-06	3.30E-06	4.82E-08	5.73E-06	0%
BHC, alpha	5.52E-09	3.81E-09	1.11E-10	9.44E-09	0%
BHC, beta	-	-	-	-	-
BHC, gamma	3.16E-06	2.19E-06	6.39E-08	5.41E-06	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	8.14E-07	5.62E-07	4.11E-08	1.42E-06	0%
Chlordane, gamma	4.30E-07	2.97E-07	2.17E-08	7.49E-07	0%
DDD	6.32E-06	4.36E-06	1.28E-07	1.08E-05	1%
DDE	7.83E-05	5.41E-05	1.58E-06	1.34E-04	7%
DDT	7.25E-05	5.01E-05	1.46E-06	1.24E-04	7%
Dieldrin	3.91E-05	5.41E-05	7.91E-07	9.40E-05	5%
Endosulfan I	7.72E-08	5.33E-08	1.56E-09	1.32E-07	0%
Endosulfan II	1.06E-06	7.30E-07	2.13E-08	1.81E-06	0%
Endosulfan sulfate	1.65E-07	1.14E-07	3.34E-09	2.83E-07	0%
Endrin	5.37E-06	1.86E-04	1.09E-07	1.91E-04	10%
Endrin aldehyde	2.55E-05	8.81E-04	5.15E-07	9.07E-04	49%
Endrin ketone	9.11E-06	3.15E-04	1.84E-07	3.24E-04	17%
Heptachlor epoxide	2.83E-05	1.96E-05	5.72E-07	4.85E-05	3%
Methoxychlor	2.39E-06	1.65E-06	4.83E-08	4.09E-06	0%
Toxaphene	-	-	-	-	-
Summation	0.000	0.002	6E-06	0.002	

Table 23
Heavy Equipment/Engineering Trainers (20 year exposure duration)
Cancer Risks and Noncancer Hazards - Cal EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

	Risk Probabilities				
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Total**	**%Contribution**
Aldrin	1.39E-09	1.92E-09	2.83E-11	3.34E-09	0%
BHC, alpha	1.36E-10	9.41E-11	2.75E-12	2.33E-10	0%
BHC, beta	1.62E-10	1.12E-10	3.29E-12	2.78E-10	0%
BHC, gamma	1.19E-09	8.25E-10	2.38E-11	2.04E-09	0%
BHC, delta	9.21E-10	6.36E-10	1.79E-08	1.95E-08	3%
Chlordane, alpha	6.04E-10	4.18E-10	1.12E-11	1.03E-09	0%
Chlordane, gamma	3.20E-10	2.21E-10	5.91E-12	5.46E-10	0%
DDD	8.66E-10	5.98E-10	1.76E-11	1.48E-09	0%
DDE	1.52E-08	1.05E-08	3.07E-10	2.60E-08	3%
DDT	1.41E-08	9.73E-09	2.84E-10	2.41E-08	3%
Dieldrin	3.58E-08	4.94E-08	7.27E-10	8.60E-08	11%
Endosulfan I	-		-	-	-
Endosulfan II	-		-	-	-
Endosulfan sulfate	-		-	-	-
Endrin	-		-	-	-
Endrin aldehyde	-		-	-	-
Endrin ketone	-		-	-	-
Heptachlor epoxide	2.31E-09	1.60E-09	7.73E-11	3.99E-09	1%
Methoxychlor	-		-	-	-
Toxaphene	3.51E-07	2.42E-07	7.03E-09	6.00E-07	78%
Summation	4E-07	3E-07	3E-08	8E-07	

	Hazard Index (HI)				
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Total**	**%Contribution**
Aldrin	9.54E-06	1.32E-05	1.93E-07	2.29E-05	0%
BHC, alpha	2.21E-08	1.52E-08	4.46E-10	3.78E-08	0%
BHC, beta	-	-	-	-	-
BHC, gamma	1.27E-05	8.75E-06	2.56E-07	2.17E-05	0%
BHC, delta	-	-	-	-	-
Chlordane, alpha	3.25E-06	2.25E-06	1.64E-07	5.67E-06	0%
Chlordane, gamma	1.72E-06	1.19E-06	8.69E-08	3.00E-06	0%
DDD	2.53E-05	1.75E-05	5.10E-07	4.32E-05	1%
DDE	3.13E-04	2.16E-04	6.32E-06	5.36E-04	7%
DDT	2.90E-04	2.00E-04	5.86E-06	4.96E-04	7%
Dieldrin	1.57E-04	2.16E-04	3.16E-06	3.76E-04	5%
Endosulfan I	3.09E-07	2.13E-07	6.24E-09	5.28E-07	0%
Endosulfan II	4.22E-06	2.92E-06	8.53E-08	7.23E-06	0%
Endosulfan sulfate	6.61E-07	4.57E-07	1.34E-08	1.13E-06	0%
Endrin	2.15E-05	7.42E-04	4.34E-07	7.64E-04	10%
Endrin aldehyde	1.02E-04	3.52E-03	2.06E-06	3.63E-03	49%
Endrin ketone	3.64E-05	1.26E-03	7.36E-07	1.30E-03	17%
Heptachlor epoxide	1.13E-04	7.83E-05	2.29E-06	1.94E-04	3%
Methoxychlor	9.56E-06	6.61E-06	1.93E-07	1.64E-05	0%
Toxaphene	-	-	-	-	-
Summation	0.001	0.006	2E-05	0.007	

Table 24
Risk-Based Screening Level Equations
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

Carcinogenic Remedial Goals (RGs) for Residents (USEPA 2012a):

Ingestion

$$RG_{ing} = \frac{TR \times AT}{SF \times EF \times IFS_{adj} \times 10^{-6}\,kg/mg}$$

where:

$$IFS_{adj} = \frac{ED_{child} \times IR_{child}}{BW_{child}} + \frac{ED_{adult} \times IR_{adult}}{BW_{adult}}$$

Dermal Contact

$$RG_{der} = \frac{TR \times AT \times OAF}{SF \times EF \times DFS_{adj} \times ABS \times 10^{-6}\,kg/mg}$$

where:

$$DFS_{adj} = \frac{ED_{child} \times AF_{child} \times SA_{child}}{BW_{child}} + \frac{ED_{adult} \times AF_{adult} \times SA_{adult}}{BW_{adult}}$$

Inhalation of volatiles and dusts emitted from soils:

$$RG_{inh} = \frac{TR \times AT \times PEF}{IUR \times EF \times ED \times ET \times 1{,}000\,\mu g/mg}$$

Noncarcancer Remedial Goals (RGs) for Residents (USEPA 2012a):

Ingestion

$$RG_{ing} = \frac{THQ \times AT \times BW \times RfD}{EF \times ED \times IR \times 10^{-6}\,kg/mg}$$

Dermal Contact

$$RG_{der} = \frac{THQ \times AT \times BW \times RfD \times OAF}{EF \times ED \times SA \times AF \times ABS \times 10^{-6}\,kg/mg}$$

Inhalation of volatiles and dusts emitted from soils:

$$RG_{inh} = \frac{THQ \times AT \times RfC \times PEF}{EF \times ED \times ET \times 1{,}000\,\mu g/mg}$$

Carcinogenic Remedial Goals (RGs) for Non-Residential Receptors (USEPA 2012a)

Ingestion

$$RG_{ing} = \frac{TR \times AT \times BW}{SF \times EF \times ED \times IR \times 10^{-6}\,kg/mg}$$

Dermal Contact

$$RG_{der} = \frac{TR \times AT \times BW \times OAF}{SF \times EF \times ED \times SA \times AF \times ABS \times 10^{-6}\,kg/mg}$$

Inhalation of volatiles and dusts emitted from soils:

$$RG_{inh} = \frac{TR \times AT \times PEF}{IUR \times EF \times ED \times ET \times 1{,}000\,\mu g/mg}$$

Noncarcancer Remedial Goals (RGs) for Non-Residential Receptors (USEPA 2012a)

Ingestion

$$RG_{ing} = \frac{THQ \times AT \times BW \times RfD}{EF \times ED \times IR \times 10^{-6}\,kg/mg}$$

Dermal Contact

$$RG_{der} = \frac{THQ \times AT \times BW \times RfD \times OAF}{EF \times ED \times SA \times AF \times ABS \times 10^{-6}\,kg/mg}$$

Inhalation of volatiles and dusts emitted from soils:

$$RG_{inh} = \frac{THQ \times AT \times RfC \times PEF}{EF \times ED \times ET \times 1{,}000\,\mu g/mg}$$

Table 25
Risk-Based Screening Level (mg/kg) Summary
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Resident	Industrial Worker	Construction Worker	5 Year Exposure Duration Maneuver Trainer	5 Year Exposure Duration MOUT Trainer	5 Year Exposure Duration Heavy Equipment Trainer	20 Year Exposure Duration Maneuver Trainer	20 Year Exposure Duration MOUT Trainer	20 Year Exposure Duration Heavy Equipment Trainer
Aldrin	0.02	0.05	0.34	0.25	0.67	0.28	0.064	0.17	0.070
BHC, alpha	0.09	0.31	2.19	1.55	4.06	1.82	0.39	1.02	0.46
BHC, beta	0.31	1.09	7.65	5.42	14.22	6.38	1.35	3.55	1.59
BHC, gamma	0.50	1.66	11.52	8.22	21.57	9.60	2.05	5.39	2.40
BHC, delta	0.13	0.44	0.26	2.19	5.75	0.21	0.55	1.44	0.05
Chlordane, alpha	0.42	1.40	2.97	6.95	18.26	8.13	1.74	4.56	2.03
Chlordane, gamma	0.42	1.40	2.97	6.95	18.26	8.13	1.74	4.56	2.03
DDD	2.29	7.59	52.79	37.67	98.88	43.99	9.42	24.72	11.00
DDE	1.62	5.36	37.26	26.59	69.80	31.05	6.65	17.45	7.76
DDT	1.62	5.36	37.26	26.59	69.80	31.05	6.65	17.45	7.76
Dieldrin	0.02	0.05	0.36	0.27	0.71	0.30	0.068	0.18	0.075
Endosulfan I	364	2,865	780	2,843	7,462	13,003	2,843	7,462	3,251
Endosulfan II	364	2,865	780	2,843	7,462	13,003	2,843	7,462	3,251
Endosulfan sulfate	364	2,865	780	2,843	7,462	13,003	2,843	7,462	3,251
Endrin	1.51	5.29	1.33	5.24	13.77	22.09	5.24	13.77	5.52
Endrin aldehyde	1.51	5.29	1.33	5.24	13.77	22.09	5.24	13.77	5.52
Endrin ketone	1.51	5.29	1.33	5.24	13.77	22.09	5.24	13.77	5.52
Heptachlor epoxide	0.05	0.15	0.99	0.73	1.91	0.83	0.18	0.48	0.21
Methoxychlor	1.37	2,388	650	2,369	6,218	10,835	2,369	6,218	2,709
Toxaphene	0.44	1.22	8.20	6.03	15.83	6.84	1.51	3.96	1.71

FIGURES

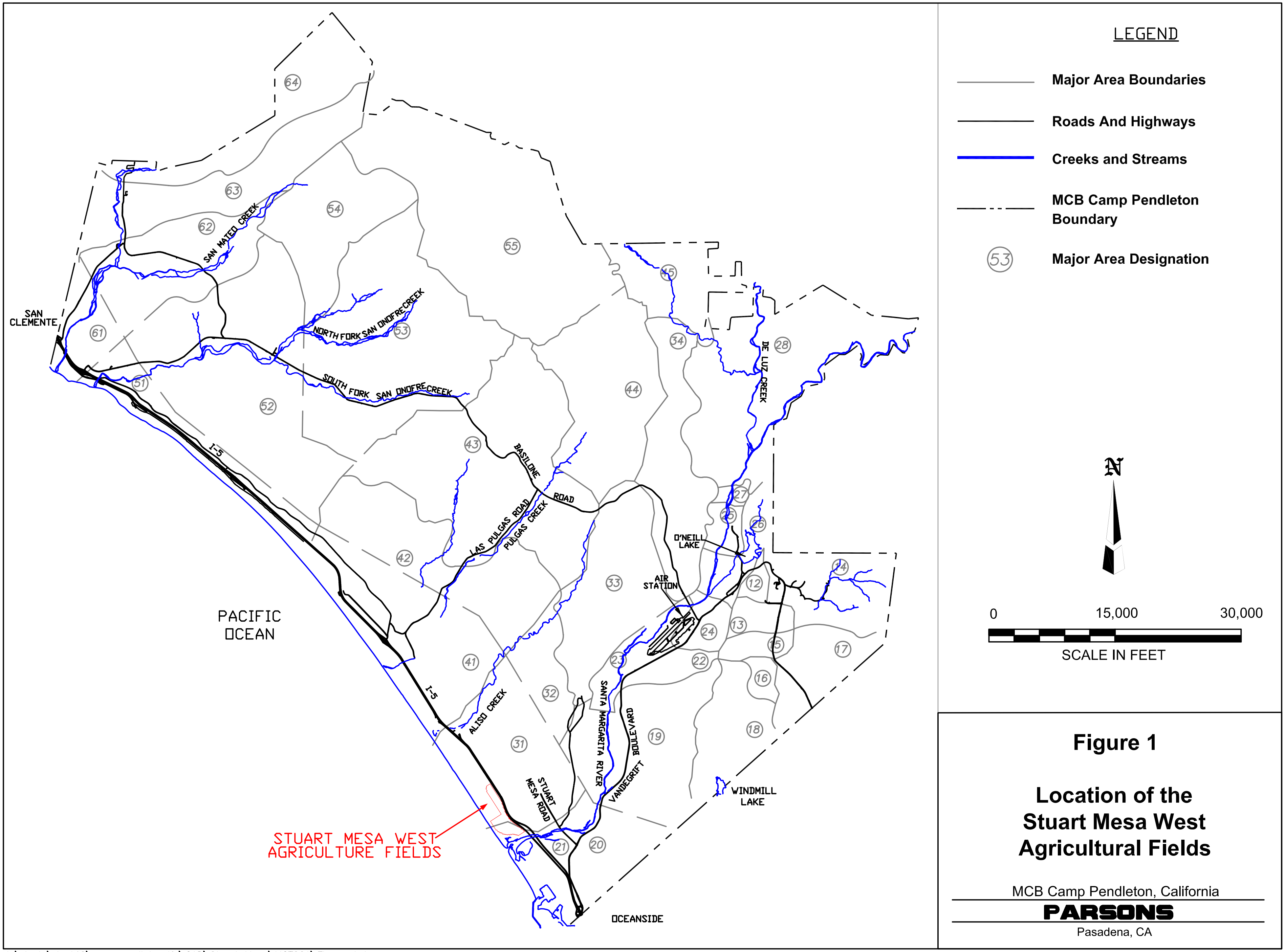

Figure 1

Location of the Stuart Mesa West Agricultural Fields

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

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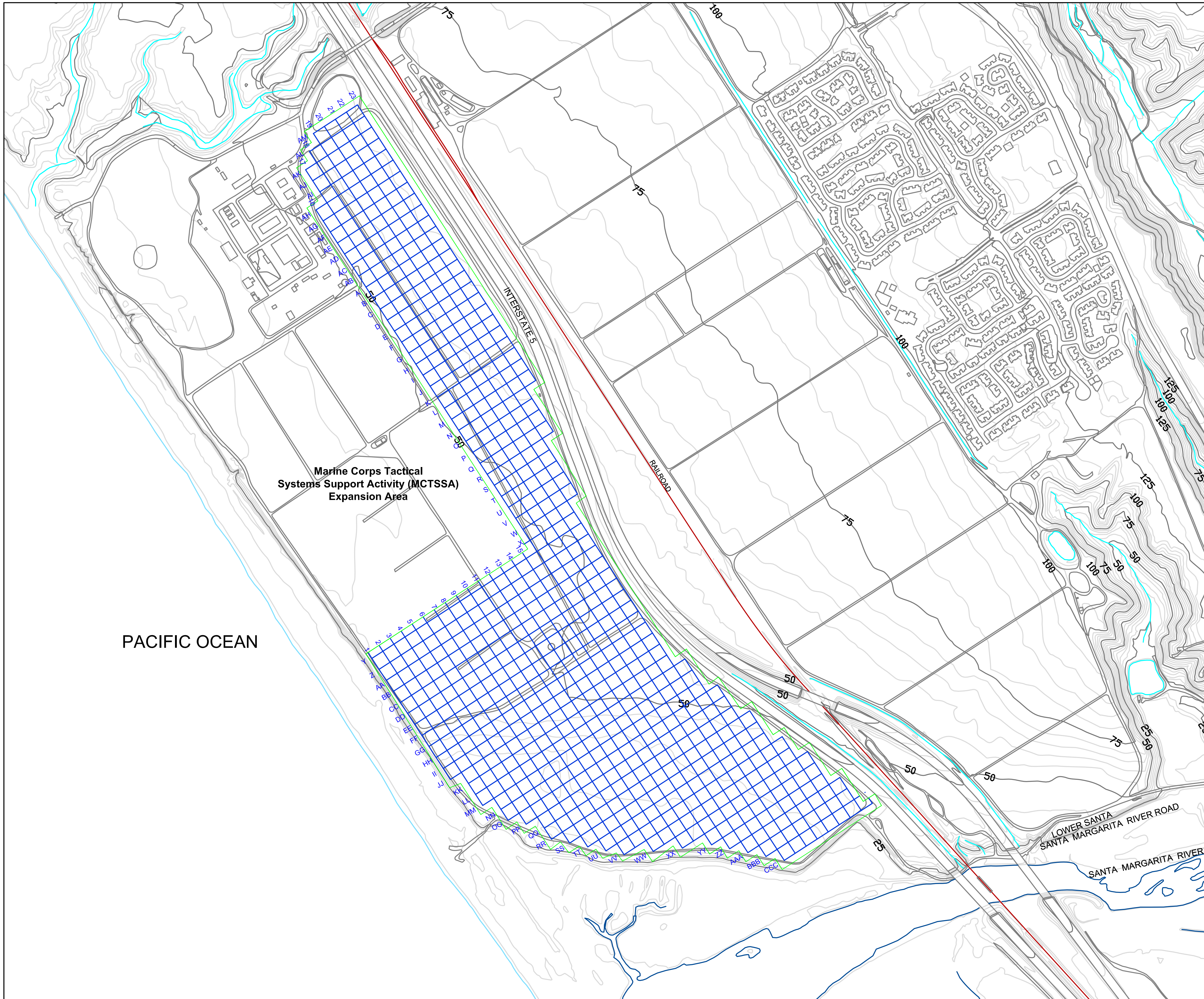


Legend

Investigation Boundary

Sample Grid (100 ft spacing)

Figure 2

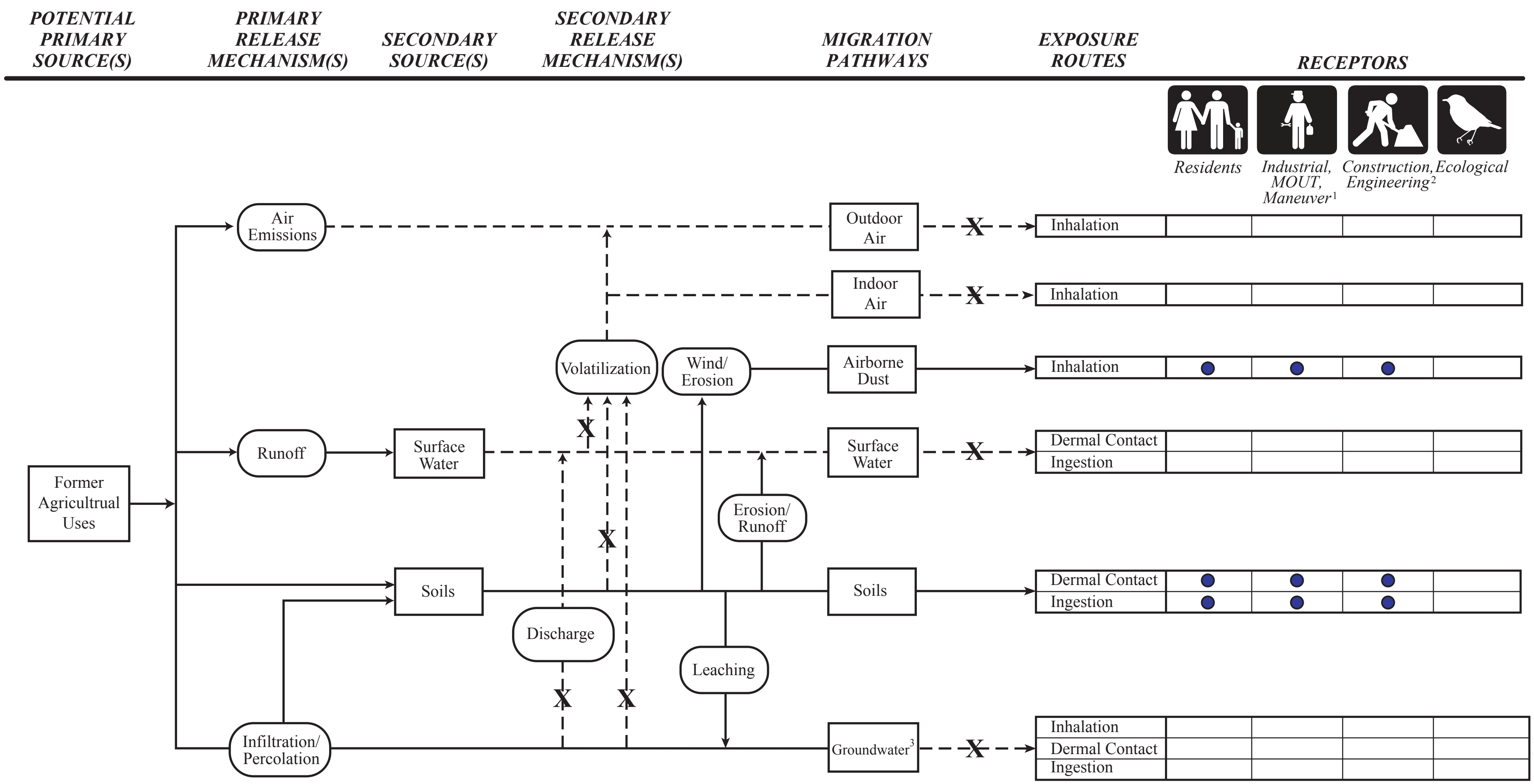
Stuart Mesa West Agriculture Fields
Soil Sample Locations

MCB Camp Pendleton, California

PARSONS

Pasadena, CA

k:\depts\dept48\CampPendletonRIFS\CAD\Ag Fields\SMWAF 2012\Figure 2_SMWAF.dwg



Legend

Potentially complete exposure pathway
Potentially incomplete exposure pathway
Incomplete exposure pathway
Potentially complete exposure route
1 Includes industrial workers, maneuver trainers, and MOUT trainers
2 Includes construction workers and heavy equipment/engineering trainers
3 Groundwater not assumed to be used as potable water source

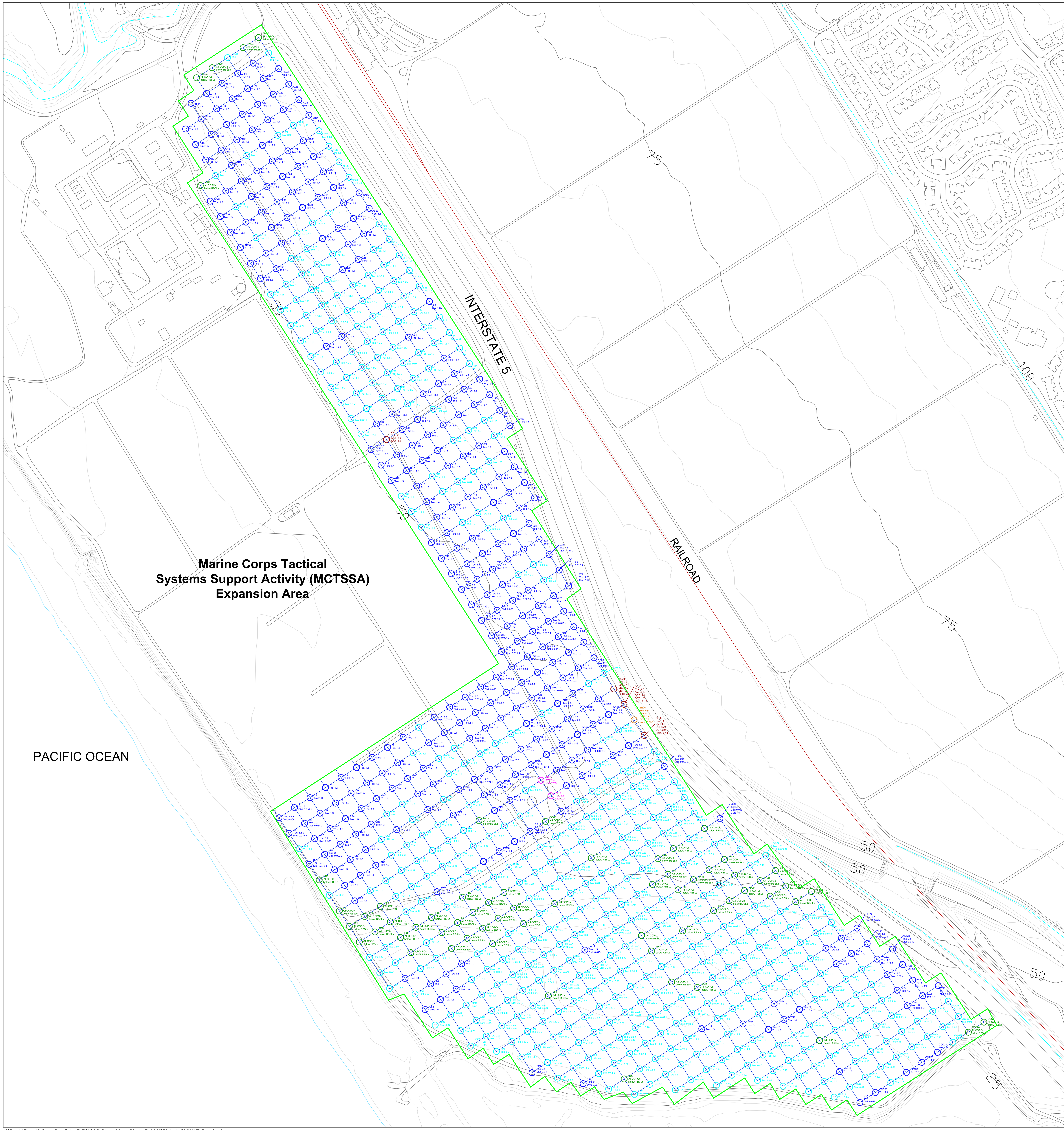
Figure 3

Conceptual Site Model

Stuart Mesa West Agricultural Fields
Camp Pendelton, California

PARSONS

Pasadena, CA



Legend

Investigation Boundary

Sample Grid (100 ft spacing)

Soil Sample - All COPCs below RBSLs

Soil Sample - At least one COPC above RBSL for Residential, but below RBSLs for Industrial Worker, Maneuver Trainer, Heavy Equipment/Engineering, Construction Worker, and MOUT Trainer

Soil Sample - At least one COPC above RBSLs for Residential and Industrial Worker, but below RBSLs for Maneuver Trainer, Heavy Equipment/Engineering, Construction Worker, and MOUT Trainer

Soil Sample - At least one COPC above RBSLs for Residential, Industrial Worker, and Maneuver Trainer, but below RBSLs for Heavy Equipment/Engineering, Construction Worker, and MOUT Trainer

Soil Sample - At least one COPC above RBSLs for Residential, Industrial Worker, Maneuver Trainer, and Heavy Equipment/Engineering, but below RBSLs for Construction Worker and MOUT Trainer

Soil Sample - At least one COPC above RBSLs for Residential, Industrial Worker, Maneuver Trainer, and Heavy Equipment/Engineering, and Construction Worker, but below RBSL for MOUT Trainer

Notes

1. All results shown in mg/kg.
2. Only results above RBSLs are shown.
3. RBSLs are not cleanup levels. Refer to Risk Assessment.

Abbreviations

RBSL: Risk Based Screening Level
Tox: Toxaphene
Diel: Dieldrin
DDE: 4,4'-Dichlorodiphenyldichloroethene
DDT: 4,4'-Dichlorodiphenyltrichloroethane
Hept: Heptachlor epoxide
Methox: Methoxychlor

N

0 400 800
Scale in Feet

Plate 1

Stuart Mesa West Agricultural Fields Soil Sample Results

MCB Camp Pendleton, California
PARSONS
Pasadena, CA

K:\Depts\Dept48\CampPendletonRIFS\CAD\Stuart Mesa\SMWAF_2012\Plate 1_SMWAF_Results.dwg

APPENDIX A
PROUCL OUTPUT

4,4'-DDD			
General Statistics			
Number of Valid Data	802	Number of Detected Data	483
Number of Distinct Detected Data	98	Number of Non-Detect Data	319
		Percent Non-Detects	39.78%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00097	Minimum Detected	-6.938
Maximum Detected	0.54	Maximum Detected	-0.616
Mean of Detected	0.0226	Mean of Detected	-4.03
SD of Detected	0.0295	SD of Detected	0.651
Minimum Non-Detect	0.00022	Minimum Non-Detect	-8.422
Maximum Non-Detect	0.055	Maximum Non-Detect	-2.9
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	789
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	13
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	98.38%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.267	Lilliefors Test Statistic	0.1
5% Lilliefors Critical Value	0.0403	5% Lilliefors Critical Value	0.0403
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0138	Mean	-5.752
SD	0.0253	SD	2.307
95% DL/2 (t) UCL	0.0153	95% H-Stat (DL/2) UCL	0.0598
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-4.605
		SD in Log Scale	0.915
		Mean in Original Scale	0.0154
		SD in Original Scale	0.0246
		95% t UCL	0.0168
		95% Percentile Bootstrap UCL	0.0169
		95% BCA Bootstrap UCL	0.0174
		95% H-UCL	0.0162
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	2.24	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	0.0101		
nu star	2164		
A-D Test Statistic	2.07E+28	**Nonparametric Statistics**	
5% A-D Critical Value	0.765	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.765	Mean	0.014
5% K-S Critical Value	0.0417	SD	0.0252
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0008913
		95% KM (t) UCL	0.0155
Assuming Gamma Distribution		95% KM (z) UCL	0.0155
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0153
Minimum	0.000001	95% KM (bootstrap t) UCL	0.016
Maximum	0.54	95% KM (BCA) UCL	0.0163
Mean	0.0136	95% KM (Percentile Bootstrap) UCL	0.0157
Median	0.011	95% KM (Chebyshev) UCL	0.0179
SD	0.0254	97.5% KM (Chebyshev) UCL	0.0196
k star	0.203	99% KM (Chebyshev) UCL	0.0229
Theta star	0.0669		
Nu star	326	**Potential UCLs to Use**	
AppChi2	285.2	95% KM (BCA) UCL	0.0163
95% Gamma Approximate UCL	0.0155		
95% Adjusted Gamma UCL	0.0155		

Appendix A
ProUCL Output

4,4'-DDE			
General Statistics			
Number of Valid Data	802	Number of Detected Data	801
Number of Distinct Detected Data	105	Number of Non-Detect Data	1
		Percent Non-Detects	0.12%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.02	Minimum Detected	-3.912
Maximum Detected	5.4	Maximum Detected	1.686
Mean of Detected	0.18	Mean of Detected	-2.043
SD of Detected	0.405	SD of Detected	0.574
Minimum Non-Detect	0.00025	Minimum Non-Detect	-8.294
Maximum Non-Detect	0.00025	Maximum Non-Detect	-8.294
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.409	Lilliefors Test Statistic	0.174
5% Lilliefors Critical Value	0.0313	5% Lilliefors Critical Value	0.0313
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.179	Mean	-2.052
SD	0.405	SD	0.624
95% DL/2 (t) UCL	0.203	95% H-Stat (DL/2) UCL	0.163
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.179	Mean in Log Scale	-2.045
SD	0.405	SD in Log Scale	0.576
95% MLE (t) UCL	0.203	Mean in Original Scale	0.179
95% MLE (Tiku) UCL	0.2	SD in Original Scale	0.405
		95% t UCL	0.203
		95% Percentile Bootstrap UCL	0.205
		95% BCA Bootstrap UCL	0.212
		95% H UCL	0.158
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.676	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.107		
nu star	2684		
A-D Test Statistic	1.248E+28	**Nonparametric Statistics**	
5% A-D Critical Value	0.77	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.77	Mean	0.179
5% K-S Critical Value	0.0339	SD	0.405
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0143
		95% KM (t) UCL	0.203
Assuming Gamma Distribution		95% KM (z) UCL	0.203
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.203
Minimum	0.000001	95% KM (bootstrap t) UCL	0.215
Maximum	5.4	95% KM (BCA) UCL	0.202
Mean	0.179	95% KM (Percentile Bootstrap) UCL	0.205
Median	0.13	95% KM (Chebyshev) UCL	0.242
SD	0.405	97.5% KM (Chebyshev) UCL	0.269
k star	1.614	99% KM (Chebyshev) UCL	0.322
Theta star	0.111		
Nu star	2589	Potential UCLs to Use	
AppChi2	2472	95% KM (BCA) UCL	0.202
95% Gamma Approximate UCL	0.188		
95% Adjusted Gamma UCL	0.188		

Appendix A
ProUCL Output

4,4'-DDT			
General Statistics			
Number of Valid Observations	802	Number of Distinct Observations	129
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.006	Minimum of Log Data	-5.116
Maximum	5.6	Maximum of Log Data	1.723
Mean	0.141	Mean of log Data	-2.301
Median	0.1	SD of log Data	0.689
SD	0.297		
Std. Error of Mean	0.0105		
Coefficient of Variation	2.102		
Skewness	12.47		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.343	Lilliefors Test Statistic	0.0814
Lilliefors Critical Value	0.0313	Lilliefors Critical Value	0.0313
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.159	95% H-UCL	0.133
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.142
95% Adjusted-CLT UCL (Chen-1995)	0.164	97.5% Chebyshev (MVUE) UCL	0.148
95% Modified-t UCL (Johnson-1978)	0.159	99% Chebyshev (MVUE) UCL	0.161
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.593	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.0887		
MLE of Mean	0.141		
MLE of Standard Deviation	0.112		
nu star	2555		
Approximate Chi Square Value (.05)	2438	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0497	95% CLT UCL	0.159
Adjusted Chi Square Value	2438	95% Jackknife UCL	0.159
		95% Standard Bootstrap UCL	0.158
Anderson-Darling Test Statistic	1.247E+28	95% Bootstrap-t UCL	0.17
Anderson-Darling 5% Critical Value	0.771	95% Hall's Bootstrap UCL	0.174
Kolmogorov-Smirnov Test Statistic	0.167	95% Percentile Bootstrap UCL	0.158
Kolmogorov-Smirnov 5% Critical Value	0.0339	95% BCA Bootstrap UCL	0.166
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.187
		97.5% Chebyshev(Mean, Sd) UCL	0.207
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.246
95% Approximate Gamma UCL	0.148		
95% Adjusted Gamma UCL	0.148		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	0.187

Appendix A
ProUCL Output

Aldrin

General Statistics

Number of Valid Data	802	Number of Detected Data	34
Number of Distinct Detected Data	28	Number of Non-Detect Data	768
		Percent Non-Detects	95.76%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00031	Minimum Detected	-8.079
Maximum Detected	0.0019	Maximum Detected	-6.266
Mean of Detected	0.0006974	Mean of Detected	-7.361
SD of Detected	0.0003465	SD of Detected	0.419
Minimum Non-Detect	0.00029	Minimum Non-Detect	-8.146
Maximum Non-Detect	0.13	Maximum Non-Detect	-2.04

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	802
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.802	Shapiro Wilk Test Statistic	0.953
5% Shapiro Wilk Critical Value	0.933	5% Shapiro Wilk Critical Value	0.933
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00179	Mean	-7.03
SD	0.00314	SD	1.282
95% DL/2 (t) UCL	0.00198	95% H-Stat (DL/2) UCL	0.00224
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-8.941
		SD in Log Scale	0.835
		Mean in Original Scale	0.0001864
		SD in Original Scale	0.0001867
		95% t UCL	0.0001973
		95% Percentile Bootstrap UCL	0.0001974
		95% BCA Bootstrap UCL	0.0001982
		95% H-UCL	0.0001967
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	5.074	Data appear Lognormal at 5% Significance Level	
Theta Star	0.0001375		
nu star	345		
A-D Test Statistic	0.81	**Nonparametric Statistics**	
5% A-D Critical Value	0.749	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.749	Mean	0.0003542
5% K-S Critical Value	0.151	SD	0.0001628
Data not Gamma Distributed at 5% Significance Level		SE of Mean	9.311E-06
		95% KM (t) UCL	0.0003695
Assuming Gamma Distribution		95% KM (z) UCL	0.0003695
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0003695
Minimum	0.000001	95% KM (bootstrap t) UCL	0.00037
Maximum	0.0019	95% KM (BCA) UCL	0.000462
Mean	6.785E-05	95% KM (Percentile Bootstrap) UCL	0.0004048
Median	0.000001	95% KM (Chebyshev) UCL	0.0003948
SD	0.0002146	97.5% KM (Chebyshev) UCL	0.0004123
k star	0.209	99% KM (Chebyshev) UCL	0.0004468
Theta star	0.0003242		
Nu star	335.7	Potential UCLs to Use	
AppChi2	294.3	95% KM (t) UCL	0.0003695
95% Gamma Approximate UCL	7.741E-05	95% KM (% Bootstrap) UCL	0.0004048
95% Adjusted Gamma UCL	7.743E-05		

Appendix A
ProUCL Output

alpha-BHC			
General Statistics			
Number of Valid Data	802	Number of Detected Data	43
Number of Distinct Detected Data	25	Number of Non-Detect Data	759
		Percent Non-Detects	94.64%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0002	Minimum Detected	-8.517
Maximum Detected	0.00064	Maximum Detected	-7.354
Mean of Detected	0.0003326	Mean of Detected	-8.061
SD of Detected	0.0001142	SD of Detected	0.32
Minimum Non-Detect	0.00019	Minimum Non-Detect	-8.568
Maximum Non-Detect	0.078	Maximum Non-Detect	-2.551
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	802
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.885	Shapiro Wilk Test Statistic	0.929
5% Shapiro Wilk Critical Value	0.943	5% Shapiro Wilk Critical Value	0.943
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00132	Mean	-7.35
SD	0.0023	SD	1.309
95% DL/2 (t) UCL	0.00145	95% H-Stat (DL/2) UCL	0.00169
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-9.118
		SD in Log Scale	0.628
		Mean in Original Scale	0.0001338
		SD in Original Scale	9.217E-05
		95% t UCL	0.0001391
		95% Percentile Bootstrap UCL	0.0001393
		95% BCA Bootstrap UCL	0.0001392
		95% H-UCL	0.0001392
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	9.066	Data do not follow a Discernable Distribution (0.05)	
Theta Star	3.668E-05		
nu star	779.6		
A-D Test Statistic	1.141	**Nonparametric Statistics**	
5% A-D Critical Value	0.748	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.748	Mean	0.0002212
5% K-S Critical Value	0.135	SD	6.515E-05
Data not Gamma Distributed at 5% Significance Level		SE of Mean	3.962E-06
		95% KM (t) UCL	0.0002278
Assuming Gamma Distribution		95% KM (z) UCL	0.0002278
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0002282
Minimum	0.000001	95% KM (bootstrap t) UCL	0.000228
Maximum	0.00064	95% KM (BCA) UCL	0.0002379
Mean	5.179E-05	95% KM (Percentile Bootstrap) UCL	0.0002343
Median	0.000001	95% KM (Chebyshev) UCL	0.0002385
SD	0.0001186	97.5% KM (Chebyshev) UCL	0.000246
k star	0.248	99% KM (Chebyshev) UCL	0.0002607
Theta star	0.0002085		
Nu star	398.4	Potential UCLs to Use	
AppChi2	353.1	95% KM (t) UCL	0.0002278
95% Gamma Approximate UCL	5.843E-05	95% KM (% Bootstrap) UCL	0.0002343
95% Adjusted Gamma UCL	5.844E-05		

Appendix A
ProUCL Output

alpha-Chlordane			
General Statistics			
Number of Valid Data	802	Number of Detected Data	202
Number of Distinct Detected Data	94	Number of Non-Detect Data	600
		Percent Non-Detects	74.81%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00044	Minimum Detected	-7.729
Maximum Detected	0.023	Maximum Detected	-3.772
Mean of Detected	0.00538	Mean of Detected	-5.459
SD of Detected	0.0034	SD of Detected	0.75
Minimum Non-Detect	0.00037	Minimum Non-Detect	-7.902
Maximum Non-Detect	0.1	Maximum Non-Detect	-2.303
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	802
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.092	Lilliefors Test Statistic	0.113
5% Lilliefors Critical Value	0.0623	5% Lilliefors Critical Value	0.0623
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00268	Mean	-6.509
SD	0.00338	SD	1.159
95% DL/2 (t) UCL	0.00288	95% H-Stat (DL/2) UCL	0.0032
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-6.869
		SD in Log Scale	1.148
		Mean in Original Scale	0.00201
		SD in Original Scale	0.00266
		95% t UCL	0.00217
		95% Percentile Bootstrap UCL	0.00216
		95% BCA Bootstrap UCL	0.00217
		95% H-UCL	0.0022
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	2.258	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.00238		
nu star	912.2		
A-D Test Statistic	0.908	**Nonparametric Statistics**	
5% A-D Critical Value	0.765	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.765	Mean	0.00193
5% K-S Critical Value	0.0641	SD	0.00276
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.000104
		95% KM (t) UCL	0.0021
Assuming Gamma Distribution		95% KM (z) UCL	0.0021
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.00209
Minimum	0.000001	95% KM (bootstrap t) UCL	0.00209
Maximum	0.023	95% KM (BCA) UCL	0.00228
Mean	0.00158	95% KM (Percentile Bootstrap) UCL	0.00222
Median	0.000001	95% KM (Chebyshev) UCL	0.00239
SD	0.00292	97.5% KM (Chebyshev) UCL	0.00258
k star	0.164	99% KM (Chebyshev) UCL	0.00297
Theta star	0.00961		
Nu star	263.1	Potential UCLs to Use	
AppChi2	226.5	95% KM (t) UCL	0.0021
95% Gamma Approximate UCL	0.00183	95% KM (% Bootstrap) UCL	0.00222
95% Adjusted Gamma UCL	0.00183		

beta-BHC			
General Statistics			
Number of Valid Data	802	Number of Detected Data	53
Number of Distinct Detected Data	38	Number of Non-Detect Data	749
		Percent Non-Detects	93.39%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00034	Minimum Detected	-7.987
Maximum Detected	0.017	Maximum Detected	-4.075
Mean of Detected	0.0011	Mean of Detected	-7.167
SD of Detected	0.00225	SD of Detected	0.605
Minimum Non-Detect	0.0003	Minimum Non-Detect	-8.112
Maximum Non-Detect	0.12	Maximum Non-Detect	-2.12
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	802
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.392	Lilliefors Test Statistic	0.147
5% Lilliefors Critical Value	0.122	5% Lilliefors Critical Value	0.122
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00223	Mean	-6.755
SD	0.0035	SD	1.293
95% DL/2 (t) UCL	0.00244	95% H-Stat (DL/2) UCL	0.00299
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-8.782
		SD in Log Scale	0.992
		Mean in Original Scale	0.0002653
		SD in Original Scale	0.0006518
		95% t UCL	0.0003032
		95% Percentile Bootstrap UCL	0.0003061
		95% BCA Bootstrap UCL	0.0003284
		95% H-UCL	0.00027
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.473	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.0007482		
nu star	156.1		
A-D Test Statistic	5.583	**Nonparametric Statistics**	
5% A-D Critical Value	0.767	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.767	Mean	0.0004468
5% K-S Critical Value	0.124	SD	0.0006328
Data not Gamma Distributed at 5% Significance Level		SE of Mean	2.534E-05
		95% KM (t) UCL	0.0004885
Assuming Gamma Distribution		95% KM (z) UCL	0.0004885
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0004802
Minimum	0.000001	95% KM (bootstrap t) UCL	0.000517
Maximum	0.017	95% KM (BCA) UCL	0.0005378
Mean	0.0001691	95% KM (Percentile Bootstrap) UCL	0.0005109
Median	0.000001	95% KM (Chebyshev) UCL	0.0005573
SD	0.0007204	97.5% KM (Chebyshev) UCL	0.0006051
k star	0.183	99% KM (Chebyshev) UCL	0.000699
Theta star	0.0009257		
Nu star	292.9	Potential UCLs to Use	
AppChi2	254.3	95% KM (t) UCL	0.0004885
95% Gamma Approximate UCL	0.0001947	95% KM (% Bootstrap) UCL	0.0005109
95% Adjusted Gamma UCL	0.0001948		

delta-BHC			
General Statistics			
Number of Valid Data	801	Number of Detected Data	70
Number of Distinct Detected Data	43	Number of Non-Detect Data	731
Number of Missing Values	1	Percent Non-Detects	91.26%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00037	Minimum Detected	-7.902
Maximum Detected	0.058	Maximum Detected	-2.847
Mean of Detected	0.00455	Mean of Detected	-5.769
SD of Detected	0.00689	SD of Detected	0.854
Minimum Non-Detect	0.00025	Minimum Non-Detect	-8.294
Maximum Non-Detect	0.13	Maximum Non-Detect	-2.04
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	801
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.297	Lilliefors Test Statistic	0.145
5% Lilliefors Critical Value	0.106	5% Lilliefors Critical Value	0.106
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00206	Mean	-7.018
SD	0.00369	SD	1.467
95% DL/2 (t) UCL	0.00227	95% H-Stat (DL/2) UCL	0.00299
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-8.211
		SD in Log Scale	1.368
		Mean in Original Scale	0.0007636
		SD in Original Scale	0.0024
		95% t UCL	0.0009031
		95% Percentile Bootstrap UCL	0.0009098
		95% BCA Bootstrap UCL	0.0009894
		95% H-UCL	0.0007776
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.422	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.0032		
nu star	199		
A-D Test Statistic	3.007	**Nonparametric Statistics**	
5% A-D Critical Value	0.769	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.769	Mean	0.0008859
5% K-S Critical Value	0.108	SD	0.00242
Data not Gamma Distributed at 5% Significance Level		SE of Mean	9.156E-05
		95% KM (t) UCL	0.00104
Assuming Gamma Distribution		95% KM (z) UCL	0.00104
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.00102
Minimum	0.000001	95% KM (bootstrap t) UCL	0.0011
Maximum	0.058	95% KM (BCA) UCL	0.00109
Mean	0.0005245	95% KM (Percentile Bootstrap) UCL	0.00106
Median	0.000001	95% KM (Chebyshev) UCL	0.00128
SD	0.0025	97.5% KM (Chebyshev) UCL	0.00146
k star	0.147	99% KM (Chebyshev) UCL	0.0018
Theta star	0.00358		
Nu star	234.8	Potential UCLs to Use	
AppChi2	200.3	95% KM (t) UCL	0.00104
95% Gamma Approximate UCL	0.0006147	95% KM (% Bootstrap) UCL	0.00106
95% Adjusted Gamma UCL	0.0006149		

Appendix A
ProUCL Output

Dieldrin			
General Statistics			
Number of Valid Data	802	Number of Detected Data	367
Number of Distinct Detected Data	111	Number of Non-Detect Data	435
		Percent Non-Detects	54.24%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00068	Minimum Detected	-7.293
Maximum Detected	0.18	Maximum Detected	-1.715
Mean of Detected	0.0193	Mean of Detected	-4.254
SD of Detected	0.0177	SD of Detected	0.817
Minimum Non-Detect	0.00019	Minimum Non-Detect	-8.568
Maximum Non-Detect	0.05	Maximum Non-Detect	-2.996
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	795
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	7
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	99.13%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.154	Lilliefors Test Statistic	0.11
5% Lilliefors Critical Value	0.0462	5% Lilliefors Critical Value	0.0462
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00925	Mean	-6.166
SD	0.0151	SD	2.046
95% DL/2 (t) UCL	0.0101	95% H-Stat (DL/2) UCL	0.0213
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-5.355
		SD in Log Scale	1.271
		Mean in Original Scale	0.0101
		SD in Original Scale	0.0147
		95% t UCL	0.0109
		95% Percentile Bootstrap UCL	0.011
		95% BCA Bootstrap UCL	0.011
		95% H-UCL	0.0118
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.775	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	0.0109		
nu star	1303		
A-D Test Statistic	1.431	**Nonparametric Statistics**	
5% A-D Critical Value	0.769	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.769	Mean	0.00921
5% K-S Critical Value	0.0482	SD	0.0151
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0005352
		95% KM (t) UCL	0.0101
Assuming Gamma Distribution		95% KM (z) UCL	0.0101
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.00993
Minimum	0.000001	95% KM (bootstrap t) UCL	0.0101
Maximum	0.18	95% KM (BCA) UCL	0.0106
Mean	0.00882	95% KM (Percentile Bootstrap) UCL	0.0104
Median	0.000001	95% KM (Chebyshev) UCL	0.0115
SD	0.0154	97.5% KM (Chebyshev) UCL	0.0126
k star	0.162	99% KM (Chebyshev) UCL	0.0145
Theta star	0.0545		
Nu star	259.3	**Potential UCLs to Use**	
AppChi2	223	95% KM (t) UCL	0.0101
95% Gamma Approximate UCL	0.0103	95% KM (% Bootstrap) UCL	0.0104
95% Adjusted Gamma UCL	0.0103		

Endosulfan I			
General Statistics			
Number of Valid Data	802	Number of Detected Data	130
Number of Distinct Detected Data	85	Number of Non-Detect Data	672
		Percent Non-Detects	83.79%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00021	Minimum Detected	-8.468
Maximum Detected	0.19	Maximum Detected	-1.661
Mean of Detected	0.00973	Mean of Detected	-5.305
SD of Detected	0.0235	SD of Detected	0.949
Minimum Non-Detect	0.00011	Minimum Non-Detect	-9.115
Maximum Non-Detect	0.055	Maximum Non-Detect	-2.9
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	798
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	4
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	99.50%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.395	Lilliefors Test Statistic	0.139
5% Lilliefors Critical Value	0.0777	5% Lilliefors Critical Value	0.0777
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0023	Mean	-7.059
SD	0.01	SD	1.131
95% DL/2 (t) UCL	0.00288	95% H-Stat (DL/2) UCL	0.00178
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-8.202
		SD in Log Scale	1.833
		Mean in Original Scale	0.00186
		SD in Original Scale	0.01
		95% t UCL	0.00244
		95% Percentile Bootstrap UCL	0.00251
		95% BCA Bootstrap UCL	0.00267
		95% H-UCL	0.00177
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.858	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.0113		
nu star	223		
A-D Test Statistic	11.98	**Nonparametric Statistics**	
5% A-D Critical Value	0.789	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.789	Mean	0.0018
5% K-S Critical Value	0.0845	SD	0.01
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0003561
		95% KM (t) UCL	0.00239
Assuming Gamma Distribution		95% KM (z) UCL	0.00239
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.00227
Minimum	0.000001	95% KM (bootstrap t) UCL	0.00261
Maximum	0.19	95% KM (BCA) UCL	0.00283
Mean	0.00158	95% KM (Percentile Bootstrap) UCL	0.00263
Median	0.000001	95% KM (Chebyshev) UCL	0.00335
SD	0.0101	97.5% KM (Chebyshev) UCL	0.00402
k star	0.131	99% KM (Chebyshev) UCL	0.00534
Theta star	0.012		
Nu star	210.8	Potential UCLs to Use	
AppChi2	178.2	95% KM (t) UCL	0.00239
95% Gamma Approximate UCL	0.00187	95% KM (% Bootstrap) UCL	0.00263
95% Adjusted Gamma UCL	0.00187		

Appendix A
ProUCL Output

Endosulfan II			
General Statistics			
Number of Valid Data	802	Number of Detected Data	733
Number of Distinct Detected Data	94	Number of Non-Detect Data	69
		Percent Non-Detects	8.60%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0025	Minimum Detected	-5.991
Maximum Detected	0.3	Maximum Detected	-1.204
Mean of Detected	0.034	Mean of Detected	-3.506
SD of Detected	0.0189	SD of Detected	0.528
Minimum Non-Detect	0.00033	Minimum Non-Detect	-8.016
Maximum Non-Detect	0.068	Maximum Non-Detect	-2.688
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	791
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	11
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	98.63%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.102	Lilliefors Test Statistic	0.12
5% Lilliefors Critical Value	0.0327	5% Lilliefors Critical Value	0.0327
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0313	Mean	-3.773
SD	0.0201	SD	1.054
95% DL/2 (t) UCL	0.0325	95% H-Stat (DL/2) UCL	0.0434
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-3.595
		SD in Log Scale	0.586
		Mean in Original Scale	0.032
		SD in Original Scale	0.0192
		95% t UCL	0.0331
		95% Percentile Bootstrap UCL	0.0331
		95% BCA Bootstrap UCL	0.0332
		95% H-UCL	0.0339
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	4.186	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.00811		
nu star	6136		
A-D Test Statistic	7.684	**Nonparametric Statistics**	
5% A-D Critical Value	0.759	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.759	Mean	0.0314
5% K-S Critical Value	0.0351	SD	0.02
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0007074
		95% KM (t) UCL	0.0326
Assuming Gamma Distribution		95% KM (z) UCL	0.0326
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0325
Minimum	0.000001	95% KM (bootstrap t) UCL	0.0327
Maximum	0.3	95% KM (BCA) UCL	0.0327
Mean	0.0312	95% KM (Percentile Bootstrap) UCL	0.0327
Median	0.031	95% KM (Chebyshev) UCL	0.0345
SD	0.0203	97.5% KM (Chebyshev) UCL	0.0358
k star	0.714	99% KM (Chebyshev) UCL	0.0384
Theta star	0.0437		
Nu star	1146	Potential UCLs to Use	
AppChi2	1068	95% KM (BCA) UCL	0.0327
95% Gamma Approximate UCL	0.0335		
95% Adjusted Gamma UCL	0.0335		

Appendix A
ProUCL Output

Endosulfan sulfate			
General Statistics			
Number of Valid Data	802	Number of Detected Data	187
Number of Distinct Detected Data	81	Number of Non-Detect Data	615
		Percent Non-Detects	76.68%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00077	Minimum Detected	-7.169
Maximum Detected	0.22	Maximum Detected	-1.514
Mean of Detected	0.0159	Mean of Detected	-4.534
SD of Detected	0.024	SD of Detected	0.796
Minimum Non-Detect	0.00032	Minimum Non-Detect	-8.047
Maximum Non-Detect	0.093	Maximum Non-Detect	-2.375
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	798
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	4
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	99.50%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.3	Lilliefors Test Statistic	0.0924
5% Lilliefors Critical Value	0.0648	5% Lilliefors Critical Value	0.0648
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00477	Mean	-6.574
SD	0.0133	SD	1.573
95% DL/2 (t) UCL	0.00554	95% H-Stat (DL/2) UCL	0.00556
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-6.556
		SD in Log Scale	1.489
		Mean in Original Scale	0.00463
		SD in Original Scale	0.0132
		95% t UCL	0.00539
		95% Percentile Bootstrap UCL	0.00542
		95% BCA Bootstrap UCL	0.00563
		95% H-UCL	0.00492
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.39	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.0115		
nu star	520		
A-D Test Statistic	8.849	**Nonparametric Statistics**	
5% A-D Critical Value	0.773	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.773	Mean	0.00435
5% K-S Critical Value	0.0684	SD	0.0132
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0004683
		95% KM (t) UCL	0.00512
Assuming Gamma Distribution		95% KM (z) UCL	0.00512
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.00502
Minimum	0.000001	95% KM (bootstrap t) UCL	0.00533
Maximum	0.22	95% KM (BCA) UCL	0.00565
Mean	0.00372	95% KM (Percentile Bootstrap) UCL	0.00529
Median	0.000001	95% KM (Chebyshev) UCL	0.00639
SD	0.0134	97.5% KM (Chebyshev) UCL	0.00727
k star	0.13	99% KM (Chebyshev) UCL	0.00901
Theta star	0.0286		
Nu star	208.4	Potential UCLs to Use	
AppChi2	176	95% KM (t) UCL	0.00512
95% Gamma Approximate UCL	0.0044	95% KM (% Bootstrap) UCL	0.00529
95% Adjusted Gamma UCL	0.0044		

Appendix A
ProUCL Output

Endrin			
General Statistics			
Number of Valid Data	802	Number of Detected Data	173
Number of Distinct Detected Data	84	Number of Non-Detect Data	629
		Percent Non-Detects	78.43%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.002	Minimum Detected	-6.215
Maximum Detected	0.25	Maximum Detected	-1.386
Mean of Detected	0.0269	Mean of Detected	-3.982
SD of Detected	0.0263	SD of Detected	0.916
Minimum Non-Detect	0.00016	Minimum Non-Detect	-8.74
Maximum Non-Detect	0.053	Maximum Non-Detect	-2.937
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	792
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	10
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	98.75%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.172	Lilliefors Test Statistic	0.123
5% Lilliefors Critical Value	0.0674	5% Lilliefors Critical Value	0.0674
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00654	Mean	-6.869
SD	0.0163	SD	1.967
95% DL/2 (t) UCL	0.00749	95% H-Stat (DL/2) UCL	0.00885
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-6.326
		SD in Log Scale	1.683
		Mean in Original Scale	0.00711
		SD in Original Scale	0.0161
		95% t UCL	0.00804
		95% Percentile Bootstrap UCL	0.00806
		95% BCA Bootstrap UCL	0.00813
		95% H-UCL	0.00866
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.481	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	0.0182		
nu star	512.4		
A-D Test Statistic	1.34	**Nonparametric Statistics**	
5% A-D Critical Value	0.771	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.771	Mean	0.00739
5% K-S Critical Value	0.0719	SD	0.0159
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	0.0005643
		95% KM (t) UCL	0.00832
Assuming Gamma Distribution		95% KM (z) UCL	0.00832
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.00832
Minimum	0.000001	95% KM (bootstrap t) UCL	0.00848
Maximum	0.25	95% KM (BCA) UCL	0.0086
Mean	0.00581	95% KM (Percentile Bootstrap) UCL	0.00845
Median	0.000001	95% KM (Chebyshev) UCL	0.00985
SD	0.0165	97.5% KM (Chebyshev) UCL	0.0109
k star	0.121	99% KM (Chebyshev) UCL	0.013
Theta star	0.0479		
Nu star	194.7	Potential UCLs to Use	
AppChi2	163.4	95% KM (t) UCL	0.00832
95% Gamma Approximate UCL	0.00692		
95% Adjusted Gamma UCL	0.00693		

Appendix A
ProUCL Output

Endrin aldehyde			
General Statistics			
Number of Valid Data	802	Number of Detected Data	442
Number of Distinct Detected Data	105	Number of Non-Detect Data	360
		Percent Non-Detects	44.89%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0016	Minimum Detected	-6.438
Maximum Detected	0.91	Maximum Detected	-0.0943
Mean of Detected	0.0646	Mean of Detected	-2.951
SD of Detected	0.0587	SD of Detected	0.67
Minimum Non-Detect	0.00019	Minimum Non-Detect	-8.568
Maximum Non-Detect	0.0066	Maximum Non-Detect	-5.021
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	369
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	433
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	46.01%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.192	Lilliefors Test Statistic	0.124
5% Lilliefors Critical Value	0.0421	5% Lilliefors Critical Value	0.0421
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0358	Mean	-5.254
SD	0.0541	SD	2.637
95% DL/2 (t) UCL	0.0389	95% H-Stat (DL/2) UCL	0.239
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.00859	Mean in Log Scale	-3.62
SD	0.0827	SD in Log Scale	0.946
95% MLE (t) UCL	0.0134	Mean in Original Scale	0.0414
95% MLE (Tiku) UCL	0.0143	SD in Original Scale	0.0507
		95% t UCL	0.0444
		95% Percentile Bootstrap UCL	0.0445
		95% BCA Bootstrap UCL	0.045
		95% H UCL	0.0449
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	2.501	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.0258		
nu star	2211		
A-D Test Statistic	8.49	**Nonparametric Statistics**	
5% A-D Critical Value	0.763	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.763	Mean	0.0363
5% K-S Critical Value	0.0436	SD	0.0537
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0019
		95% KM (t) UCL	0.0395
Assuming Gamma Distribution		95% KM (z) UCL	0.0395
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0392
Minimum	0.000001	95% KM (bootstrap t) UCL	0.0398
Maximum	0.91	95% KM (BCA) UCL	0.0403
Mean	0.0356	95% KM (Percentile Bootstrap) UCL	0.04
Median	0.03	95% KM (Chebyshev) UCL	0.0446
SD	0.0542	97.5% KM (Chebyshev) UCL	0.0482
k star	0.168	99% KM (Chebyshev) UCL	0.0552
Theta star	0.212		
Nu star	270.1	Potential UCLs to Use	
AppChi2	233.1	95% KM (t) UCL	0.0395
95% Gamma Approximate UCL	0.0413	95% KM (% Bootstrap) UCL	0.04
95% Adjusted Gamma UCL	0.0413		

Appendix A
ProUCL Output

Endrin ketone			
General Statistics			
Number of Valid Data	802	Number of Detected Data	376
Number of Distinct Detected Data	135	Number of Non-Detect Data	426
		Percent Non-Detects	53.12%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00049	Minimum Detected	-7.621
Maximum Detected	0.24	Maximum Detected	-1.427
Mean of Detected	0.0267	Mean of Detected	-4.024
SD of Detected	0.0229	SD of Detected	0.991
Minimum Non-Detect	0.00026	Minimum Non-Detect	-8.255
Maximum Non-Detect	0.072	Maximum Non-Detect	-2.631
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	790
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	12
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	98.50%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.126	Lilliefors Test Statistic	0.0983
5% Lilliefors Critical Value	0.0457	5% Lilliefors Critical Value	0.0457
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0132	Mean	-5.954
SD	0.0203	SD	2.118
95% DL/2 (t) UCL	0.0143	95% H-Stat (DL/2) UCL	0.031
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-5.275
		SD in Log Scale	1.474
		Mean in Original Scale	0.0137
		SD in Original Scale	0.0199
		95% t UCL	0.0148
		95% Percentile Bootstrap UCL	0.0148
		95% BCA Bootstrap UCL	0.0149
		95% H-UCL	0.0173
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.382	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	0.0193		
nu star	1040		
A-D Test Statistic	3.013	**Nonparametric Statistics**	
5% A-D Critical Value	0.775	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.775	Mean	0.0129
5% K-S Critical Value	0.0478	SD	0.0204
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0007224
		95% KM (t) UCL	0.0141
Assuming Gamma Distribution		95% KM (z) UCL	0.0141
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.014
Minimum	0.000001	95% KM (bootstrap t) UCL	0.014
Maximum	0.24	95% KM (BCA) UCL	0.0143
Mean	0.0125	95% KM (Percentile Bootstrap) UCL	0.0142
Median	0.000001	95% KM (Chebyshev) UCL	0.016
SD	0.0206	97.5% KM (Chebyshev) UCL	0.0174
k star	0.158	99% KM (Chebyshev) UCL	0.0201
Theta star	0.0791		
Nu star	254	**Potential UCLs to Use**	
AppChi2	218.1	95% KM (t) UCL	0.0141
95% Gamma Approximate UCL	0.0146	95% KM (% Bootstrap) UCL	0.0142
95% Adjusted Gamma UCL	0.0146		

Appendix A
ProUCL Output

gamma-BHC (Lindane)			
General Statistics			
Number of Valid Data	802	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	800
		Percent Non-Detects	99.75%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0049	Minimum Detected	-5.319
Maximum Detected	0.006	Maximum Detected	-5.116
Mean of Detected	0.00545	Mean of Detected	-5.217
SD of Detected	0.0007778	SD of Detected	0.143
Minimum Non-Detect	0.00017	Minimum Non-Detect	-8.68
Maximum Non-Detect	0.079	Maximum Non-Detect	-2.538
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	802
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%
Warning: Data set has only 2 Distinct Detected Values.			
This may not be adequate enough to compute meaningful and reliable test statistics and estimates.			
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).			
Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.			
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.			
Those methods will return a 'N/A' value on your output display!			
It is necessary to have 4 or more Distinct Values for bootstrap methods.			
However, results obtained using 4 to 9 distinct values may not be reliable.			
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.			
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00138	Mean	-7.334
SD	0.0021	SD	1.419
95% DL/2 (t) UCL	0.0015	95% H-Stat (DL/2) UCL	0.00202
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% t UCL	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
		95% H-UCL	N/A
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	N/A	Data do not follow a Discernable Distribution (0.05)	
Theta Star	N/A		
nu star	N/A		

gamma-BHC (Lindane) (Continued)			
A-D Test Statistic	N/A	**Nonparametric Statistics**	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.0049
5% K-S Critical Value	N/A	SD	3.926E-05
Data not Gamma Distributed at 5% Significance Level		SE of Mean	1.983E-06
		95% KM (t) UCL	0.0049
Assuming Gamma Distribution		95% KM (z) UCL	0.0049
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.00561
Minimum	N/A	95% KM (bootstrap t) UCL	0.0049
Maximum	N/A	95% KM (BCA) UCL	0.006
Mean	N/A	95% KM (Percentile Bootstrap) UCL	0.006
Median	N/A	95% KM (Chebyshev) UCL	0.00491
SD	N/A	97.5% KM (Chebyshev) UCL	0.00491
k star	N/A	99% KM (Chebyshev) UCL	0.00492
Theta star	N/A		
Nu star	N/A	**Potential UCLs to Use**	
AppChi2	N/A	95% KM (t) UCL	0.0049
95% Gamma Approximate UCL	N/A	95% KM (% Bootstrap) UCL	0.006
95% Adjusted Gamma UCL	N/A		

Appendix A
ProUCL Output

gamma-Chlordane			
General Statistics			
Number of Valid Data	802	Number of Detected Data	137
Number of Distinct Detected Data	70	Number of Non-Detect Data	665
		Percent Non-Detects	82.92%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00036	Minimum Detected	-7.929
Maximum Detected	0.028	Maximum Detected	-3.576
Mean of Detected	0.00357	Mean of Detected	-6.013
SD of Detected	0.00429	SD of Detected	0.816
Minimum Non-Detect	0.00016	Minimum Non-Detect	-8.74
Maximum Non-Detect	0.045	Maximum Non-Detect	-3.101
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	802
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.24	Lilliefors Test Statistic	0.0579
5% Lilliefors Critical Value	0.0757	5% Lilliefors Critical Value	0.0757
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00126	Mean	-7.461
SD	0.00229	SD	1.345
95% DL/2 (t) UCL	0.00139	95% H-Stat (DL/2) UCL	0.00159
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-8.186
		SD in Log Scale	1.473
		Mean in Original Scale	0.0008672
		SD in Original Scale	0.00217
		95% t UCL	0.0009936
		95% Percentile Bootstrap UCL	0.0009988
		95% BCA Bootstrap UCL	0.00101
		95% H-UCL	0.0009384
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.437	Data appear Lognormal at 5% Significance Level	
Theta Star	0.00248		
nu star	393.8		
A-D Test Statistic	3.405	**Nonparametric Statistics**	
5% A-D Critical Value	0.771	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.771	Mean	0.0009861
5% K-S Critical Value	0.0815	SD	0.00214
Data not Gamma Distributed at 5% Significance Level		SE of Mean	7.721E-05
		95% KM (t) UCL	0.00111
Assuming Gamma Distribution		95% KM (z) UCL	0.00111
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.00109
Minimum	0.000001	95% KM (bootstrap t) UCL	0.00113
Maximum	0.028	95% KM (BCA) UCL	0.00124
Mean	0.0006873	95% KM (Percentile Bootstrap) UCL	0.00119
Median	0.000001	95% KM (Chebyshev) UCL	0.00132
SD	0.00224	97.5% KM (Chebyshev) UCL	0.00147
k star	0.156	99% KM (Chebyshev) UCL	0.00175
Theta star	0.0044		
Nu star	250.8	Potential UCLs to Use	
AppChi2	215.1	95% KM (t) UCL	0.00111
95% Gamma Approximate UCL	0.0008012	95% KM (% Bootstrap) UCL	0.00119
95% Adjusted Gamma UCL	0.0008014		

Heptachlor			
General Statistics			
Number of Valid Data	802	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	802
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Heptachlor was not processed!

Appendix A
ProUCL Output

Heptachlor epoxide			
General Statistics			
Number of Valid Data	802	Number of Detected Data	101
Number of Distinct Detected Data	61	Number of Non-Detect Data	701
		Percent Non-Detects	87.41%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00038	Minimum Detected	-7.875
Maximum Detected	0.13	Maximum Detected	-2.04
Mean of Detected	0.00711	Mean of Detected	-6.039
SD of Detected	0.021	SD of Detected	1.152
Minimum Non-Detect	0.00025	Minimum Non-Detect	-8.294
Maximum Non-Detect	0.085	Maximum Non-Detect	-2.465
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	799
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	3
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	99.63%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.42	Lilliefors Test Statistic	0.127
5% Lilliefors Critical Value	0.0882	5% Lilliefors Critical Value	0.0882
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00212	Mean	-6.911
SD	0.00789	SD	1.103
95% DL/2 (t) UCL	0.00258	95% H-Stat (DL/2) UCL	0.00199
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-8.855
		SD in Log Scale	1.828
		Mean in Original Scale	0.00113
		SD in Original Scale	0.00779
		95% t UCL	0.00158
		95% Percentile Bootstrap UCL	0.00161
		95% BCA Bootstrap UCL	0.00181
		95% H-UCL	0.0009112
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.559	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.0127		
nu star	113		
A-D Test Statistic	11.1	**Nonparametric Statistics**	
5% A-D Critical Value	0.812	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.812	Mean	0.00136
5% K-S Critical Value	0.0939	SD	0.00776
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0002763
		95% KM (t) UCL	0.00182
Assuming Gamma Distribution		95% KM (z) UCL	0.00182
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0018
Minimum	0.000001	95% KM (bootstrap t) UCL	0.00211
Maximum	0.13	95% KM (BCA) UCL	0.0019
Mean	0.00125	95% KM (Percentile Bootstrap) UCL	0.00187
Median	0.000001	95% KM (Chebyshev) UCL	0.00257
SD	0.00794	97.5% KM (Chebyshev) UCL	0.00309
k star	0.138	99% KM (Chebyshev) UCL	0.00411
Theta star	0.00909		
Nu star	221	Potential UCLs to Use	
AppChi2	187.6	95% KM (BCA) UCL	0.0019
95% Gamma Approximate UCL	0.00148		
95% Adjusted Gamma UCL	0.00148		

Appendix A
ProUCL Output

Methoxychlor			
General Statistics			
Number of Valid Data	802	Number of Detected Data	395
Number of Distinct Detected Data	119	Number of Non-Detect Data	407
		Percent Non-Detects	50.75%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.0018	Minimum Detected	-6.32
Maximum Detected	3.5	Maximum Detected	1.253
Mean of Detected	0.103	Mean of Detected	-2.875
SD of Detected	0.199	SD of Detected	1.118
Minimum Non-Detect	0.00052	Minimum Non-Detect	-7.562
Maximum Non-Detect	0.14	Maximum Non-Detect	-1.966
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	688
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	114
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	85.79%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.304	Lilliefors Test Statistic	0.0977
5% Lilliefors Critical Value	0.0446	5% Lilliefors Critical Value	0.0446
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0524	Mean	-4.845
SD	0.148	SD	2.269
95% DL/2 (t) UCL	0.061	95% H-Stat (DL/2) UCL	0.135
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-4.255
		SD in Log Scale	1.689
		Mean in Original Scale	0.0535
		SD in Original Scale	0.148
		95% t UCL	0.0621
		95% Percentile Bootstrap UCL	0.0625
		95% BCA Bootstrap UCL	0.0662
		95% H-UCL	0.0695
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.951	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.109		
nu star	751.6		
A-D Test Statistic	6.459	**Nonparametric Statistics**	
5% A-D Critical Value	0.787	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.787	Mean	0.0521
5% K-S Critical Value	0.047	SD	0.148
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.00524
		95% KM (t) UCL	0.0607
Assuming Gamma Distribution		95% KM (z) UCL	0.0607
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.0607
Minimum	0.000001	95% KM (bootstrap t) UCL	0.0661
Maximum	3.5	95% KM (BCA) UCL	0.0617
Mean	0.051	95% KM (Percentile Bootstrap) UCL	0.0614
Median	0.000001	95% KM (Chebyshev) UCL	0.0749
SD	0.149	97.5% KM (Chebyshev) UCL	0.0848
k star	0.142	99% KM (Chebyshev) UCL	0.104
Theta star	0.358		
Nu star	228.4	Potential UCLs to Use	
AppChi2	194.4	95% KM (BCA) UCL	0.0617
95% Gamma Approximate UCL	0.0599		
95% Adjusted Gamma UCL	0.0599		

Appendix A
ProUCL Output

Toxaphene			
General Statistics			
Number of Valid Data	802	Number of Detected Data	797
Number of Distinct Detected Data	124	Number of Non-Detect Data	5
		Percent Non-Detects	0.62%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.055	Minimum Detected	-2.9
Maximum Detected	12	Maximum Detected	2.485
Mean of Detected	1.264	Mean of Detected	0.0518
SD of Detected	0.963	SD of Detected	0.615
Minimum Non-Detect	0.012	Minimum Non-Detect	-4.423
Maximum Non-Detect	1.1	Maximum Non-Detect	0.0953
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	364
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	438
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	45.39%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.19	Lilliefors Test Statistic	0.0954
5% Lilliefors Critical Value	0.0314	5% Lilliefors Critical Value	0.0314
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.257	Mean	0.0345
SD	0.964	SD	0.663
95% DL/2 (t) UCL	1.313	95% H-Stat (DL/2) UCL	1.347
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.946	Mean in Log Scale	0.0435
SD	1.286	SD in Log Scale	0.623
95% MLE (t) UCL	1.02	Mean in Original Scale	1.258
95% MLE (Tiku) UCL	1.034	SD in Original Scale	0.963
		95% t UCL	1.314
		95% Percentile Bootstrap UCL	1.316
		95% BCA Bootstrap UCL	1.319
		95% H UCL	1.321
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	2.89	Data do not follow a Discernable Distribution (0.05)	
Theta Star	0.437		
nu star	4607		
A-D Test Statistic	9.377	**Nonparametric Statistics**	
5% A-D Critical Value	0.761	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.761	Mean	1.257
5% K-S Critical Value	0.0337	SD	0.963
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.034
		95% KM (t) UCL	1.313
Assuming Gamma Distribution		95% KM (z) UCL	1.313
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.313
Minimum	0.000001	95% KM (bootstrap t) UCL	1.318
Maximum	12	95% KM (BCA) UCL	1.32
Mean	1.257	95% KM (Percentile Bootstrap) UCL	1.314
Median	1.1	95% KM (Chebyshev) UCL	1.406
SD	0.964	97.5% KM (Chebyshev) UCL	1.47
k star	2.266	99% KM (Chebyshev) UCL	1.596
Theta star	0.555		
Nu star	3635	Potential UCLs to Use	
AppChi2	3496	95% KM (BCA) UCL	1.32
95% Gamma Approximate UCL	1.307		
95% Adjusted Gamma UCL	1.307		

APPENDIX B
REMEDIAL GOALS

Table B-1
Risk-Based Screening Level (mg/kg) Summary
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

				5 Year Exposure Duration			20 Year Exposure Duration		
COPC	Resident	Industrial Worker	Construction Worker	Maneuver Trainer	MOUT Trainer	Heavy Equipment Trainer	Maneuver Trainer	MOUT Trainer	Heavy Equipment Trainer
Aldrin	0.02	0.05	0.34	0.25	0.67	0.28	0.064	0.17	0.070
BHC, alpha	0.09	0.31	2.19	1.55	4.06	1.82	0.39	1.02	0.46
BHC, beta	0.31	1.09	7.65	5.42	14.22	6.38	1.35	3.55	1.59
BHC, gamma	0.50	1.66	11.52	8.22	21.57	9.60	2.05	5.39	2.40
BHC, delta	0.13	0.44	0.26	2.19	5.75	0.21	0.55	1.44	0.05
Chlordane, alpha	0.42	1.40	2.97	6.95	18.26	8.13	1.74	4.56	2.03
Chlordane, gamma	0.42	1.40	2.97	6.95	18.26	8.13	1.74	4.56	2.03
DDD	2.29	7.59	52.79	37.67	98.88	43.99	9.42	24.72	11.00
DDE	1.62	5.36	37.26	26.59	69.80	31.05	6.65	17.45	7.76
DDT	1.62	5.36	37.26	26.59	69.80	31.05	6.65	17.45	7.76
Dieldrin	0.02	0.05	0.36	0.27	0.71	0.30	0.068	0.18	0.075
Endosulfan I	364	2,865	780	2,843	7,462	13,003	711	1,866	3,251
Endosulfan II	364	2,865	780	2,843	7,462	13,003	711	1,866	3,251
Endosulfan sulfate	364	2,865	780	2,843	7,462	13,003	711	1,866	3,251
Endrin	1.51	5.29	1.33	5.24	13.77	22.09	1.31	3.44	5.52
Endrin aldehyde	1.51	5.29	1.33	5.24	13.77	22.09	1.31	3.44	5.52
Endrin ketone	1.51	5.29	1.33	5.24	13.77	22.09	1.31	3.44	5.52
Heptachlor epoxide	0.05	0.15	0.99	0.73	1.91	0.83	0.18	0.48	0.21
Methoxychlor	1.37	2,388	650	2,369	6,218	10,835	592	1,555	2,709
Toxaphene	0.44	1.22	8.20	6.03	15.83	6.84	1.51	3.96	1.71

Table B-2
Residents
Risk-Based Screening Levels - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	3.76E-02	5.82E-02	6.54E+02	2.28E-02
BHC, alpha	1.01E-01	7.85E-01	1.78E+03	8.98E-02
BHC, beta	3.55E-01	2.75E+00	6.04E+03	3.14E-01
BHC, gamma	5.81E-01	4.50E+00	1.03E+04	5.14E-01
BHC, delta	3.55E-01	2.75E+00	6.28E+03	3.14E-01
Chlordane, alpha	1.83E+00	1.41E+01	3.20E+04	1.62E+00
Chlordane, gamma	1.83E+00	1.41E+01	3.20E+04	1.62E+00
DDD	2.66E+00	2.75E+01	4.64E+04	2.43E+00
DDE	1.88E+00	1.94E+01	3.30E+04	1.71E+00
DDT	1.88E+00	1.94E+01	3.30E+04	1.71E+00
Dieldrin	3.99E-02	6.19E-02	6.96E+02	2.43E-02
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	7.02E-02	2.18E-01	1.23E+03	5.31E-02
Methoxychlor	-	-	-	-
Toxaphene	5.81E-01	1.80E+00	1.00E+04	4.39E-01

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	2.35E+00	4.05E+00	-	1.49E+00
BHC, alpha	6.26E+02	5.39E+03	-	5.61E+02
BHC, beta	-	-	-	-
BHC, gamma	2.35E+01	2.02E+02	-	2.10E+01
BHC, delta	-	-	-	-
Chlordane, alpha	3.91E+01	3.37E+02	9.61E+02	3.38E+01
Chlordane, gamma	3.91E+01	3.37E+02	9.61E+02	3.38E+01
DDD	3.91E+01	4.50E+02	-	3.60E+01
DDE	3.91E+01	4.50E+02	-	3.60E+01
DDT	3.91E+01	4.50E+02	-	3.60E+01
Dieldrin	3.91E+00	6.74E+00	-	2.48E+00
Endosulfan I	4.69E+02	1.62E+03	-	3.64E+02
Endosulfan II	4.69E+02	1.62E+03	-	3.64E+02
Endosulfan sulfate	4.69E+02	1.62E+03	-	3.64E+02
Endrin	2.35E+01	1.62E+00	-	1.51E+00
Endrin aldehyde	2.35E+01	1.62E+00	-	1.51E+00
Endrin ketone	2.35E+01	1.62E+00	-	1.51E+00
Heptachlor epoxide	1.02E+00	3.51E+00	-	7.88E-01
Methoxychlor	3.91E+02	1.35E+03	-	3.03E+02
Toxaphene	-	-	-	-

Table B-3
Residents
Risk-Based Screening Levels - CAL EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	3.76E-02	1.16E-01	6.54E+02	2.84E-02
BHC, alpha	2.37E-01	1.47E+00	4.16E+03	2.04E-01
BHC, beta	4.26E-01	2.64E+00	7.45E+03	3.67E-01
BHC, gamma	5.81E-01	3.60E+00	1.03E+04	5.00E-01
BHC, delta	1.60E-01	9.90E-01	2.91E+00	1.31E-01
Chlordane, alpha	4.91E-01	3.05E+00	9.42E+03	4.23E-01
Chlordane, gamma	4.91E-01	3.05E+00	9.42E+03	4.23E-01
DDD	2.66E+00	1.65E+01	4.64E+04	2.29E+00
DDE	1.88E+00	1.16E+01	3.30E+04	1.62E+00
DDT	1.88E+00	1.16E+01	3.30E+04	1.62E+00
Dieldrin	3.99E-02	1.24E-01	6.96E+02	3.02E-02
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	1.16E-01	7.20E-01	1.23E+03	1.00E-01
Methoxychlor	-	-	-	-
Toxaphene	5.32E-01	3.30E+00	9.42E+03	4.58E-01

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	2.35E+00	8.09E+00	1.44E+02	1.80E+00
BHC, alpha	6.26E+02	4.32E+03	3.84E+04	5.39E+02
BHC, beta	-	-	-	-
BHC, gamma	2.35E+01	1.62E+02	1.44E+03	2.02E+01
BHC, delta	-	-	-	-
Chlordane, alpha	2.58E+00	1.78E+01	9.61E+02	2.25E+00
Chlordane, gamma	2.58E+00	1.78E+01	9.61E+02	2.25E+00
DDD	3.91E+01	2.70E+02	2.40E+03	3.37E+01
DDE	3.91E+01	2.70E+02	2.40E+03	3.37E+01
DDT	3.91E+01	2.70E+02	2.40E+03	3.37E+01
Dieldrin	3.91E+00	1.35E+01	2.40E+02	2.99E+00
Endosulfan I	4.69E+02	3.24E+03	2.88E+04	4.04E+02
Endosulfan II	4.69E+02	3.24E+03	2.88E+04	4.04E+02
Endosulfan sulfate	4.69E+02	3.24E+03	2.88E+04	4.04E+02
Endrin	2.35E+01	3.24E+00	1.44E+03	2.84E+00
Endrin aldehyde	2.35E+01	3.24E+00	1.44E+03	2.84E+00
Endrin ketone	2.35E+01	3.24E+00	1.44E+03	2.84E+00
Heptachlor epoxide	1.02E+00	7.01E+00	6.24E+01	8.76E-01
Methoxychlor	1.56E+00	1.08E+01	2.40E+04	1.37E+00
Toxaphene	-	-	-	-

Table B-4
Industrial Workers
Risk-Based Screening Levels - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	**Dermal**	**Inhalation**	**Combined**
Aldrin	1.68E-01	7.38E-02	3.29E+03	5.13E-02
BHC, alpha	4.54E-01	9.96E-01	8.97E+03	3.12E-01
BHC, beta	1.59E+00	3.49E+00	3.05E+04	1.09E+00
BHC, gamma	2.60E+00	5.70E+00	5.21E+04	1.79E+00
BHC, delta	1.59E+00	3.49E+00	3.16E+04	1.09E+00
Chlordane, alpha	8.18E+00	1.79E+01	1.61E+05	5.62E+00
Chlordane, gamma	8.18E+00	1.79E+01	1.61E+05	5.62E+00
DDD	1.19E+01	3.49E+01	2.34E+05	8.88E+00
DDE	8.42E+00	2.46E+01	1.66E+05	6.27E+00
DDT	8.42E+00	2.46E+01	1.66E+05	6.27E+00
Dieldrin	1.79E-01	7.84E-02	3.51E+03	5.45E-02
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	3.14E-01	2.76E-01	6.21E+03	1.47E-01
Methoxychlor	-	-	-	-
Toxaphene	2.60E+00	2.28E+00	5.04E+04	1.22E+00

COPC	Noncancer Remedial Goals			
	Ingestion	**Dermal**	**Inhalation**	**Combined**
Aldrin	3.07E+01	1.34E+01	-	9.35E+00
BHC, alpha	8.18E+03	1.79E+04	-	5.62E+03
BHC, beta	-	-	-	-
BHC, gamma	3.07E+02	6.72E+02	-	2.11E+02
BHC, delta	-	-	-	-
Chlordane, alpha	5.11E+02	1.12E+03	4.03E+03	3.23E+02
Chlordane, gamma	5.11E+02	1.12E+03	4.03E+03	3.23E+02
DDD	5.11E+02	1.49E+03	-	3.81E+02
DDE	5.11E+02	1.49E+03	-	3.81E+02
DDT	5.11E+02	1.49E+03	-	3.81E+02
Dieldrin	5.11E+01	2.24E+01	-	1.56E+01
Endosulfan I	6.13E+03	5.38E+03	-	2.87E+03
Endosulfan II	6.13E+03	5.38E+03	-	2.87E+03
Endosulfan sulfate	6.13E+03	5.38E+03	-	2.87E+03
Endrin	3.07E+02	5.38E+00	-	5.29E+00
Endrin aldehyde	3.07E+02	5.38E+00	-	5.29E+00
Endrin ketone	3.07E+02	5.38E+00	-	5.29E+00
Heptachlor epoxide	1.33E+01	1.17E+01	-	6.21E+00
Methoxychlor	5.11E+03	4.48E+03	-	2.39E+03
Toxaphene	-	-	-	-

Table B-4
Industrial Workers
Risk-Based Screening Levels - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	1.68E-01	7.38E-02	3.29E+03	5.13E-02
BHC, alpha	4.54E-01	9.96E-01	8.97E+03	3.12E-01
BHC, beta	1.59E+00	3.49E+00	3.05E+04	1.09E+00
BHC, gamma	2.60E+00	5.70E+00	5.21E+04	1.79E+00
BHC, delta	1.59E+00	3.49E+00	3.16E+04	1.09E+00
Chlordane, alpha	8.18E+00	1.79E+01	1.61E+05	5.62E+00
Chlordane, gamma	8.18E+00	1.79E+01	1.61E+05	5.62E+00
DDD	1.19E+01	3.49E+01	2.34E+05	8.88E+00
DDE	8.42E+00	2.46E+01	1.66E+05	6.27E+00
DDT	8.42E+00	2.46E+01	1.66E+05	6.27E+00
Dieldrin	1.79E-01	7.84E-02	3.51E+03	5.45E-02
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	3.14E-01	2.76E-01	6.21E+03	1.47E-01
Methoxychlor	-	-	-	-
Toxaphene	2.60E+00	2.28E+00	5.04E+04	1.22E+00

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	3.07E+01	1.34E+01	-	9.35E+00
BHC, alpha	8.18E+03	1.79E+04	-	5.62E+03
BHC, beta	-	-	-	-
BHC, gamma	3.07E+02	6.72E+02	-	2.11E+02
BHC, delta	-	-	-	-
Chlordane, alpha	5.11E+02	1.12E+03	4.03E+03	3.23E+02
Chlordane, gamma	5.11E+02	1.12E+03	4.03E+03	3.23E+02
DDD	5.11E+02	1.49E+03	-	3.81E+02
DDE	5.11E+02	1.49E+03	-	3.81E+02
DDT	5.11E+02	1.49E+03	-	3.81E+02
Dieldrin	5.11E+01	2.24E+01	-	1.56E+01
Endosulfan I	6.13E+03	5.38E+03	-	2.87E+03
Endosulfan II	6.13E+03	5.38E+03	-	2.87E+03
Endosulfan sulfate	6.13E+03	5.38E+03	-	2.87E+03
Endrin	3.07E+02	5.38E+00	-	5.29E+00
Endrin aldehyde	3.07E+02	5.38E+00	-	5.29E+00
Endrin ketone	3.07E+02	5.38E+00	-	5.29E+00
Heptachlor epoxide	1.33E+01	1.17E+01	-	6.21E+00
Methoxychlor	5.11E+03	4.48E+03	-	2.39E+03
Toxaphene	-	-	-	-

Table B-5
Industrial Workers
Risk-Based Screening Levels - CAL EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	1.68E-01	1.48E-01	3.29E+03	7.87E-02
BHC, alpha	1.06E+00	1.86E+00	2.10E+04	6.75E-01
BHC, beta	1.91E+00	3.35E+00	3.75E+04	1.22E+00
BHC, gamma	2.60E+00	4.56E+00	5.21E+04	1.66E+00
BHC, delta	7.15E-01	1.26E+00	1.47E+01	4.42E-01
Chlordane, alpha	2.20E+00	3.86E+00	4.75E+04	1.40E+00
Chlordane, gamma	2.20E+00	3.86E+00	4.75E+04	1.40E+00
DDD	1.19E+01	2.09E+01	2.34E+05	7.59E+00
DDE	8.42E+00	1.48E+01	1.66E+05	5.36E+00
DDT	8.42E+00	1.48E+01	1.66E+05	5.36E+00
Dieldrin	1.79E-01	1.57E-01	3.51E+03	8.36E-02
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	5.20E-01	9.13E-01	6.21E+03	3.31E-01
Methoxychlor	-	-	-	-
Toxaphene	2.38E+00	4.18E+00	4.75E+04	1.52E+00

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	3.07E+01	2.69E+01	6.05E+02	1.43E+01
BHC, alpha	8.18E+03	1.43E+04	1.61E+05	5.21E+03
BHC, beta	-	-	-	-
BHC, gamma	3.07E+02	5.38E+02	6.05E+03	1.95E+02
BHC, delta	-	-	-	-
Chlordane, alpha	5.11E+02	8.96E+02	4.03E+03	3.25E+02
Chlordane, gamma	5.11E+02	8.96E+02	4.03E+03	3.25E+02
DDD	5.11E+02	8.96E+02	1.01E+04	3.25E+02
DDE	5.11E+02	8.96E+02	1.01E+04	3.25E+02
DDT	5.11E+02	8.96E+02	1.01E+04	3.25E+02
Dieldrin	5.11E+01	4.48E+01	1.01E+03	2.39E+01
Endosulfan I	6.13E+03	1.08E+04	1.21E+05	3.91E+03
Endosulfan II	6.13E+03	1.08E+04	1.21E+05	3.91E+03
Endosulfan sulfate	6.13E+03	1.08E+04	1.21E+05	3.91E+03
Endrin	3.07E+02	1.08E+01	6.05E+03	1.04E+01
Endrin aldehyde	3.07E+02	1.08E+01	6.05E+03	1.04E+01
Endrin ketone	3.07E+02	1.08E+01	6.05E+03	1.04E+01
Heptachlor epoxide	1.33E+01	2.33E+01	2.62E+02	8.46E+00
Methoxychlor	5.11E+03	8.96E+03	1.01E+05	3.25E+03
Toxaphene	-	-	-	-

Table B-6
Construction Workers
Risk-Based Screening Levels - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	1.28E+00	4.61E-01	6.26E+01	3.37E-01
BHC, alpha	3.44E+00	6.23E+00	1.70E+02	2.19E+00
BHC, beta	1.20E+01	2.18E+01	5.78E+02	7.65E+00
BHC, gamma	1.97E+01	3.57E+01	9.89E+02	1.25E+01
BHC, delta	1.20E+01	2.18E+01	6.01E+02	7.66E+00
Chlordane, alpha	6.19E+01	1.12E+02	3.07E+03	3.94E+01
Chlordane, gamma	6.19E+01	1.12E+02	3.07E+03	3.94E+01
DDD	9.03E+01	2.18E+02	4.44E+03	6.30E+01
DDE	6.38E+01	1.54E+02	3.16E+03	4.44E+01
DDT	6.38E+01	1.54E+02	3.16E+03	4.44E+01
Dieldrin	1.35E+00	4.90E-01	6.67E+01	3.58E-01
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	2.38E+00	1.72E+00	1.18E+02	9.92E-01
Methoxychlor	-	-	-	-
Toxaphene	1.97E+01	1.43E+01	9.58E+02	8.20E+00

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	9.29E+00	3.36E+00	-	2.47E+00
BHC, alpha	2.48E+03	4.48E+03	-	1.60E+03
BHC, beta	-	-	-	-
BHC, gamma	9.29E+01	1.68E+02	-	5.98E+01
BHC, delta	-	-	-	-
Chlordane, alpha	1.55E+02	2.80E+02	3.07E+00	2.97E+00
Chlordane, gamma	1.55E+02	2.80E+02	3.07E+00	2.97E+00
DDD	1.55E+02	3.74E+02	-	1.09E+02
DDE	1.55E+02	3.74E+02	-	1.09E+02
DDT	1.55E+02	3.74E+02	-	1.09E+02
Dieldrin	1.55E+01	5.60E+00	-	4.11E+00
Endosulfan I	1.86E+03	1.34E+03	-	7.80E+02
Endosulfan II	1.86E+03	1.34E+03	-	7.80E+02
Endosulfan sulfate	1.86E+03	1.34E+03	-	7.80E+02
Endrin	9.29E+01	1.34E+00	-	1.33E+00
Endrin aldehyde	9.29E+01	1.34E+00	-	1.33E+00
Endrin ketone	9.29E+01	1.34E+00	-	1.33E+00
Heptachlor epoxide	4.03E+00	2.91E+00	-	1.69E+00
Methoxychlor	1.55E+03	1.12E+03	-	6.50E+02
Toxaphene	-	-	-	-

Table B-7
Construction Workers
Risk-Based Screening Levels - CAL EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	1.28E+00	9.23E-01	6.26E+01	5.31E-01
BHC, alpha	8.03E+00	1.16E+01	3.98E+02	4.69E+00
BHC, beta	1.45E+01	2.09E+01	7.13E+02	8.45E+00
BHC, gamma	1.97E+01	2.85E+01	9.89E+02	1.15E+01
BHC, delta	5.42E+00	7.84E+00	2.79E-01	2.56E-01
Chlordane, alpha	1.67E+01	2.41E+01	9.02E+02	9.76E+00
Chlordane, gamma	1.67E+01	2.41E+01	9.02E+02	9.76E+00
DDD	9.03E+01	1.31E+02	4.44E+03	5.28E+01
DDE	6.38E+01	9.23E+01	3.16E+03	3.73E+01
DDT	6.38E+01	9.23E+01	3.16E+03	3.73E+01
Dieldrin	1.35E+00	9.81E-01	6.67E+01	5.64E-01
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	3.94E+00	5.70E+00	1.18E+02	2.29E+00
Methoxychlor	-	-	-	-
Toxaphene	1.81E+01	2.61E+01	9.02E+02	1.06E+01

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	9.29E+00	6.72E+00	4.60E-01	3.90E+00
BHC, alpha	2.48E+03	3.59E+03	1.23E+02	1.47E+03
BHC, beta	-	-	-	-
BHC, gamma	9.29E+01	1.34E+02	4.60E+00	5.49E+01
BHC, delta	-	-	-	-
Chlordane, alpha	1.55E+02	2.24E+02	3.07E+00	9.16E+01
Chlordane, gamma	1.55E+02	2.24E+02	3.07E+00	9.16E+01
DDD	1.55E+02	2.24E+02	7.67E+00	9.16E+01
DDE	1.55E+02	2.24E+02	7.67E+00	9.16E+01
DDT	1.55E+02	2.24E+02	7.67E+00	9.16E+01
Dieldrin	1.55E+01	1.12E+01	7.67E-01	6.50E+00
Endosulfan I	1.86E+03	2.69E+03	9.20E+01	1.10E+03
Endosulfan II	1.86E+03	2.69E+03	9.20E+01	1.10E+03
Endosulfan sulfate	1.86E+03	2.69E+03	9.20E+01	1.10E+03
Endrin	9.29E+01	2.69E+00	4.60E+00	2.61E+00
Endrin aldehyde	9.29E+01	2.69E+00	4.60E+00	2.61E+00
Endrin ketone	9.29E+01	2.69E+00	4.60E+00	2.61E+00
Heptachlor epoxide	4.03E+00	5.83E+00	1.99E-01	2.38E+00
Methoxychlor	1.55E+03	2.24E+03	7.67E+01	9.16E+02
Toxaphene	-	-	-	-

Table B-8
Maneuver Trainers (5 year exposure duration)
Risk-Based Screening Levels - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	8.35E-01	3.66E-01	1.63E+04	2.55E-01
BHC, alpha	2.25E+00	4.94E+00	4.45E+04	1.55E+00
BHC, beta	7.89E+00	1.73E+01	1.51E+05	5.42E+00
BHC, gamma	1.29E+01	2.83E+01	2.58E+05	8.86E+00
BHC, delta	7.89E+00	1.73E+01	1.57E+05	5.42E+00
Chlordane, alpha	4.06E+01	8.89E+01	8.01E+05	2.79E+01
Chlordane, gamma	4.06E+01	8.89E+01	8.01E+05	2.79E+01
DDD	5.91E+01	1.73E+02	1.16E+06	4.41E+01
DDE	4.17E+01	1.22E+02	8.25E+05	3.11E+01
DDT	4.17E+01	1.22E+02	8.25E+05	3.11E+01
Dieldrin	8.87E-01	3.89E-01	1.74E+04	2.70E-01
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	1.56E+00	1.37E+00	3.08E+04	7.29E-01
Methoxychlor	-	-	-	-
Toxaphene	1.29E+01	1.13E+01	2.50E+05	6.03E+00

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	3.04E+01	1.33E+01	-	9.27E+00
BHC, alpha	8.11E+03	1.78E+04	-	5.57E+03
BHC, beta	-	-	-	-
BHC, gamma	3.04E+02	6.67E+02	-	2.09E+02
BHC, delta	-	-	-	-
Chlordane, alpha	5.07E+02	1.11E+03	4.00E+03	3.20E+02
Chlordane, gamma	5.07E+02	1.11E+03	4.00E+03	3.20E+02
DDD	5.07E+02	1.48E+03	-	3.78E+02
DDE	5.07E+02	1.48E+03	-	3.78E+02
DDT	5.07E+02	1.48E+03	-	3.78E+02
Dieldrin	5.07E+01	2.22E+01	-	1.55E+01
Endosulfan I	6.08E+03	5.34E+03	-	2.84E+03
Endosulfan II	6.08E+03	5.34E+03	-	2.84E+03
Endosulfan sulfate	6.08E+03	5.34E+03	-	2.84E+03
Endrin	3.04E+02	5.34E+00	-	5.24E+00
Endrin aldehyde	3.04E+02	5.34E+00	-	5.24E+00
Endrin ketone	3.04E+02	5.34E+00	-	5.24E+00
Heptachlor epoxide	1.32E+01	1.16E+01	-	6.16E+00
Methoxychlor	5.07E+03	4.45E+03	-	2.37E+03
Toxaphene	-	-	-	-

Table B-9
Maneuver Trainers
Risk-Based Screening Levels - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	2.09E-01	9.16E-02	4.08E+03	6.36E-02
BHC, alpha	5.63E-01	1.24E+00	1.11E+04	3.87E-01
BHC, beta	1.97E+00	4.32E+00	3.78E+04	1.35E+00
BHC, gamma	3.23E+00	7.07E+00	6.46E+04	2.22E+00
BHC, delta	1.97E+00	4.32E+00	3.92E+04	1.35E+00
Chlordane, alpha	1.01E+01	2.22E+01	2.00E+05	6.96E+00
Chlordane, gamma	1.01E+01	2.22E+01	2.00E+05	6.96E+00
DDD	1.48E+01	4.32E+01	2.90E+05	1.10E+01
DDE	1.04E+01	3.05E+01	2.06E+05	7.78E+00
DDT	1.04E+01	3.05E+01	2.06E+05	7.78E+00
Dieldrin	2.22E-01	9.73E-02	4.35E+03	6.76E-02
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	3.90E-01	3.42E-01	7.70E+03	1.82E-01
Methoxychlor	-	-	-	-
Toxaphene	3.23E+00	2.83E+00	6.25E+04	1.51E+00

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	7.60E+00	3.34E+00	-	2.32E+00
BHC, alpha	2.03E+03	4.45E+03	-	1.39E+03
BHC, beta	-	-	-	-
BHC, gamma	7.60E+01	1.67E+02	-	5.22E+01
BHC, delta	-	-	-	-
Chlordane, alpha	1.27E+02	2.78E+02	1.00E+03	8.01E+01
Chlordane, gamma	1.27E+02	2.78E+02	1.00E+03	8.01E+01
DDD	1.27E+02	3.71E+02	-	9.44E+01
DDE	1.27E+02	3.71E+02	-	9.44E+01
DDT	1.27E+02	3.71E+02	-	9.44E+01
Dieldrin	1.27E+01	5.56E+00	-	3.86E+00
Endosulfan I	1.52E+03	1.33E+03	-	7.11E+02
Endosulfan II	1.52E+03	1.33E+03	-	7.11E+02
Endosulfan sulfate	1.52E+03	1.33E+03	-	7.11E+02
Endrin	7.60E+01	1.33E+00	-	1.31E+00
Endrin aldehyde	7.60E+01	1.33E+00	-	1.31E+00
Endrin ketone	7.60E+01	1.33E+00	-	1.31E+00
Heptachlor epoxide	3.30E+00	2.89E+00	-	1.54E+00
Methoxychlor	1.27E+03	1.11E+03	-	5.92E+02
Toxaphene	-	-	-	-

Table B-10
Maneuver Trainers (5 year exposure duration)
Risk-Based Screening Levels - CAL EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

	Carcinogenic Remedial Goals			
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Combined**
Aldrin	8.35E-01	7.32E-01	1.63E+04	3.90E-01
BHC, alpha	5.26E+00	9.22E+00	1.04E+05	3.35E+00
BHC, beta	9.46E+00	1.66E+01	1.86E+05	6.03E+00
BHC, gamma	1.29E+01	2.26E+01	2.58E+05	8.22E+00
BHC, delta	3.55E+00	6.23E+00	7.28E+01	2.19E+00
Chlordane, alpha	1.09E+01	1.92E+01	2.35E+05	6.95E+00
Chlordane, gamma	1.09E+01	1.92E+01	2.35E+05	6.95E+00
DDD	5.91E+01	1.04E+02	1.16E+06	3.77E+01
DDE	4.17E+01	7.32E+01	8.25E+05	2.66E+01
DDT	4.17E+01	7.32E+01	8.25E+05	2.66E+01
Dieldrin	8.87E-01	7.78E-01	1.74E+04	4.15E-01
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	2.58E+00	4.53E+00	3.08E+04	1.64E+00
Methoxychlor	-	-	-	-
Toxaphene	1.18E+01	2.08E+01	2.35E+05	7.53E+00

	Noncancer Remedial Goals			
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Combined**
Aldrin	3.04E+01	2.67E+01	6.00E+02	1.42E+01
BHC, alpha	8.11E+03	1.42E+04	1.60E+05	5.17E+03
BHC, beta	-	-	-	-
BHC, gamma	3.04E+02	5.34E+02	6.00E+03	1.94E+02
BHC, delta	-	-	-	-
Chlordane, alpha	5.07E+02	8.89E+02	4.00E+03	3.23E+02
Chlordane, gamma	5.07E+02	8.89E+02	4.00E+03	3.23E+02
DDD	5.07E+02	8.89E+02	1.00E+04	3.23E+02
DDE	5.07E+02	8.89E+02	1.00E+04	3.23E+02
DDT	5.07E+02	8.89E+02	1.00E+04	3.23E+02
Dieldrin	5.07E+01	4.45E+01	1.00E+03	2.37E+01
Endosulfan I	6.08E+03	1.07E+04	1.20E+05	3.87E+03
Endosulfan II	6.08E+03	1.07E+04	1.20E+05	3.87E+03
Endosulfan sulfate	6.08E+03	1.07E+04	1.20E+05	3.87E+03
Endrin	3.04E+02	1.07E+01	6.00E+03	1.03E+01
Endrin aldehyde	3.04E+02	1.07E+01	6.00E+03	1.03E+01
Endrin ketone	3.04E+02	1.07E+01	6.00E+03	1.03E+01
Heptachlor epoxide	1.32E+01	2.31E+01	2.60E+02	8.40E+00
Methoxychlor	5.07E+03	8.89E+03	1.00E+05	3.23E+03
Toxaphene	-	-	-	-

Table B-11
Maneuver Trainers (20 year exposure duration)
Risk-Based Screening Levels - CAL EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

	Carcinogenic Remedial Goals			
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Combined**
Aldrin	2.09E-01	1.83E-01	4.08E+03	9.75E-02
BHC, alpha	1.31E+00	2.31E+00	2.60E+04	8.37E-01
BHC, beta	2.37E+00	4.15E+00	4.65E+04	1.51E+00
BHC, gamma	3.23E+00	5.66E+00	6.46E+04	2.05E+00
BHC, delta	8.87E-01	1.56E+00	1.82E+01	5.48E-01
Chlordane, alpha	2.73E+00	4.79E+00	5.89E+04	1.74E+00
Chlordane, gamma	2.73E+00	4.79E+00	5.89E+04	1.74E+00
DDD	1.48E+01	2.59E+01	2.90E+05	9.42E+00
DDE	1.04E+01	1.83E+01	2.06E+05	6.65E+00
DDT	1.04E+01	1.83E+01	2.06E+05	6.65E+00
Dieldrin	2.22E-01	1.95E-01	4.35E+03	1.04E-01
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	6.45E-01	1.13E+00	7.70E+03	4.11E-01
Methoxychlor	-	-	-	-
Toxaphene	2.96E+00	5.19E+00	5.89E+04	1.88E+00

	Noncancer Remedial Goals			
COPC	**Ingestion**	**Dermal**	**Inhalation**	**Combined**
Aldrin	7.60E+00	6.67E+00	1.50E+02	3.55E+00
BHC, alpha	2.03E+03	3.56E+03	4.00E+04	1.29E+03
BHC, beta	-	-	-	-
BHC, gamma	7.60E+01	1.33E+02	1.50E+03	4.84E+01
BHC, delta	-	-	-	-
Chlordane, alpha	1.27E+02	2.22E+02	1.00E+03	8.07E+01
Chlordane, gamma	1.27E+02	2.22E+02	1.00E+03	8.07E+01
DDD	1.27E+02	2.22E+02	2.50E+03	8.07E+01
DDE	1.27E+02	2.22E+02	2.50E+03	8.07E+01
DDT	1.27E+02	2.22E+02	2.50E+03	8.07E+01
Dieldrin	1.27E+01	1.11E+01	2.50E+02	5.92E+00
Endosulfan I	1.52E+03	2.67E+03	3.00E+04	9.69E+02
Endosulfan II	1.52E+03	2.67E+03	3.00E+04	9.69E+02
Endosulfan sulfate	1.52E+03	2.67E+03	3.00E+04	9.69E+02
Endrin	7.60E+01	2.67E+00	1.50E+03	2.58E+00
Endrin aldehyde	7.60E+01	2.67E+00	1.50E+03	2.58E+00
Endrin ketone	7.60E+01	2.67E+00	1.50E+03	2.58E+00
Heptachlor epoxide	3.30E+00	5.78E+00	6.50E+01	2.10E+00
Methoxychlor	1.27E+03	2.22E+03	2.50E+04	8.07E+02
Toxaphene	-	-	-	-

Table B-12
MOUT Trainers (5 year exposure duration)
Risk-Based Screening Levels - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	2.19E+00	9.61E-01	4.29E+04	6.68E-01
BHC, alpha	5.91E+00	1.30E+01	1.17E+05	4.06E+00
BHC, beta	2.07E+01	4.54E+01	3.97E+05	1.42E+01
BHC, gamma	3.39E+01	7.43E+01	6.78E+05	2.33E+01
BHC, delta	2.07E+01	4.54E+01	4.12E+05	1.42E+01
Chlordane, alpha	1.06E+02	2.33E+02	2.10E+06	7.31E+01
Chlordane, gamma	1.06E+02	2.33E+02	2.10E+06	7.31E+01
DDD	1.55E+02	4.54E+02	3.05E+06	1.16E+02
DDE	1.10E+02	3.20E+02	2.17E+06	8.17E+01
DDT	1.10E+02	3.20E+02	2.17E+06	8.17E+01
Dieldrin	2.33E+00	1.02E+00	4.57E+04	7.10E-01
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	4.09E+00	3.59E+00	8.08E+04	1.91E+00
Methoxychlor	-	-	-	-
Toxaphene	3.39E+01	2.97E+01	6.57E+05	1.58E+01

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	7.98E+01	3.50E+01	-	2.43E+01
BHC, alpha	2.13E+04	4.67E+04	-	1.46E+04
BHC, beta	-	-	-	-
BHC, gamma	7.98E+02	1.75E+03	-	5.48E+02
BHC, delta	-	-	-	-
Chlordane, alpha	1.33E+03	2.92E+03	1.05E+04	8.41E+02
Chlordane, gamma	1.33E+03	2.92E+03	1.05E+04	8.41E+02
DDD	1.33E+03	3.89E+03	-	9.92E+02
DDE	1.33E+03	3.89E+03	-	9.92E+02
DDT	1.33E+03	3.89E+03	-	9.92E+02
Dieldrin	1.33E+02	5.84E+01	-	4.06E+01
Endosulfan I	1.60E+04	1.40E+04	-	7.46E+03
Endosulfan II	1.60E+04	1.40E+04	-	7.46E+03
Endosulfan sulfate	1.60E+04	1.40E+04	-	7.46E+03
Endrin	7.98E+02	1.40E+01	-	1.38E+01
Endrin aldehyde	7.98E+02	1.40E+01	-	1.38E+01
Endrin ketone	7.98E+02	1.40E+01	-	1.38E+01
Heptachlor epoxide	3.46E+01	3.03E+01	-	1.62E+01
Methoxychlor	1.33E+04	1.17E+04	-	6.22E+03
Toxaphene	-	-	-	-

Table B-13
MOUT Trainers (20 year exposure duration)
Risk-Based Screening Levels - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	5.48E-01	2.40E-01	1.07E+04	1.67E-01
BHC, alpha	1.48E+00	3.24E+00	2.92E+04	1.02E+00
BHC, beta	5.18E+00	1.13E+01	9.91E+04	3.55E+00
BHC, gamma	8.47E+00	1.86E+01	1.69E+05	5.82E+00
BHC, delta	5.18E+00	1.13E+01	1.03E+05	3.55E+00
Chlordane, alpha	2.66E+01	5.84E+01	5.25E+05	1.83E+01
Chlordane, gamma	2.66E+01	5.84E+01	5.25E+05	1.83E+01
DDD	3.88E+01	1.13E+02	7.61E+05	2.89E+01
DDE	2.74E+01	8.01E+01	5.42E+05	2.04E+01
DDT	2.74E+01	8.01E+01	5.42E+05	2.04E+01
Dieldrin	5.82E-01	2.55E-01	1.14E+04	1.77E-01
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	1.02E+00	8.98E-01	2.02E+04	4.78E-01
Methoxychlor	-	-	-	-
Toxaphene	8.47E+00	7.43E+00	1.64E+05	3.96E+00

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	2.00E+01	8.75E+00	-	6.09E+00
BHC, alpha	5.32E+03	1.17E+04	-	3.66E+03
BHC, beta	-	-	-	-
BHC, gamma	2.00E+02	4.38E+02	-	1.37E+02
BHC, delta	-	-	-	-
Chlordane, alpha	3.33E+02	7.30E+02	2.63E+03	2.10E+02
Chlordane, gamma	3.33E+02	7.30E+02	2.63E+03	2.10E+02
DDD	3.33E+02	9.73E+02	-	2.48E+02
DDE	3.33E+02	9.73E+02	-	2.48E+02
DDT	3.33E+02	9.73E+02	-	2.48E+02
Dieldrin	3.33E+01	1.46E+01	-	1.01E+01
Endosulfan I	3.99E+03	3.50E+03	-	1.87E+03
Endosulfan II	3.99E+03	3.50E+03	-	1.87E+03
Endosulfan sulfate	3.99E+03	3.50E+03	-	1.87E+03
Endrin	2.00E+02	3.50E+00	-	3.44E+00
Endrin aldehyde	2.00E+02	3.50E+00	-	3.44E+00
Endrin ketone	2.00E+02	3.50E+00	-	3.44E+00
Heptachlor epoxide	8.65E+00	7.59E+00	-	4.04E+00
Methoxychlor	3.33E+03	2.92E+03	-	1.55E+03
Toxaphene	-	-	-	-

Table B-14
MOUT Trainers (5 year exposure duration)
Risk-Based Screening Levels - CAL EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	2.19E+00	1.92E+00	4.29E+04	1.02E+00
BHC, alpha	1.38E+01	2.42E+01	2.73E+05	8.79E+00
BHC, beta	2.48E+01	4.36E+01	4.89E+05	1.58E+01
BHC, gamma	3.39E+01	5.94E+01	6.78E+05	2.16E+01
BHC, delta	9.32E+00	1.63E+01	1.91E+02	5.75E+00
Chlordane, alpha	2.87E+01	5.03E+01	6.18E+05	1.83E+01
Chlordane, gamma	2.87E+01	5.03E+01	6.18E+05	1.83E+01
DDD	1.55E+02	2.72E+02	3.05E+06	9.89E+01
DDE	1.10E+02	1.92E+02	2.17E+06	6.98E+01
DDT	1.10E+02	1.92E+02	2.17E+06	6.98E+01
Dieldrin	2.33E+00	2.04E+00	4.57E+04	1.09E+00
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	6.77E+00	1.19E+01	8.08E+04	4.31E+00
Methoxychlor	-	-	-	-
Toxaphene	3.11E+01	5.45E+01	6.18E+05	1.98E+01

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	7.98E+01	7.00E+01	1.58E+03	3.73E+01
BHC, alpha	2.13E+04	3.74E+04	4.20E+05	1.36E+04
BHC, beta	-	-	-	-
BHC, gamma	7.98E+02	1.40E+03	1.58E+04	5.09E+02
BHC, delta	-	-	-	-
Chlordane, alpha	1.33E+03	2.33E+03	1.05E+04	8.48E+02
Chlordane, gamma	1.33E+03	2.33E+03	1.05E+04	8.48E+02
DDD	1.33E+03	2.33E+03	2.63E+04	8.48E+02
DDE	1.33E+03	2.33E+03	2.63E+04	8.48E+02
DDT	1.33E+03	2.33E+03	2.63E+04	8.48E+02
Dieldrin	1.33E+02	1.17E+02	2.63E+03	6.22E+01
Endosulfan I	1.60E+04	2.80E+04	3.15E+05	1.02E+04
Endosulfan II	1.60E+04	2.80E+04	3.15E+05	1.02E+04
Endosulfan sulfate	1.60E+04	2.80E+04	3.15E+05	1.02E+04
Endrin	7.98E+02	2.80E+01	1.58E+04	2.71E+01
Endrin aldehyde	7.98E+02	2.80E+01	1.58E+04	2.71E+01
Endrin ketone	7.98E+02	2.80E+01	1.58E+04	2.71E+01
Heptachlor epoxide	3.46E+01	6.07E+01	6.83E+02	2.20E+01
Methoxychlor	1.33E+04	2.33E+04	2.63E+05	8.48E+03
Toxaphene	-	-	-	-

Table B-15
MOUT Trainers (20 year exposure duration)
Risk-Based Screening Levels - CAL EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	5.48E-01	4.81E-01	1.07E+04	2.56E-01
BHC, alpha	3.45E+00	6.05E+00	6.82E+04	2.20E+00
BHC, beta	6.21E+00	1.09E+01	1.22E+05	3.96E+00
BHC, gamma	8.47E+00	1.49E+01	1.69E+05	5.39E+00
BHC, delta	2.33E+00	4.09E+00	4.78E+01	1.44E+00
Chlordane, alpha	7.17E+00	1.26E+01	1.55E+05	4.56E+00
Chlordane, gamma	7.17E+00	1.26E+01	1.55E+05	4.56E+00
DDD	3.88E+01	6.81E+01	7.61E+05	2.47E+01
DDE	2.74E+01	4.81E+01	5.42E+05	1.74E+01
DDT	2.74E+01	4.81E+01	5.42E+05	1.74E+01
Dieldrin	5.82E-01	5.11E-01	1.14E+04	2.72E-01
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	1.69E+00	2.97E+00	2.02E+04	1.08E+00
Methoxychlor	-	-	-	-
Toxaphene	7.76E+00	1.36E+01	1.55E+05	4.94E+00

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	2.00E+01	1.75E+01	3.94E+02	9.33E+00
BHC, alpha	5.32E+03	9.34E+03	1.05E+05	3.39E+03
BHC, beta	-	-	-	-
BHC, gamma	2.00E+02	3.50E+02	3.94E+03	1.27E+02
BHC, delta	-	-	-	-
Chlordane, alpha	3.33E+02	5.84E+02	2.63E+03	2.12E+02
Chlordane, gamma	3.33E+02	5.84E+02	2.63E+03	2.12E+02
DDD	3.33E+02	5.84E+02	6.57E+03	2.12E+02
DDE	3.33E+02	5.84E+02	6.57E+03	2.12E+02
DDT	3.33E+02	5.84E+02	6.57E+03	2.12E+02
Dieldrin	3.33E+01	2.92E+01	6.57E+02	1.55E+01
Endosulfan I	3.99E+03	7.00E+03	7.88E+04	2.54E+03
Endosulfan II	3.99E+03	7.00E+03	7.88E+04	2.54E+03
Endosulfan sulfate	3.99E+03	7.00E+03	7.88E+04	2.54E+03
Endrin	2.00E+02	7.00E+00	3.94E+03	6.77E+00
Endrin aldehyde	2.00E+02	7.00E+00	3.94E+03	6.77E+00
Endrin ketone	2.00E+02	7.00E+00	3.94E+03	6.77E+00
Heptachlor epoxide	8.65E+00	1.52E+01	1.71E+02	5.51E+00
Methoxychlor	3.33E+03	5.84E+03	6.57E+04	2.12E+03
Toxaphene	-	-	-	-

Table B-16
Heavy Equipment/Engineering Trainers (5 year exposure duration)
Risk-Based Screening Levels - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	1.06E+00	3.85E-01	5.21E+01	2.81E-01
BHC, alpha	2.87E+00	5.19E+00	1.42E+02	1.82E+00
BHC, beta	1.00E+01	1.82E+01	4.82E+02	6.38E+00
BHC, gamma	1.64E+01	2.97E+01	8.24E+02	1.04E+01
BHC, delta	1.00E+01	1.82E+01	5.01E+02	6.38E+00
Chlordane, alpha	5.16E+01	9.34E+01	2.56E+03	3.28E+01
Chlordane, gamma	5.16E+01	9.34E+01	2.56E+03	3.28E+01
DDD	7.53E+01	1.82E+02	3.70E+03	5.25E+01
DDE	5.31E+01	1.28E+02	2.63E+03	3.70E+01
DDT	5.31E+01	1.28E+02	2.63E+03	3.70E+01
Dieldrin	1.13E+00	4.09E-01	5.55E+01	2.98E-01
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	1.99E+00	1.44E+00	9.83E+01	8.26E-01
Methoxychlor	-	-	-	-
Toxaphene	1.64E+01	1.19E+01	7.98E+02	6.84E+00

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	1.55E+02	5.60E+01	-	4.11E+01
BHC, alpha	4.13E+04	7.47E+04	-	2.66E+04
BHC, beta	-	-	-	-
BHC, gamma	1.55E+03	2.80E+03	-	9.97E+02
BHC, delta	-	-	-	-
Chlordane, alpha	2.58E+03	4.67E+03	5.11E+01	4.96E+01
Chlordane, gamma	2.58E+03	4.67E+03	5.11E+01	4.96E+01
DDD	2.58E+03	6.23E+03	-	1.82E+03
DDE	2.58E+03	6.23E+03	-	1.82E+03
DDT	2.58E+03	6.23E+03	-	1.82E+03
Dieldrin	2.58E+02	9.34E+01	-	6.86E+01
Endosulfan I	3.10E+04	2.24E+04	-	1.30E+04
Endosulfan II	3.10E+04	2.24E+04	-	1.30E+04
Endosulfan sulfate	3.10E+04	2.24E+04	-	1.30E+04
Endrin	1.55E+03	2.24E+01	-	2.21E+01
Endrin aldehyde	1.55E+03	2.24E+01	-	2.21E+01
Endrin ketone	1.55E+03	2.24E+01	-	2.21E+01
Heptachlor epoxide	6.71E+01	4.86E+01	-	2.82E+01
Methoxychlor	2.58E+04	1.87E+04	-	1.08E+04
Toxaphene	-	-	-	-

Table B-17
Heavy Equipment/Engineering Trainers (20 year exposure duration)
Risk-Based Screening Levels - USEPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	2.66E-01	9.61E-02	1.30E+01	7.02E-02
BHC, alpha	7.17E-01	1.30E+00	3.55E+01	4.56E-01
BHC, beta	2.51E+00	4.54E+00	1.21E+02	1.59E+00
BHC, gamma	4.11E+00	7.43E+00	2.06E+02	2.61E+00
BHC, delta	2.51E+00	4.54E+00	1.25E+02	1.60E+00
Chlordane, alpha	1.29E+01	2.33E+01	6.39E+02	8.20E+00
Chlordane, gamma	1.29E+01	2.33E+01	6.39E+02	8.20E+00
DDD	1.88E+01	4.54E+01	9.26E+02	1.31E+01
DDE	1.33E+01	3.20E+01	6.59E+02	9.26E+00
DDT	1.33E+01	3.20E+01	6.59E+02	9.26E+00
Dieldrin	2.82E-01	1.02E-01	1.39E+01	7.46E-02
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	4.96E-01	3.59E-01	2.46E+01	2.07E-01
Methoxychlor	-	-	-	-
Toxaphene	4.11E+00	2.97E+00	2.00E+02	1.71E+00

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	3.87E+01	1.40E+01	-	1.03E+01
BHC, alpha	1.03E+04	1.87E+04	-	6.65E+03
BHC, beta	-	-	-	-
BHC, gamma	3.87E+02	7.00E+02	-	2.49E+02
BHC, delta	-	-	-	-
Chlordane, alpha	6.45E+02	1.17E+03	1.28E+01	1.24E+01
Chlordane, gamma	6.45E+02	1.17E+03	1.28E+01	1.24E+01
DDD	6.45E+02	1.56E+03	-	4.56E+02
DDE	6.45E+02	1.56E+03	-	4.56E+02
DDT	6.45E+02	1.56E+03	-	4.56E+02
Dieldrin	6.45E+01	2.33E+01	-	1.71E+01
Endosulfan I	7.74E+03	5.60E+03	-	3.25E+03
Endosulfan II	7.74E+03	5.60E+03	-	3.25E+03
Endosulfan sulfate	7.74E+03	5.60E+03	-	3.25E+03
Endrin	3.87E+02	5.60E+00	-	5.52E+00
Endrin aldehyde	3.87E+02	5.60E+00	-	5.52E+00
Endrin ketone	3.87E+02	5.60E+00	-	5.52E+00
Heptachlor epoxide	1.68E+01	1.21E+01	-	7.04E+00
Methoxychlor	6.45E+03	4.67E+03	-	2.71E+03
Toxaphene	-	-	-	-

Table B-18
Heavy Equipment/Engineering Trainers (5 year exposure duration)
Risk-Based Screening Levels - CAL EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	**Dermal**	**Inhalation**	**Combined**
Aldrin	1.06E+00	7.69E-01	5.21E+01	4.42E-01
BHC, alpha	6.69E+00	9.68E+00	3.32E+02	3.91E+00
BHC, beta	1.20E+01	1.74E+01	5.94E+02	7.04E+00
BHC, gamma	1.64E+01	2.38E+01	8.24E+02	9.60E+00
BHC, delta	4.52E+00	6.54E+00	2.32E-01	2.14E-01
Chlordane, alpha	1.39E+01	2.01E+01	7.51E+02	8.13E+00
Chlordane, gamma	1.39E+01	2.01E+01	7.51E+02	8.13E+00
DDD	7.53E+01	1.09E+02	3.70E+03	4.40E+01
DDE	5.31E+01	7.69E+01	2.63E+03	3.11E+01
DDT	5.31E+01	7.69E+01	2.63E+03	3.11E+01
Dieldrin	1.13E+00	8.17E-01	5.55E+01	4.70E-01
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	3.28E+00	4.75E+00	9.83E+01	1.90E+00
Methoxychlor	-	-	-	-
Toxaphene	1.51E+01	2.18E+01	7.51E+02	8.80E+00

COPC	Noncancer Remedial Goals			
	Ingestion	**Dermal**	**Inhalation**	**Combined**
Aldrin	1.55E+02	1.12E+02	7.67E+00	6.50E+01
BHC, alpha	4.13E+04	5.98E+04	2.04E+03	2.44E+04
BHC, beta	-	-	-	-
BHC, gamma	1.55E+03	2.24E+03	7.67E+01	9.16E+02
BHC, delta	-	-	-	-
Chlordane, alpha	2.58E+03	3.74E+03	5.11E+01	1.53E+03
Chlordane, gamma	2.58E+03	3.74E+03	5.11E+01	1.53E+03
DDD	2.58E+03	3.74E+03	1.28E+02	1.53E+03
DDE	2.58E+03	3.74E+03	1.28E+02	1.53E+03
DDT	2.58E+03	3.74E+03	1.28E+02	1.53E+03
Dieldrin	2.58E+02	1.87E+02	1.28E+01	1.08E+02
Endosulfan I	3.10E+04	4.48E+04	1.53E+03	1.83E+04
Endosulfan II	3.10E+04	4.48E+04	1.53E+03	1.83E+04
Endosulfan sulfate	3.10E+04	4.48E+04	1.53E+03	1.83E+04
Endrin	1.55E+03	4.48E+01	7.67E+01	4.36E+01
Endrin aldehyde	1.55E+03	4.48E+01	7.67E+01	4.36E+01
Endrin ketone	1.55E+03	4.48E+01	7.67E+01	4.36E+01
Heptachlor epoxide	6.71E+01	9.71E+01	3.32E+00	3.97E+01
Methoxychlor	2.58E+04	3.74E+04	1.28E+03	1.53E+04
Toxaphene	-	-	-	-

Table B-19
Heavy Equipment/Engineering Trainers (20 year exposure duration)
Risk-Based Screening Levels - CAL EPA Toxicity Values
Stuart Mesa West Agriculture Fields
MCB Camp Pendleton, California

COPC	Carcinogenic Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	2.66E-01	1.92E-01	1.30E+01	1.11E-01
BHC, alpha	1.67E+00	2.42E+00	8.30E+01	9.78E-01
BHC, beta	3.01E+00	4.36E+00	1.49E+02	1.76E+00
BHC, gamma	4.11E+00	5.94E+00	2.06E+02	2.40E+00
BHC, delta	1.13E+00	1.63E+00	5.81E-02	5.34E-02
Chlordane, alpha	3.47E+00	5.03E+00	1.88E+02	2.03E+00
Chlordane, gamma	3.47E+00	5.03E+00	1.88E+02	2.03E+00
DDD	1.88E+01	2.72E+01	9.26E+02	1.10E+01
DDE	1.33E+01	1.92E+01	6.59E+02	7.76E+00
DDT	1.33E+01	1.92E+01	6.59E+02	7.76E+00
Dieldrin	2.82E-01	2.04E-01	1.39E+01	1.18E-01
Endosulfan I	-	-	-	-
Endosulfan II	-	-	-	-
Endosulfan sulfate	-	-	-	-
Endrin	-	-	-	-
Endrin aldehyde	-	-	-	-
Endrin ketone	-	-	-	-
Heptachlor epoxide	8.21E-01	1.19E+00	2.46E+01	4.76E-01
Methoxychlor	-	-	-	-
Toxaphene	3.76E+00	5.45E+00	1.88E+02	2.20E+00

COPC	Noncancer Remedial Goals			
	Ingestion	Dermal	Inhalation	Combined
Aldrin	3.87E+01	2.80E+01	1.92E+00	1.63E+01
BHC, alpha	1.03E+04	1.49E+04	5.11E+02	6.11E+03
BHC, beta	-	-	-	-
BHC, gamma	3.87E+02	5.60E+02	1.92E+01	2.29E+02
BHC, delta	-	-	-	-
Chlordane, alpha	6.45E+02	9.34E+02	1.28E+01	3.82E+02
Chlordane, gamma	6.45E+02	9.34E+02	1.28E+01	3.82E+02
DDD	6.45E+02	9.34E+02	3.19E+01	3.82E+02
DDE	6.45E+02	9.34E+02	3.19E+01	3.82E+02
DDT	6.45E+02	9.34E+02	3.19E+01	3.82E+02
Dieldrin	6.45E+01	4.67E+01	3.19E+00	2.71E+01
Endosulfan I	7.74E+03	1.12E+04	3.83E+02	4.58E+03
Endosulfan II	7.74E+03	1.12E+04	3.83E+02	4.58E+03
Endosulfan sulfate	7.74E+03	1.12E+04	3.83E+02	4.58E+03
Endrin	3.87E+02	1.12E+01	1.92E+01	1.09E+01
Endrin aldehyde	3.87E+02	1.12E+01	1.92E+01	1.09E+01
Endrin ketone	3.87E+02	1.12E+01	1.92E+01	1.09E+01
Heptachlor epoxide	1.68E+01	2.43E+01	8.30E-01	9.92E+00
Methoxychlor	6.45E+03	9.34E+03	3.19E+02	3.82E+03
Toxaphene	-	-	-	-

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Appendix I

Federal Aviation Administration Regulations and Correspondence

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Degner, Jessica C.

From: Vidal CIV Marc S <marc.vidal@usmc.mil>
Sent: Thursday, June 27, 2013 11:15 AM
To: Lorenzo CIV Michael J; Dowd CIV James P
Subject: FW: CAMP PENDLETON VORTAC - AAV DRIVER'S COURSE

Gents,

FYSA...FAA concurrence with AAV driver's course project.

Respectfully,

Marc S. Vidal
Base Wide Planner
AC/S G-F, Public Works Division, Planning Branch
Box 555013
Building 220102T
Marine Corps Base Camp Pendleton, CA
92055-5013
Phone: 760-763-7848
Fax: 760-763-7856
marc.vidal@usmc.mil

-----Original Message-----
From: Mike.Fairman@faa.gov [mailto:Mike.Fairman@faa.gov]
Sent: Thursday, June 27, 2013 8:59 AM
To: Vidal CIV Marc S
Cc: jim.skalsky@faa.gov; Eddie.F.Hune@faa.gov; Isidoro.Balistreri@faa.gov
Subject: Re: CAMP PENDLETON VORTAC - AAV DRIVER'S COURSE

Hi Marc,

I apologize for taking so long in replying. I've consulted with our technical experts and everything appears to be in order and compliant with any operational restrictions that we might have for the VOR. The only request that I have is that whatever construction takes place, or after,when facilities are completed, that we retain 7/24 access to the VOR to insure our ability to rapidly respond to unscheduled outages. Thank you for keeping us in the loop and please don't hesitate to contact us should you have any questions or concerns.

Mike Fairman
Manager
SAN NAV/COMM SSC
office (858) 492-9870
cell (858) 243-6683

"Kindness is a language which the deaf can hear and the blind can see" - Mark Twain

From: "Vidal CIV Marc S" <marc.vidal@usmc.mil>

To: Mike Fairman/AWP/FAA@FAA

Date: 06/10/2013 08:11 AM

Subject: CAMP PENDLETON VORTAC - AAV DRIVER'S COURSE

Mike,

Good morning, my name is Marc Vidal and I work planning office at MCB Camp Pendleton. I wanted to give you some details, and solicit comments/feedback, regarding a proposal to locate an AAV (Assault Amphibious Vehicle) driver's course in a portion of the formal agricultural field, south of the existing VORTAC site. As part of our internal site approval process, the Planning office routinely solicits input from interested parties in the form of CONCUR/NON-CONCUR statements.

The attached document contains the preliminary design for the following scope of work:

Control Tower - Provides instructors with raised platform to observe and evaluate training. In addition, it could serve as VIP viewing area when appropriate. Dimensions: 25 feet tall with an area of 256 square feet.
Electrical lighting required.

Staging Area - Traced vehicle parking area with improved surface and drainage. Dimensions: An area of 8700 square feet.

Start/Stopping Area - An apron extending from staging area allowing drivers to begin and end driver training without entering staging area. This area would also serve as a crew-change over point.

Recovery Pits - A pit 44 inches at depth with a 30 percent entry-exit grade. A second pit 40 inches deep with a 25 percent entry-exit grade.

Bivouac/Bleacher Area - Covered, field classroom with 90 Marine sized bleachers permitting student training and observation of events. Area should be sufficient enough in size (7600 square feet) to support 60 students to bivouac/sleep under cover using sleeping bags. Concrete surface with drainage. Area should be adjacent to staging area and have electrical lighting to support evening classes.

Adjustable Gap - A variable 6 to 10 foot gap crossing. Replaceable rubber or wood buffer (cushioned bottom) for shock absorption at impact area.

Driving Loops - Two inner loops at least ¾ mile in length and an outer loop at least one mile in length.

Side Slope Obstacle - 40% incline for distance of 100 meters.

High Angle Obstacle - 60% incline leading to a plateau and follow on 60% decline. Approximately 15 meters high with 24 feet wide, 326 feet long
(100m) plateau.

Gripping Station - A concrete pad capable of supporting vehicle tie-downs to simulate Navy ship-like conditions. Station is co-located w/ staging area.

Vertical Walls - Two walls three feet high by 20 feet wide. Replaceable wood or rubber buffer for shock absorption at impact area as needed. Walls should be capable of sustaining 15 mph impact up to 200 percent of load.

Variable Height Walls - Two walls three feet high by 20 feet wide with adjustable height capability of one to three feet. Replaceable wood or rubber buffer for shock absorption at impact area as needed. Walls should be capable of sustaining 15 mph impact up to 200 percent of load.

Washboard - This component should be incorporated into outer loop road, be
200 yards in length, and have random, undulating terrain one to two feet high dispersed 6 to 10 feet apart.

Turning Circle - A Portland Cement Concrete pad with a diameter of 262.5 feet and a 1% slope from center in all directions to shed water.

V-Ditch - Approximately 12.7 feet deep and 148 feet wide with 36 degree angled walls and drain to shed water.

Belgium Block Road - Approximately 450 feet long by 20 foot wide section of road consisting of Belgium blocks. It can be incorporated into outer loop.

Bump Course - Approximately 450 feet long and 16 foot wide section of road consisting of bumps variably spaced at distances of 6 to 7 and 10 to 11 inches apart.

Angled Curve - Placement of one angled curve along inner road loop at a max angle of 40 degrees.

Cross Steering - Approximately 800 feet long section of road consisting of ruts one to two feet in depth and undulating terrain to replicate unimproved road/micro terrain common in the Tango Training Area aboard Camp Pendleton.

Fording Basin - Approximately 200 feet long by 20 feet wide feature with
100 foot long flat section/bottom capable of holding 5 feet of water.

Gates - Four range style pipe gates placed along outer perimeter road to prevent intrusion from unscheduled users.

Improved Perimeter Road - Compact sub-grade of existing perimeter (approximately 12 feet wide) and add approximately 18 inches of class two base material on top to reduce/minimize dust levels leaving site.

I look forward to hearing back from you. Thanks for your time.

Respectfully,

Marc S. Vidal
Base Wide Planner
AC/S G-F, Public Works Division, Planning Branch Box 555013 Building 220102T Marine Corps Base Camp Pendleton, CA 92055-5013
Phone: 760-763-7848

Fax: 760-763-7856
marc.vidal@usmc.mil

[attachment "AAV Licensing Course Design_Final.pdf" deleted by Mike Fairman/AWP/FAA]

Code of Federal Regulations

Part 91 GENERAL OPERATING AND FLIGHT RULES

Section 91.119 Minimum safe altitudes: General.

Except when necessary for takeoff or landing, no person may operate an aircraft below the following altitudes:

(a) *Anywhere.* An altitude allowing, if a power unit fails, an emergency landing without undue hazard to persons or property on the surface.

(b) *Over congested areas.* Over any congested area of a city, town, or settlement, or over any open air assembly of persons, an altitude of 1,000 feet above the highest obstacle within a horizontal radius of 2,000 feet of the aircraft.

(c) *Over other than congested areas.* An altitude of 500 feet above the surface, except over open water or sparsely populated areas. In those cases, the aircraft may not be operated closer than 500 feet to any person, vessel, vehicle, or structure.

(d) Helicopters, powered parachutes, and weight-shift-control aircraft. If the operation is conducted without hazard to persons or property on the surface—

(1) A helicopter may be operated at less than the minimums prescribed in paragraph (b) or (c) of this section, provided each person operating the helicopter complies with any routes or altitudes specifically prescribed for helicopters by the FAA; and

(2) A powered parachute or weight-shift-control aircraft may be operated at less than the minimums prescribed in paragraph (c) of this section.

[Doc. No. 18334, 54 FR 34294, August 18, 1989, as amended by Amdt. 91-311, 75 FR 5223, February 1, 2010]

ORDER

6820.10

VOR, VOR/DME, AND VORTAC SITING CRITERIA

APRIL 17, 1986

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION

Distribution: Selected Airway Facilities Field and Regional offices; ZAF-601
Initiated By: APM-420

FOREWORD

This order provides guidance and reference material to be used in certain practical applications of the very high frequency omnidirectional radio range (VOR), VOR distance measuring equipment (VOR/DME), and VOR tactical air navigation (VORTAC) in the Federal Aviation Administration's (FAA's) National Airspace System. It deals with the procedures and techniques that apply to the initial evaluation, selection, and acquisition of sites for these navigational aids. It also deals with site improvement and the minimization of performance degradation due to multipath. Finally, it provides guidance for the consolidation of buildings and antenna structures when such consolidation involves VOR, VOR/DME, or VORTAC installations.

Where the facilities consolidation program requires the relocation, consolidation, or establishment of a new VOR, VOR/DME, or VORTAC installation, this order provides technical guidance for the selection and acquisition of a site for the installation. It also provides technical guidance for improving the performance of VOR, VOR/DME, or VORTAC installations where performance degradation can be attributed to site conditions.

The guidance provided in this order applies to new establishments, relocated facilities, and consolidated facilities as specified by the facilities consolidation program. The guidance may also be applied to existing installations where performance is degraded to unacceptable levels by siting factors.

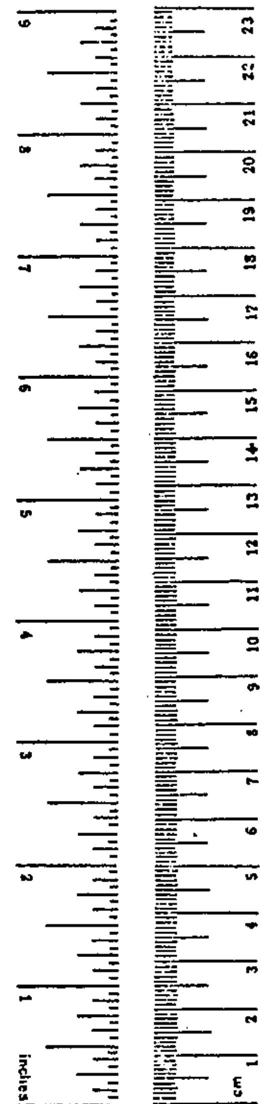
Thomas J. O'Brien
Acting Director, Program Engineering
and Maintenance Service

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

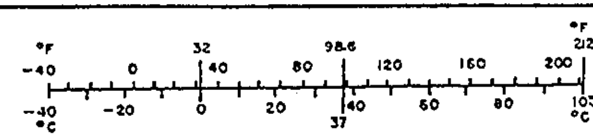
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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CHAPTER 1. GENERAL

1. PURPOSE. This order provides guidance and reference material to be used in certain practical applications of the very high frequency omnidirectional radio range (VOR), VOR with distance measuring equipment (VOR/DME), and VOR with tactical air navigation (VORTAC) in the Federal Aviation Administration's (FAA's) National Airspace System (NAS). The order deals with the procedures and techniques that apply to the initial evaluation, selection, and acquisition of sites for these navigational aids. It deals with site improvement and the minimization of performance degradation due to multipath. Finally, the order provides guidance for the colocation of equipments and antenna structures when such colocation involves VOR, VOR/DME, or VORTAC installations.

2. DISTRIBUTION. This order is distributed to division level in the Program Engineering and Maintenance and Systems Engineering Services, in the Offices of Airport Standards and Flight Operations, and the Aviation Standards National Field divisions in Washington headquarters; to branch level in the regional Airway Facilities divisions and to the Airway Facilities sectors, sector field offices, sector field office units, and sector field units.

3. CANCELLATION. Order 6700.11, VOR/VORTAC Siting Criteria dated August 7, 1968, is canceled.

4. BACKGROUND. The first two chapters in this order provide an introduction and an overview of the subject matter. Chapters 3, 4, and 5 deal with site evaluation, acquisition, and improvement, respectively. These are intended to be the "how-to-do-it" chapters. Chapters 6, 7, and 8 represent in-depth presentations of technical information useful in the siting process. Chapters 6 and 7 present results from analysis of wave propagation and interference. These results have been used in summary fashion or by reference in the earlier chapters. Chapter 8 presents information on computer simulation models that have proven to be useful in the applications of interest here.

5. DEFINITIONS.

a. VOR, as its name indicates, is a navigational aid that operates in the very high frequency (vhf) band of the radio spectrum and that radiates uniformly in azimuth. Specifically, this facility operates between 108 MHz and 118 MHz and provides azimuth guidance to the pilot in the form of a visual display. There are two general types of VOR systems being used by the FAA, namely, the conventional VOR and the Doppler VOR.

b. DME is used for measuring the slant range between the aircraft and the facility. It operates in the 960- to 1215-MHz portion of the radio spectrum.

c. VOR/DME refers to associated VOR and DME systems. VOR and DME are the International Civil Aviation Organization (ICAO) standard for navigation.

d. Tactical air navigation (TACAN) was developed by the military, which accounts for the term "tactical." It operates in the same frequency range as DME and provides omnidirectional azimuth information primarily for military users of the NAS and distance information to all users of NAS. The distance measuring portion of the TACAN is compatible with the DME described above.

e. VORTAC refers to associated VOR and TACAN navigational facilities providing both azimuth and distance information to all users of the NAS.

f. The systems to be considered are presented in table 1-1. The VORTAC combination of systems is also referred to as the VOR/DME/TACAN system and is the short distance navigation system providing navigational signals to properly equipped civil and military aircraft (see also figure 1-1). For further details refer to FAA Order 9840.1, U.S. National Aviation Standard for the VOR/DME/TACAN Systems, September 9, 1982.

TABLE 1-1. SUMMARY DEFINITIONS OF SHORT DISTANCE NAVIGATION SYSTEMS

Designation	Type of Facility
VOR	vhf navigational facility, omnidirectional azimuth only
DME	uhf navigational facility, distance only
TACAN	uhf navigational facility, omnidirectional azimuth and distance
VOR/DME	associated VOR and DME navigational facilities
VORTAC	associated VOR and TACAN navigational facilities

6. APPLICATION. The criteria set forth in this order apply only to new establishments or relocated facilities. Changes to existing facilities for the sole purpose of obtaining compliance with this criteria are not required.

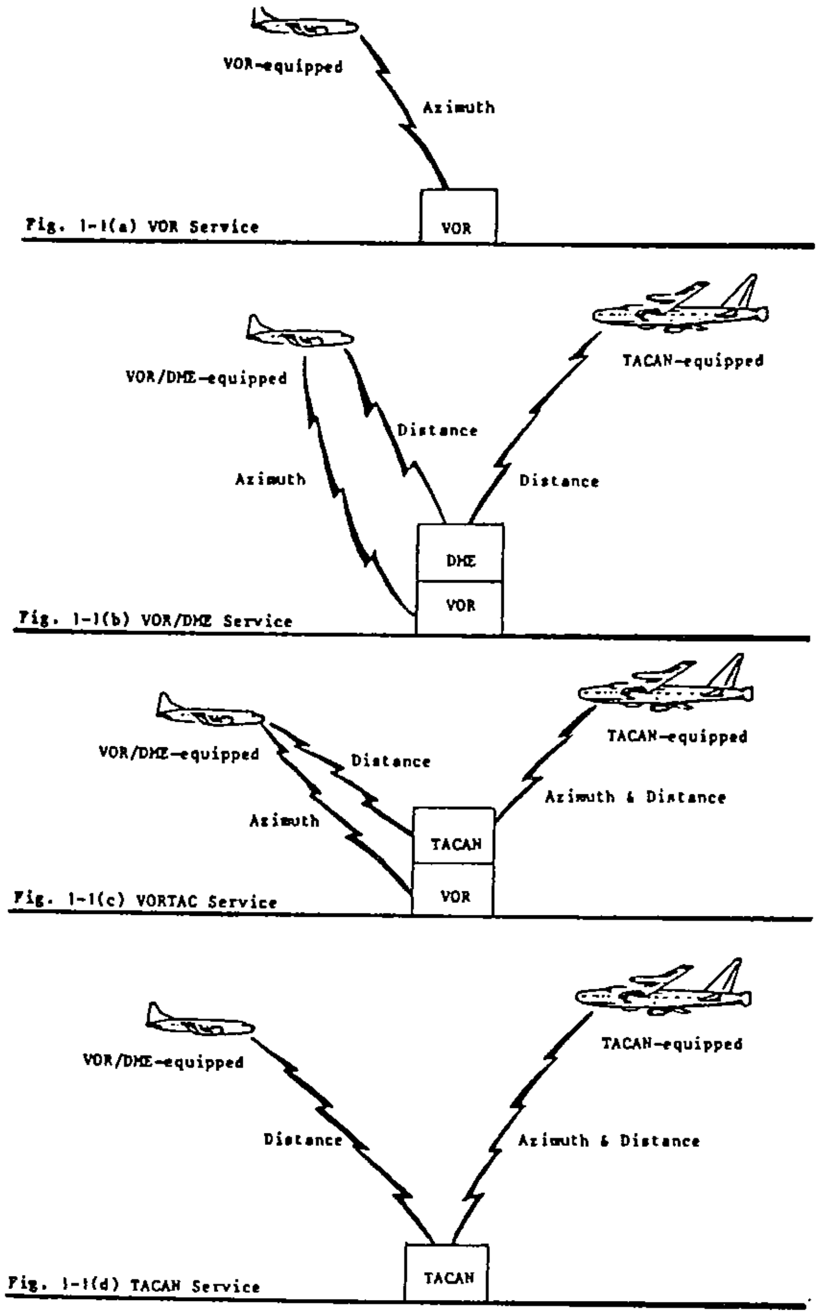


FIGURE 1-1. SHORT RANGE NAVAID GROUND STATION ARRANGEMENTS

7. SYSTEM CONCEPTS.

a. VOR.

(1) Both conventional VOR and Doppler VOR operate in the 108- to 118-MHz frequency band. Both VORs provide separate 30-Hz am and fm signals to the airborne avionics for phase comparison to determine the azimuth of the aircraft from the VOR site at a given time. The phase difference between the two 30-Hz modulation components is equal to the azimuth (in degrees clockwise from magnetic North) from the VOR site.

(2) Conventional VOR provides a 9960-Hz subcarrier modulated with a fixed-phase 30-Hz fm and a 30-Hz am whose phase is lagging the 30-Hz fm component proportional to the azimuth of the avionics from the VOR. Doppler VOR provides a 9960-Hz subcarrier modulated with a fixed 30-Hz am and a 30-Hz fm advancing counterclockwise, which also produces a phase difference proportional to the azimuth of the avionics from the VOR.

(3) The aircraft avionics is indifferent to whether its input signal is conventional or Doppler VOR. The avionics simply recovers the 30-Hz am and the 30-Hz fm, determines how much the am lags the fm, and displays that phase difference as azimuth from the VOR.

b. Conventional VOR.

(1) The VOR operates on the principle that measurement of the phase difference between two signals can be employed to determine azimuth if one of the signals maintains a fixed phase through 360 degrees and serves as a reference, and the phase of the second signal is made to vary as a direct function of azimuth. In practice, two 30-Hz signals are used and are termed the "reference phase" signal and the "variable phase" signal.

(2) The analogy used to describe VOR is that of a light bulb in the center of a large circle with 360 light bulbs each one degree apart on the circumference. The center bulb and the one due north are pulsed to light at the same time; then each bulb clockwise is pulsed to light in turn so that in 1/30th of a second the complete circle of bulbs is traversed and, once more, the center bulb and the north bulb light simultaneously. An observer, located on the north radial, would establish his direction by observing that the two bulbs in his line of vision were illuminated simultaneously. An observer on another radial would establish his azimuth by measuring the time delay between the illumination of the two bulbs in his line of vision.

(3) A pair of dipole antennas placed close together along the north-south line in a common equatorial plane and fed with electromagnetic (em) energy of equal amplitude but opposite phase will radiate a cosine pattern in that plane.

Consider such a pair of dipoles oriented along a northwest-southeast line. If the radio frequency (rf) carrier is modulated with a sinusoid of angular frequency, then the radiated pattern can be expressed as:

$$e_{NW-SE} = E_1 \cos \Theta \cos W_m t$$

A second pair of dipoles mounted concentric and coplanar with the first pair but aligned along the northeast-southwest line can, with proper adjustment be made to provide the pattern:

$$e_{NE-SW} = E_1 \sin \Theta \sin W_m t$$

The resultant field is a double sideband suppressed-carrier signal, with the sidebands in phase quadrature:

$$e = e_{NW-SE} + e_{NE-SW} = E_1 \left[\cos \Theta \cos W_m t - \sin \Theta \sin W_m t\right]$$

$$= E_1 \cos \left[W_m t + \Theta\right]$$

Thus the envelope of the carrier has a phase delay that varies one degree electrically for each degree of physical azimuth. To eliminate the symmetry, which causes a 180-degree ambiguity, an omnidirectional signal of constant amplitude is added to yield the final field amplitude of:

$$e_{TOT} = E_o + E_1 \cos (W_m t + \Theta)$$

which yields a limacon rotating at the angular frequency W_m. See figure 1-2.

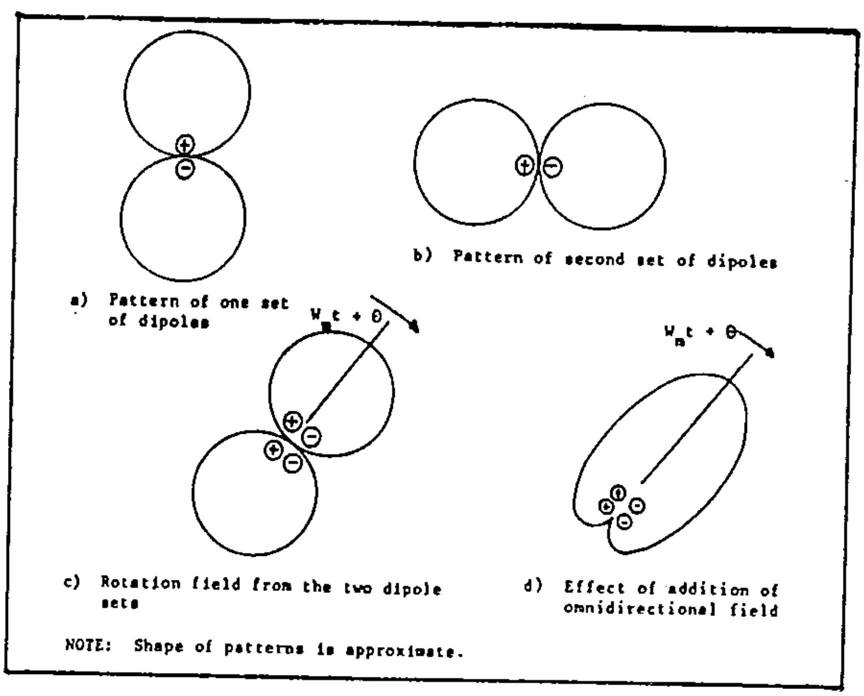


FIGURE 1-2. COMPONENTS OF THE VOR RADIATION PATTERN

(4) In conventional VOR, the variable-phase 30-Hz signal is radiated as a double sideband suppressed carrier (DSB-SC) modulation. The composite modulated signal, made up of a carrier and two sidebands in quadrature, is structured as three separate signals radiated independently which are combined in the receiver detector. This technique of space modulation is susceptible to multipath interference, since each radiated signal component may take a slightly different path to the receiver. Space modulation contrasts with the more conventional modulation techniques wherein the complete composite signal is created within the transmitting equipment, and the components travel together to the receiver.

(5) In the 4-loop antenna array, the modulated rf carrier containing the 30-Hz reference signal is fed, through a bridge network, to each of the four loops in phase. This provides the desired composite carrier circular (omnidirectional) radiation pattern. For the variable-phase signal, two separate sets of 30-Hz sidebands are generated by a rotating capacitor goniometer. The phase of one sideband varies as the sine of the goniometer angle. The phase of the second varies as the cosine of the goniometer angle. In the most recent equipment, the goniometer has been replaced with solid-state circuitry which performs the same function. The combination of the relationship of sideband signals and antenna geometry results in a radiated signal whose phase angle is a direct measure of azimuth as illustrated in figure 1-2 and the associated discussion. In the aircraft, presuming no distortions from multipath, the phases of the reference and the variable signals are compared to determine a line of position along which the phase difference is constant.

(6) Phase coherence in the 30-Hz reference and variable signals is obtained in the older equipment through electromechanical coupling and, in more recent equipment, through solid-state circuitry.

c. Doppler VOR.

(1) The Doppler VOR, DVOR uses a completely different method from that of conventional VOR for generating the azimuth information but, nevertheless, may be used with the conventional VOR aircraft receiver. If a distant radiating source is rotating sufficiently rapidly to create a noticeable Doppler shift, an aircraft properly instrumented can determine when the radiating source is in line with the aircraft and the center of rotation by the disappearance of the Doppler shift.

(2) The generation of the radiated variable-frequency DVOR signal is usually explained in terms of an analogy. Imagine a single radiating antenna located at the end of a 22-foot beam and rotating about a central point at the rate of 30 revolutions per second (rps). At the midfrequency of the 108- to 118-MHz VOR band, 113 MHz, this rotational motion causes a frequency deviation of +/-480 Hz due to the Doppler effect. An antenna located at the center of rotation radiates a signal which differs in frequency by 9960 Hz from the center frequency of the rotating radiator. The beating of these two frequencies in the receiver produces a 9960-Hz subcarrier which is frequency modulated at a 30-Hz rate by the +/-480-Hz deviation in the radiation from the rotating antenna. The deviation ratio of 16 of the 30-Hz fm is the variable signal in DVOR which fm capture effect protects from the interfering effects of multipath or noise.

(3) In the DVOR, the antenna field which simulates the single rotating antenna is made up of 50 separate antennas equally spaced in a circle of 22-foot radius. The 50 antennas are fed em energy sequentially to simulate the rotation. In older models of DVOR, the energy distribution is by means of an electromechanical distributor rotating at 30 rps. More recent models achieve the same effect with solid-state circuitry and electronic switching.

(4) The 30-Hz am reference phase signal for DVOR is carried as DSB-SC modulation on the carrier frequency and radiated from a centrally located antenna. The signal is less susceptible to multipath than is the equivalent DSB-SC space modulated signal in conventional VOR. The DVOR 30-Hz reference signal, however, should be carefully filtered in the airborne receiver if the best performance is to be achieved from DVOR.

(5) DVOR exists in the double sideband Doppler VOR (DSBDVOR) and single sideband Doppler VOR (SSBDVOR) versions. If the rotating distributor feeds rf energy simultaneously to oppositely located circumferential antennas, a double sideband Doppler signal is produced. Tests have revealed that DSBDVOR is much less susceptible to errors due to a coaxially located VOR and TACAN antennas than is SSBDVOR and, hence, may be superior for some applications.

(6) A summary comparison of the basic characteristics of conventional VOR and DVOR is contained in table 1-2. The conventional VOR and DVOR sites are generally similar but readily distinguished because of the multiple DVOR sideband antennas. See figures 1-3 and 1-4.

TABLE 1-2. SUMMARY COMPARISON OF BASIC CHARACTERISTICS OF CONVENTIONAL VOR AND DVOR

Parameter	Conventional VOR	Doppler VOR
Reference Signal	30-Hz fm, β of 16, modulation of 9960-Hz subcarrier	30-Hz, DSB-SC amplitude modulation of rf carrier
Variable Signal	30-Hz, DSB-SC amplitude modulation of rf carrier	30-Hz fm, β of 16 modulation of 9960-Hz subcarrier
Rotation of Intelligence	Peak amplitude rotates clockwise at rate of 30 rps	Peak frequency deviation rotates counter-clockwise at rate of 30 rps
Counterpoise	52' or 21' diameter	SSBDVOR - 150' diameter DSBDVOR - 100' diameter

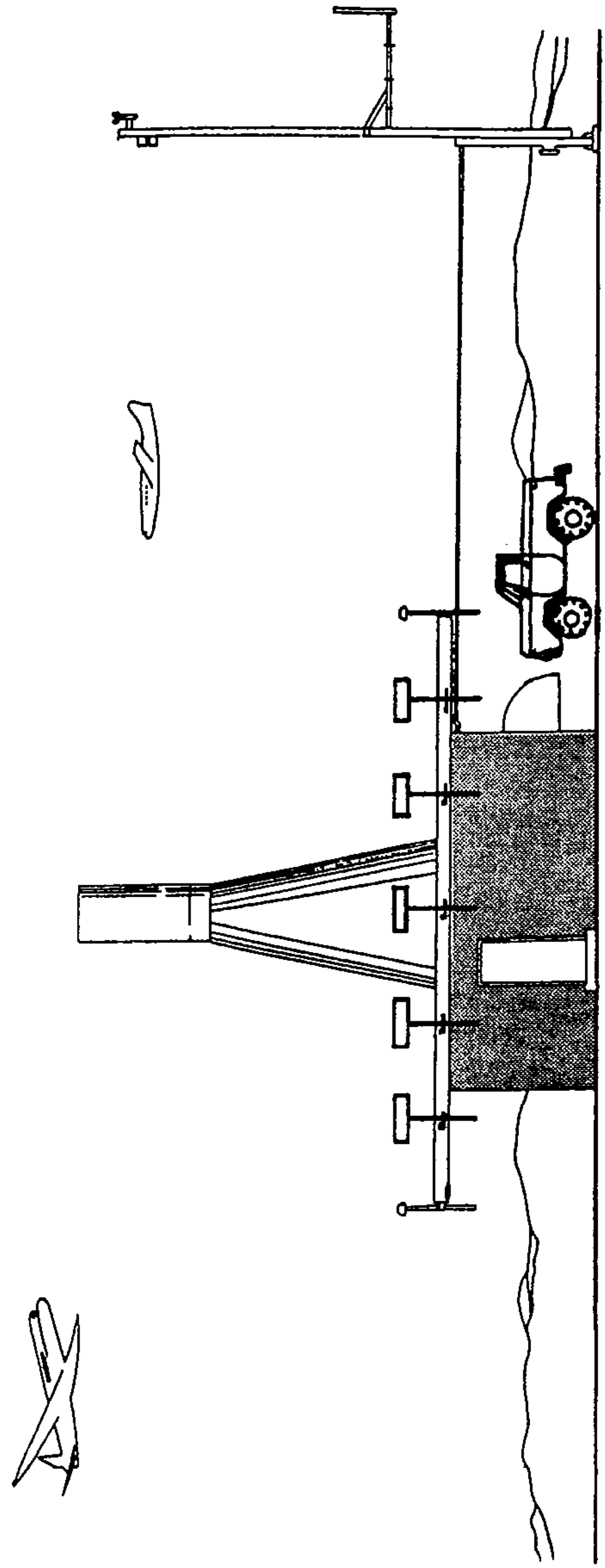


FIGURE 1-3. TYPICAL INTEGRAL VORTAC FACILITY

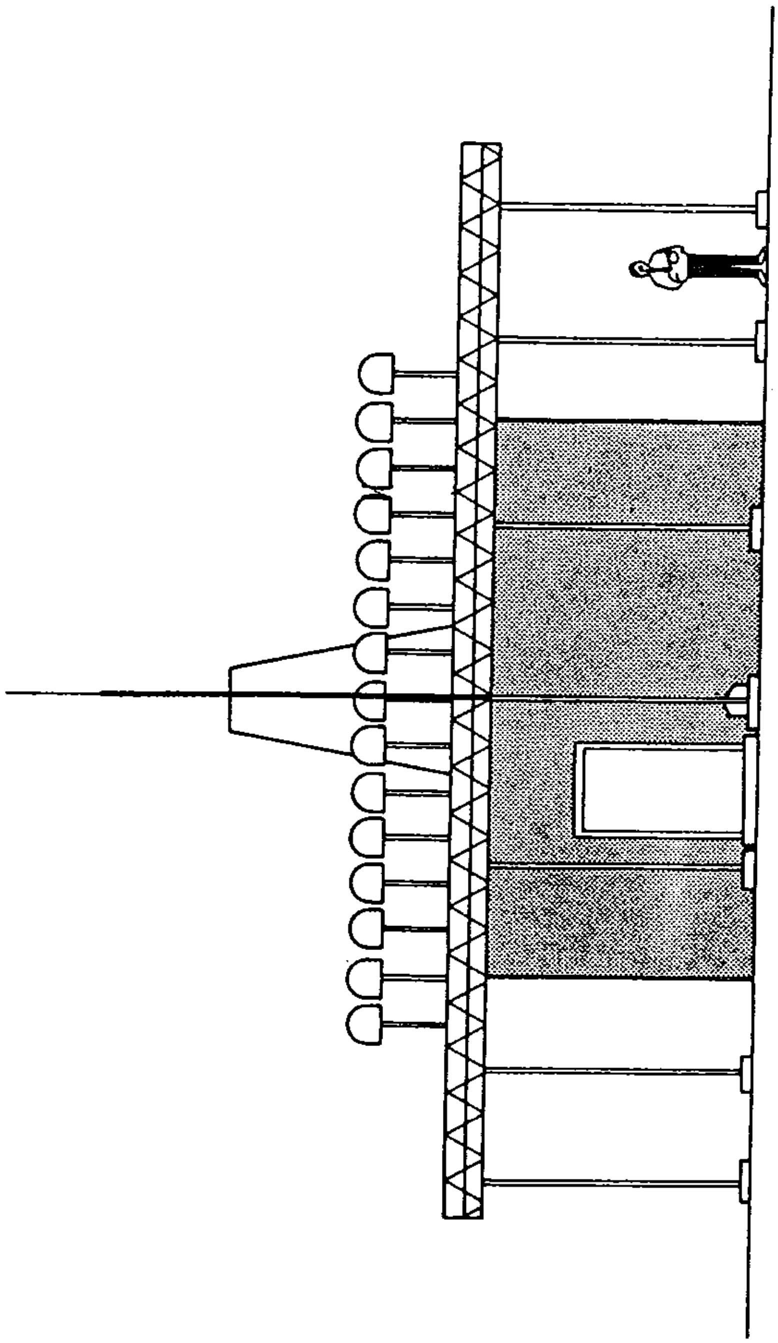


FIGURE 1-4. TYPICAL DVOR FACILITY

d. DME.

(1) The DME operates in the 960- to 1215-MHz band to enable a properly equipped aircraft to determine its slant range to the DME site by measurement of the travel time of pulse-modulated radio waves. The aircraft transmits a radio signal to a ground station. The ground station transmits a response signal to the aircraft on a second frequency, and the DME equipment in the aircraft measures the time interval between the transmission of the interrogation signal and the reception of the reply signal. Knowing that the time delay for the round trip is proportional to distance and allowing for the delay in the ground-based equipment, the airborne instrument displays the slant distance on the distance indicator.

(2) The x-mode interrogation signal from the aircraft itself consists of two pulses spaced 12 microseconds apart, each pulse being 3-1/2 microseconds in width. The reply is very similar: an identical pair of pulses having the same pulse width and spacing but on a different frequency 63 MHz from the interrogation signal (see figure 1-5). There are a hundred DME channels allocated in the frequency range of 1041 to 1150 MHz. These are in 1-MHz steps and, of course, there are likewise 100 reply frequencies which are in the two bands, 978 to 1020 MHz and 1157 to 1215 MHz, the frequency difference being in all cases 63 MHz between the aircraft transmitted frequency and the reply frequency. These frequency channels, incidentally, are paired on a channel-for-channel basis with the ILS (108-112) or VOR (112-118) navigation channels between 108 and 118 MHz.

(3) The pulse replies from the ground station are mixed with many others which are replies to other aircraft. The appropriate replies must be distinguished and identified at the aircraft by their phase coherence with the original interrogation pulses.

(4) The DME antenna generally is mounted above and coaxially with the VOR antenna in the center antenna housing on the VOR counterpoise (figure 1-6).

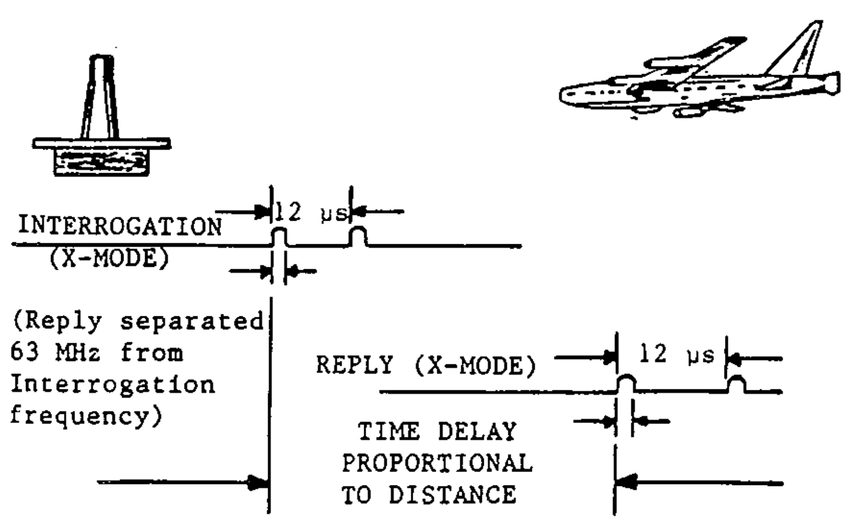


FIGURE 1-5. DME X-MODE PULSE CHARACTERISTICS

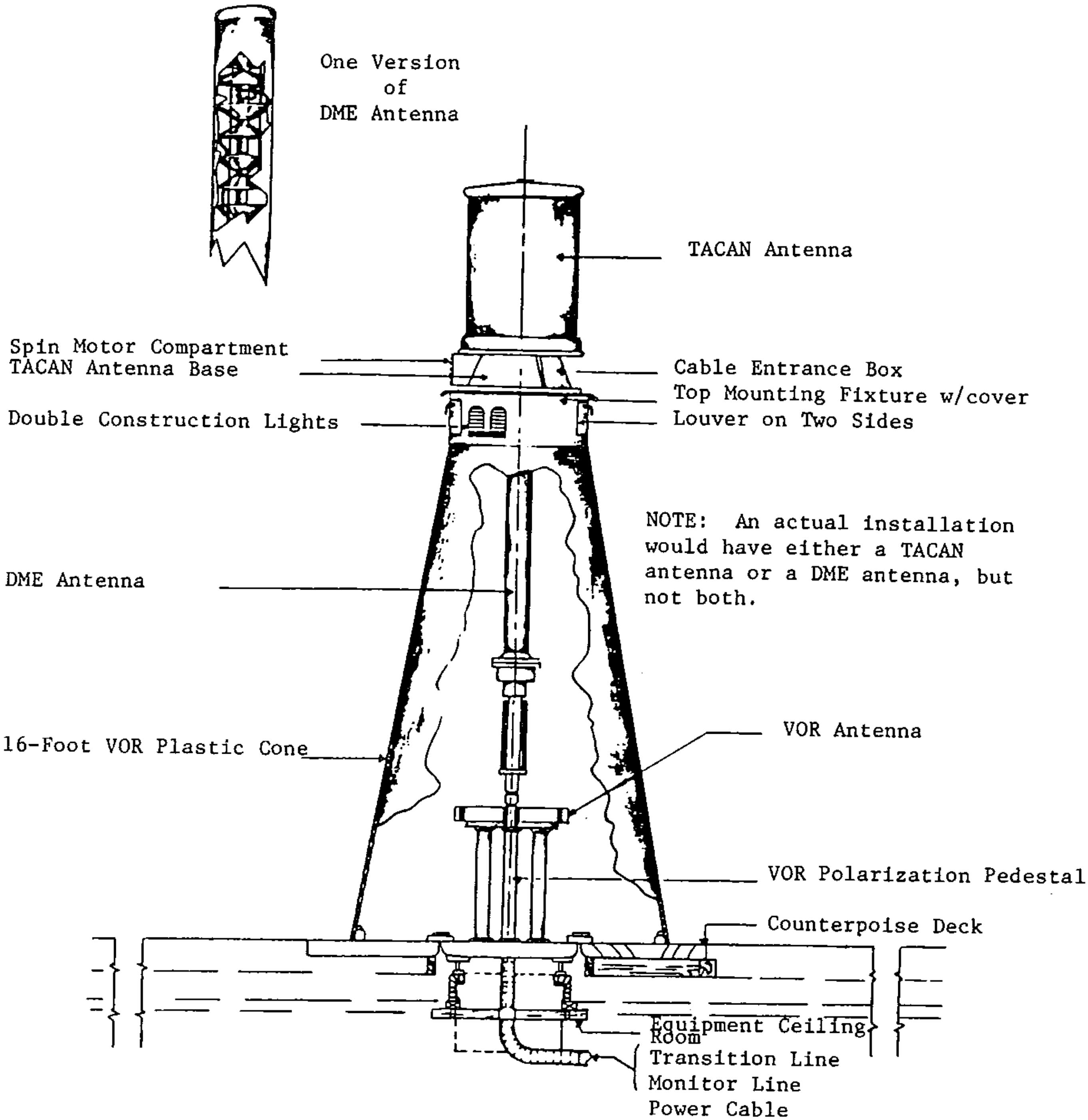


FIGURE 1-6. HOUSING FOR COAXIALLY MOUNTED NAVAID ANTENNAS

e. <u>The TACAN Azimuth Determining Subsystem</u>.

(1) The azimuth-determining TACAN subsystem, operating in the same frequency range as DME, utilizes a single radiated pattern rotating at 15 rps to provide a signal variable with azimuth in a scheme similar to that of conventional VOR. Superimposed upon this pattern is one rotating at 135 rps which provides a fine structure for a more accurate determination of azimuth than could be obtained from the 15-rps signal alone. The 15-Hz and 135-Hz signals appear as amplitude modulation of the train of DME pulse pairs. See figure 1-5. When such pulse pairs are not sufficiently frequent to support the am signals, additional randomly spaced pulse pairs called squitter pulses must be generated. A reference signal, called the North reference burst, is transmitted for each revolution of the director elements. Eight additional signals, called auxiliary reference bursts, are transmitted between North reference bursts, dividing each North reference burst cycle into nine equal parts. Since the coded characteristics of the different signals are not relevant to siting problems, they are not presented herein. For details on the signal coding, see MIL-STD-219A, Standard Tactical Air Navigation (TACAN) Signals.

(2) The 15-Hz and 135-Hz modulation signals are developed by mechanically rotating passive elements within the TACAN antenna assembly. See figure 1-7. The resulting radiation pattern developed in terms of the various contributing elements in the radiating antenna structure is shown graphically in figure 1-8. For a more detailed discussion, refer to the text by Greco and Reed entitled, <u>TACAN - Principles and Siting Criteria</u> published in 1968 by the Naval Electronic <u>Systems Test and Evaluation Facility</u> (renamed Naval Electronic Systems Engineering Activity, Code 0242, St. Inigoes, MD 20684).

(3) Figure 1-9 illustrates the bearing location of a receiver with respect to the TACAN beacon. The TACAN antenna assembly is aligned so that the omnidirectional reference burst is emitted when the maximum of the cardiod pattern is pointed to the geographic east. Figure 1-9 is a simplification to the extent that the 135-Hz fine structure is suppressed. As shown in the figure, the observer located due north of the TACAN antenna receives the coded reference burst on the 15-Hz sinusoid on its negative slope halfway between the maximum and minimum points.

(4) In practice, most TACAN airborne equipments utilize the North reference burst and the 15-Hz am to determine the azimuth of the TACAN transmitter within a 40-degree section ("coarse" bearing), and then utilize the auxiliary reference bursts and the 135-Hz am to determine the actual station azimuth within the 40-degree sector ("fine" bearing). The "fine" bearing provides a 9-to-1 improvement over the "coarse" 40-degree sectors in determining the azimuth.

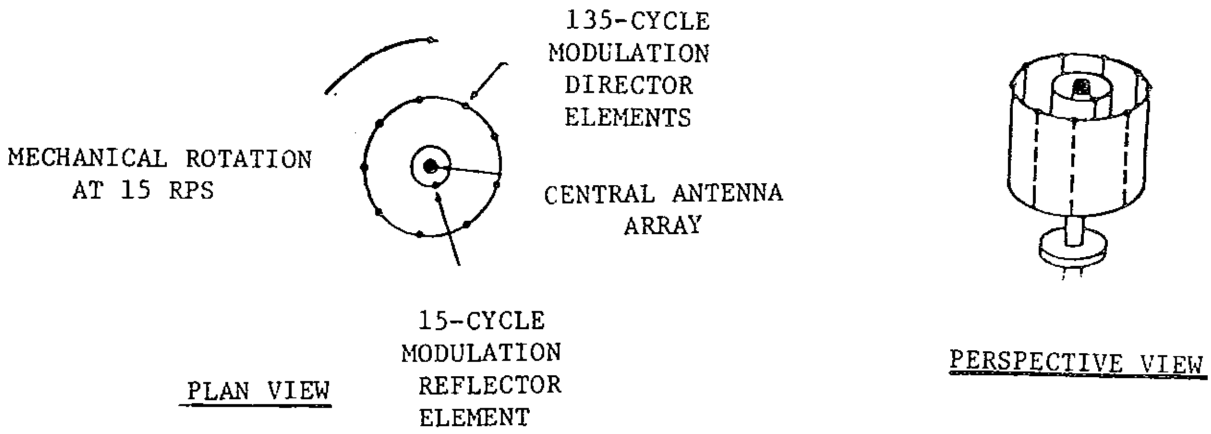


FIGURE 1-7. THE TACAN ANTENNA CONCEPT

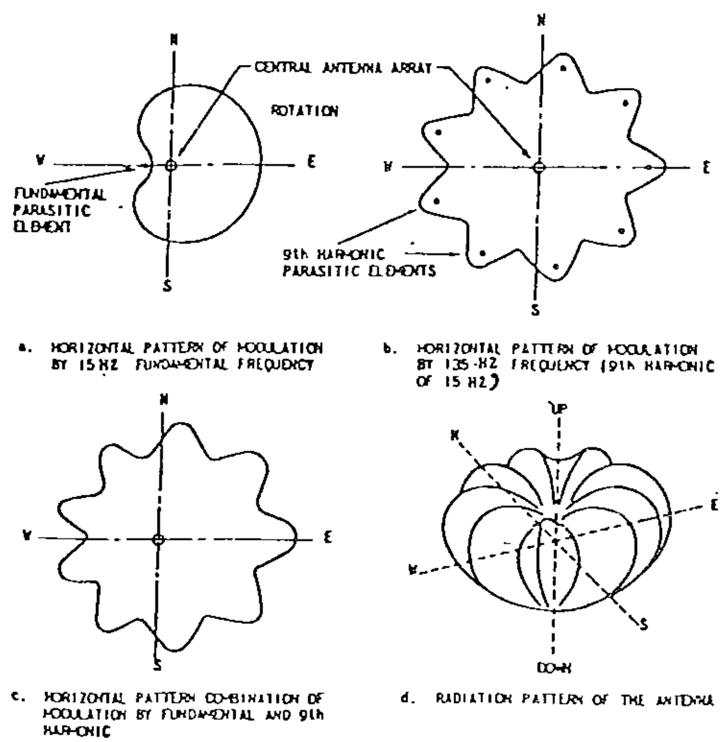


FIGURE 1-8. COMPONENTS OF THE TACAN RADIATION PATTERN

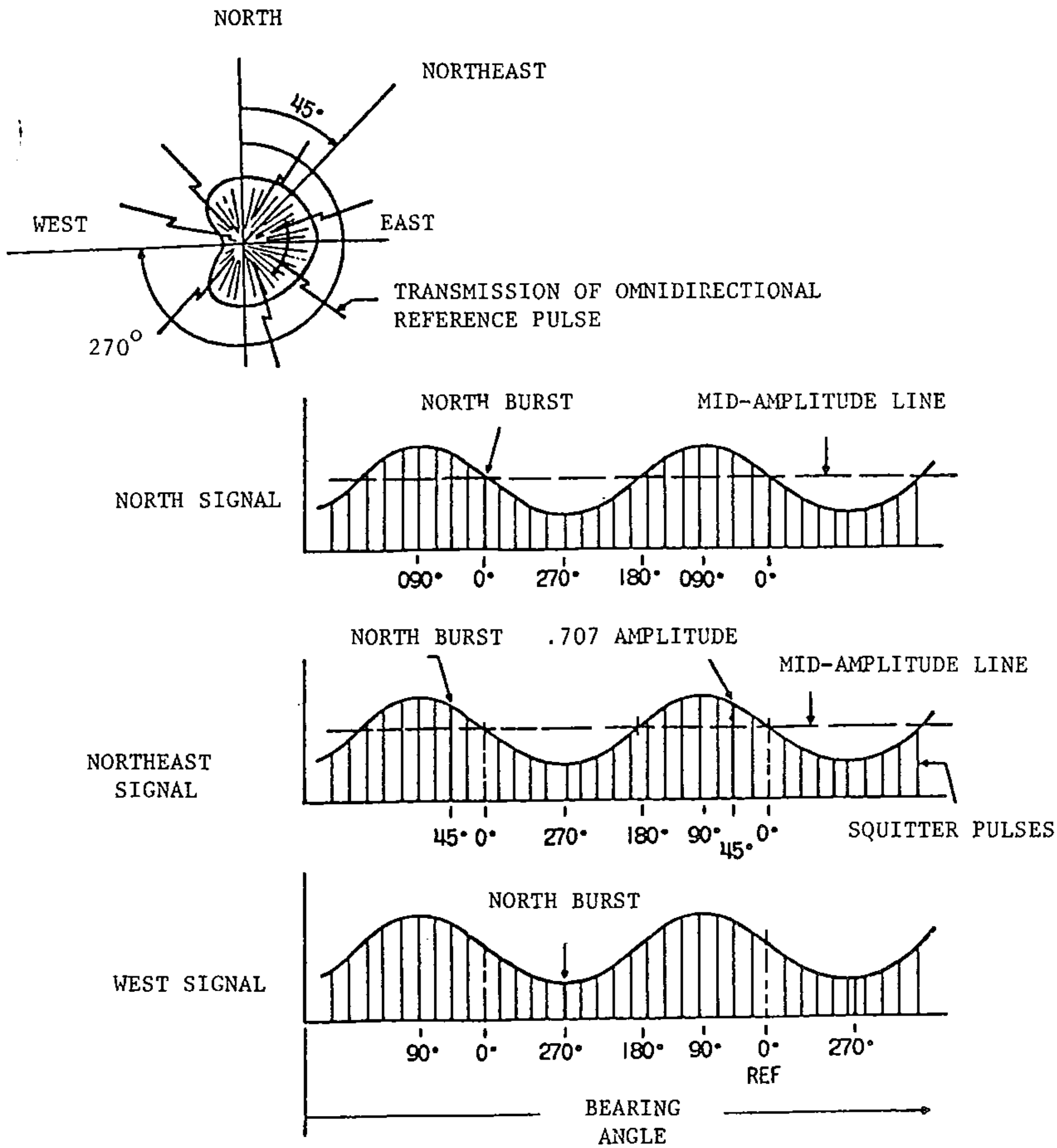


FIGURE 1-9. ILLUSTRATING GEOGRAPHIC BEARING FROM BEACON

CHAPTER 2. OVERVIEW OF LOCATION AND COVERAGE CONSIDERATIONS

8. GENERAL. This chapter provides general background on the subject of the siting of VOR, VOR/DME, and VORTAC as an introduction to chapters 3, 4, and 5 which deal with site evaluation, acquisition, and improvement, respectively.

a. When a TVOR or VORTAC is installed on an airport, the facility should be located, if possible, in an area adjacent to the intersection of the principle runways in order to provide approach guidance to the ends of these runways. To prevent the facility from being an obstruction to aircraft, it should not be located closer than 500 feet to the centerline of any runway or 250 feet to the centerline of a taxiway. Additionally, no part of the facility shall penetrate any surface defined in paragraphs 77.25, 77.28, or 77.29 of the Federal Aviation Regulations.

b. When located off an airport, consideration shall be given to selecting a site so that one or more of the course radials will provide an approach procedure to the primary bad weather runway in accordance with chapter 4 or chapter 5 of FAA Order 8260.3B, United States Standard for Terminal Instrument Procedures.

c. TVOR/VORTAC facilities on airports come under paragraph 77.15(c) of the Federal Aviation Regulations and do not require submission of a Notice of Construction or Alteration.

d. All of the navaids under consideration use either the phase difference between sinusoids of the same modulating frequency, or the time difference between pulses, or in the VORTAC azimuth determination a hybrid of the two. DVOR may be considered a special case of phase difference determination. In brief, the information is contained in the modulation rather than in the carrier. The modulation is at a much lower frequency than is the carrier. It follows that phase, amplitude, or frequency distortion of the modulation will usually cause performance errors, and similarly, momentary phase, amplitude, or frequency distortions of the rf carrier are not ordinarily of concern. An exception to this statement is noted below.

e. The one situation where interactions at rf are of critical importance is that where the combination of the direct ray and the interfering ray due to longitudinal multipath results in destructive interference causing a null in the radiation pattern at a specific elevation angle. The complete destruction of the carrier destroys the modulation information as well.

f. Lateral multipath can, in certain of the navaids, cause rays emitted from the navaid ground station at different azimuth angles to meet and combine at the airborne equipment. The combination of two different modulating signals yields a resultant generally containing false bearing information.

g. Note that longitudinal multipath cannot ordinarily cause errors in the modulating intelligence except, as mentioned, when it causes the serious weakening of the total signal. Similarly, lateral multipaths cannot cause nulls in the vertical radiation pattern. Figure 2-1 illustrates the two different categories of multipath. The objective of successful siting is that of avoiding the harmful effects of either type of multipath within the required coverage volume of the navaid.

h. The DME and TACAN radiations are vertically polarized. By contrast, VOR and DVOR radiations are horizontally polarized. For vertical polarization there is an angle of incidence on a smooth earth at which the reflected component, the longitudinal multipath, vanishes. This is the angle of incidence at which the radiation refracted into the ground and the reflected radiation, if it existed, would be at right angles (see figure 2-2). Related to the Brewster's angle effect is the much smaller coefficient of reflection from the ground for vertically polarized rays compared to horizontally polarized rays.

i. As shown in figure 2-3, the longitudinal multipath can result from reflection from the counterpoise and from the earth. Additionally, the diameter of the counterpoise can be selected so as to set a lower limit to the grazing angle of the radiation illuminating the earth.

j. In the material which follows and in the remainder of the order, certain parameters associated with the radiated energy will be useful. These parameters are summarized in table 2-1. Note that the quantities provided are often only approximates. For site evaluation and improvement activities, the quantities of table 2-1 will usually be found to be both convenient and sufficient. In applications requiring greater accuracy, the actual wavelength should be used and antenna heights should be determined by measurement.

k. As illustrated in figure 2-4, reflection can be specular or diffuse. Specular reflection provides a stronger signal in a specific direction than does diffuse reflection. Hence, if specular reflection causes undesirable interference, the interference can be expected to be relatively strong. Diffuse reflection from a rough surface is unpredictable in its effects. If the reflecting area is sufficiently large it can cause multipath problems. See figure 2-5 for an example of directional reflection due to periodicity in the roughness.

l. Judgement is required to determine whether or not a particular ground will be seen as rough or smooth by the electromagnetic energy. The criterion that is usually used is the Rayleigh criterion. See figure 2-6 and note that for small grazing angles a very irregular ground can act as a smooth reflective surface.

m. The brief review of the discussion of multipath is summarized in table 2-2.

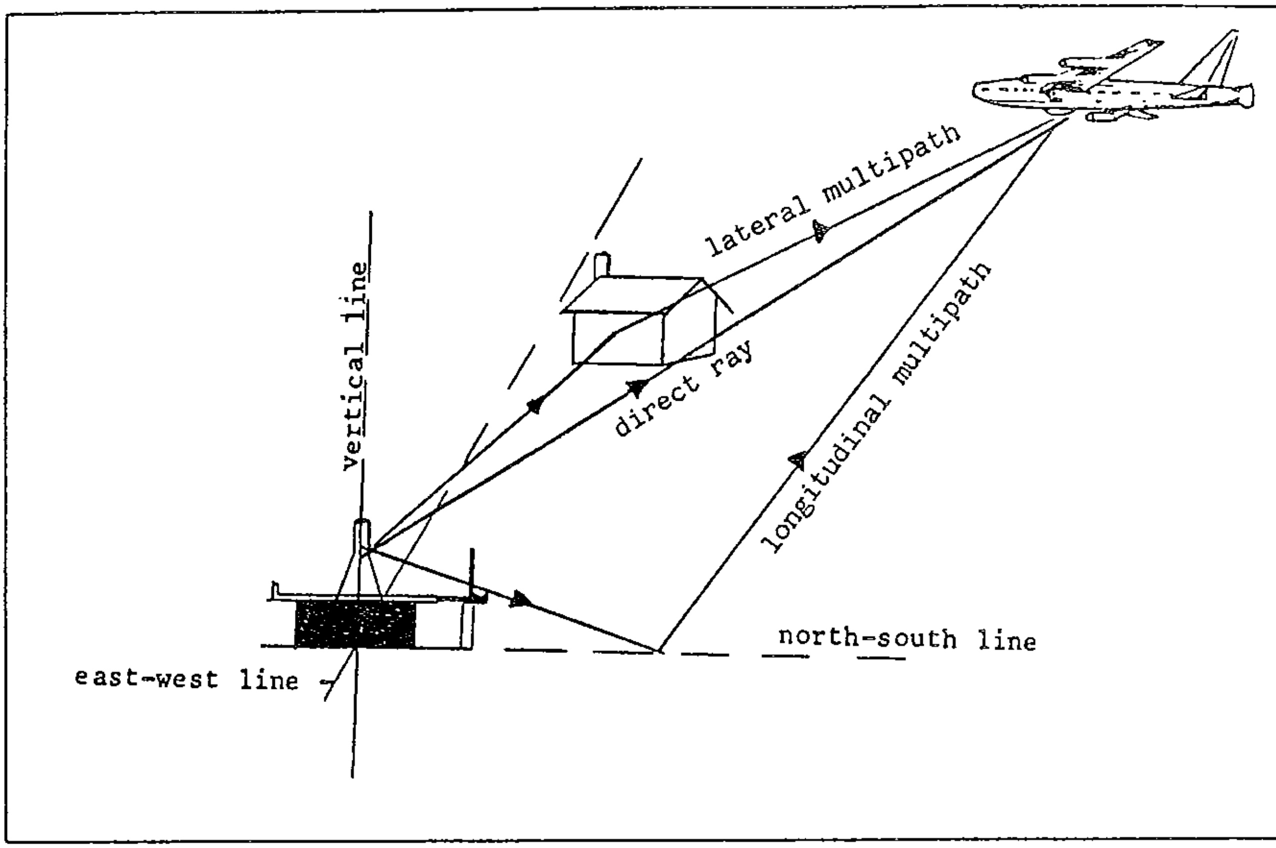


FIGURE 2-1. TYPES OF MULTIPATH

Type of Earth	Brewster's Angle at 1000 MHz (Approx)
Marshland	10°
Average	15°
Desert	30°

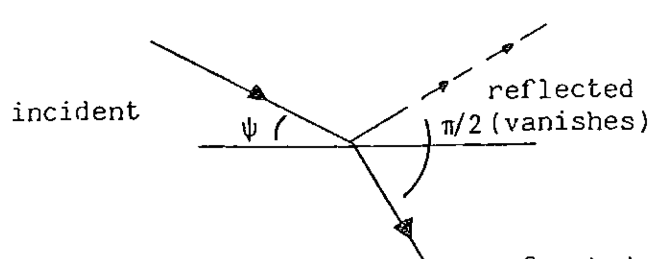


FIGURE 2-2. THE VANISHING OF REFLECTIONS AT BREWSTER'S ANGLE

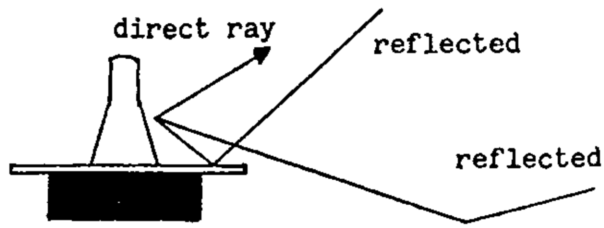


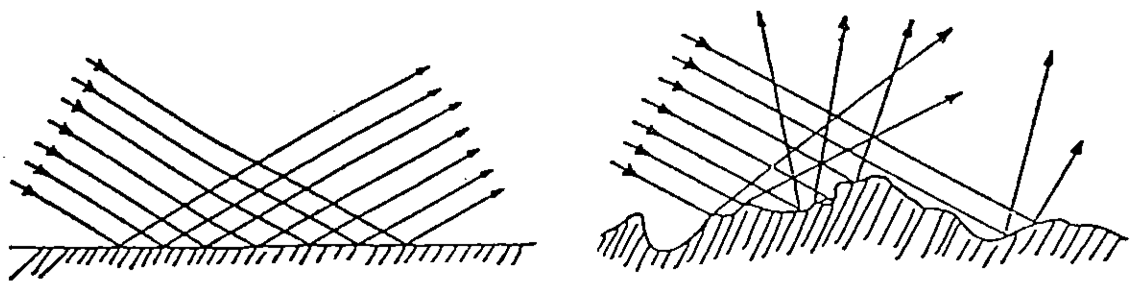
FIGURE 2-3. TWO LEVEL LONGITUDINAL MULTIPATH

TABLE 2-1. USEFUL PARAMETERS IN SITE EVALUATION

System	rf Carrier	Nominal rf Wavelength	Polarization	Ht Above Counter-poise*	Modulation	Max. Freq. of Modulation
VOR/ DVOR	108-118 MHz	8 ft	Horizontal	4.0 ft	Sinusoid (DSB-SC)	10,540 Hz
DME	962-1213 MHz	1 ft	Vertical	11.5 ft	Pulse	1 MHz**
TACAN	962-1213 MHz	1 ft	Vertical	20.5 ft	Pulse & Sinusoid	1 MHz**

* Height of effective radiating center above counterpoise. The figures given here are only approximate and should be checked for a specific installation. Counterpoise height is usually 12' but it also may vary; typical diameters are 52 feet and 21 feet (VOR), 150 feet (SSBDVOR), and 100 feet (DSBDVOR).

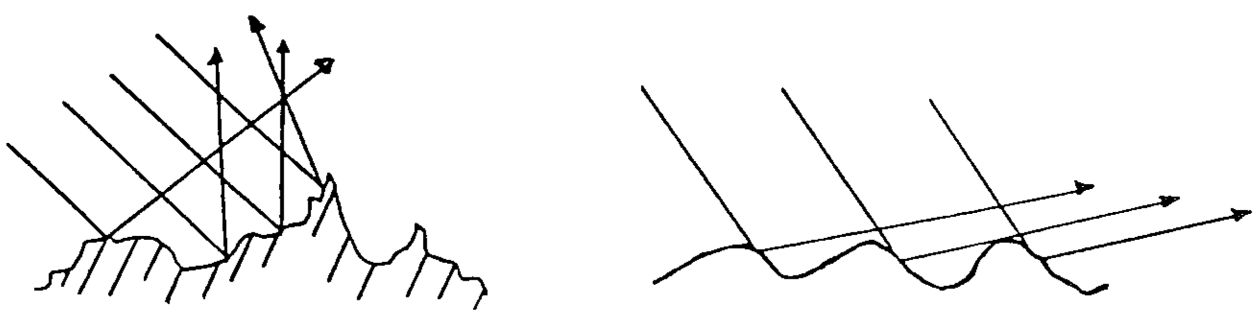
** Estimated on the basis of pulse rise time of 2.5 + 0.5 - 1.0 microseconds.



SPECULAR REFLECTION

DIFFUSE REFLECTION

FIGURE 2-4. EFFECTS OF TERRAIN IN PRODUCING SPECULAR & DIFFUSE REFLECTION



NON-UNIFORM ROUGHNESS

ROUGHNESS WITH A PERIODIC STRUCTURE (INTERFEROMETER EFFECT)

FIGURE 2-5. EFFECT OF PERIODICITY IN SURFACE ROUGHNESS

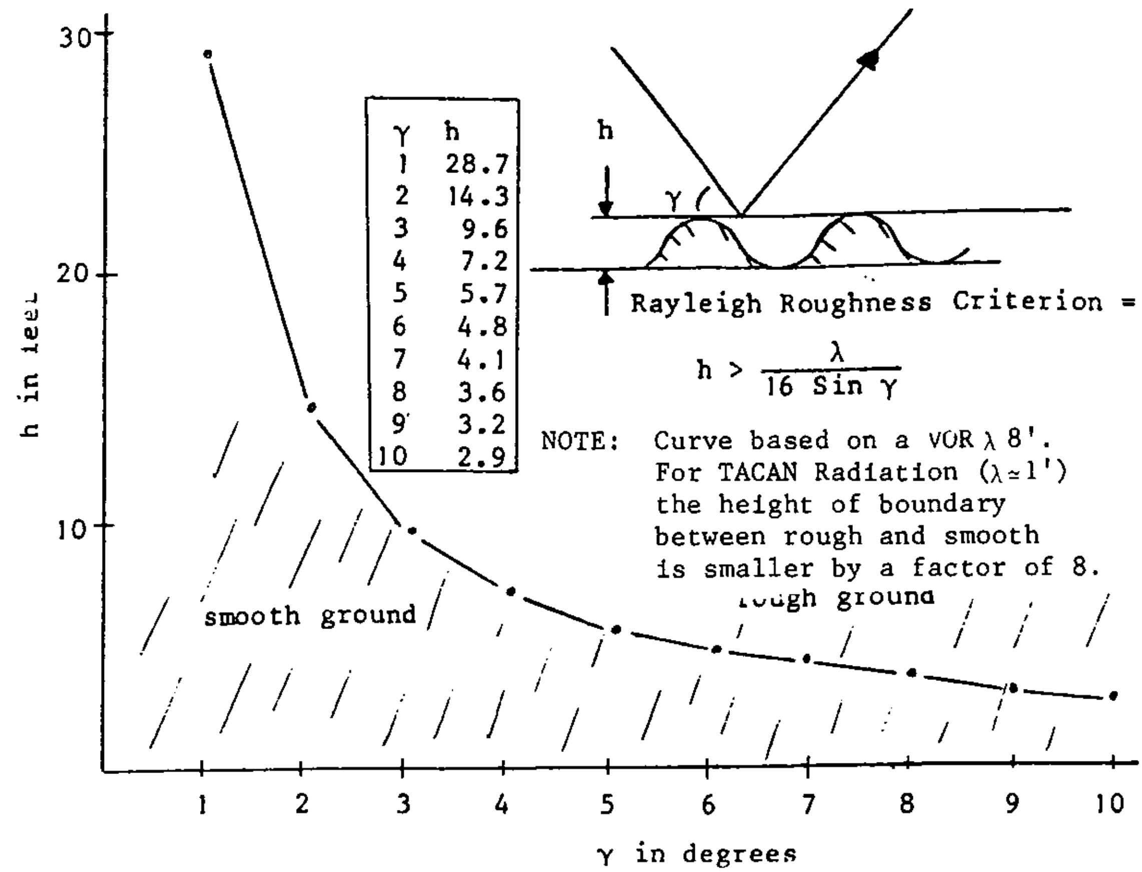


FIGURE 2-6. THE RAYLEIGH ROUGHNESS CRITERION

TABLE 2-2. TYPES OF MULTIPATH AND REFLECTION

Type or Parameter	Consideration
Longitudinal	Causes nulls in the vertical radiated pattern
Lateral	Causes interference in modulated information
Horizontal Polarization	Angular location of destructive longitudinal multi-path is a matter of geometry
Vertical Polarization	Brewster angle effect eliminates some longitudinal multipath
Specular	Strong interference at specific angles
Diffuse	Interference weaker generally but occurs over a wide range of angles than does specular reflection

9. CONSIDERATIONS OF VERTICAL MULTIPATH.

a. General. Vertical multipath causes nulls in the vertical pattern of radiation and this in turn causes loss of signal in the airborne receiver. Hence, it is important in site analysis to identify those features that may lead to excessive multipath problems. Because of the different wavelengths, geometries, and problem details, vertical multipath for VOR, DME, and TACAN are considered separately.

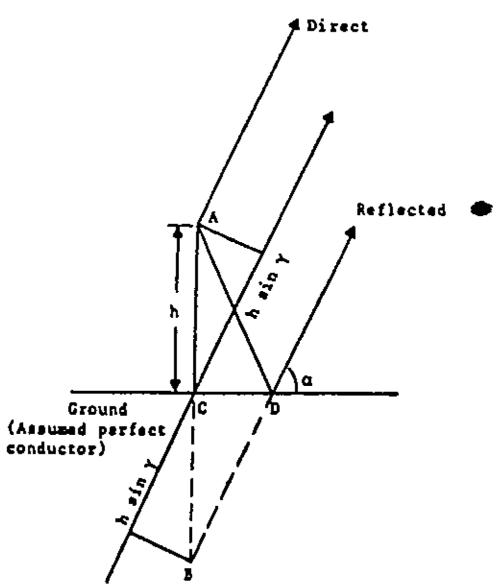
b. Vertical Multipath in VOR.

(1) Refer to figure 2-3. Vertical multipath in VOR can result from reflection from the counterpoise and from the ground. Counterpoise reflections cause a null in the vertical pattern at an elevation angle of approximately 60 degrees. Since primary interest is in elevation angles of less than 10 degrees, this is of little importance. The elevation angles at which destructive multipath takes place due to ground reflection can be determined (see figure 2-7) from:

$$E(\gamma) = \cos[\gamma + kh \sin\gamma] - \sin[\gamma - kh \sin\gamma]$$

$$= 1/2 \cos\gamma \sin[kh \sin\gamma]$$

where the first term represents the antenna radiation pattern and the second term, the effect of the multipath.



A = Source of radiation.

B = Apparent source of reflected radiation.

C = Source of combined radiation as seen by distant receiver.

D = Point of reflection.

FIGURE 2-7. VERTICAL MULTIPATH

The pattern has nulls where

$$\sin [kh \sin \gamma] = 0$$

$$\gamma = \sin^{-1} \left[\frac{n\lambda}{2h}\right]$$

when n = 1, 2, ...

(2) The usual 52-foot diameter counterpoise prevents DME antenna rays at angles greater than about 24 degrees from illuminating the ground. Similarly, the counterpoise prevents TACAN antenna rays greater than about 38 degrees from illuminating the ground. Because of the short wavelength of the TACAN and the height of the TACAN and DME antennas above the counterpoise, longitudinal multipath cannot be entirely prevented. As an example, DME destruction multipath will occur at about 1/2 degree if the ground is only 30 feet below ground level at the antenna site. See figure 2-8.

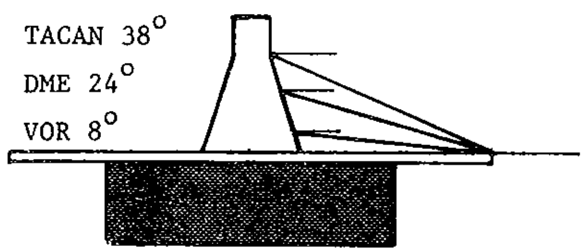


FIGURE 2-8. SHOWING EFFECT OF THE COUNTERPOISE IN LIMITING GROUND ILLUMINATION

c. Consideration of Longitudinal Multipath for DME and TACAN.

(1) It is readily seen from paragraph 5.b.(1) that for the shorter wavelengths of DME and TACAN there will be many more possibilities for destructive longitudinal multipath than there were for VOR. The vertical pattern has nulls when

$$\gamma_n = \sin^{-1} \left[\frac{n\lambda}{2h}\right]$$

$$n = 1, 2, 3, ...$$

For a given h and for the smaller wavelength there is a greater range of the integer n before $[n\lambda/2h] > 1$, and for each such integer there is an angle γ_n at which a null can occur.

(2) From figure 2-8, the counterpoise provides less angular blocking of DME and VORTAC rays from the ground. Hence, destructive longitudinal multipath can occur for a greater range of vertical angles for these two navaids.

(3) The first Fresnel zone for DME and TACAN is much smaller than for VOR. The width and length are reduced to approximately 1/3 the values for VOR and the total area is reduced by a factor of approximately 8. (See Chapter 3, figure 3-3.)

(4) The single favorable factor, of those discussed, which would make it more difficult to have destructive longitudinal multipath with DME and TACAN, is that greater ground smoothness is required for these shorter wavelength navaids. Note, for example that at nine degrees, a ground height variation of only 0.4 foot or about 5 inches makes the ground too rough for specular DME or TACAN reflection.

10. CONSIDERATIONS OF LATERAL MULTIPATH.

a. Lateral multipath involves the mutual interference between signals radiated at two different azimuth bearings. One is the direct ray. The second, the interfering ray, contains different navigational information than does the direct ray. The mix of the two modulations in the airborne receiver results in incorrect information being presented to the pilot.

b. In an idealized environment in which the ground based antenna site was surrounded by a smooth earth, it would be possible to have destructive longitudinal multipath. It would not, however, under these circumstances, be possible to have destructive lateral multipath. The requirement for lateral multipath to exist is that there be obstacles in the radiation field that accept radiation at one azimuth angle and reflect it off in a different direction either in a specular or a diffuse fashion.

c. Obstacles will exist in the radiation field and may consist of buildings that cannot be removed, telephone wires, power lines, and antennas for other FAA equipments. This order provides information on how to determine the effects caused by obstacles and how to minimize or eliminate such effects.

CHAPTER 3. SITE EVALUATION

11. GENERAL.

a. This chapter provides information to aid in the process of evaluating a site as a candidate location for any combination of the VOR, TACAN, and DME. It also provides information which may be used to evaluate the effect that physical changes proposed in the area of a site may be expected to have on the performance of existing navigational aids. Such changes can occur as areas evolve from rural to urban characteristics. Additionally, antenna systems of various kinds may be brought into the vicinity of the VORTAC/DME site as part of site consolidation efforts. The presence of these additional facilities can impact on navaids performance. This chapter also deals with the practical application of the technical material available in chapters 6, 7, and 8 to the problem of site evaluation. These chapters should be consulted for additional details.

b. In this order, the antenna systems are considered only as metallic objects in the radiation field of the navigational aids. Considerations of the mutual electromagnetic interference problems that may develop as a variety of radiators are brought into close geographic proximity are beyond the scope of this order.

12. CONSIDERATIONS OF LONGITUDINAL MULTIPATH.

a. General.

(1) Ground slope and ground smoothness in the vicinty of the VOR site determines the extent to which the ground will sustain reflections that, by interfering with the direct rays, cause nulls in the vertical radiated pattern. Since there are always some vertical angles for which such destructive interference can exist, the beam is shaped to avoid illuminating the ground. VOR and DVOR radiation is inhibited from illuminating the ground by the presence of the counterpoise. This is true only for a small area less than 10 to 20 feet from the VOR. The DME radiation pattern is shaped to attenuate ground illumination through use of multiple radiating elements. The site itself is not to be expected to completely inhibit destructive reflection. Considerable judgement is required in selecting sites with satisfactory properties, and no simple rules exist for concluding that one site is superior to another insofar as longitudinal multipath is concerned.

(2) The site evaluator should determine how far from the radiating antenna position his interest should extend. There is no simple answer. Areas close to the antenna location are relatively more important than distant areas because the close-in Fresnel zones are smaller. A distant rough area will, however, look smooth to the radiation traveling at a small grazing angle. This makes it easier for the large Fresnel zone to exist. A possible rule of thumb is that primary attention should be focused on the first 1,000 feet, with secondary attention given to the surrounding mile. In addition, a cursory examination of the first five miles is required to ensure the identification of geographic areas that might cause particular difficulty.

(3) Any site can be made to be satisfactory in its longitudinal multipath performance provided that sufficient care is taken in the selection and installation of the radiating system. Although such systems are nonconventional, it is possible to use site modifications such as oversized counterpoises or additional grounding elements. Accordingly, the investigator may consider preparing qualified recommendations for sites. One site, for example, may be attractive for a number of reasons but be characterized by unusually poor ground conductivity which could result in an abrupt discontinuity in electric field boundary conditions at the perimeter of the counterpoise. A recommendation regarding this site which identified the potential problem and its implication for wavefront binding would allow the next level of management to make tradeoffs between technical, financial, and acquisition problems in choosing between alternative possibilities.

b. Longitudinal Multipath and the VOR Equipment.

(1) It was pointed out in chapter 2, in connection with figure 2-7 and the associated discussion, that nulls in the vertical radiation pattern of the VOR will appear where:

$$\sin \left[kh \sin \gamma_n\right] = 0$$

where $\gamma_n = \sin^{-1} \left[\frac{n\lambda}{2h}\right]$

$n = 1, 2, \ldots.$

Using this relationship one may develop an approximate range within which the surrounding terrain can sustain destructive multipath. See figure 3-1.

(2) Note from figure 3-1 that, in order to minimize the possibility of longitudinal multipath from the VOR antenna, the ground in the vicinity of the VOR site must be level or must fall away gently from the ground level at the base of the antenna structure. If the ground falls away too sharply, geometry necessary for destructive multipath may exist. If the ground falls away precipitously, however, it becomes impossible to have destructive multipath because the counterpoise prevents ground illumination at angles of depression greater than 8 degrees. Finally, if the ground falls away and slopes away from the VOR, the ground slope can direct the multipath away from the direct ray. Note that the results of figure 3-1 are based on the assumption that the ground is level in the area of ground reflection. The action of a slope in reflecting energy downward cannot be relied upon since the reflection can be expected to be partly diffuse and partly specular in many cases. Regardless of how fast the terrain falls away from the VOR, there will be some terrain visible to the VOR within the service volume which will support vertical multipath.

(3) While there is no clear-cut boundary around the VOR site beyond which one is not required to be interested in the terrain, as the distance from the site increases, the terrain features become less important. As distance from the VOR site increases, the size of the first Fresnel zone increases. Since contributions from most of the first Fresnel zone are required to obtain substantial multipath, it is evident that there is smaller probability of finding a reflecting area as large as the first Fresnel zone at a large distance from the VOR site than is the case closer in. The growth of the VOR Fresnel zone with distance is shown in figure 3-2.

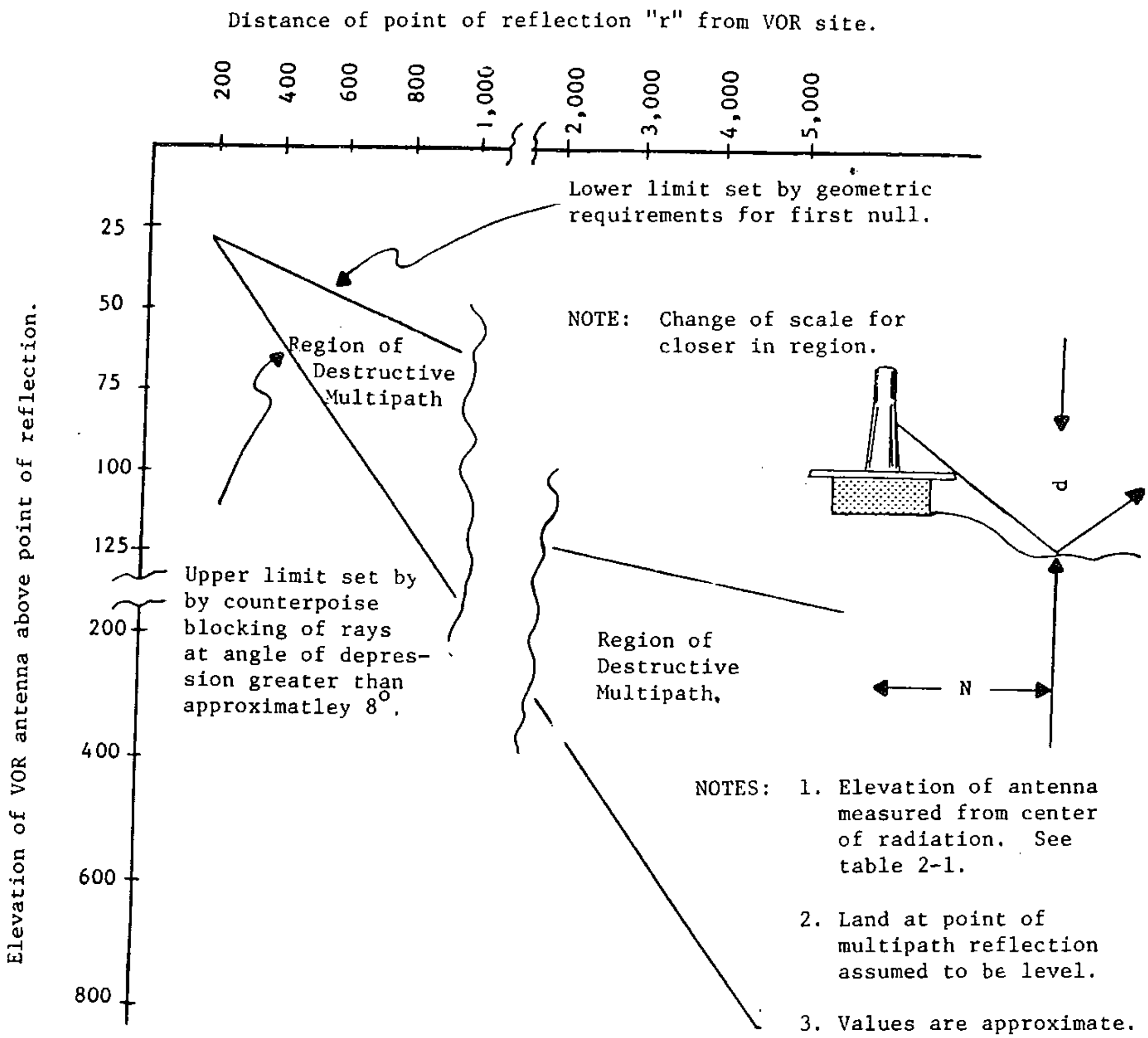


FIGURE 3-1. GROUND SLOPE CONSIDERATIONS

(4) Figure 3-3 illustrates this point in more detail and shows that the first Fresnel zone for small angles of reflection is several miles in length at a distance of a mile from the VOR site. Considerable judgement is required when using this figure, since the Rayleigh criterion shows that, at shallow grazing angles, even very rough terrain can look smooth to the incident radiation (see figure 2-6). The large Fresnel zones required may in fact exist.

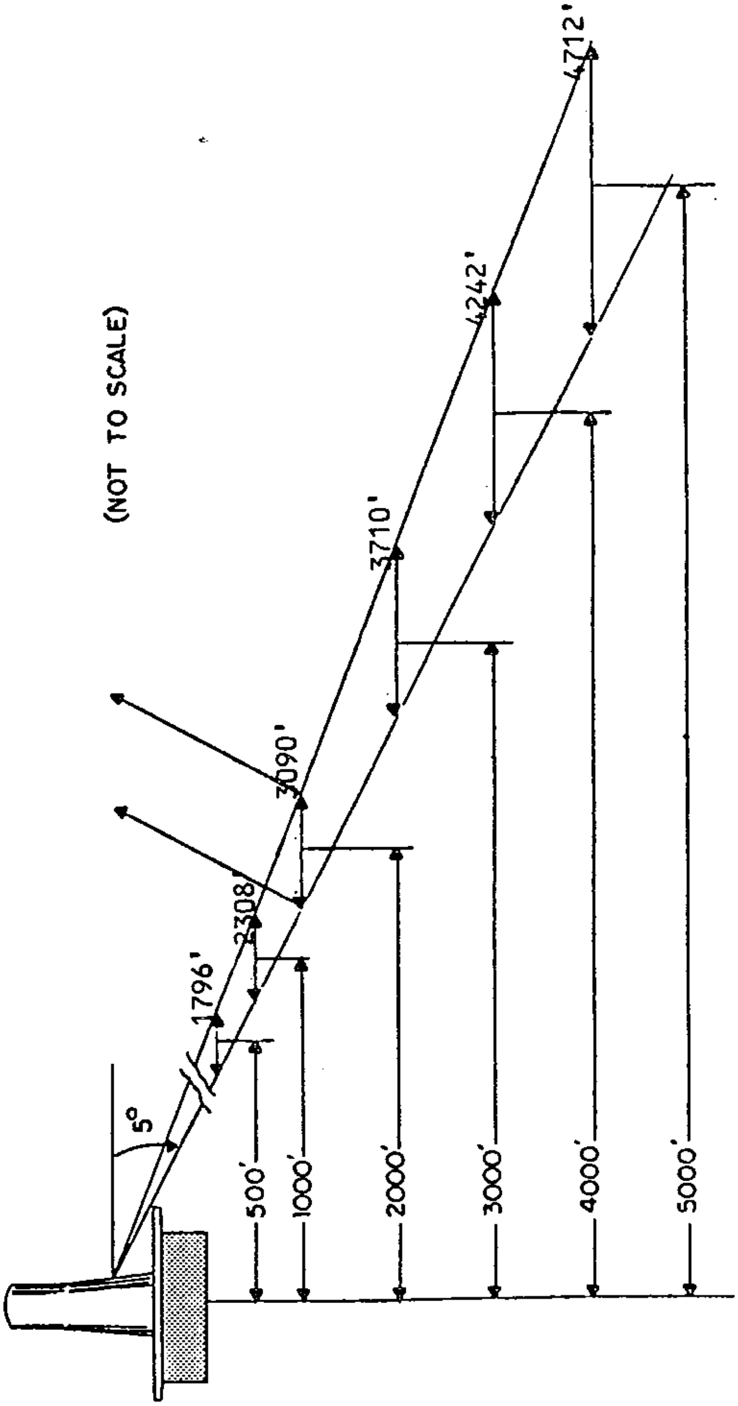


FIGURE 3-2. GROWTH OF VOR FRESNEL ZONE LENGTH WITH DISTANCE

Distance of Reflection Area from VOR Site in Feet	Range of Angles of Reflection	Dimensions of Fresnel Zone	
		Range of Widths (Feet) (W)	Range of Lengths (Feet) $(X_1 + X_2)$
1000	3.8° to 8°	175 - 183	1,377 - 3,197
2000	2.6° to 8°	251 - 258	1,904 - 6,743
3000	2.2° to 8°	302 - 316	2,314 - 9,579
4000	2.0° to 8°	345 - 365	2,661 - 11,871
5000	1.7° to 8°	389 - 409	2,978 - 15,936
6000	1.5° to 8°	428 - 448	3,257 - 20,086

$$W = 2\sqrt{\frac{\lambda h}{\sin \gamma}} \qquad X_1 = \frac{-\lambda \cos \gamma + \sqrt{\lambda^2 \cos^2 \gamma + 4 h \lambda \sin \gamma}}{2 \sin^2 \gamma}$$

$$X_2 = \frac{+\lambda \cos \gamma + \sqrt{\lambda^2 \cos^2 \gamma + 4 h \lambda \sin \gamma}}{2 \sin^2 \gamma}.$$

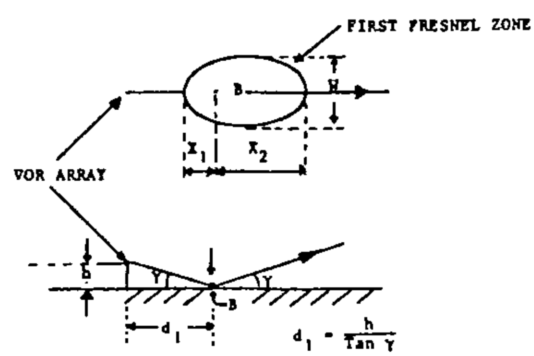


FIGURE 3-3. RANGE OF SIZES FOR FIRST FRESNEL ZONE

c. Longitudinal Multipath and the DVOR Equipment.

(1) The effect of longitudinal multipath on DVOR equipment performance will be discussed in terms of a comparison between VOR, SSBDVOR, and DSBDVOR. The diameter of the counterpoise is different for the three different pieces of equipment. The height above the counterpoise of the radiating center of the antennas is four feet in all three cases. The VOR antenna, for purposes of the discussion of longitudinal multipath, can be considered to be located at the center of the counterpoise. The DVOR antennas which generate the azimuth information are located in a circle of 22-foot radius, concentric with the counterpoise center. Additionally, the VOR signal containing the

azimuth information is a form of amplitude modulation called space modulation. Refer to figure 1-2 and the associated discussion. For both variations of DVOR, the azimuth information is carried as fm modulation with a deviation ratio, β, of 16.

(2) The DVOR azimuth information-bearing signal should be less susceptible to multipath interference because of the well-known fm threshold effect. By contrast, the VOR azimuth signal, since it involves three separately radiated amplitude-modulated signals, should be comparatively more vulnerable to multipath interference. The DVOR requires a larger counterpoise than does VOR. From any azimuth, the different antennas in the 22-foot DVOR circle experience different amounts of counterpoise, which results in a cyclic modulation on the radiated signal. In the nonlinear elements in the airborne receiver, this undesirable modulation can be transferred to other signals. The larger DVOR counterpoises diminish this asymmetrical effect, and DSBDVOR is less susceptible to the asymmetrical effects of the counterpoise than is SSBDVOR.

(3) The counterpoise's primary purpose is the sharp attenuation of the vertical radiation pattern for angles of radiation negative with respect to the horizon. The counterpoise weakens the radiated field in the direction of the horizon (see figure 3-4). There is some evidence that for every 15 feet in VOR counterpoise diameter, there is a loss of range at 1,000-foot altitude of approximately 15 miles. Since the same effect should exist in DVOR, it is reasonable to expect the DVOR low altitude coverage to be less than that of VOR.

(4) It may be thought that the large DVOR counterpoise could itself be a reflecting surface for multipath signals. At angles of 30 degrees or more, the Fresnel zone dimensions are 20 feet or less in their longest dimension. The DVOR geometry will not sustain destructive longitudinal multipath. Presuming a good conducting counterpoise which is properly grounded, longitudinal multipath should not be a problem with DVOR installations.

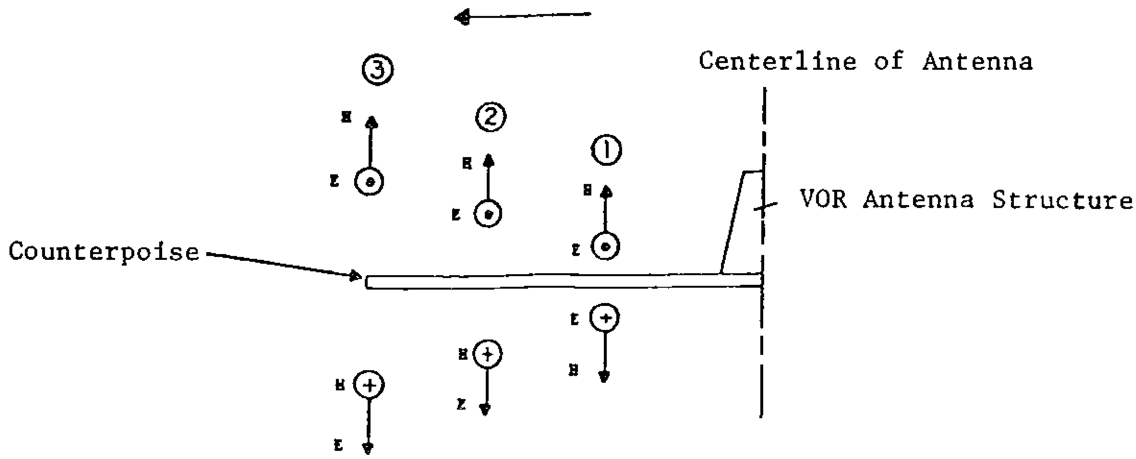
(5) The reduced range of the DVOR as compared with VOR suggests that DVOR is more appropriate for terminal area applications. See table 6-1 and the associated discussion. This does not preclude the use of DVOR for enroute applications when it is determined that the DVOR will satisfy and/or improve coverage requirements. A second characteristic of DVOR supports this conclusion. The simulated doppler signal decreases with the cosine of the angle of elevation so that at 60 degrees above the horizon, the effective β of the fm modulation is only 8 rather than 16. Some airborne receivers will release the malfunction flag at this low a value of β. Additionally, because of this cosine behavior, the cone of confusion whose center is directly above the navaid site is much larger in angular extent for DVOR than for VOR.

d. <u>Longitudinal Multipath and the TACAN Equipment</u>.

(1) Three factors make the analysis of longitudinal multipath effects for DME and TACAN differ from those of VOR:

(a) The wavelength for DME and TACAN is much shorter than for VOR (see table 2-1) making the Fresnel zone much smaller but requiring greater surface smoothness for specular reflection.

Direction of Radiation.



NOTES:

⊙ Indicates vector pointing out of page.

⊕ Indicates vector pointing into page.

FIGURE 3-4. RADIATED AND REFLECTED ELECTRIC FIELD AT COUNTERPOISE

(b) The DME and TACAN radiations are vertically polarized, whereas that of VOR is horizontally polarized. Ground reflections are generally much weaker for vertical polarization. See figure 6-1.

(c) The effect of the counterpoise is weaker for DME and TACAN because the antennas are mounted higher above the counterpoise, both in number of wavelengths and in absolute distance, than is the VOR antenna.

(2) These factors and their effects upon longitudinal multipath are summarized in table 3-1.

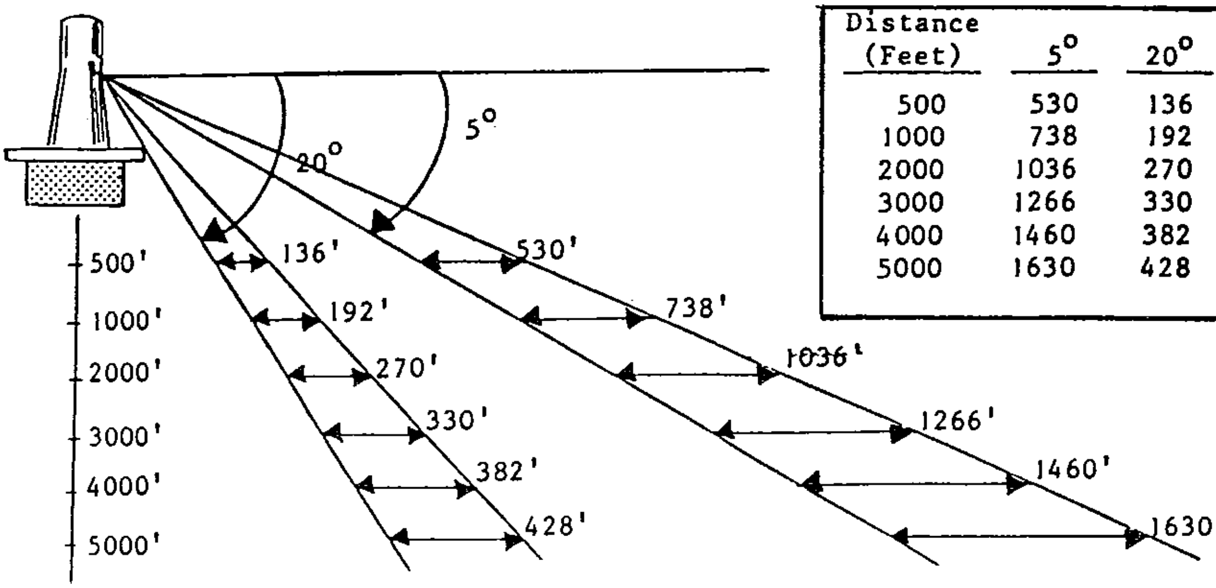
(3) The smaller dimensions of the Fresnel zone for TACAN are seen by developing a figure (similar to figure 3-2) which shows the growth of the Fresnel zone with distance, figure 3-5.

(4) Consider now the ground smoothness characteristic. At 5 degrees, the variation in ground elevation within the Fresnel zone should be less than 6 feet for the ground to be considered smooth to the VOR radiation. For the TACAN or DME, however, at the same angle the variation would have to be less than 9 inches (see figure 2-6). Hence, although the smaller Fresnel zone areas of TACAN and DME make it easier to produce longitudinal multipath, the greater ground smoothness required partly compensates for the reduced area.

TABLE 3-1. LONGITUDINAL MULTIPATH: TACAN COMPARED WITH VOR

NOTE: For purposes of this comparison DME may be associated with TACAN

Parameter	Differences	Effect
λ	λ (VOR) $\approx$ 8 feet λ (TACAN) $\approx$ 1 foot	Total area of Fresnel zone reduced by a factor of 8 for TACAN compared to VOR thus facilitating TACAN longitudinal multipath. Ground must be much smoother in the Fresnel zone area to sustain specular reflection for TACAN as compared to VOR.
Polarization of Radiation	VOR-Horizontally Polarized TACAN-Vertically Polarized	Vertically polarized radiation of TACAN is much <u>less</u> strongly reflected from the ground than is horizontally polarized radiation.
Height of Radiator Above Counterpoise	VOR - 4 feet TACAN - 20.5 feet	Below the horizon radiation from TACAN is not as sharply attenuated by the counterpoise as is that of VOR. Additionally, counterpoise is less effective in its blocking action. See figure 2-8.



Distance (Feet)	5°	20°
500	530	136
1000	738	192
2000	1036	270
3000	1266	330
4000	1460	382
5000	1630	428

NOTE: Compare with figure 3-2.

FIGURE 3-5. Growth of TACAN/DME Fresnel Zone Length with Distance

(5) The use of vertical polarization for TACAN and DME aids in reducing the ground reflection, particularly in the angular region of the Brewster's angle. Unfortunately the Brewster's angle varies over a range of 5 to 30 degrees for various types of terrain and, in a particular geographic area, will vary with the season. Nevertheless, the effect is generally favorable to reducing longitudinal multipath. See detailed discussion in paragraph 23.f, chapter 6.

(6) The counterpoise is much less effective for TACAN and DME than it is for VOR. On the other hand, the antennas of TACAN and DME are multiple-element radiators designed to shape the pattern of radiation in the vertical plane so that energy directed toward the ground is sharply attenuated.

(7) A smooth, flat ground surface within approximately 25 feet of the navaids antenna complex will sustain longitudinal multipath from the DME at the angle of 24 degrees if the surface is smooth to within about two inches over a range of 27 feet. In most cases, the radiation at 24 degrees below the horizon will be sharply attenuated; however, the smooth, flat surface characteristic in the vicinity of the antenna complex is to be avoided.

13. CONSIDERATIONS OF LATERAL MULTIPATH.

a. General.

(1) Lateral multipath involves the mutual interference between signals radiated at two different azimuth angles from the same antenna. These signals contain different azimuth information in their modulations.

The resultant signal, if the interference is sufficiently strong, will contain erroneous azimuth information. The interference effects arise from the combining of two modulations which are not of the same phase angle.

(2) Existing sources of lateral multipath, such as permanent structures, often cannot be removed. The investigator should consider the option of preparing qualified recommendations for such sites, identifying the potential sources of multipath and his reasons for believing that such sources may be problems. Using the techniques for minimizing lateral multipath discussed in chapter 6, the cost and probability of success of such techniques can be factored into the overall evaluation.

b. Lateral Multipath and the VOR Equipment.

(1) Lateral multipath is caused generally by objects and structures rather than by the ground itself. Hence, a discussion of lateral multipath includes such objects as long wires, trees, cylinders, planes, and combinations of these. The general guidance provided here is supplemented by additional technical material provided in chapter 7 and, for wires and cylinders, by computer simulation techniques described in chapter 8.

(2) The previous discussion of Fresnel zones reveals that it is angular size, measured from the antenna site, rather than absolute dimensions. This is significant in determining the effect of a reradiating surface. Thus from figure 3-2, a ground surface of 1800 feet in extent can be as large in its effect as a surface extending over a mile at a longer distance. Hence, an appropriate measure of objects in the VOR field is the angle subtended by such objects at the VOR antenna.

(3) A second important consideration in evaluating the potential effect of objects in the VOR field is the azimuth at which the possible lateral multipath will be experienced. At some installations, notably terminal areas, some azimuths are relatively more important than others. It is characteristic of lateral multipath that the effect is most pronounced at azimuths other than the one at which the causing object is located.

(4) A useful reference for comparison purposes is the TACAN antenna monitor and support mast. This monitor structure will always be present in those situations where the navaids antenna complex is already installed and the site is being evaluated for possible modification. It subtends an angle of approximately 1.4 degrees at the VOR antenna and, as a reflecting re-radiator, causes a scalloping error in the VOR of about 0.2 degree at azimuths ±55 degrees from its location. See paragraph 25.b. for a more detailed discussion of directional re-radiators. Directional re-radiators of the same angular width as the TACAN antenna monitor, even though at a greater distance, can be expected to cause similar scalloping effects.

(5) Figure 3-6 is a qualitative guide to estimating the possible effect in causing lateral multipath of objects in the area of the VOR antenna. Several conclusions may be drawn from an examination of the figure, but judgement must be used in the application of these conclusions:

(a) Single trees and objects of similar angular dimensions can cause substantial lateral multipath if located within a few hundred feet of the VOR antenna. Because the VOR radiation is horizontally polarized, it is the angular extent of the tree in the horizontal plane that is significant. The height of the tree, however, enables it to project above the plane of the counterpoise.

(b) Cleared forest areas can cause scalloping.

(c) VOR does discriminate against objects which may cause severe lateral multipath.

(6) Specular reflectors and other directional reflectors have maximum scalloping amplitudes when the angle of incidence is in the region of 55 degrees. The half-power scalloping amplitudes occur for angles of 35 and 73 degrees. See figure 7-7 and the associated discussion in chapter 7.

(7) The scalloping amplitude for diffuse radiators is maximum when the azimuth of the re-radiator and the azimuth of the aircraft are at 90 degrees one to another. See figure 7-10 and the associated discussion in chapter 7.

c. Lateral Multipath and the DVOR Equipment

(1) Lateral multipath is known to involve interference for the 30-Hz modulating signal which carries the azimuth information. Lateral multipath of the reference signal cannot cause problems since the direct and multipath signals are essentially in the same phase and hence add constructively. In the

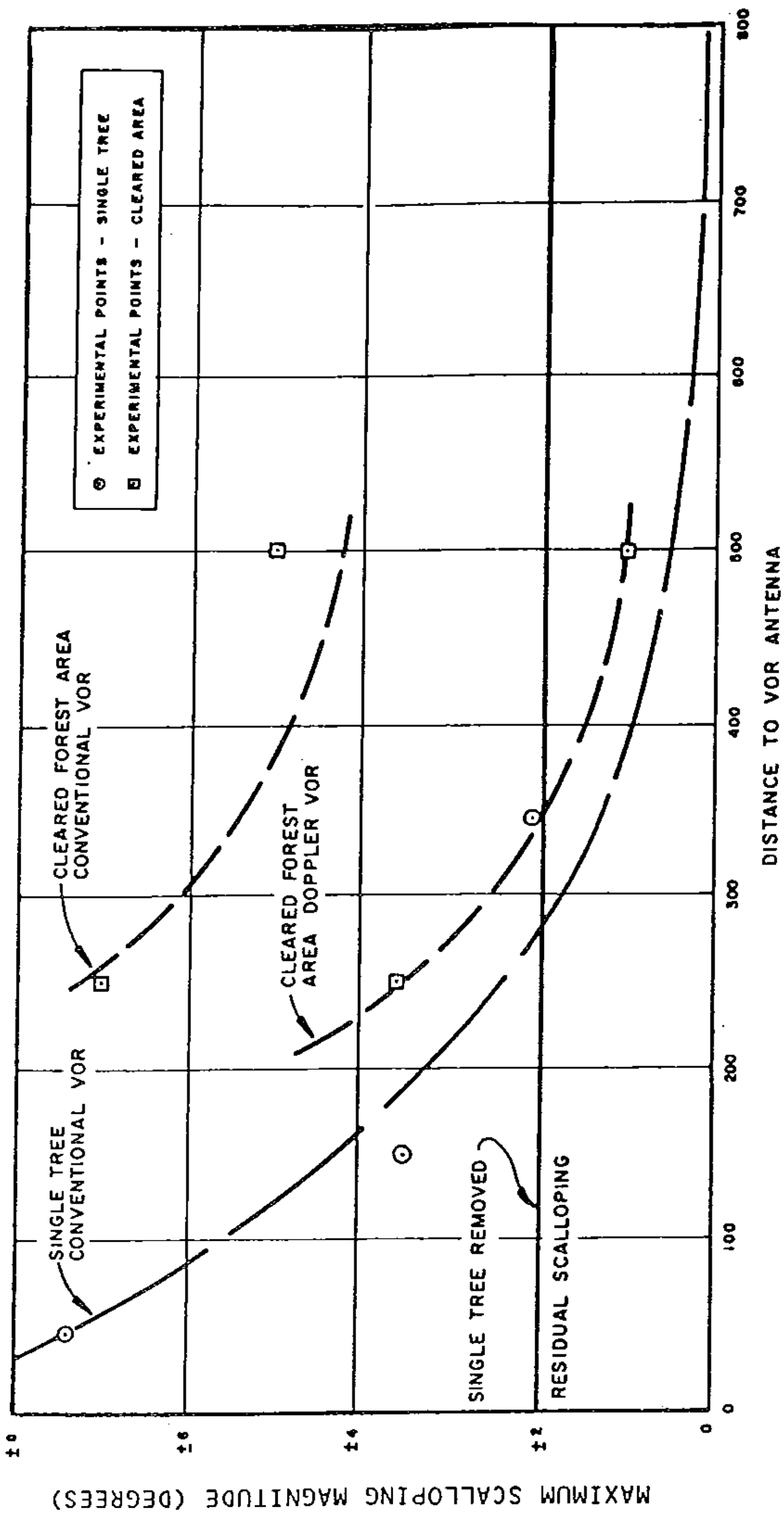


FIGURE 3-6. MAXIMUM SCALLOPING AMPLITUDE CAUSED BY SINGLE TREE AND BY FOREST

doppler VOR, the variable azimuth information is protected from interference because of the nature of fm modulation. It follows that DVOR is inherently resistant to lateral multipath.

(2) Site evaluation involves the identification of potential problems associated with the site and the recognition of approaches to the resolution of such problems. For sites with severe multipath problems, the DVOR may appear to be a reasonable candidate solution. DVOR has specific characteristics that should be taken into account in the development of such recommendations. The doppler shift decreases directly with the cosine of the angle of elevation, resulting in a large "cone of confusion" centered on the 90-degree angle of direct overhead. The very large DVOR counterpoise serves to reduce low angle coverage. The amount of the reduction is a function of the site elevation over average terrain in the direction of propagation. Finally, the cost and complexity of DVOR makes this equipment the practical candidate only for those sites for which few other alternatives exist. DVOR was developed originally for terminal areas, and its use has been largely restricted to such locations.

d. Special Considerations for Mountain Top Sites.

(1) It is usual to locate the VOR counterpoise directly at ground level at mountain top sites. One reason for this practice is that the low conductivity of the ground at such sites requires particular emphasis upon the best obtainable electrical connectivity between the ground and the counterpoise. A second reason is that the radiating wavefront tends to cling to the counterpoise at the counterpoise perimeter and so bend downward and direct some energy into the ground. The effect is less serious when the antenna is not elevated.

(2) Siting a VOR on a mountain top several thousand feet above surrounding terrain may result in VOR bearing errors which exceed flight check tolerances. Even with the large counterpoise on mountain top VORs, portions of the valleys may be illuminated by the VOR antenna. When this occurs, vertical lobing (longitudinal multipath) of the signal will cause nulls in the VOR vertical radiation pattern. When aircraft fly through these vertical nulls, the direct signal from the VOR is reduced compared to the reflections (lateral multipath) received from surrounding objects. This may result in bearings which are out of flight check tolerance and subsequent restrictions or shutdown of the VOR. If this condition exists, little or no improvement will be gained by installing a DVOR. A DVOR will provide significant signal improvement when lateral multipath is from relatively close objects; however, at mountain top sites where the source of the multipath may be several miles away, little improvement is gained.

e. Lateral Multipath and TACAN.

(1) Lateral multipath is more readily generated for the TACAN than for VOR because the shorter wavelength of TACAN requires a smaller Fresnel zone.

(2) Vertical wires that cause only slight multipath problems for the horizontally polarized VOR signal can cause substantial problems for the vertically polarized TACAN signal. Conversely, horizontal wires that cause serious multipath problems for VOR may have a much smaller effect on TACAN.

f. Wind Turbine Generators. The recent growth of alternative energy sources has led to an increasing number of wind turbine generators and to increasing complaints of electromagnetic interference from these generators. A study at the University of Michigan (D. Sengupta and T. Senior, "Electromagnetic Interference by Wind Turbine Generator," Report No. 014438-2-F, March 1978) indicates that VOR and DVOR facilities will experience no significant degradation of performance due to the presence of wind turbine generators if the generators are sited in accordance with FAA standard guidelines for objects near VOR and DVOR facilities.

14.-15. RESERVED.

CHAPTER 4. SITE SELECTION AND ACQUISITION

16. PROCEDURE FOR SITE SELECTION.

a. General. The selection of a suitable site for a navigation facility (VOR, VOR/DME, TACAN, or VORTAC) is primarily a function of performance and cost. No candidate site shall be selected that does not satisfy the minimum performance requirement at a cost commensurate with the benefit to be received. Primarily, this order provides the siting engineer with techniques for estimating site performance and the effect on performance of various corrective measures. This chapter presents a methodology for selecting a VOR, VOR/DME, TACAN, or VORTAC site which meets the performance requirements of the system and the cost limitations of the program. Although detailed performance or cost estimates are beyond the scope of this order, a good first approximation is required for site selection and acquisition. See figure 4-1 for a flowchart of the selection process.

b. Initial Locality. The general location of a navigation facility (VOR, VOR/DME, TACAN, or VORTAC) is initially determined by its type; whether it is a terminal facility or an en route facility (see paragraph 21.b). The location of a terminal facility is constrained by the actual location of the airport and by the orientation of the primary instrument landing runway. The location of en route facilities is determined largely by the location of the airways which they serve and, to a lesser extent, by the distance to other facilities serving the same airways.

c. Office Survey.

(1) Once the general location has been determined, candidate sites may be identified from topographic maps readily obtained from the U.S. Geological Survey of the Department of the Interior. These map studies will identify, as accurately as possible, the coordinates of the candidate sites and the locations of triangulation points or other control points. These points will permit establishment of an accurate baseline and verification of coordinates in the field.

(2) The initial office survey should develop a candidate site and several alternative sites, if possible. This will save the cost and time of additional field trips if the primary candidate is determined to be unsuitable or unavailable. Maps of each area should be acquired, and if the installation is to be within an existing facility, all available engineering drawings describing the site should also be assembled. Other information that does not require a site visit may also be compiled at this time. This includes some or all of the following:

(a) Ownership characteristics of the land, particularly name and address of owner(s); easements, rights-of-way, or other use limitations; and zoning or use restrictions imposed by the local political jurisdictions.

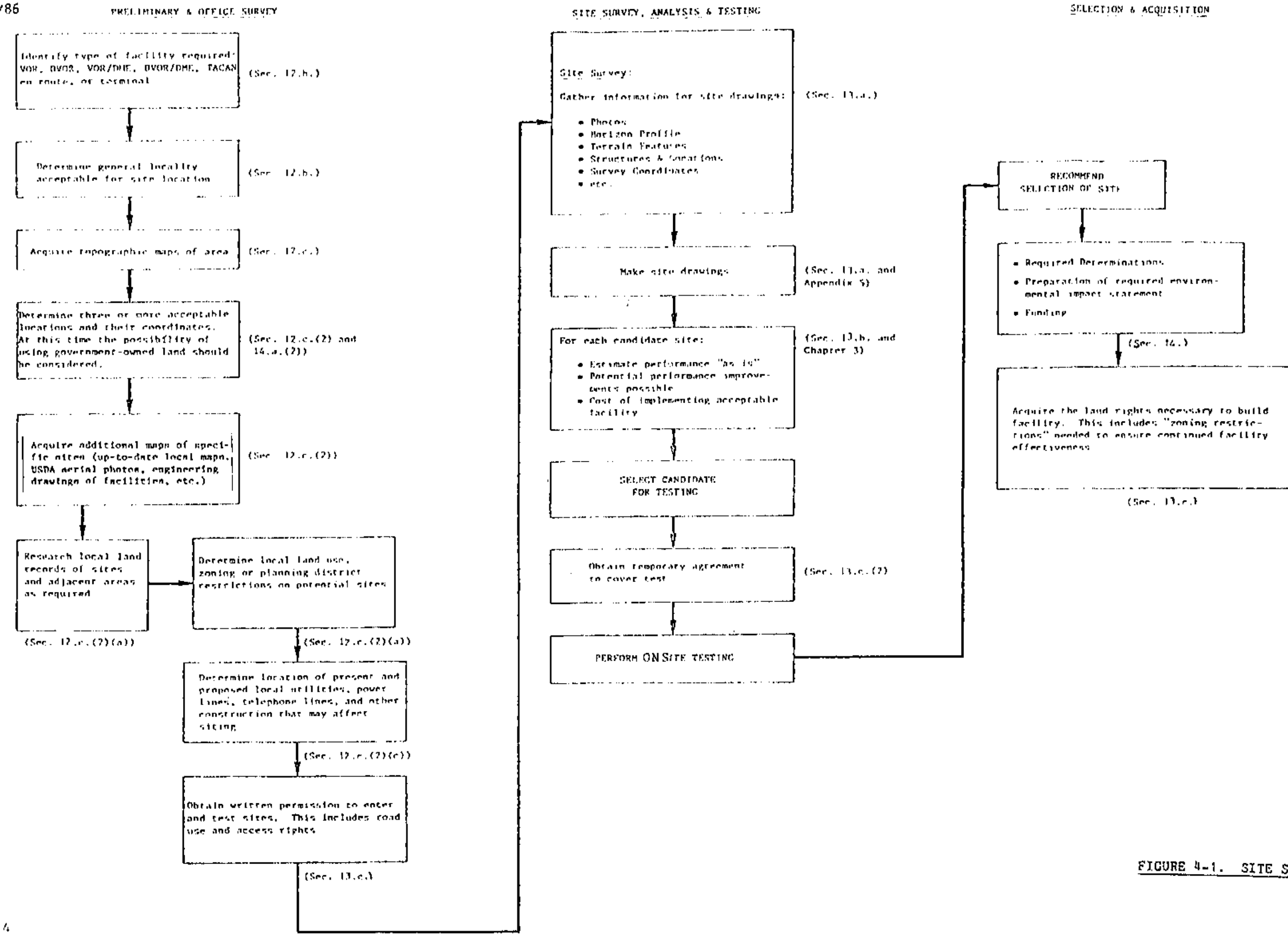


FIGURE 4-1. SITE SELECTION PROCEDURE

(b) The possibility of using Government-owned land should be investigated at this time. See FAA Order 4660.1, Real Property Accountability Handbook.

(c) Location of the proposed facility with respect to any nearby town or airport, roads, utility lines, and boundary lines in the vicinity.

(d) Local utilities' plans for new or upgraded lines near the proposed sites and local planning districts' long-range plans that might impact on these sites.

17. SITE SURVEY, ANALYSIS, AND TESTING.

a. General.

(1) The primary purpose of the site survey is to obtain sufficient information to prepare site drawings (see appendix 6). The site drawings should include a vicinity sketch, site plan, plot layout plan, and horizon profile. The survey will establish (and document in the various drawings) a dimensional description of the site, including the locations and heights of prominent adjacent natural and man-made terrain features and obstructions. Distant terrain features that represent potential obstructions should also be identified. See paragraph 13.c(2) below for information concerning permission to enter the land.

(2) Features to be noted in the survey will include such details as trees, fences, drainage, existing buildings, utility lines, and obstructions within the vicinity of the antenna position out to a distance of 2000 feet. During the survey, other features that may be noted are topographical characteristics, particularly surface variations, that may have an impact on the propagation of signals from the site.

(3) Accurate measurements are required for the coordinates of the location and the horizon profile. The latitude and longitude of the location must be determined to the nearest 15 seconds of arc. The coordinates will later be refined to an accuracy of ± 40 feet by the U.S. Geological Survey. The horizon profile is obtained by setting up a transit or theodolite at the correct antenna height and location for the site, and recording the vertical angle of all obstructions in a full circle around the site. These measurements must be accurate to ± 0.1 degree in vertical angle and should be given for each 10 degrees around the circle, unless elevation changes warrant more frequent measurements. If the profile taken for an antenna height of 4 feet does not show any object above 0.5 degree, then the profile at 16 feet does not need to be made. A set of accurately registered panoramic photos are an alternative to the horizon profile.

b. Site Evaluation.

(1) After preparation of the site drawings, the techniques discussed throughout chapter 3 should be applied to analyze the characteristics associated with each site under consideration. The evaluation should include:

(a) Estimates of performance that can be expected from each unimproved site.

(b) Improvement of the above performance that can be expected if corrective measures are taken. Such techniques are discussed at length in chapter 5.

(c) Estimated cost of implementing a facility that will provide acceptable performance.

(2) Selection of a tentative VOR, VOR/DME, TACAN, or VORTAC site is then made, based on the above analysis, with the objective of meeting the required performance at the least possible cost. This site should then be field tested to verify the predicted performance. In unusual cases where the site test is unsatisfactory and the performance deviates greatly from expectations, the site should be reanalyzed in light of the new data. If, as a result of a complete reevaluation, one of the alternative sites previously ruled out is now found to be most promising, a new site test will be required. Successful completion of a site test(s) will provide data for the site selection. If more than one site is technically satisfactory, then relative costs will be the determining factor.

c. Preliminary Considerations Before Testing.

(1) At the time of the office survey, it is of prime importance to establish the identity of the owners of the land for all candidate sites and the addresses through which they may be contacted. The legal description of land can usually be obtained locally from city, township, or county clerk's office. If possible, a copy of the deed(s) or other appropriate documentation showing land ownership should be attached to the Site Survey Report. In addition, there may be land adjacent to the proposed sites which would be affected by the site zoning restrictions. These restrictions, discussed in detail in paragraph (3) below, may be determined during the office survey, so that the ownership information of this type land, if required, may also be included in the Site Survey Report.

(2) Once the site surveys are completed and it has been decided to field test a specific candidate site, a temporary agreement must be entered into with the property owner(s). This agreement (Permit to Test, Testing License, etc.) will secure entry and access to the property for setting up a portable VOR and testing the site. These agreements, and the initial permission to enter the land for the site surveys, are governed by FAA Order 4660.1, Real Property Accountability Handbook.

(3) At the time that the temporary agreement is secured, the landowner(s) should be made aware that the following zoning restrictions will be required if the site is actually selected. This will reduce the possibility of complications in this regard at the time of lease negotiations. The restrictions are:

(a) General. All obstructions within 1000 feet of the antenna are to be removed except as noted below. Normal crop raising and grazing operations may be permitted in this area, except at mountain top facilities where antennas are 4-feet high. In these instances, crop raising and grazing must be restricted to areas below and off the counterpoise. No grazing should be permitted in the vicinity of the monitor detectors.

(b) Trees and Forests. Trees close to the VOR antenna can cause severe scalloping. Single trees of moderate height (up to 30 feet) may be tolerated beyond 500 feet, but no closer. No groups of trees should be within a 1000-foot radius or subtend a vertical angle of more than 2 degrees. At mountain top sites, no trees within 1000 feet should be visible from the antenna array.

(c) Wire Fences. Ordinary farm-type wire fences about 4-feet high are not permitted within 200 feet of the antenna; fences of the chain type (6 feet or more in height) are not permitted within 500 feet of the antenna; beyond these distances no wire fence should extend more than 0.5 degree above the horizontal, measured from the antenna. These requirements may be relaxed for fences essentially radial to the antenna. Since there is a large number of possible combinations of fence height and orientation with terrain configuration of various types, each of which may produce a different effect, the foregoing must serve as a general guide only. At many sites, a special study by experienced engineering personnel will be required to permit a judgement as to what fences can be tolerated. At mountain top sites, wire fences may be permitted within 200 feet of the antenna, provided they do not extend above the line of sight from the top of the antenna to the edge of the level area (that is, they are within the shadow area of the ground counterpoise).

(d) Power and Control Lines. Power and control line extensions should be installed underground for a minimum distance of 600 feet from the antenna. Overhead power and control lines may be installed beyond 600 feet but should be essentially radial to the antenna for a minimum distance of 1200 feet. No overhead conductors (including possible future construction), except for extensions serving the site, should be permitted within 1200 feet of the antenna. If a nonradial conductor is so oriented that it does not come within 1200 feet of the antenna, but the perpendicular distance to the antenna from its imaginary extension is less than 1200 feet, then the vertical angle subtended by the uppermost conductor and/or the top of the pole (measured from ground elevation at the antenna site) should not exceed 1 degree; also no conductor should extend above the horizontal plane of the antenna.

Other than the foregoing, there should be no lines or supporting structures so located that they subtend a vertical angle (measured from ground elevation at the site) of greater than 1.5 degrees. In addition, no conductor should extend more than 0.5 degree above the horizontal plane containing the antennas, unless they are essentially radial (within ± 10 degrees) to the antenna array. At mountain top sites, the conductors will be permitted within 1200 feet of the antenna, provided they do not extend above the conical surface formed by the top of the antenna and the edge of the leveled area.

(e) Structures. No structures should be permitted within 1000 feet of the antenna, except for buildings such as the transmitter building at a mountain top site located on a slope below the ground level of the antenna so that they are not visible from the antenna. All structures that are partly or entirely metallic shall subtend vertical angles of 1.2 degrees or less, measured from ground elevation at the antenna site. Wooden structures with negligible metallic content and little prospect of future metallic additions (such as roofs and wiring) may be tolerated if subtending vertical angles of less than 2.5 degrees. However, at airports, where a single hangar or line of hangars, administrative buildings, etc., may have considerable length, it is necessary to look upon such structures as producing interference in the same manner (only more severe) as power and telephone lines, and the criteria for power, control, and telephone lines will apply.

(4) Temporary permits to utilize access roads of adjacent property owners shall also be obtained prior to site testing. Easements are very often all that are required to install a permanent access road to a facility after it is established, and the actual purchase of land for this purpose is not necessary. Leases or other agreements, as required, should be entered into with appropriate governing agencies or property owner(s) for the use of existing roads. Appropriate procedures for entering into such agreements are given in FAA Order 4660.1, Real Property Accountability Handbook.

14. LAND ACQUISITION

a. When a site has finally been selected as appropriate for permanent installation of a VOR/DME/TACAN facility, a legal description and plat of the site, access road, utility easements, and zoning restrictions must be obtained prior to requesting the acquisition of the property rights. All transactions for acquiring an interest in property, whether purchase, lease, or use restriction, are governed by FAA Order 4660.1, Real Property Accountability Handbook, and are handled by Real Estate Office personnel. As an aid to planning, several excerpts as well as references to certain sections, are given below:

(1) Funding. When land is to be purchased for a new facility site, funds for the purchase shall be included in the region or center Facilities and Equipment (F&E) budget in the same fiscal year as the funds for the facility equipment, installation, and building, as applicable. This amount will only be an estimate of the value of the land rights to be acquired, plus acquisition costs, plus a 15- to 20-percent contingency. Instructions for including land acquisition funds in the annual F&E budget submission are found in Order 2500.24, Call For Estimates - Facilities and Equipment (RIS: BU-2500-4).

(2) Required Determinations All possible sites which are technically acceptable for the efficient operation of the facility must be considered. Before any action is begun to acquire new land, a determination must be made that the requirements cannot be satisfied by use of property already held by the FAA, property which is excess to other government agencies, public land, exchange of government-owned property for privately owned property, or the use of existing rights-of-way and easements when available at nominal cost or less.

(3) Site Investigation and Testing. Prior to conducting investigations and tests, the legal right to enter and use the land must be obtained in writing from the landowner and, if appropriate, the right to clear or otherwise change the character of the land. If only verbal authority is granted, confirm this in a letter with a return receipt. When a landowner will not grant a right of entry, then a right of entry must be obtained through the U.S. courts. Local U.S. attorneys should be consulted in these instances through Regional Counsel. Contacts with landowners should generally be made by Real Estate personnel, and when contacts are made by others they must be under the direction of the Real Estate Office.

(4) Environmental Impact Statements. Environmental Impact Statements (EIS), or Finding of No Significant Impact (FONSI) shall be approved before negotiations for the acquisition of any land interest. Real Estate files should contain a copy of the EIS or FONSI as applicable, or a reference to the office of record.

(5) General. The above are included to assist site planning personnel in developing the information base and time line needed to implement their activity. Order 4660.1, Real Property Accountability Handbook also contains comprehensive information regarding the actual purchase of land or leasing it. Close coordination with the Real Estate Office will ensure the most efficient handling of this process.

19. RESERVED.

CHAPTER 5. SITE IMPROVEMENT

20. GENERAL.

a. The navaids of interest here are intended to provide reliable service within acceptable performance margins on a continuous basis in spite of extremes of weather and changing terrain caused by seasonal variations in vegetation or the encroachment of new construction. These variations of the environment in which the navaids must perform require that measures for performance improvement be undertaken each time such a change adversely affects performance. When it is determined that additional FAA equipments be located near the VORTAC antenna site, such a colocation may require additional site improvement features relative to the VORTAC. Thus, site improvements may be required throughout the useful lifetime of the site.

b. Site improvements involve two separate and distinct activities. One is the analysis of the performance or the predicted performance of the VORTAC within the site environment. For a proposed new site, such analysis may be a paper-and-pencil exercise primarily of ray tracing to analyze potential interference sources. After substantial commitment to the site, either through actual site acquisition or as alternates are eliminated, the investment in analysis may be more substantial and include computer simulations. Once the VORTAC is installed, the analysis may involve instrumented flights and analysis of flight data. In the latter activity, the measuring instrument is often a commercial receiver. In such situations, the analyst is presented not with raw data, but with data as processed by a specific receiver, and the idiosyncracies of the receiver must be taken into account in the evaluation process.

c. The second aspect of site improvement is the selection and implementation of the improvement features. Specific site improvement actions should not be undertaken until the sources and the nature of potential or actual performance problems have been identified through the process of analysis. Because of the cost and the time delays associated with such improvements, however, the investigator may elect to initiate preventative measures during the site installation phase when construction labor and materials may be conveniently available. Initial attention to potential site problems can prevent expensive delays in service availability to the flying public.

d. There are two general approaches to site improvement. One is through site modification such as removal of an offending structure or by minimizing the multipath by destructive reflection. The second approach is through changes in the VORTAC antenna equipment. Strictly speaking, these latter activities are not site improvements. They will be described as such, however, since the changes are made in response to specific site problems. A larger-than-conventional counterpoise, for example, may be used in a site where distant low angle coverage is not a major problem but where longitudinal multipath is of concern. The installation of the counterpoise at ground level in mountain top sites where height-gain is not a problem but where ground conductivity is of concern is another example of modification of the antenna installation in response to site peculiarities.

e. The VORTAC antenna installation including counterpoise should, whenever possible, conform with one of the several conventional types in use within the FAA. First priority, however, shall be given to the achievement of an overall VORTAC performance that conforms with FAA requirements. No two sites are alike and the encroachments of suburbia on formerly rural areas creates increasingly severe environments for navaid sites. As a result, in the interest of VORTAC performance, measures may have to be taken in the future which were not required in the past.

21. SITE IMPROVEMENT FOR VOR.

a. Uses of the Counterpoise.

(1) The VOR is the workhorse navigational instrument for en route applications. It is used almost universally for en route applications and at or near many terminal facilities. The DVOR is recommended only for those applications with severe and unavoidable lateral multipath problems.

(2) The large VOR counterpoise is designed to diminish the effects of longitudinal multipath (reduce nulls and signal amplitude minimums). The counterpoise results in the sharp attenuation of radiation at negative elevation angles (see figure 5-1).

(3) The large DVOR counterpoise aids in minimizing longitudinal multipath. In addition, however, the large diameter reduces the asymmetry experienced by the off-center DVOR radiating elements and minimizes modulation created by such asymmetries.

(4) A properly installed counterpoise minimizes the effect upon lateral multipath (course scalloping) of obstacles which do not extend above the horizon of the counterpoise. Further, it minimizes the effect upon longitudinal multipath of those ground areas below its horizon (see figure 5-1).

5) Effective functioning of the counterpoise depends upon good ground conductivity in the vicinity of the counterpoise and good electrical bonding between transmitter "ground", counterpoise, and the surrounding earth ground (see figure 5-2).

(6) Height-gain of the VOR site over the average terrain out to several miles is desirable for distance coverage. It should not be obtained through elevating the counterpoise significantly above the immediate area.

Such elevations create sharp discontinuities for the radiating wavefront in the vicinity of the counterpoise perimeter. The discontinuity can cause wavefront bending resulting in increased ground illumination and more longitudinal multipath. The 12-foot elevation of the counterpoise in conventional installations (see figure 1-3) should not be exceeded if at all possible, and where ground conductivity is poor, ground-level counterpoises are preferable.

b. Diminishing the Effect of Longitudinal Multipath in VOR.

(1) Preliminary to the minimization of longitudinal multipath (amplitude variations) is the task of identifying the specific nature of that multipath and the probable causes. Table 5-1 provides guidance for this process.

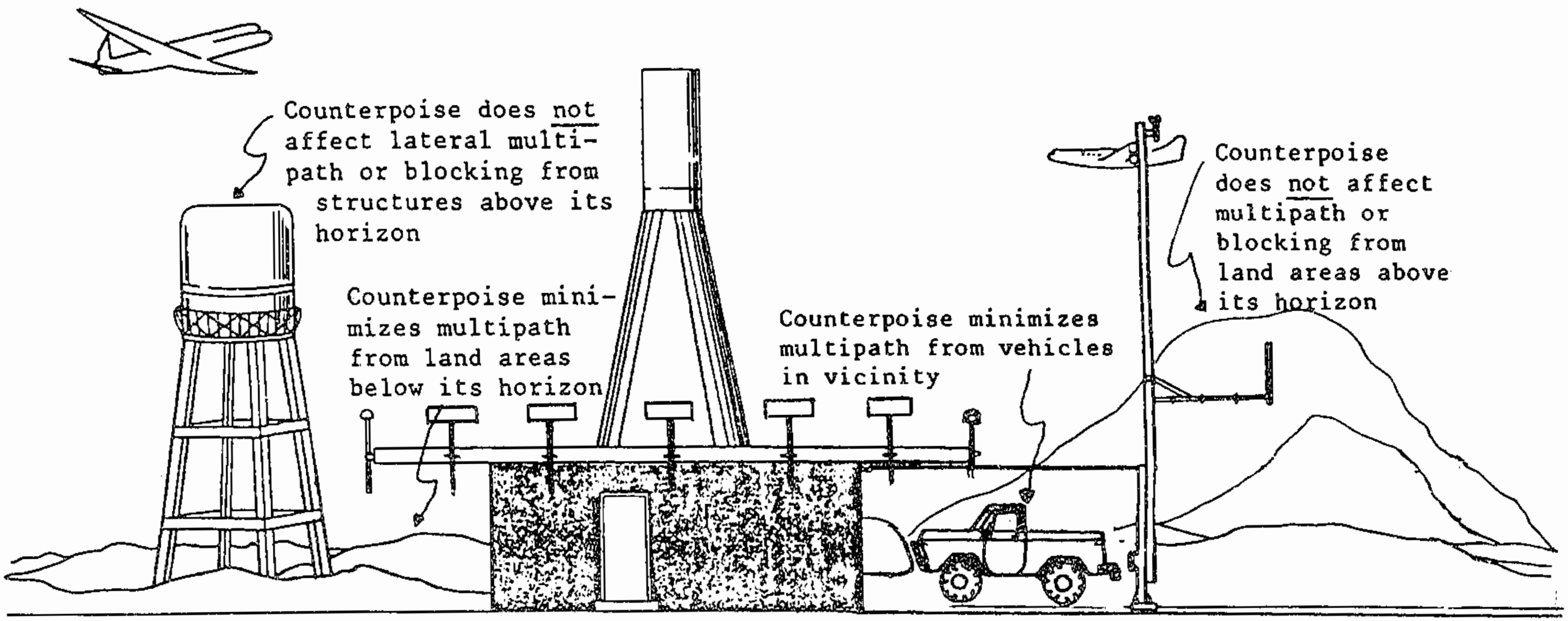
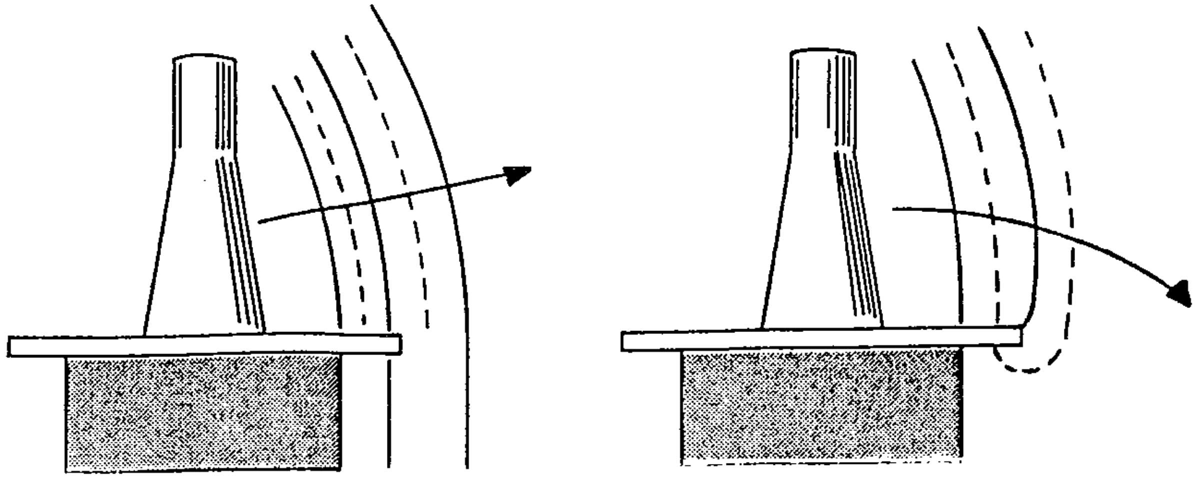


FIGURE 5-1. UTILITY AND SHORTCOMINGS OF THE VOR COUNTERPOISE



(a) Smooth em interface at perimeter. (b) Discontinuity at perimeter.

FIGURE 5-2. COUNTERPOISE BOUNDARY

TABLE 5-1. EXPLORATION OF MULTIPATH CAUSES

Vertical Angle of Null	Possible Cause	Comment
0° to 8°	Geography conducive to multipath	Consider counterpoise size and shape
More than 8°	Discontinuities experienced by em field at counterpoise boundary	Consider quality of ground connection and of ground conductivity
Null location the same at all azimuths	Cause or solution primarily with the counterpoise	See text
Null location in vertical angle found to be limited to restricted range of azimuths	Cause or solution primarily with the geography	See text

(2) From the viewpoint of geometry and simple ray tracing, the counterpoise prevents all VOR em propagation at vertical angles of declination greater than 8 degrees from illuminating the ground (see figure 2-8). The viewpoint is an oversimplification but does indicate that vertical nulls at angles of 8 degrees or less are susceptible to minimization through increase in counterpoise diameter. Before any such change is considered, however, it is useful to further identify the characteristics of the problem. See paragraph 17.b.(6) for a discussion of sloping the outer edge of the counterpoise as a means of increasing diameter as seen by the em radiation.

(3) The vertical nulls may be in the vertical angular region below 8 degrees but limited in azimuths. Such a characteristic indicates that a particular geographic area is contributing to the multipath. Examination of figure 5-3 reveals that there is a range of ground levels which will contribute destructive VOR longitudinal multipaths. It should be evident from the figure that the site geometry may be conducive to longitudinal multipath in one direction only. Consideration of figure 5-1, of the Rayleigh roughness criterion (see figure 2-6), and of the required Fresnel zone size (see figure 3-3) should assist in identifying the ground area of interest. Cost and other factors then will determine whether the null minimization is most readily accomplished by counterpoise expansion or by modification of the geography. Generally, land close to the VOR site is the only land which can be readily modified.

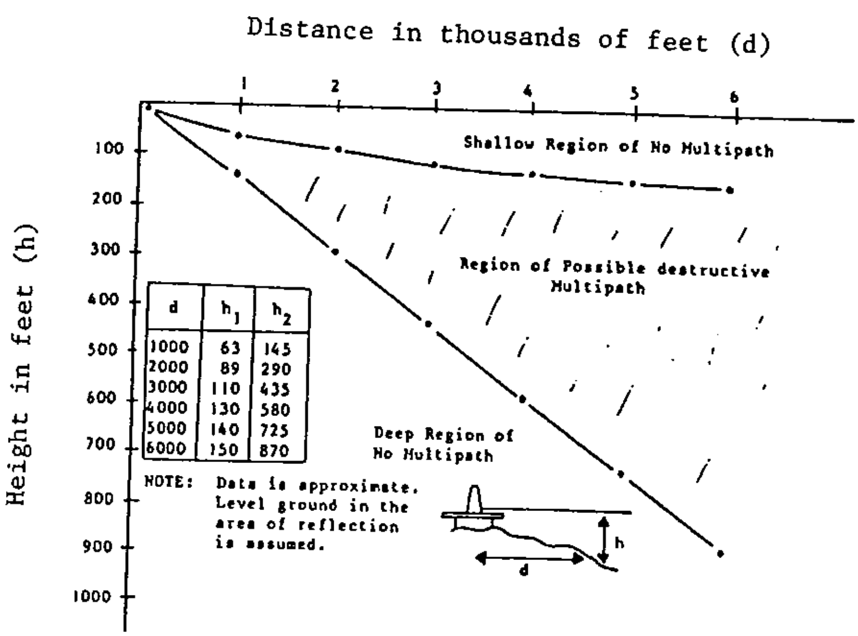


FIGURE 5-3. RANGE OF ELEVATIONS WITHIN WHICH VOR DESTRUCTIVE LONGITUDINAL MULTIPATH (VERTICAL NULLS) CAN OCCUR

(4) Depending upon the geometry and the magnitude of the Rayleigh roughness criterion, a reflecting area of limited extent can be diminished in its effects by plowing, the planting of shrubs, or the deliberate positioning of buildings as part of a site consolidation program. Large and distant reflecting areas associated with low grazing angles are usually less amenable to modification.

(5) For nulls at vertical angles greater than 8 degrees, the investigator should consider the possibility that discontinuities at the perimeter of the counterpoise may be causing the em wave front to bend toward the ground. These discontinuities may be caused by excessive height of the counterpoise above ground, poor connectivity between counterpoise and ground, poor ground conductivity, or a combination of two or more of these factors.

(6) A variety of improvements are possible for the problem of discontinuity at the counterpoise perimeter. In Europe, good results have been obtained by sloping the outer edge of the counterpoise upward. It is claimed, for the particular configuration used in Europe that this modification simulated a counterpoise of approximately double the actual diameter. See Feyer and Nattrodt, IEEE Transactions on Aerospace and Navigational Electronics, March 1965. It has been suggested that sowing metallic filings in the area around the counterpoise will compensate for poor ground conductivity. Finally, it is the usual practice at mountain top sites, where soil conductivity is often poor, to install the counterpoise at ground level.

c. Locating the Contributors to VOR Lateral Multipath.

(1) Lateral multipath creates scalloping, a periodically varying deviation of indicated bearing from true bearing. Locating an object which is a source of scalloping is accomplished by analysis of the course deviation recording taken on an orbital flight. Scalloping characteristics observed over a complete orbit can then be analyzed to identify the bearing to the interfering object from the VOR site and the distance of that object from the site.

(2) Two sets of procedures have been developed for identifying the location of scalloping sources. The first method is based on theoretical considerations and differentiates among three types of interfering objects according to the way in which they interact with the VOR field. The second method is an empirical one, which uses two simple graphic procedures to identify either nearby interfering objects or more distant ones. These two methods are discussed below in general terms, with detailed instructions for both included in appendices 3 and 4.

(3) The theoretical approach requires classification of the interfering object as a nondirectional re-radiator or a directional reflector. Directional reflectors may be either of short length or long length. Classification is accomplished by inspection of the scalloping in the flight record. The determination of the location of the object is based on the fact that the azimuth on which maximum scalloping amplitude occurs is related to the bearing of the object from the VOR. Furthermore, the frequency of the scalloping is a function of the distance of the object from the VOR.

(a) Using the approach based on theory, the relationship of the azimuth of the object to the azimuth of the scalloping source depends upon the type of object involved. For the nondirectional re-radiator, maximum scalloping amplitude will occur along two oppposing radials (180-degree separation) at a right angle (90 degrees) to the radial of the interfering object. A directional reflector will show maximum scalloping on one or two azimuths, depending upon the length of the reflector. Such maxima will be 145 degrees from an azimuth normal to the reflector. If there are two maxima 180 degrees apart, the procedure for locating a nondirectional re-radiator is appropriate. If there are two maxima 70 degrees apart, the procedure for a long-length directional reflector should be used. For a single maximum, or multiple maxima not spaced as above, the procedure for a short-length directional reflector should be used. These procedures are described in detail in appendix 3.

(b) There are several limitations on the use of the theoretically derived method described above. Interference sources may exhibit both re-radiating and reflecting characteristics. This can serve to obscure the identifying characteristics of the actual scalloping observed in the bearing error recording. Furthermore, the flight-check receiver circuits will damp out scalloping that occurs at frequencies greater than about one-half cycle per second. This can be a significant problem for scalloping sources distant from the VOR. The use of a slower aircraft and/or larger orbits can alleviate some, but not all, of this problem. If the scalloping source is very close to the VOR, the scallops may be so long that they may not be apparent on the recordings. Finally, some of the procedures will yield only a general locus of the possible locations of the scalloping source, creating a significant practical difficulty in locating the specific interfering object.

(4) To overcome the practical difficulties in the use of the theoretical method, two empirical procedures for locating VOR scalloping sources were developed and documented in internal FAA memoranda by Earl E. Palmer of the Northwest Region. The first procedure is called the Scallop Counting Method (SCM). It provides satisfactory results for locating scalloping sources from approximately 30 to 6000 feet from the VOR, and is useful for the majority of scalloping problems. The second procedure is called the Center of Symmetry Method (CSM). This procedure uses orbital data or ground error curves and is useful for finding scalloping sources very near the VOR, approximately 100 feet or less. Both methods are described in detail in appendix 4.

(a) The Scallop Counting Method uses the orbital scalloping frequency at several azimuths to determine a locus of points (straight lines) where the scalloping source could be located. The common intersection of three or more of these lines is the location of the scalloping source. Flight inspection recordings are most useful for this method, since higher frequency scalloping that is damped by the receiver may be observed on the recording of the automatic gain control voltage level. Other factors that may impact on the usefulness of the recordings are aircraft speed, altitude, and orbital radius. Consideration of these factors and a discussion of the complete procedures for this method are detailed in appendix 4.

(b) The Center of Symmetry Method relies on the principle that the scalloping source causes scalloping that is symmetrical, but out of phase, on each side of the radial on which the source is located. All scalloping sources exhibit this property; however, as the scalloping source gets farther away from the VOR, the orbital scalloping frequency becomes higher, and will be damped out and lost in the VOR bearing recording process. The CSM uses SAFI Bearing Error Reports or Saberliner orbital error plots on FAA Form 8240-4, and applies the symmetrical and out-of-phase relationship mentioned above. The recordings are taped into a continuous loop representing 360 degrees, and examined on a light table so that each half of the loop can be seen superimposed on the other. The loop is then rolled until the symmetrical scallops are aligned. A full description of the technique, with examples, is given in appendix 4.

d. Minimization of VOR Lateral Multipath.

(1) The horizontally polarized VOR signals are very susceptible to interfering lateral multipath reflection from power lines, metal fences, and metal buildings. The most satisfactory approach to minimization of these reflections is the physical removal of the reflector, the relocation of the VOR site, or the conversion of the facility to DVOR which is resistant to such interference. These methods are often costly and sometimes impractical.

(2) The use of wave-cancellation techniques to reduce the reflections to acceptable levels has proven to be practical in many situations (see figure 5-4). Wave cancellation is accomplished by the use of a secondary reflector placed at such a distance in front of the offending reflector as to create destructive interference.

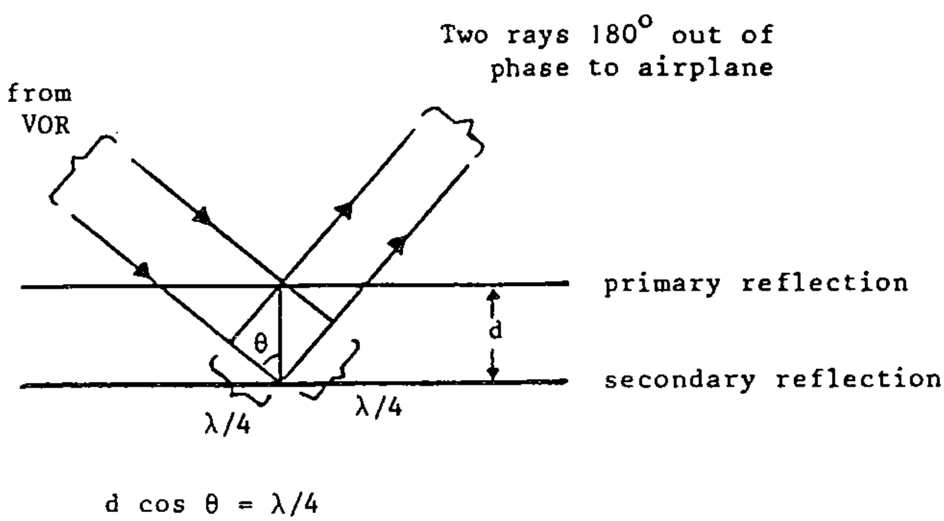


FIGURE 5-4. GEOMETRY FOR WAVE CANCELLATION

(3) Wave cancellation techniques can also be used in connection with metallic buildings. In such applications, more than one cancelling conductor is required. The horizontal spacing of the conductors is in accordance with the principles illustrated in figure 5-3. A vertical conductor spacing of one-eighth wavelength has been found to be satisfactory. See Karns, IEEE Transactions on Aerospace and Navigational Electronics, March 1964.

(4) Because of the horizontal polarization of the VOR radiation, telephone lines and power lines are particularly effective sources of disturbance since these conductors are usually installed parallel to the earth. Their effects can be minimized if these conductors are installed along radials of the VOR radiating system. Alternately, they may be buried underground. See figures 7-8 and 7-9 and the associated discussion on short and long conductors.

(5) Fences are in a similar category to telephone and power lines, although the possibility is greater that fences will be below the horizon of the counterpoise.

(6) In areas of severe lateral multipath, which may include metallic buildings and vehicles of a variety of types, the DVOR should be considered as a replacement for the VOR. Because of the poorer low-angle distance performance of the DVOR and its large overhead "cone of confusion", the use of the DVOR has been limited in the past to terminal areas.

(7) The discussion of VOR lateral multipath minimization is summarized in table 5-2.

e. Minimization of DME and TACAN Longitudinal Multipath.

(1) Fading effects due to longitudinal multipath can be expected to be more severe for DME and TACAN than for VOR because of the higher carrier frequency of these two navaids. In addition, the VOR antenna elements are closer to the counterpoise, both in absolute distance and in wavelengths, than is the situation for DME and TACAN. Hence, the counterpoise is more effective in reducing below-the-horizon radiation for VOR than for the antennas more highly elevated above the counterpoise.

(2) There are two features of the DME and TACAN radiators which assist in the minimization of longitudinal multipath. One is the fact that these are multielement antennas designed to provide sharp attenuation for radiation below the horizon. See the cutaway sketch of a DME antenna in figure 1-6. The second feature is the vertical polarization of the radiation which provides a lower coefficient of reflection from the earth than horizontal polarization does. See figure 6-1 and the discussion associated with figures 6-33 through 6-39.

(3) The requirement for co-siting of TACAN and VOR components requires that compromises be made in the site features. It is emphasized, see section 23.b.(8), that the first Fresnel zone be free of obstacles in order to minimize TACAN signal fading. A discussion of Fresnel zones is presented in order to develop the importance of the first Fresnel zone.

TABLE 5-2. MINIMIZATION OF VOR LATERAL MULTIPATH

Source of Lateral Multipath	Method of Minimization of Multipath Effects
Long wires (telephone, power lines)	o Wave cancellation - see figure 5-4 o Bury conductors underground o Install along radial lines from the VOR
Metal fences	o Replace metal with nonconducting material o Wave cancellation o Install along radial lines from the VOR o Keep well below counterpoise horizon
Metallic building surfaces	o Wave cancellation o Keep below counterpoise horizon
Many unavoidable sources	o Replace VOR with DVOR (Provided DVOR characteristics are acceptable to the needs)

In the following paragraph, however, typical calculations are presented, showing the practical difficulty of providing a clear first Fresnel zone. See figure 5-5 and imagine an infinitely large transparent screen in the path of radiation from VORTAC to aircraft and with its plane perpendicular to the direct ray. Concentric circles may be drawn on this screen centered on the point where the direct ray intersects the screen. The radius of the first circle is such that the difference in path length between the direct path from the screen to the aircraft and the path from the circumference of the circle is $\lambda/2$. For this simplified discussion, we assume that the screen is at least 10 times as far from the VORTAC as it is from the aircraft so that all points within the first few Fresnel zones are essentially equidistant from transmitter. The area included within this first circle is the first Fresnel zone. The radii of succeeding circles are such that the corresponding path-length differences are integral multiples of $\lambda/2$. The ring-shaped areas thus formed are the second, third, etc., Fresnel zones. The em fields from the odd-numbered zones are in phase at the aircraft; the em fields from the even-numbered zones are opposite in phase to the fields from the odd-numbered zone. If it were possible to block off all contributions except those from the first Fresnel zone, the em field at the aircraft would be found to be double its free space value. If the contributions from only the first two Fresnel zones are permitted, they almost cancel, resulting in a nearly zero field at the aircraft. The locus of the first Fresnel zone is an ellipse with a circular cross section. The elliptical outline ~~is~~ is shown in figure 6-44.

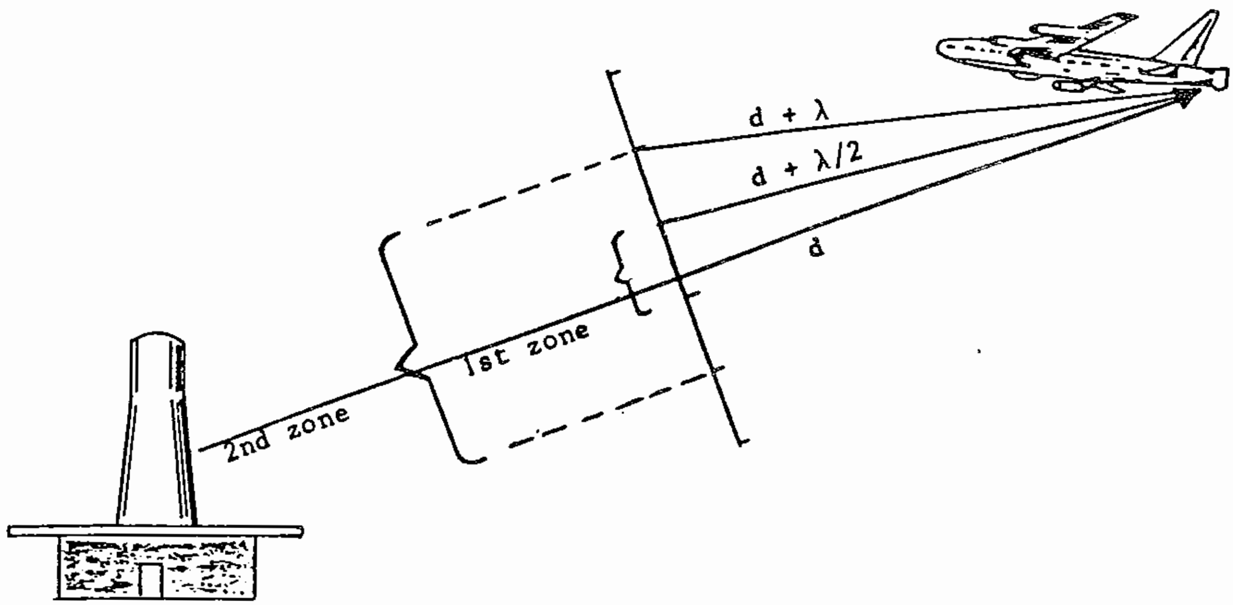


FIGURE 5-5. THE FRESNEL ZONE CONCEPT

(4) Table 5-3 shows the clearance required around the direct ray to the aircraft for first Fresnel zone clearance for an aircraft 40 nautical miles away at an altitude of 1,000 feet. The DME antenna site elevation must be on the order of 5,000 feet above the terrain, which is 20 nautical miles distant in order to provide the required Fresnel zone clearance. It is rare that one is able to obtain a site having these characteristics. The conclusion reached is that considerable reliance must be placed upon the beam shaping characteristics of the antenna and the Brewster angle effect in minimizing the effect of ground blocking or ground reflections. Once the VORTAC equipment is installed, the detailed graphic procedures described in section 23.c. may be used to locate and determine the operational importance of the individual nulls in the vertical pattern. The nature of these nulls can be modified by changes in the ground roughness (see figure 2-6) in the area where the reflection is taking place.

(5) Natural terrain features or specially constructed screens can be used to trap null-producing rays. The techniques are illustrated in figure 5-6. The construction of the screens is described in connection with lateral multipath.

TABLE 5-3. GROUND CLEARANCE REQUIRED FOR FIRST FRESNEL ZONE

$$R = \left\{\frac{\lambda d(r_o - d)}{r_o}\right\}^{\frac{1}{2}} \cong \frac{1}{22.2}\left[d(r_o - d)\right]^{\frac{1}{2}} \text{ for } \lambda = 10^3 \text{ ft, } r_o = 40 \text{ n.m.}$$

(see section 23.b.(8).

d (n.m.)	R (n.m.)	R (feet)	Approx. Elev. of Ray Center (ft) *	Additional Ground Clearance Needed (feet) **
0.5	0.20	1217	24	1193
1.0	0.28	1710	24	1686
2.0	0.39	2388	26	2362
5.0	0.60	3623	40	2583
10	0.78	4744	88	4656
15	0.87	5303	168	5135
20	0.90	5477	280	5197
25	0.87	5303	424	4879
30	0.78	4744	600	4144
35	0.60	3623	808	2815
38	0.39	2388	948	1440
39	0.28	1710	997	713
39.5	0.20	1217	1022	195

* Based on the approximation for the distance to the radio horizon, see paragraph 21.a.(4).

** These results are approximate only.

NOTE: Rays below 1 in (c) above which could produce nulls are trapped by the screen. Rays above 1 do not produce nulls.

FIGURE 5-6. TECHNIQUES FOR TRAPPING NULL PRODUCING RAYS (From: TACAN Principles and Siting Criteria, Greco and Reed, Naval Electronic System Test and Evaluations Facility, 1968)

(6) At military installations, the areas causing null-producing rays can sometimes be engineered to be in the region of the Brewster angle through variation in the height of the TACAN antenna installation. This degree of freedom is not usually available to the site investigator concerned with a VORTAC facility.

f. Minimization of DME and TACAN Lateral Multipath.

(1) The important distinguishing feature of lateral multipath for TACAN and DME as contrasted with VOR is the much smaller size of the Fresnel zone. In simple language this means that a much smaller metallic surface than is required for VOR lateral multipath will cause strong side reflections for TACAN and DME. Parked aircraft can, for example, have such an effect.

(2) Because of the smaller size of TACAN-associated Fresnel zones, it is practical to construct relatively small-sized traps to capture and divert the offending signals (see figures 5-7 and 5-8).

(3) Wave cancellation techniques used with VOR and described in connection with figure 5-4 should be effective with TACAN radiation as well. Because of the shorter wavelengths involved, more precision will be required in the placement of the reflecting elements, and the associated support structure should be sufficiently rigid to maintain the spacing.

22.-23. RESERVED

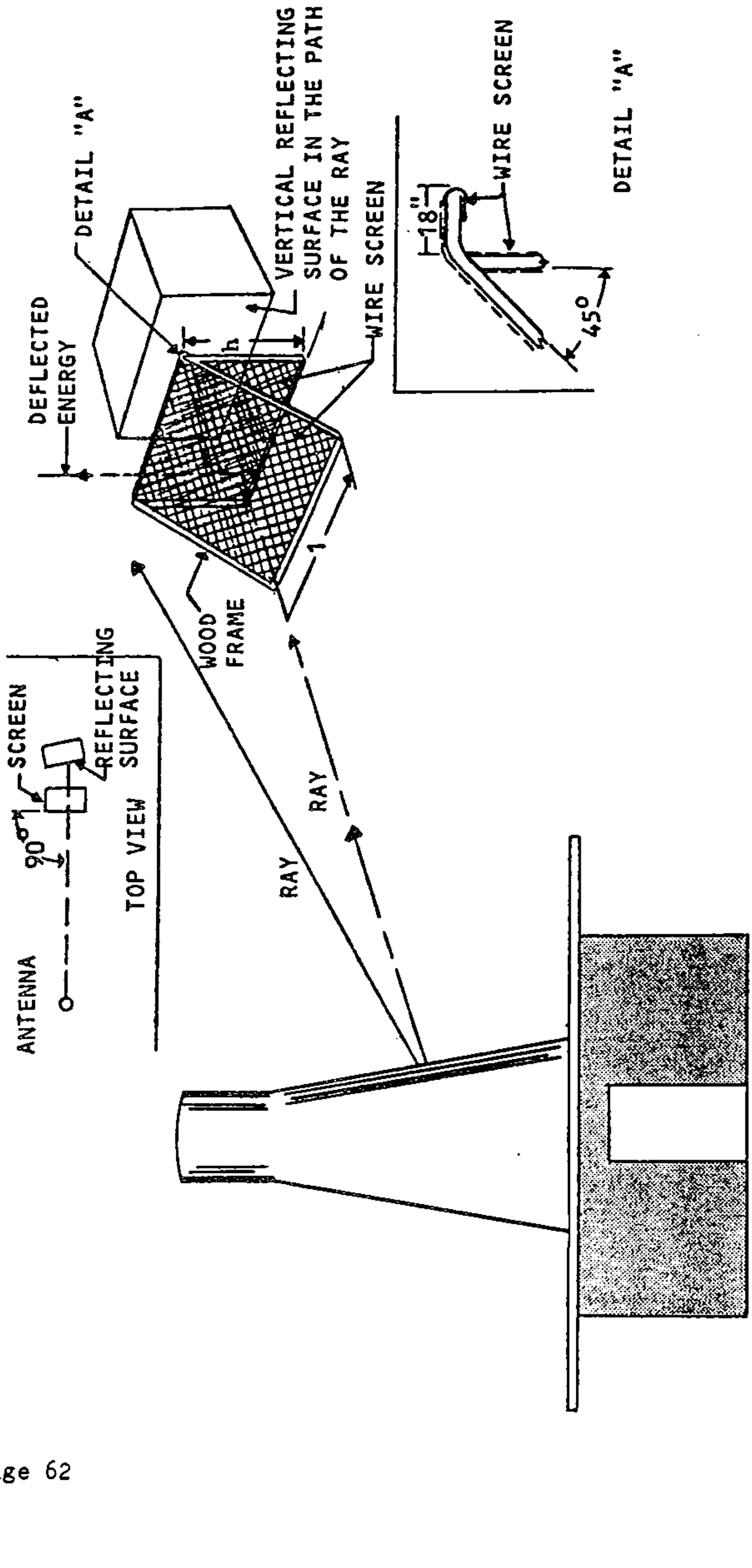


FIGURE 5-7. REFLECTIVE SCREEN CONFIGURATION (From: TACAN Principles and Siting Criteria, Greco and Reed, Naval Electronic System Test and Evaluations Facility, 1968)

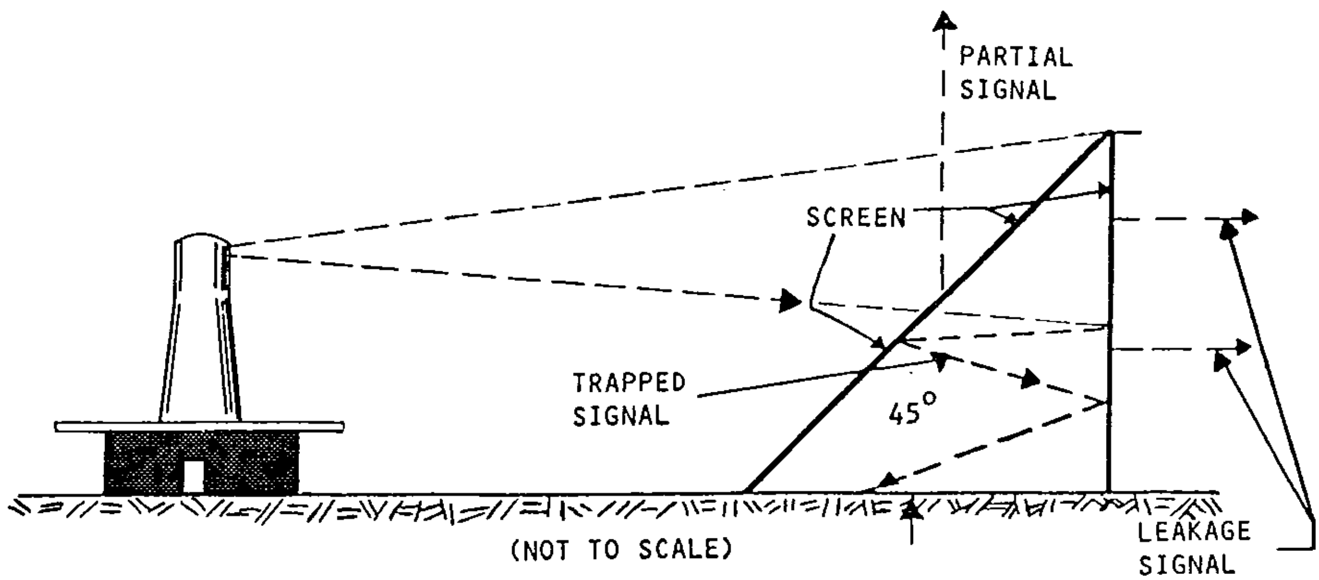


FIGURE 5-8. USE OF REFLECTIVE SCREEN (From: TACAN Principles and Siting Criteria, Greco and Reed, Naval Electronic System Test and Evaluation Facility, 1968)

CHAPTER 6. CONSIDERATIONS OF LONGITUDINAL MULTIPATH

24. GENERAL.

a. The main reason for elimination of VOR longitudinal multipath is that the VOR operation depends on the comparison of two signals, the reference and the variable phase signals, and the destructive interference of either of the two prevents proper system performance. A second reason is that horizontally polarized radiation reflects very readily, particularly at low grazing angles, thus having the capacity for producing deep nulls seriously affecting system operations.

b. The use of the counterpoise, the choice of site geography, and the growth of Fresnel zone requirements with distance all make it possible to minimize VOR longitudinal multipath at most sites.

c. By way of contrast, the longitudinal multipath associated with DME and TACAN cannot readily be eliminated but it is generally less serious in its effects than in the case of VOR. The vertically polarized radiation reflects with a considerably greater attenuation than does horizontally polarized radiation, and the pulsed nature of the modulations provides some multipath protection.

d. In summary, longitudinal multipath exists at all TACAN and DME installations, but its presence may not appreciably deteriorate performance. Hence, considerable analysis of such multipath may be of use in evaluating equipment performance. The longitudinal multipath should not cause problems in the average VOR installation, and analysis is of interest only to the extent necessary to eliminate the effect.

e. In view of the foregoing, the treatment of longitudinal multipath for DME and TACAN is detailed and complete while that for VOR is very brief. Note, however, that all of the geometric considerations discussed in connection with TACAN and DME apply as well to VOR and DVOR.

25. PROPAGATION CONSIDERATIONS IN GENERAL.

a. Propagation Components and Effects.

(1) The four components of a navaid signal radiated from a ground station and received at the airborne receiver are the direct signal, the longitudinal multipath signal, the lateral multipath signal, and the ground wave.

(2) Propagation effects due to the ground wave may be ignored since these effects are limited to the range of 1 to 10 wavelengths above the surface of the earth. Additionally, ground wave effects are of secondary importance at 100 MHz and entirely negligible at 1,000 MHz.

(3) The reflection coefficient for longitudinal multipath differs considerably for vertical polarization, as in DME and VORTAC, and horizontal polarization, as in VOR and DVOR. See figure 6-1.

(4) Radio Horizon. Distance to the radio horizon may be determined from the geometry of figure 6-2. Calculations reveal that the standard service volume as defined in paragraph 21.b is entirely within the radio horizon for VOR, DME, and VORTAC.

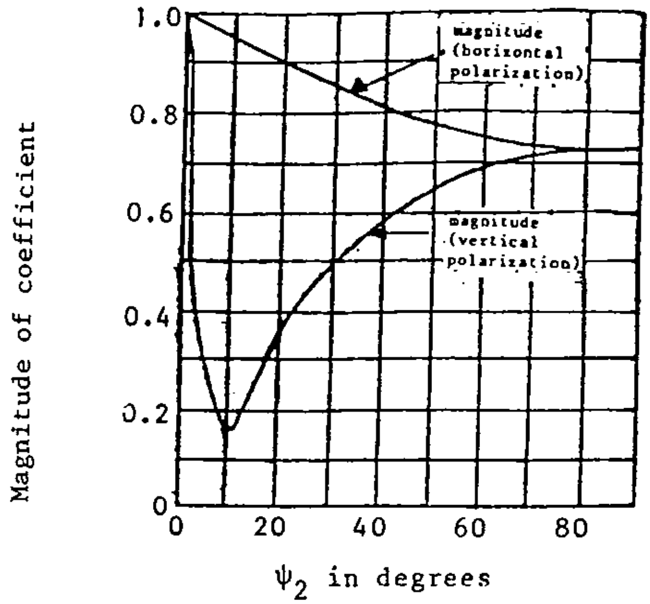
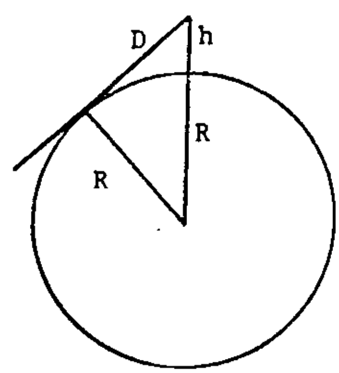


FIGURE 6-1. REFLECTION FROM A PERFECT EARTH



$$D^2 + R^2 \cong (h + R)^2$$
$$D \simeq [2Rh]^{\frac{1}{2}}$$
$$h << R$$

FIGURE 6-2. RADIO HORIZON GEOMETRY

The conventional simplified relationship for distance to the radio horizon is:

$$D = \sqrt{2h}$$

h in feet

D in statute miles

In the dimensions used in the present order and with h always in feet, this may be written as:

$$D = 1.23\sqrt{h} \cong 5/4\sqrt{h} \text{ nautical miles}$$

$$D = 2.3\sqrt{h} \text{ kilometers}$$

(5) Multipath Fading. Figure 6-3 shows the multipath fading characteristics that can result because the phase difference between direct and reflected rays varies with atmospheric conditions. The geometry of the navaid situation, with the airborne receiver much higher than the transmitter, results in the point of re-radiation being very close to the ground-based transmitter. With this geometry, the phase difference between the two rays is relatively constant, and fading is reduced in importance.

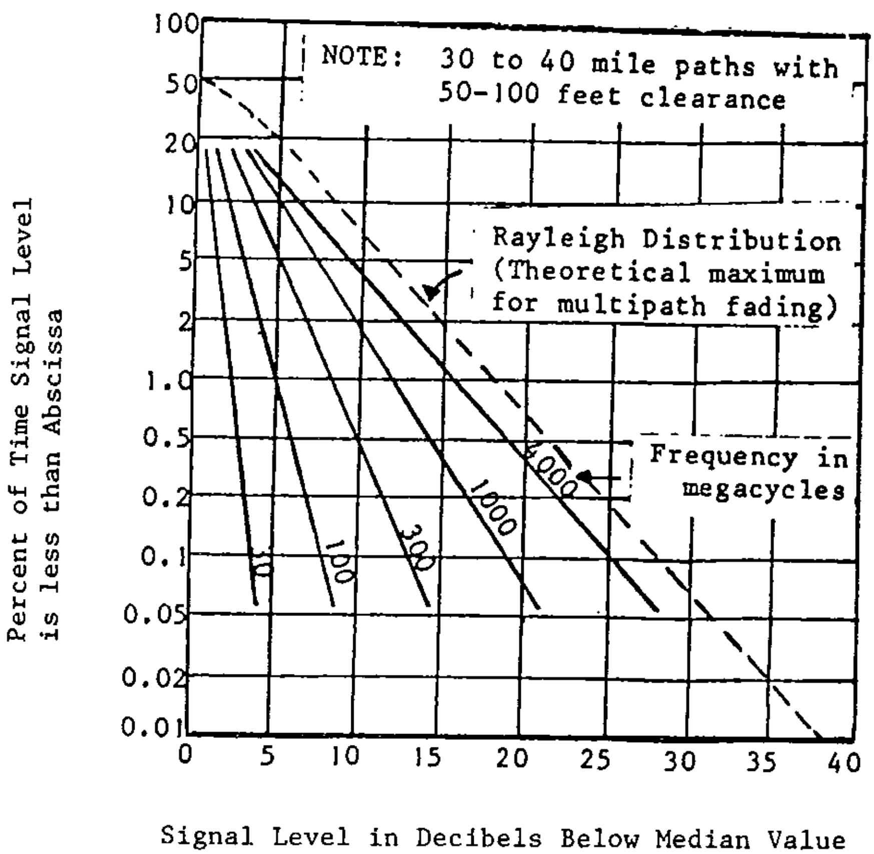


FIGURE 6-3. TYPICAL FADING CHARACTERISTICS

(6) Diffraction Due to Obstacles. The horizontal ray, in the case of low-altitude and high-altitude navaids of the types under consideration here, must provide a usable signal at 1,000 feet altitude (305 m) at a slant range of 40 nautical miles (74 km). This horizontal ray may be considered as propagating in free space only if it has substantial clearance over all obstacles. The signal loss when this ray grazes a hill (see figure 6-4) may be anywhere in the range of 2 to 20 dB, with 6 dB as a probable value.

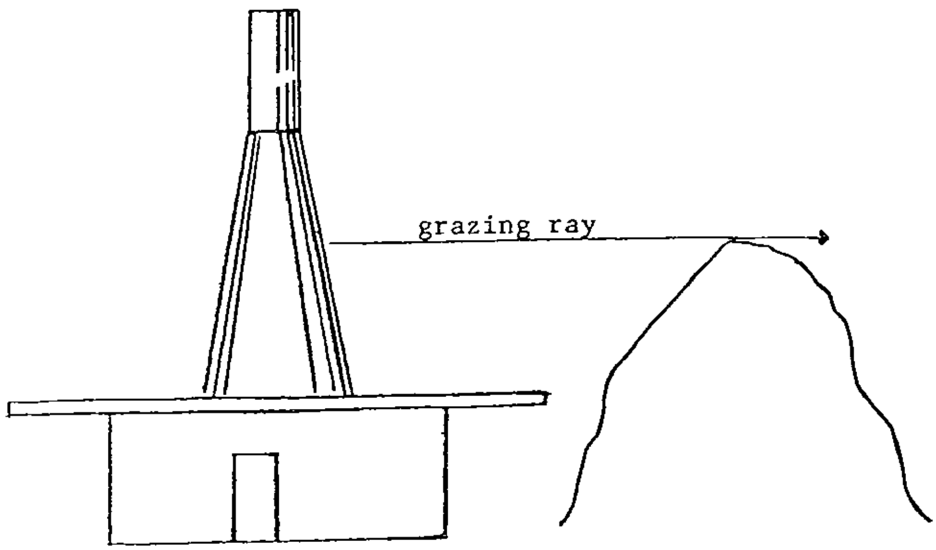


FIGURE 6-4. DIFFRACTION ACROSS A HILL

b. Standard Service Volumes[1/]

(1) Ground stations are classified according to their intended use. These stations are available for use within their service volume. Outside the service volume, reliable service may not be available. For standard use, the airspace boundaries are called standard service volumes. They are defined in table 6-1 below for the three station classes. These SSVs are graphically shown in figures 6-5 through 6-9. The SSV of a station is indicated by using the class designator as a prefix to the station type designation. (Examples: TVOR, LDME, and HVORTAC.)

1/ Text and illustrations for subsection 21.b. from: FAA Advisory Circular No. 00-31A, September 20, 1982.

TABLE 6-1. STANDARD SERVICE VOLUME DESIGNATOR

SSV Class Designator	Altitude and Range Boundaries
T (Terminal)	From 1000 feet (305 m) AGL up to and including 12,000 feet (3,658 m) AGL at radial distances out to 25 nmi (46 km). See figures 6-7 and 6-8.
L (Low Altitude)	From 1000 feet (305 m) AGL up to and including 18,000 feet (5,486 m) AGL at radial distances out to 40 nmi (74 km). See figures 6-6 and 6-9.
H (High Altitude)	From 1000 feet (305 m) AGL up to and including 14,500 feet (4,420 m) AGL at radial distances out to 40 nmi (74 km). See figures 6-5 and 6-9. From 14,500 feet (4,420 m) AGL up to and including 60,000 feet (18,288 m) at radial distances out to 100 nmi (185 km). See figures 6-5 and 6-9. From 18,000 feet (5,486 m) AGL up to and including 45,000 feet (13,716 m) at radial distances out to 130 nmi (241 km). See figures 6-5 and 6-8).

c. Considerations for Extended Coverage.

(1) Introduction. This order is concerned primarily with siting the navaid systems in order to obtain reliable service within the standard service volume. It is, however, useful to be able to determine the extended coverage performance of the various equipments for applications where extended coverage is desired and for determining interference potential between different sites. For additional material refer to FAA Advisory Circular 00-31A.

(2) Radio Line of Site for Low Elevation Angles. From figure 6-10,

$$ha \cong 6080\, r_o \left[\frac{r_o}{2R_1} + \tan\alpha\right]$$

and extending the earth radius by a factor of 4/3 to account for atmospheric diffraction:

$$ha \cong 0.662\, r_o^2 + 6080\, r_o \tan\alpha$$

for

$$\alpha \leq 6^o$$

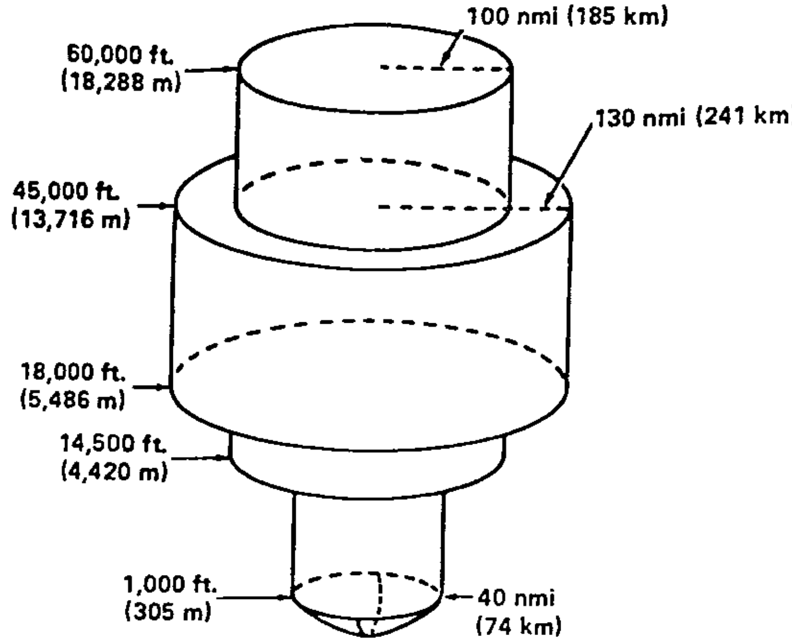


FIGURE 6-5. STANDARD HIGH ALTITUDE SERVICE VOLUME
(Refer to figure 6-9 for altitudes below 1000 feet 305 m)

NOTE 1: All elevations shown are with respect to the station's site elevation (AGL). Metric measurements are given for convenience and are approximations. These figures do not reference the area defined as the Vertical Angle Coverage Limitations (see note 2).

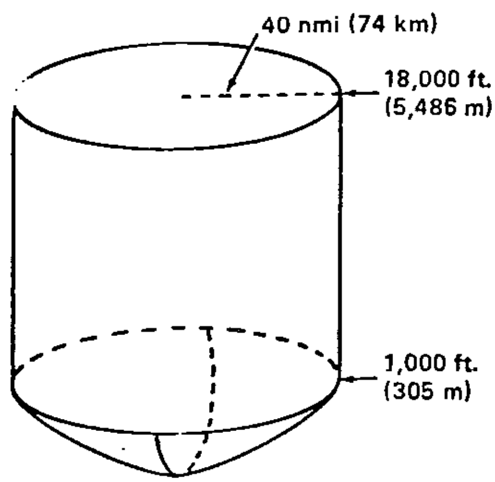


FIGURE 6-6. STANDARD LOW ALTITUDE SERVICE VOLUME
(Refer to figure 6-9 for altitude service volume)

NOTE 2: Azimuth signal information is normally provided from the radio horizon up to elevation angles of approximately 60 degrees for VOR components and 40 degrees for TACAN components. Distance information provided by TACAN and DME will provide satisfactory service from the radio horizon to an elevation angle of not less than 60 degrees.

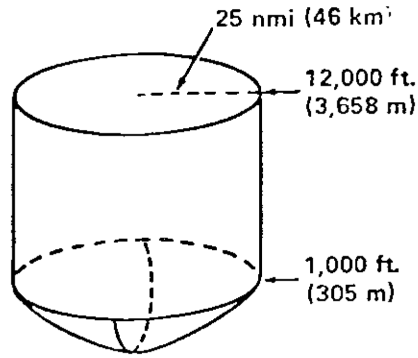


FIGURE 6-7. STANDARD TERMINAL SERVICE VOLUME (Refer to figure 6-8 for altitudes below 1000 feet 305 m)

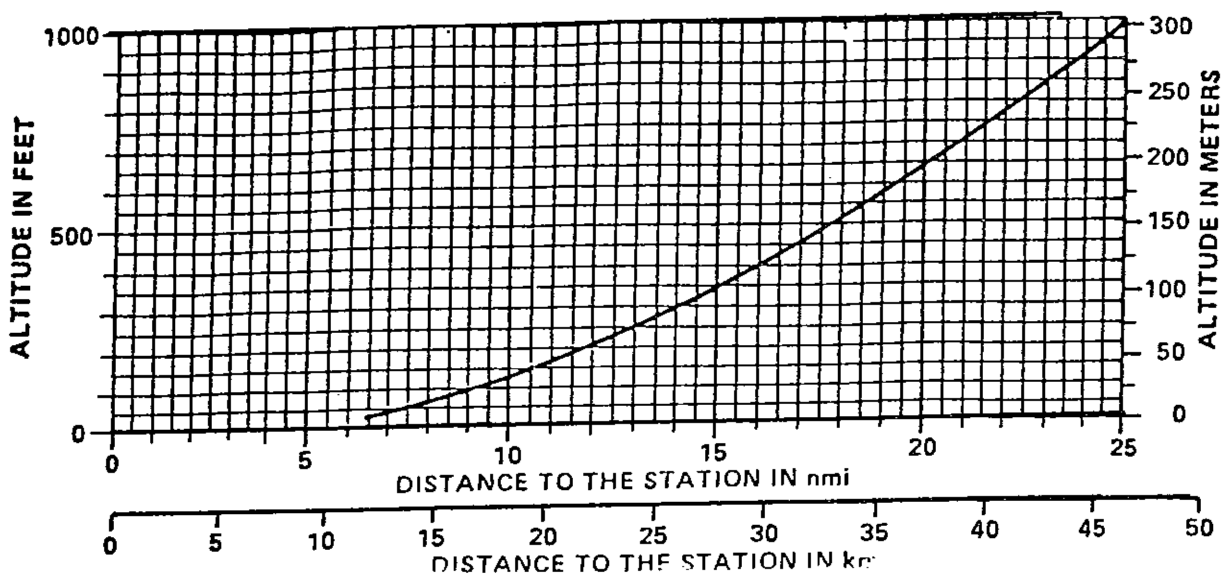


FIGURE 6-8. DEFINITION OF THE LOWER EDGE OF THE STANDARD T (TERMINAL) SERVICE VOLUME

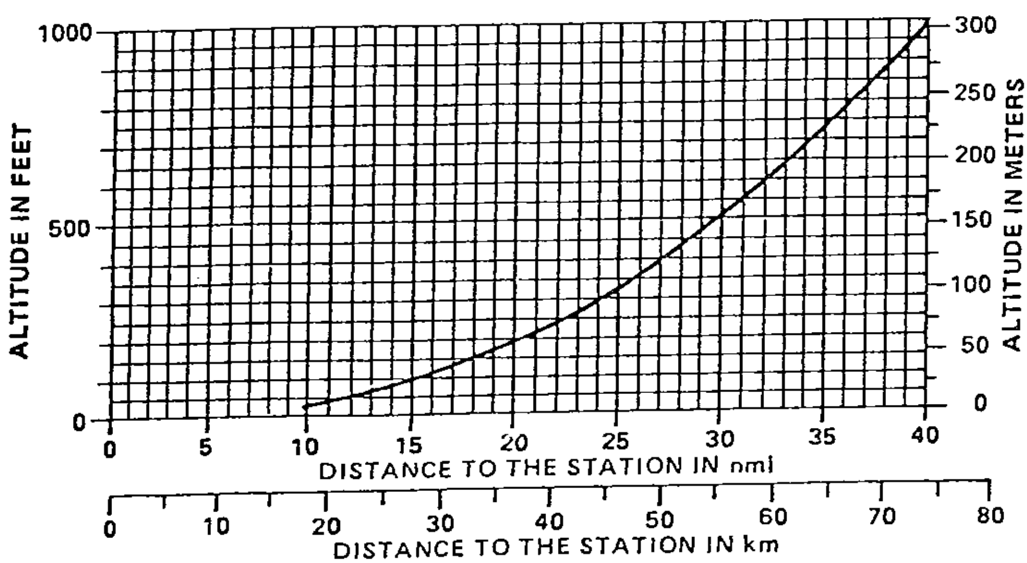
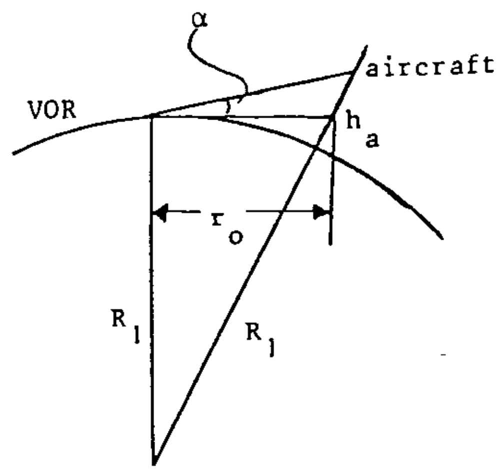


FIGURE 6-9. DEFINITION OF THE LOWER EDGE OF THE STANDARD H (HIGH) AND L (LOW) SERVICE VOLUMES



α = elevation angle in degrees

$r_o \simeq$ distance from VOR to aircraft in nm. (for small α)

h_a = height of aircraft in feet

R_1 = radius of earth (3440 nm)

FIGURE 6-10. LINE OF SIGHT RELATIONSHIPS

These results are plotted in figures 6-11 and 6-12.

(3) VOR Coverage. The VOR ground station shall provide a minimum signal power density of -120 dBW/m^2 (95 percent time availability) through the operational service volume. Assuming, as is reasonable, that the VOR transmitting system has the following power budget:

20 dBW	transmitter power
- 3 dB	cable loss
+ 2.2dBi	antenna gain
19.2dBW	effective isotropic radiated power (118 MHz)

Then the curves of coverage of VOR as shown in figures 6-13 and 6-14 are obtained.

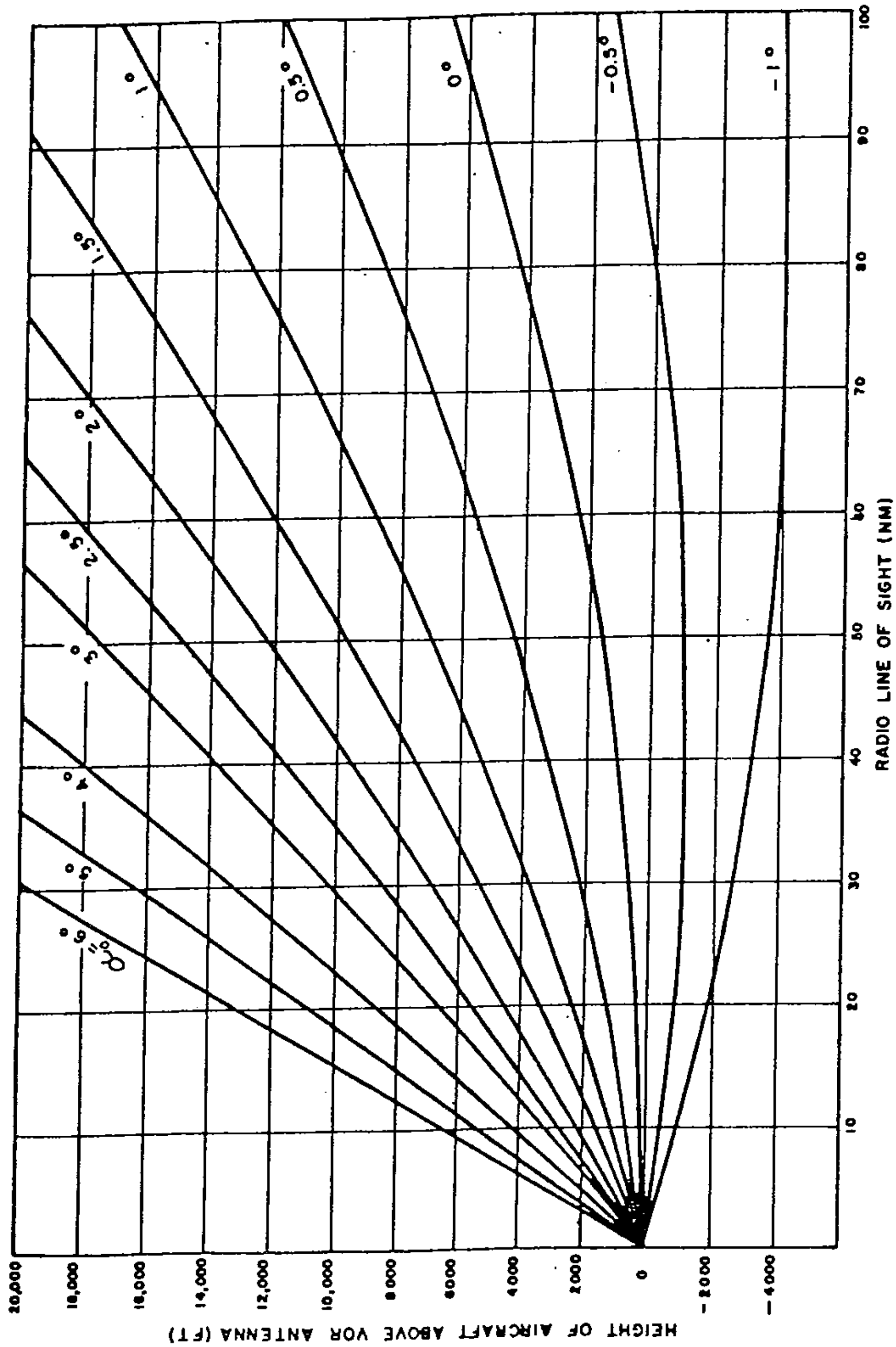


FIGURE 6-11. RADIO LINE OF SIGHT (AIRCRAFT BELOW 20K)

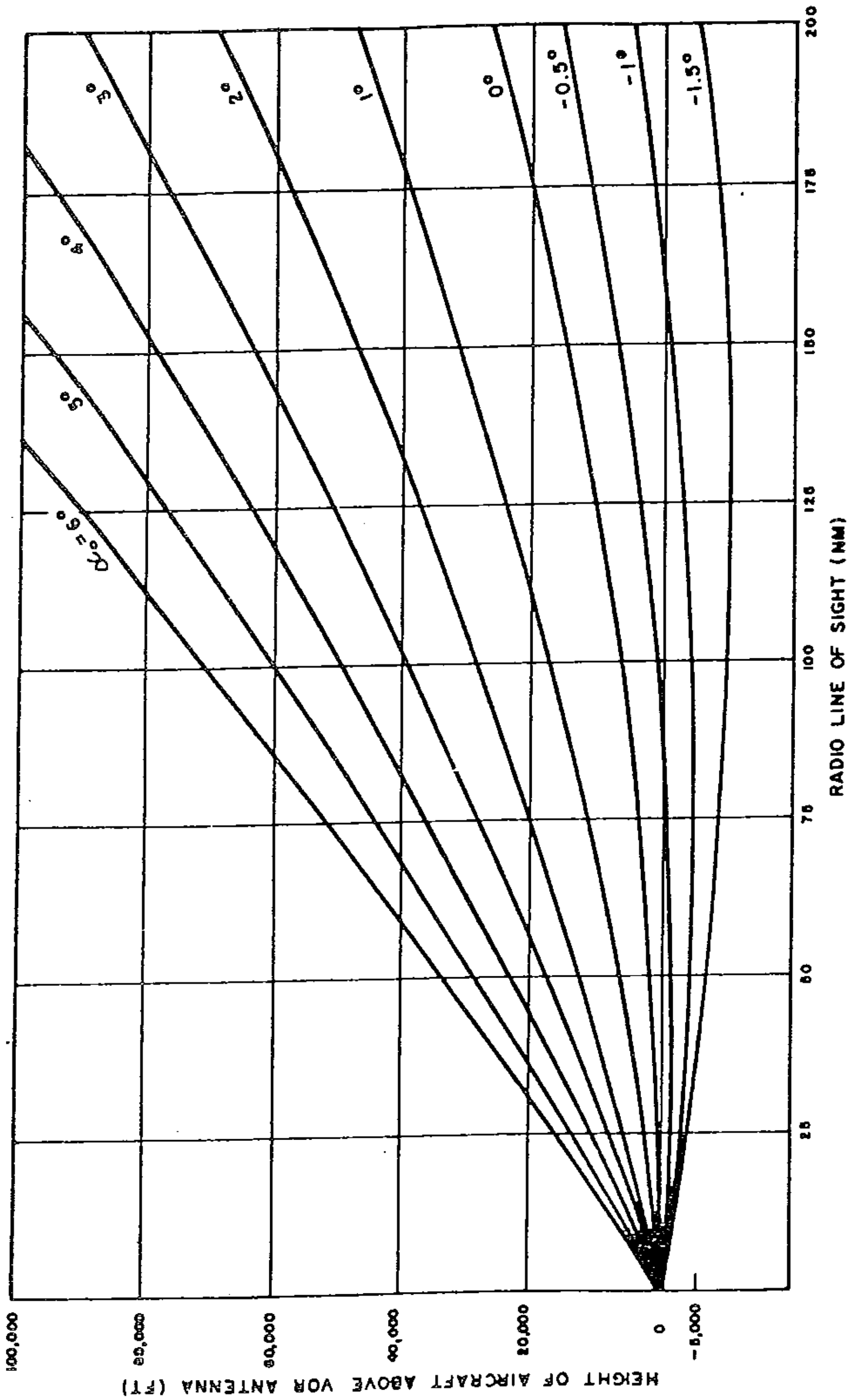


FIGURE 6-12. RADIO LINE OF SIGHT (AIRCRAFT BELOW 100K)
(From: FAA Advisory Circular No. 00-31A, September 20, 1982)

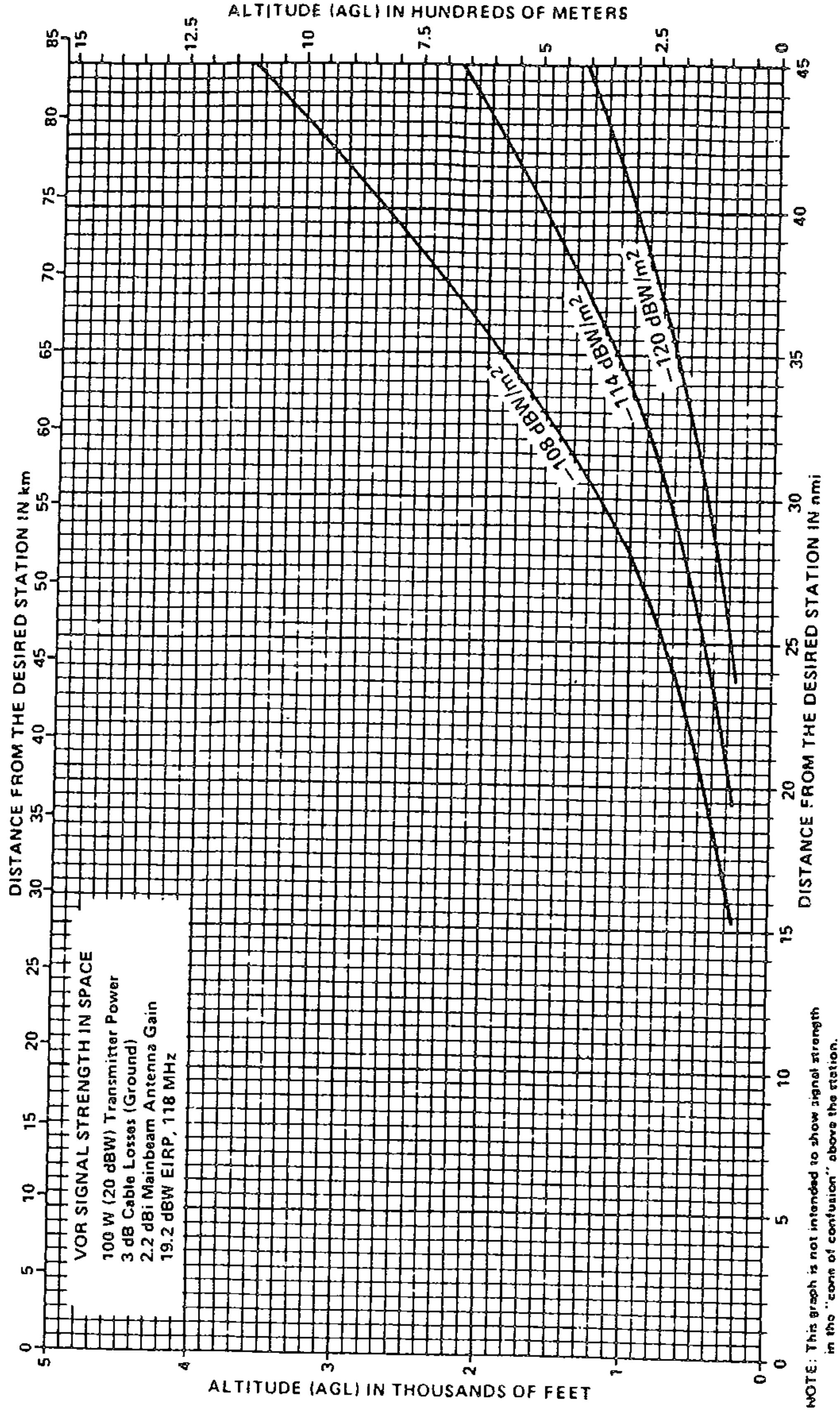


FIGURE 6-13. VOR SIGNAL STRENGTH IN SPACE - SHORT RANGE
(From: FAA Advisory Circular No. 00-31A, Appendix 1)

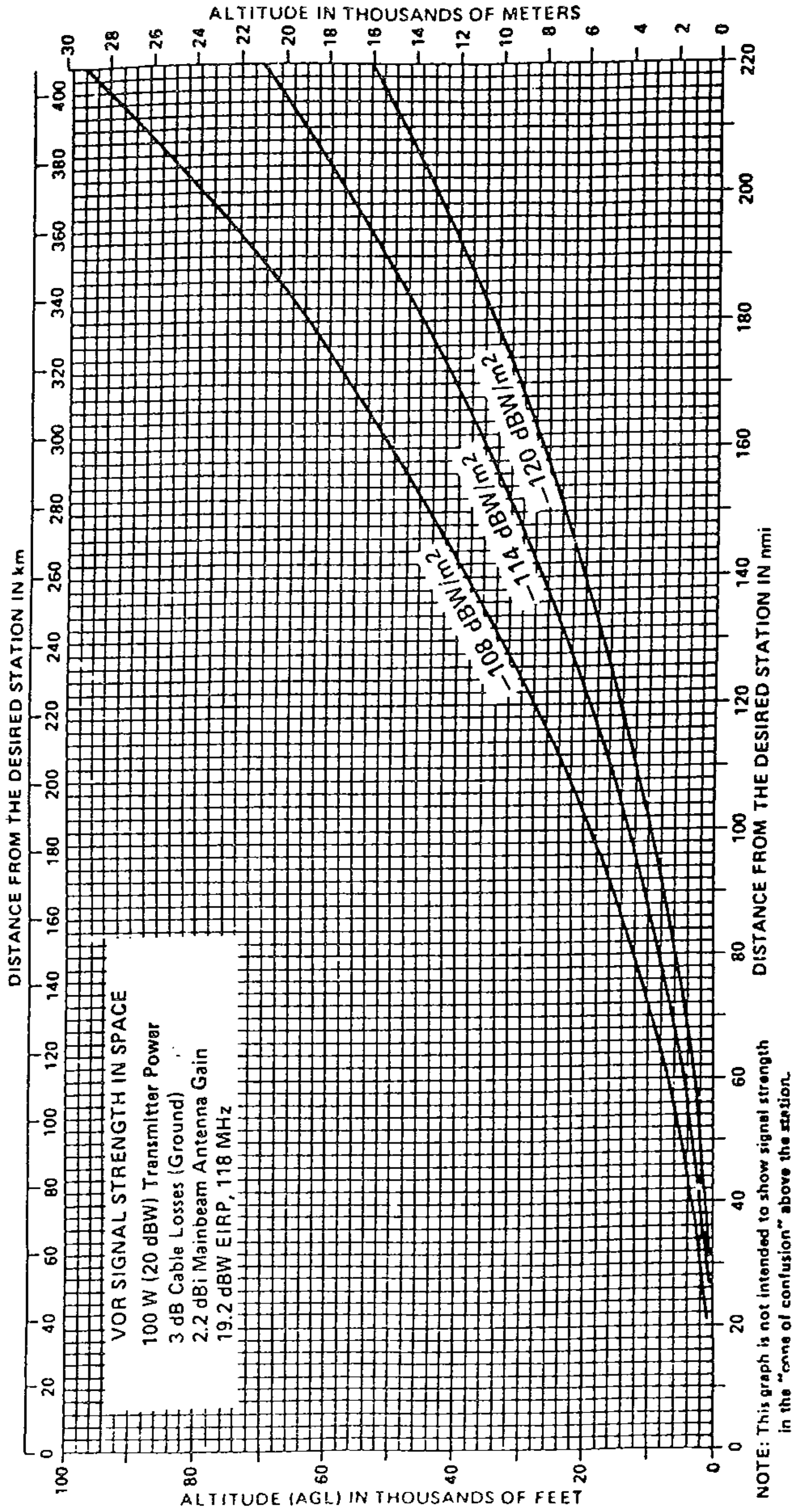


FIGURE 6-14. VOR SIGNAL STRENGTH IN SPACE - LONG RANGE
(From: FAA Advisory Circular No. 00-31A, Appendix 1)

(4) DME Coverage. The DME ground station shall provide a minimum signal power density of -91.5 dBW/m^2 (95 percent time availability) for that part of the operational service volume which is above 18,000 feet (5,486 m). Within that part of the service volume which is below 18,000 feet (5,486 m) a minimum signal power density of -86.0 dBW/m^2 shall be provided. Signal power is determined by the average over one second of the equivalent peak pulse voltage waveform. Assuming, as is reasonable, that the DME transmitting system has the following power budget:

20 dBW	transmitter power
- 1.5dB	cable loss
+11.4dBi	antenna gain
29.9dBW	effective isotropic radiated power (1213 MHz)

Then the curves of coverage of DME as shown in figures 6-15 and 6-16 are obtained.

(5) TACAN Coverage. The TACAN shall provide the same signal coverage as already described for the DME. A reasonable power budget for the TACAN is:

37 dBW	transmitter power
- 1.5dB	cable loss
+ 7.4dBi	antenna gain
42.9dBW	effective isotropic radiated power (1213 MHz)

Then the curves of coverage of DME as shown in figures 6-17 and 6-18 are obtained.

(6) For an additional discussion of coverage see FAA Advisory Circular 00-31A.

26. LONGITUDINAL MULTIPATH FOR VOR.

a. Overview.

(1) An objective in the siting of VOR and DVOR equipments is to completely eliminate any substantial instrumental errors due to longitudinal multipath. It is in furtherance of this objective that the large counterpoise is a feature of every VOR and DVOR installation.

(2) In those situations where longitudinal multipath adversely affects system performance, its effects shall be minimized or, if possible, eliminated by refinements of the engineering of the counterpoise and the characteristics of the ground in the vicinity of the counterpoise. See chapter 5.

(3) In situations where costs or other constraints prevent the minimization of longitudinal multipath to permit equipment performance within standard service volumes and tolerances, appropriate steps shall be taken to inform the flying public of that portion of the standard service volume for which the system is not operational within specifications.

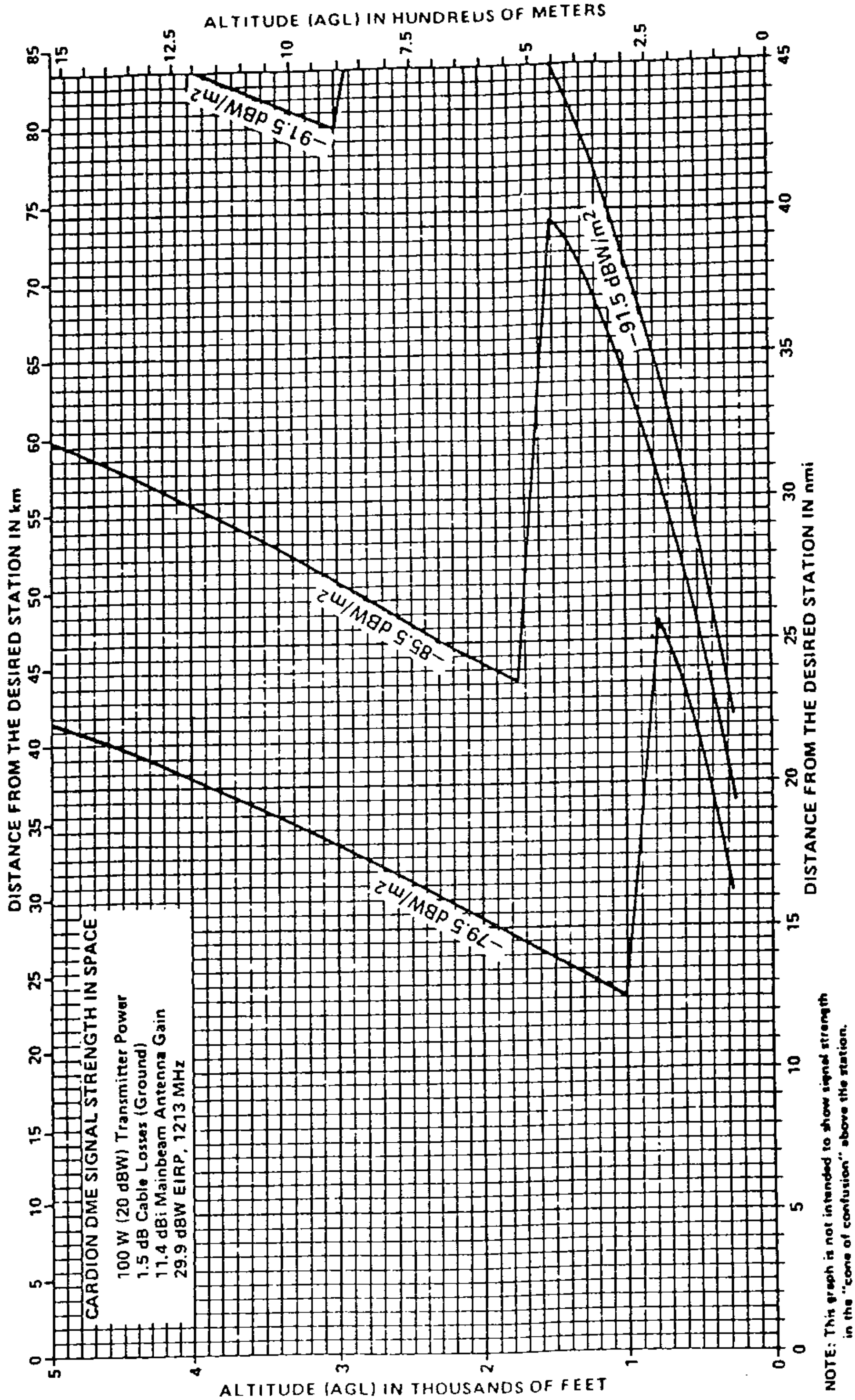


FIGURE 6-15. CARDION DME SIGNAL STRENGTH IN SPACE - SHORT RANGE
(From: FAA Advisory Circular No. 00-31A, Appendix 1)

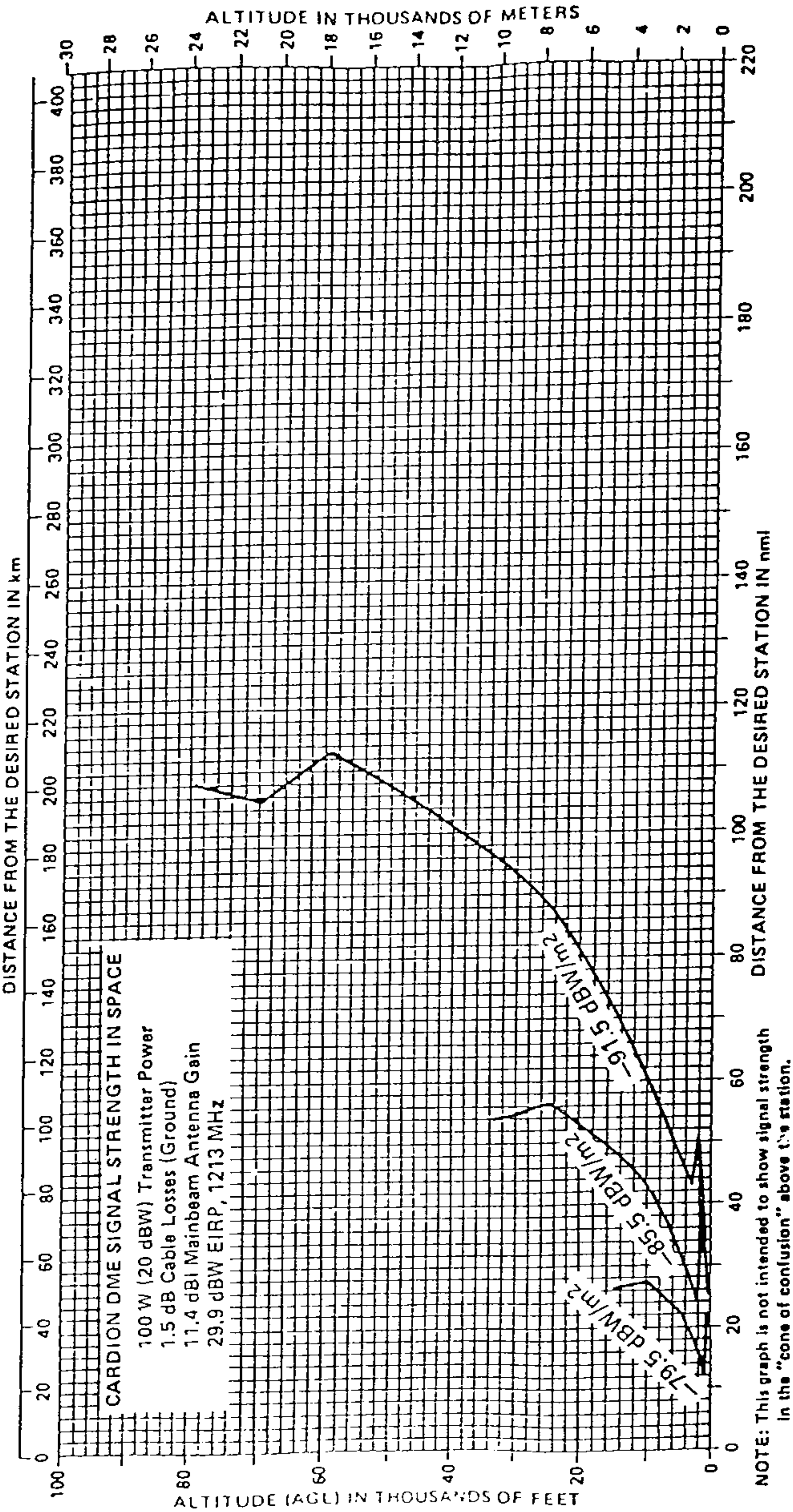


FIGURE 6-16. CARDION DME SIGNAL STRENGTH IN SPACE - LONG RANGE
(From: FAA Advisory Circular No. 00-31A, Appendix 1)

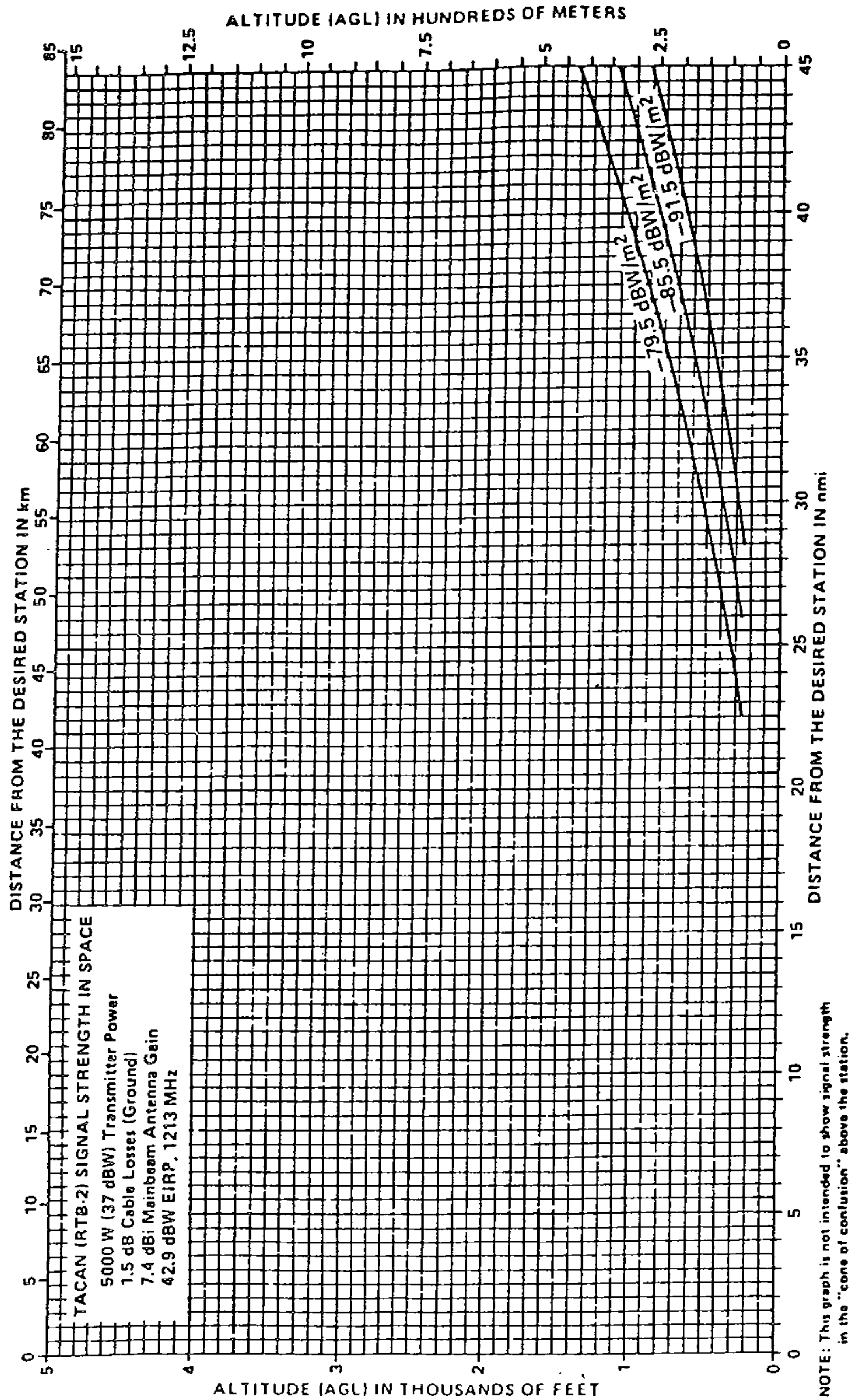


FIGURE 6-17. TACAN (RTB-2) SIGNAL STRENGH IN SPACE - SHORT RANGE
(From: FAA Advisory Circular No. 00-31A, Appendix 1)

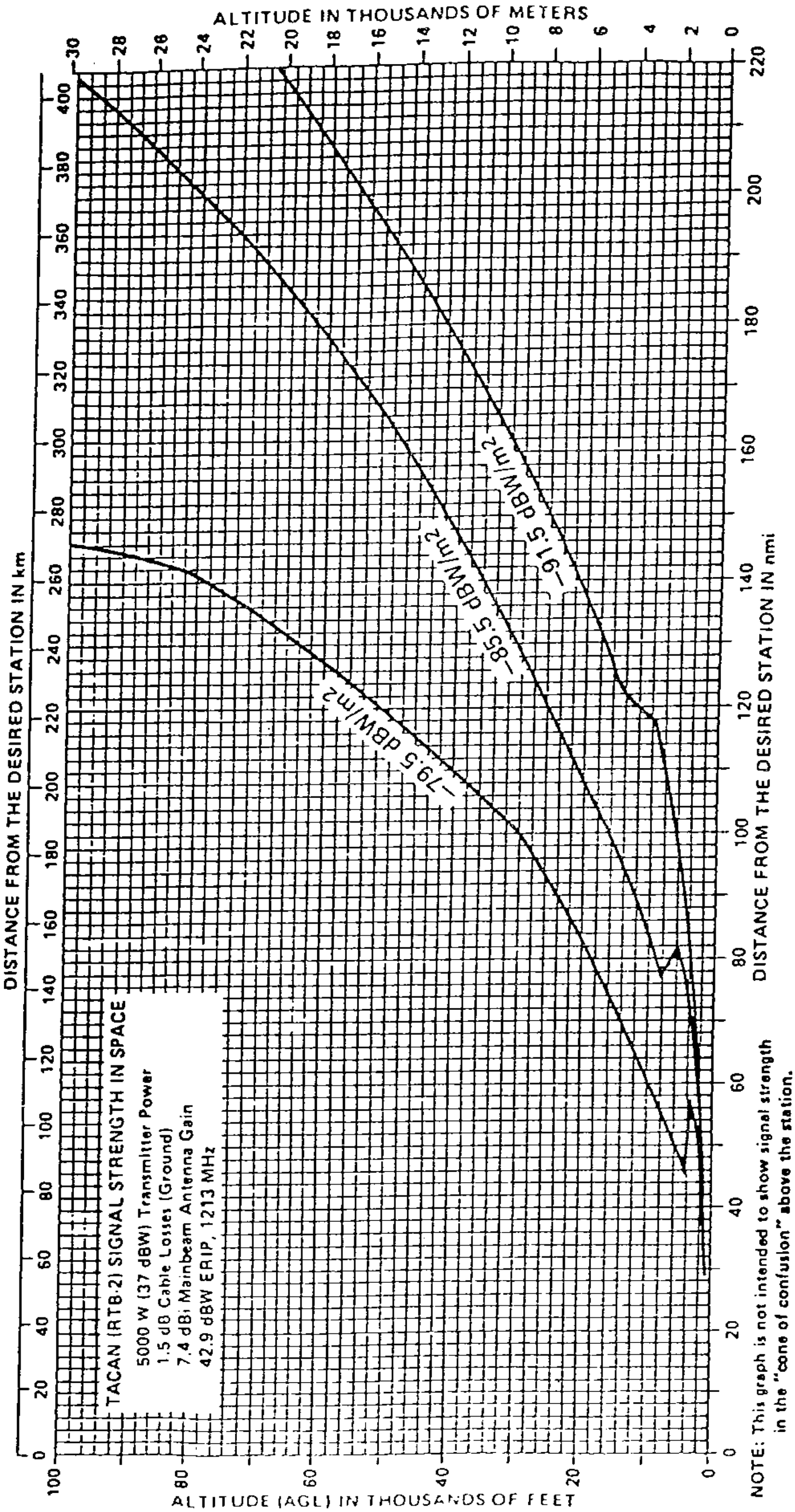


FIGURE 6-18. TACAN (RTB-2) SIGNAL STRENGTH IN SPACE - LONG RANGE
(From Advisory Circular No. 00-31A, Appendix 1)

b. The Effect of Reflecting Surfaces.

(1) The function given in paragraph 5.b.(1) represents the vertical radiation pattern of the VOR in the presence of a perfectly conducting ground.

(2) For the usual height of the VOR radiating loops of 15 feet and at the VOR wavelength of approximately 8 feet, this pattern produced by the source and reflected source has a first null at about 15 degrees.

(3) The depth and severity of the 15-degree null is a function of the ground conductivity, roughness, and slope over the Fresnel zone illuminated by the 15-degree ray. Generally, these physical imperfections, as contrasted with a smooth, perfectly reflecting ground, tend to fill in the null that is predicted by theory.

(4) Considering the 4-foot height of the VOR antenna above the counterpoise and the counterpoise as a reflector yields a radiation pattern null at about 60 degrees. This is at the limit of the standard service volume of the VOR.

(5) Operationally, the equipment performance at angles below about 10 degrees is the most important. The conventional counterpoise provides little protection for angles below about 8 degrees (see figure 2-8). Additionally, the ground is a good reflector for horizontal polarization and low grazing angles at VOR frequencies.

c. Uses of the Fresnel Zone Size.

(1) The VOR is susceptible to the effects of longitudinal multipath primarily in the region of grazing angles below 8 degrees. The principle natural protection of the equipment in this angular region is the size of the Fresnel zone required to support the reflection.

(2) Figure 3-3 demonstrates that the farther the area of reflection can be removed from the VOR site, the larger the Fresnel zone required to sustain the reflections. Hence, it is desirable to select geography sufficiently irregular to place the reflection point at a distance of perhaps a mile or more.

(3) Smooth valley floors around high mesa sites, as may occur in western states, can be expected to provide the required large-area Fresnel zones for grazing angle multipath. The height-gain of such sites, however, affords the possibility for use of a larger-than-conventional counterpoise with no loss in distant coverage.

(4) Ocean surfaces, by their regularity, can provide the large-area Fresnel zones for grazing angle multipath. The single degree of freedom available at locations experiencing such problems is the variation of the height of the radiating antennas. Counterpoises have been used at ground level at such locations.

d. VOR Versus DVOR for Longitudinal Multipath.

(1) The performance of both VOR and DVOR depends upon the near simultaneous arrival at the aircraft receiver of both the reference-phase and the variable-phase signals. The elimination of either of these signals by destructive longitudinal multipath adversely affects performance.

(2) In VOR, the variable-phase signal is relatively vulnerable to the effect of longitudinal multipath, whereas the reference-phase signal, because of the characteristics of fm, is relatively resistant. In DVOR, exactly the reverse is true. It follows that there is no inherent advantage to one over the other in combatting longitudinal multipath, although, in some situations, second-order effects may favor one over the other.

(3) The discussion is summarized in table 6-2 below.

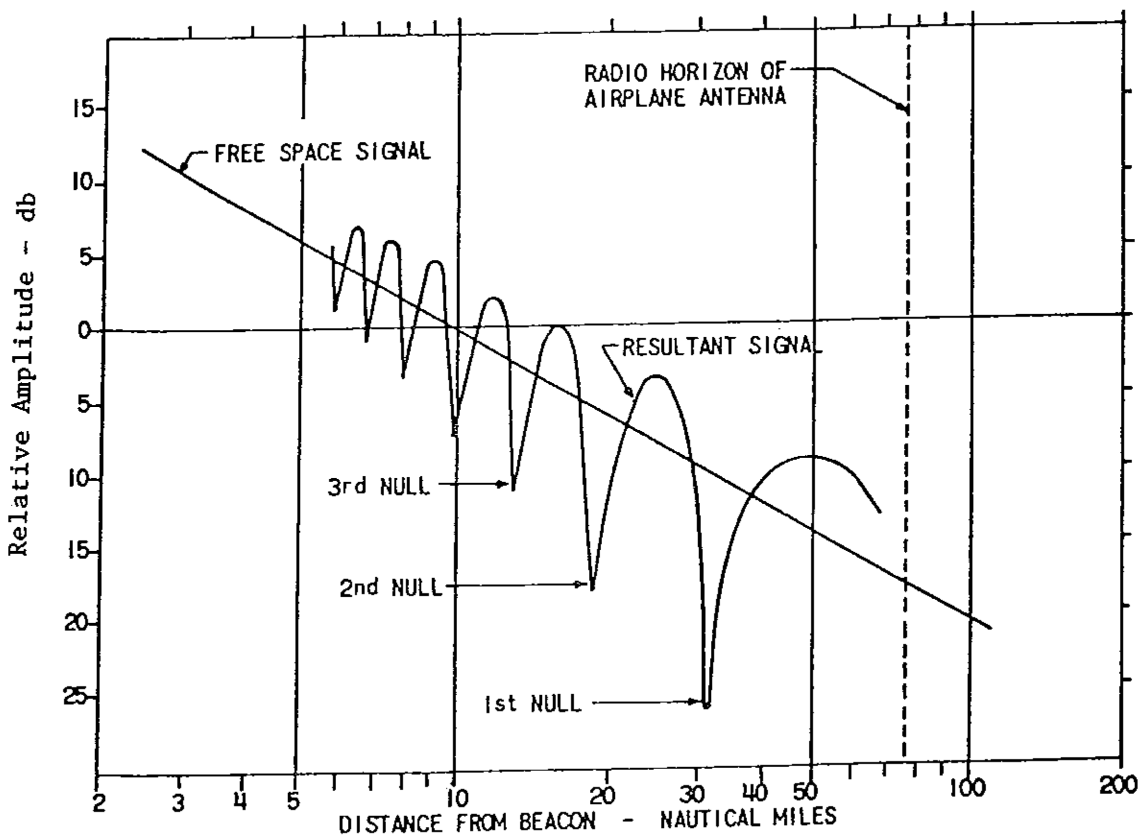
TABLE 6-2. ELIMINATION OF VOR LONGITUDINAL MULTIPATH

Parameter	Comment
Overall Objective	Reduce or eliminate effects of longitudinal multipath
Angular Area of Concern	Operationally, the region of vertical angle of 0 degree to 10 degrees is of most concern; particularly because the effect of the counterpoise is diminished in the 0-degree to 8-degrees region
Effect of Ground	Excellent reflector for low grazing angle VOR radiation
Effect of Fresnel Zone Size	Large Fresnel zone size makes coherent reflection more difficult. Hence, move reflection area as far from site as possible
VOR Versus DVOR	No intrinsic merits of one over the other for longitudinal multipath

27. LONGITUDINAL MULTIPATH FOR TACAN.

a. Calculation of the Basic Parameters.

(1) In an aircraft flying at a constant altitude toward a ground-based VORTAC beacon, the airborne antenna intercepts field strengths which go through a series of maxima and minima as shown in figure 6-19. The lobe formation, in a given geometry, is dependent upon the frequency of the transmitted signal and the characteristics of the reflecting ground or water. Since satisfactory operation of TACAN equipment is dependent upon the strength of the arriving signal, it is desirable to prevent the specular reflection which causes the lobe structure.



1. Frequency: 1000 Mc.
2. Antenna height above ground: 40 feet
3. Antenna type: AN/GRA-60
4. Aircraft altitude: 3000 feet
5. Terrain: smooth average land with no obstructions; conductivity (σ) of 0.03 mho-m/sq m; and a relative permittivity (ϵ_r) of 15.

FIGURE 6-19. RADIATION PATTERN OF A TWO-PATH INTERFERENCE PHENOMENA

(2) Since the formation of nulls is primarily a geometric problem, their locations may be calculated without regard to the specific antenna to be used. Refer to figure 6-20. A ray leaving the transmitting antenna at height h_1 will strike the ground at a grazing angle Ψ and

$$\tan \Psi \cong \frac{h_1}{6080d_1} - \frac{d_1}{9120k}$$

at a distance d_1, from the transmitting antenna measured along the earth's surface. These parameters are related by:

$$d_1 \cong -3445k \tan \Psi + \left[(3445 \tan \Psi)^2 + 1.14\ k\ h_1\right]^{1/2} \text{ (nautical miles)}$$

The height above terrain, h_2, of a receiving antenna which will intercept this reflected ray is given by:

$$h_2 = ka \frac{1 - \cos d_2/ka + \sin d_2/ka_1 \tan \psi}{\cos d_2/ka - \sin d_2/ka \tan \psi} \times 6080 \text{ (feet)}$$

(3) The factor k used in the foregoing equations to compensate for atmospheric refraction is given by

$$k = \frac{1}{1 + \frac{a\Delta N}{n(10)^6}}$$

where n is the refractive index and ΔN is the change in refractivity of the atmosphere between the earth's surface and a height of one thousand feet or 0.308 kilometer above the surface. Note that the dimension of a and ΔN must agree. It is sufficient for purposes of this order to consider only three values of k. The value at the location of interest should be calculated, as will be explained, and then for purposes of referring to charts, the standard value nearest to the calculated value should be added. The refractivity,ΔN, is given by

$$N = N_o e^{-0.0322h_s} + \Delta N(h-h_s)$$

where:

h_s = height of the earth's surface above mean sea level in thousands of feet

h = height above earth's surface in thousands of feet

alternatively

$$N = N_o e^{0.10577h_s} + \Delta N(h-h_s)$$

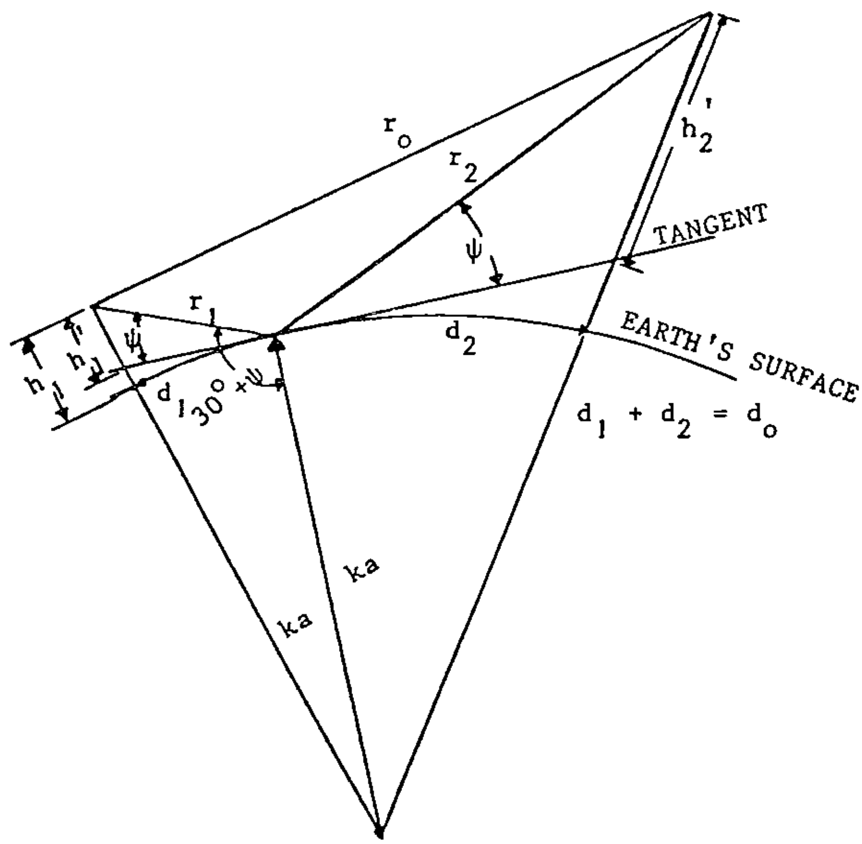


FIGURE 6-20. TWO-PATH PROPAGATION GEOMETRY

where:

d_1 = distance from the transmitting antenna to the earth reflecting point in nmi as measured along the earth surface.

h_1 = transmitting antenna height in feet.

a = earth radius, 3445 nmi.

when h_s is measured in kilometers. Note that the second term on the right above must also be in the appropriate metric units.

From the above equation both N_s, the refractivity at the earth's surface and ΔN can be calculated, since, using English units,

$$N_s = N_o \, e^{-0.0322 h_s}$$

and

$$\Delta N = N_1 - N_s$$

where N_1 = refractivity at 1,000 feet. The value of n is $N_s(10)^{-6}$. The three values of k which are adopted as standard are:

N_s	ΔN (metric)	k
200	-22.33	1.166
301	-39.23	1.333
400	-68.13	1.766

The maps of figures 6-21 and 6-22 may be consulted for the values of N_o for the geographic area of interest.

(4) Divergence factor is defined as the ratio of the field strength obtained after reflection from a spherical surface to that obtained after reflection from a plane surface, where the radiated power, total axial distance, and type of reflecting surface are the same in both cases, and the solid angle is a small elemental angle approaching zero in magnitude. The divergence factor for any grazing angle Ψ is given by

$$D = \frac{1}{\left[1 + \dfrac{2r_1 r_2}{ka d_o \tan\Psi}\right]^{\frac{1}{2}}} = \left[\frac{ka d_o \tan\Psi}{ka d_o \tan\Psi + 2r_1 r_2}\right]^{\frac{1}{2}}$$

where:

$$r_1 = \frac{(ka + h_1)\sin d_1/ka}{\cos\Psi}$$

and

$$r_2 = \frac{(ka + h_2)\cos d_2/ka - ka}{\sin\Psi}$$

$$d_o = d_1 + d_2$$

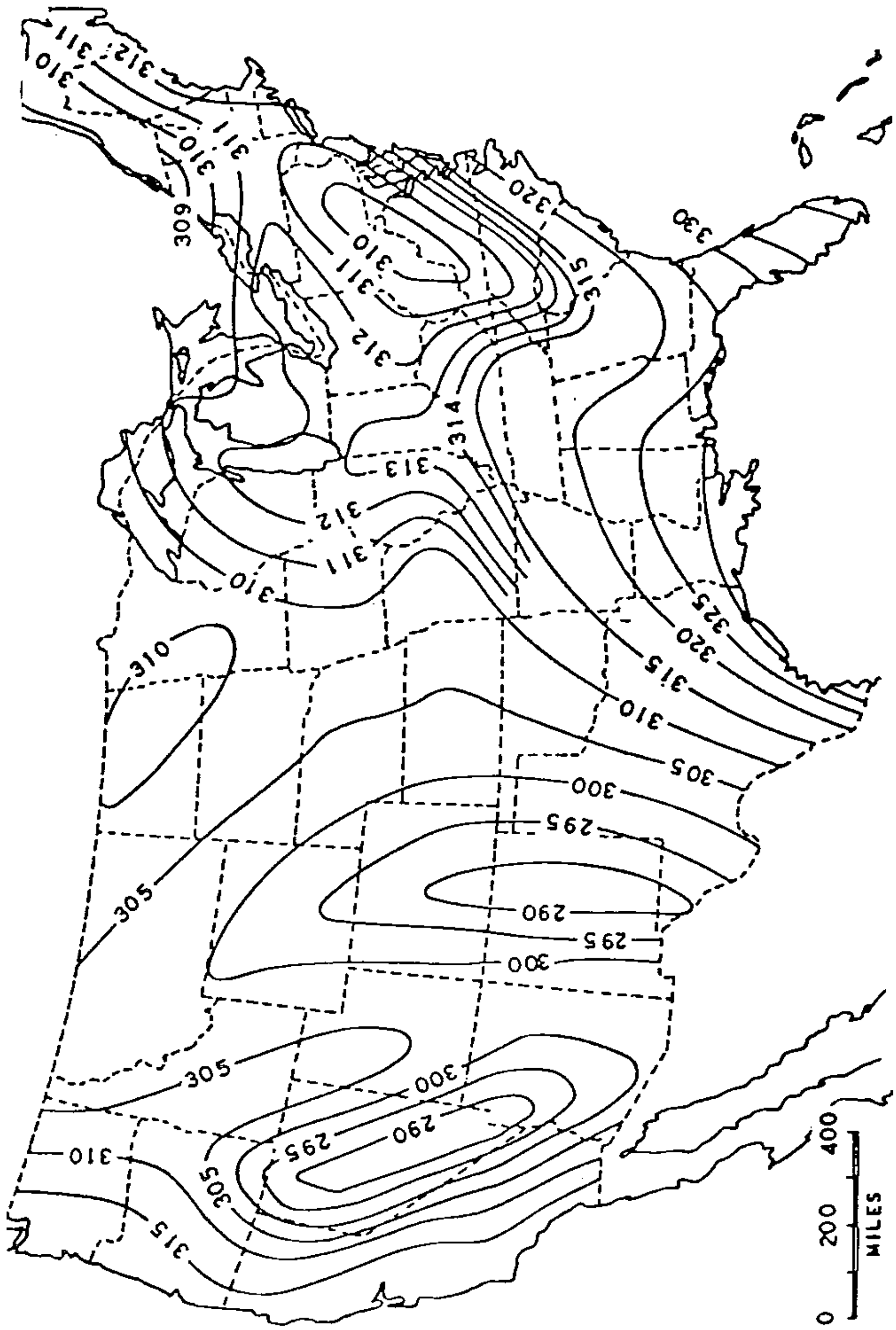


FIGURE 6-21. CONTOURS OF SURFACE REFRACTIVITY REDUCED-TO-SEA-LEVEL VALUES (N_o) FOR THE UNITED STATES

MINIMUM MONTHLY SURFACE REFRACTIVITY VALUES REFERRED TO MEAN SEA LEVEL

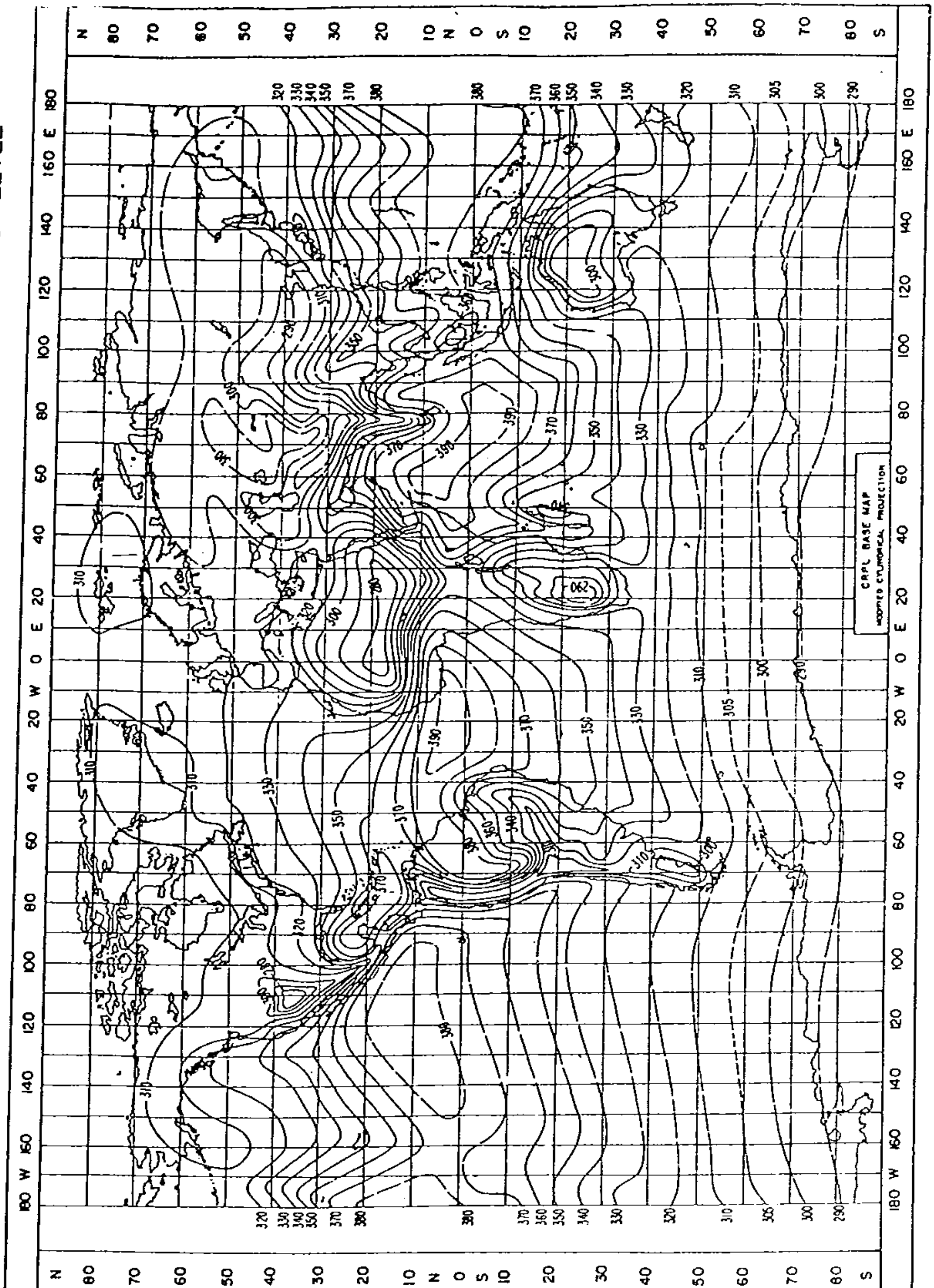


FIGURE 6-22. CONTOURS OF SURFACE REFRACTIVITY REDUCED-TO-SEA-LEVEL VALUES (N_o) FOR THE WORLD

Note that d_2 may be obtained in the same manner as d_1 except that h_2 is used as the height in the equation. For reference purposes, note the following:

$$h_1 = h_1 - 0.88{d_1}^2/k \quad h_2 = h_2 - 0.88{d_2}^2/k$$

where h_1 and h_2 are in feet and d_1 and d_2 are in nautical miles.

(5) TACAN antennas use vertical polarization, and the reflection coefficient for vertically polarized waves is given by

$$R_v e^{j\phi v} = \frac{\bar{n}^2 \sin\psi - \sqrt{n^2 - \cos^2 \psi}}{n^2 \sin\psi + \sqrt{n^2 - \cos^2 \psi}}$$

where n^2 is a complex permittivity coefficient and is given by

$$n^2 = {}_r - j\,\frac{18000\sigma}{f_{MHz}} = {}_r - jx$$

where

er is the relative permittivity of the earth at the reflecting Fresnel zone,

σ is the conductivity of the reflecting earth in mho-m/sq m,

f_{MHz} is the carrier frequency in megahertz.

For adaptation to the computer operation, these relationships may be expressed in the following form:

$$R_v = \left[\frac{({\varepsilon_r}^2+x^2)\sin^2\psi+m(\varepsilon_r-\cos^2\psi)-\sqrt{2}\sin\psi\sqrt{\varepsilon_r-\cos^2\psi}\left[\varepsilon_r\sqrt{m+1}+x\sqrt{m-1}\right]}{({\varepsilon_r}^2+x^2)\sin^2\psi+m(\varepsilon_r-\cos^2\psi)+\sqrt{2}\sin\psi\sqrt{\varepsilon_r-\cos^2\psi}\left[\varepsilon_r\sqrt{m+1}+x\sqrt{m-1}\right]}\right]^{\frac{1}{2}}$$

$$\text{where } m = \sqrt{1 + \frac{x^2}{(\varepsilon_r-\cos^2\psi)^2}}$$

$$\phi_v = \tan^{-1}\frac{\sqrt{2}\sin\psi\sqrt{\varepsilon_r-\cos^2\psi}\left[\varepsilon_r\sqrt{m-1}-x\sqrt{m+1}\right]}{({\varepsilon_r}^2+x^2)\sin^2\psi-m(\varepsilon_r-\cos^2\psi)}$$

where $(-90\leqslant\phi<0^\circ)$

$$\phi_v = 180^\circ+\tan^{-1}\frac{\sqrt{2}\sin\psi\sqrt{\varepsilon_r-\cos^2\psi}\left[\varepsilon_r\sqrt{m-1}-x\sqrt{m+1}\right]}{({\varepsilon_r}^2+x^2)\sin^2\psi-m(\varepsilon_r-\cos^2\psi)}$$

where $(-180\leqslant\phi\leqslant-90^\circ)$

The curves of figures 6-23 through 6-29 show the variation of R and d for a number of ground conditions at 1000 MHz. These curves may be used with negligible error at all TACAN frequencies.

(6) The path-length difference, Θ, in degrees is given by:

$$\theta = \frac{\Delta r}{\lambda} \times 360^{\circ} = \frac{\Delta r x f_{MHz}}{2.733} \text{ degrees}$$

where λ is the wavelength

Δr is the path-length difference, and

$\Delta r = r_1 + r_2 - r_o$ (see figure 6-20)

The direct ray path length, r_o, between transmitter and receiver is

$$r_o = \left[r_1^{\,2} + r_2^{\,2} - 2r_1r_2 \cos (180^{\circ} - 2\Psi)\right]^{\frac{1}{2}}$$

$$= \left[r_1^{\,2} + r_2^{\,2} + 2r_1r_2 \cos 2\Psi)\right]^{\frac{1}{2}}$$

(7) The magnitude of the direct ray will be given as E_o, and the magnitude of the reflected ray by DRE_o. This discussion assumes that, for direct and reflected signal magnitudes, the direct and reflected path lengths are the same. This assumption produces negligible error. The total phase difference between the direct and reflected rays is given by $\Theta - \phi$, but since the angle ϕ is inherently negative, these angles in effect are additive. The vector sum of the two components is shown in figure 6-30 for the two conditions, (a) where $(\Theta - \phi)$ is less than 90° and (b) where $(\Theta - \phi)$ is greater than 90°. The resultant field is given by

$$E_d = E_o \left[1 + DR^2 + 2DR \cos (\Theta - \phi)\right]^{\frac{1}{2}}$$

The ratio of the magnitude of the field in an earth environment to the magnitude of the free-space field (E_d/E_o) is designated $g(\theta)$ and is called the earth-gain factor or

$$g(\Theta) = \frac{E_d}{E_o} = \left[1 + DR^2 + 2DR \cos (\Theta - \phi)\right]^{\frac{1}{2}}$$

where D is the divergence factor and R is the absolute value of the reflection coefficient.

The earth, with its many types of land and water surface conditions and, hence, many conductivity and permittivity factors, and the type of wave polarization, cause the earth-gain function to vary from a small value (nearly zero) to a value slightly less than 2.0. With vertical polarization, such as the TACAN

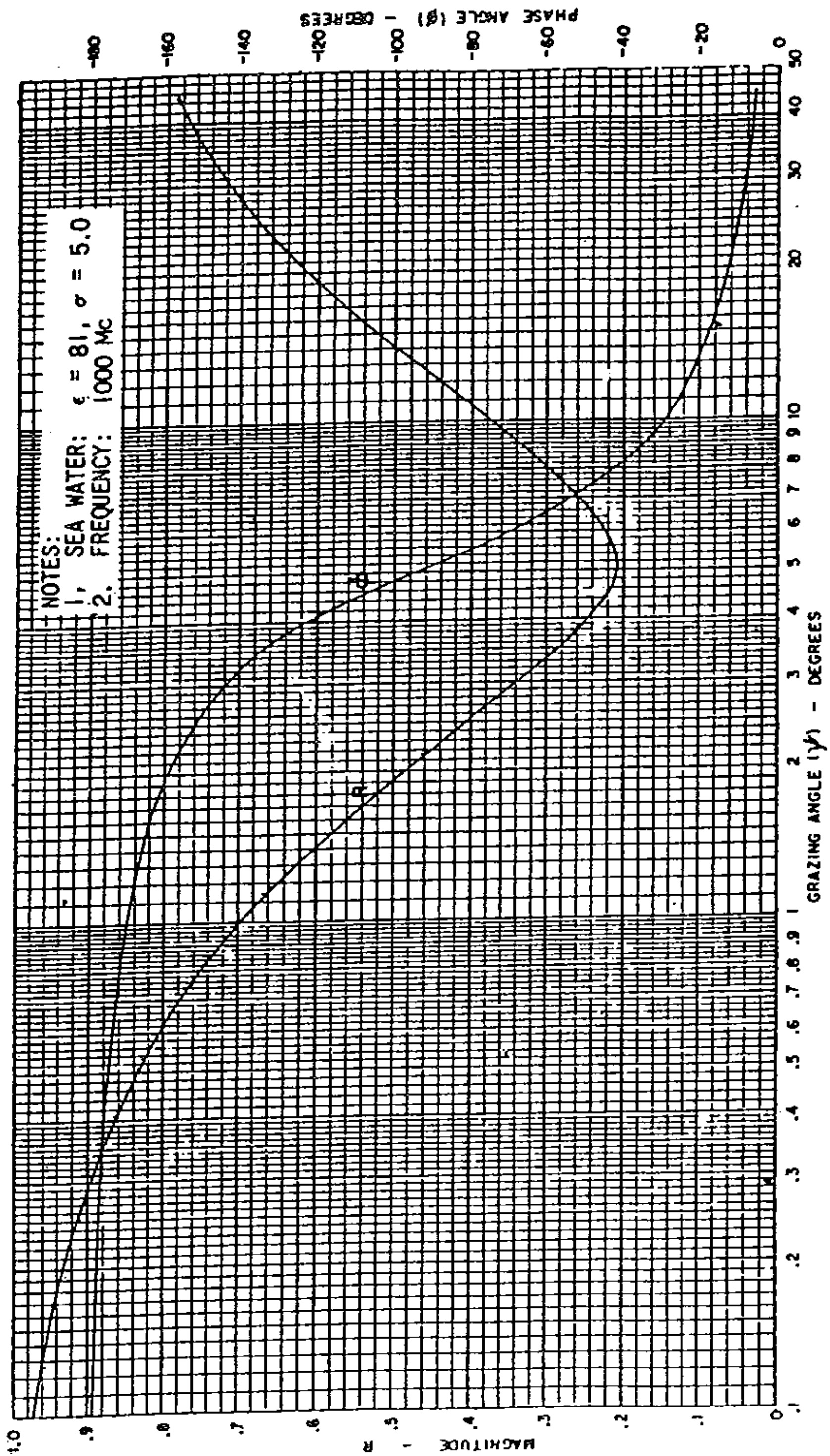


FIGURE 6-23. REFLECTION COEFFICIENT FOR SEA WATER

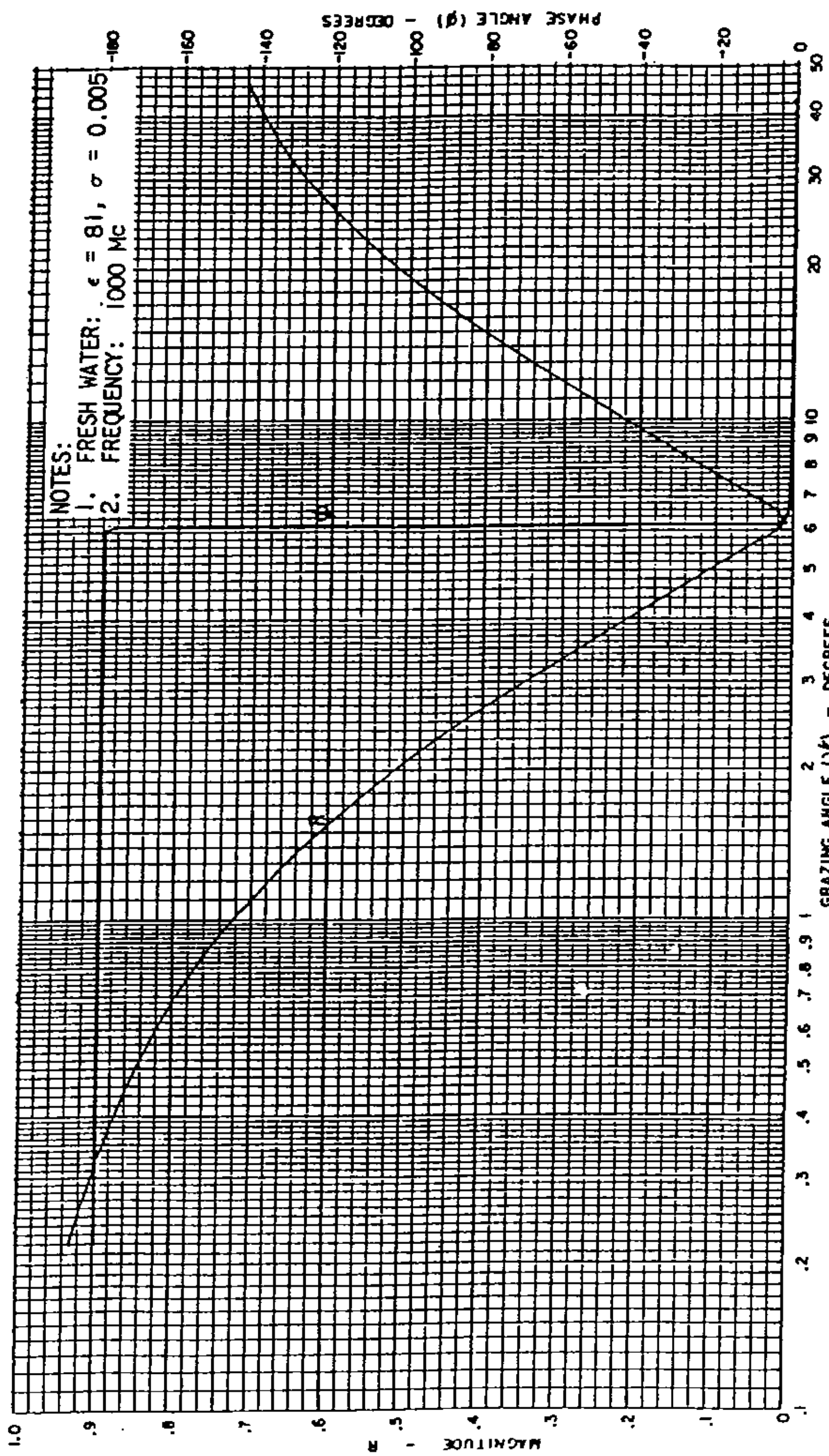


FIGURE 6-24. REFLECTION COEFFICIENT FOR FRESH WATER

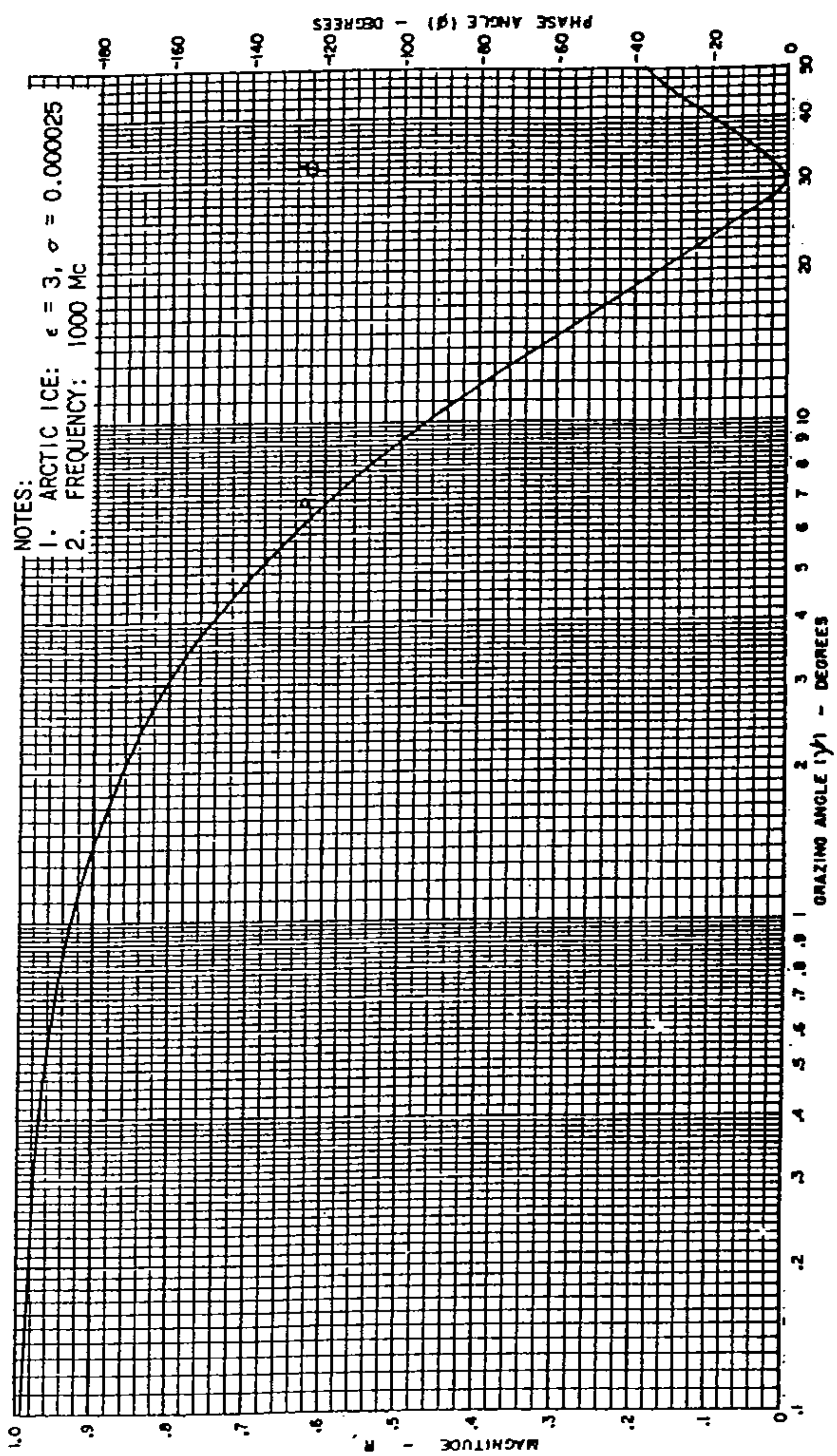


FIGURE 6-25. REFLECTION COEFFICIENT FOR GLACIAL ICE

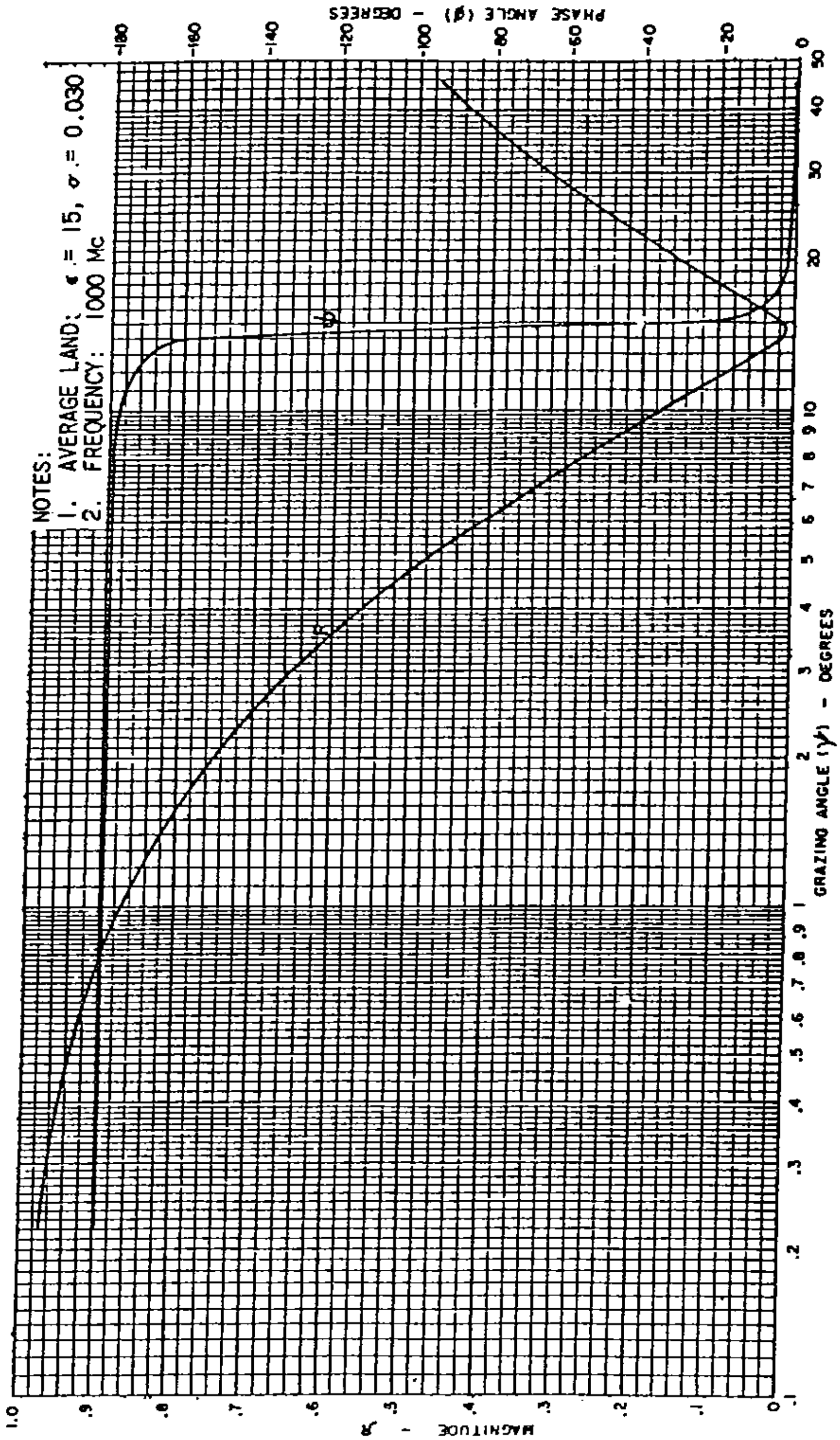


FIGURE 6-26. REFLECTION COEFFICIENT FOR AVERAGE LAND, ε = 15

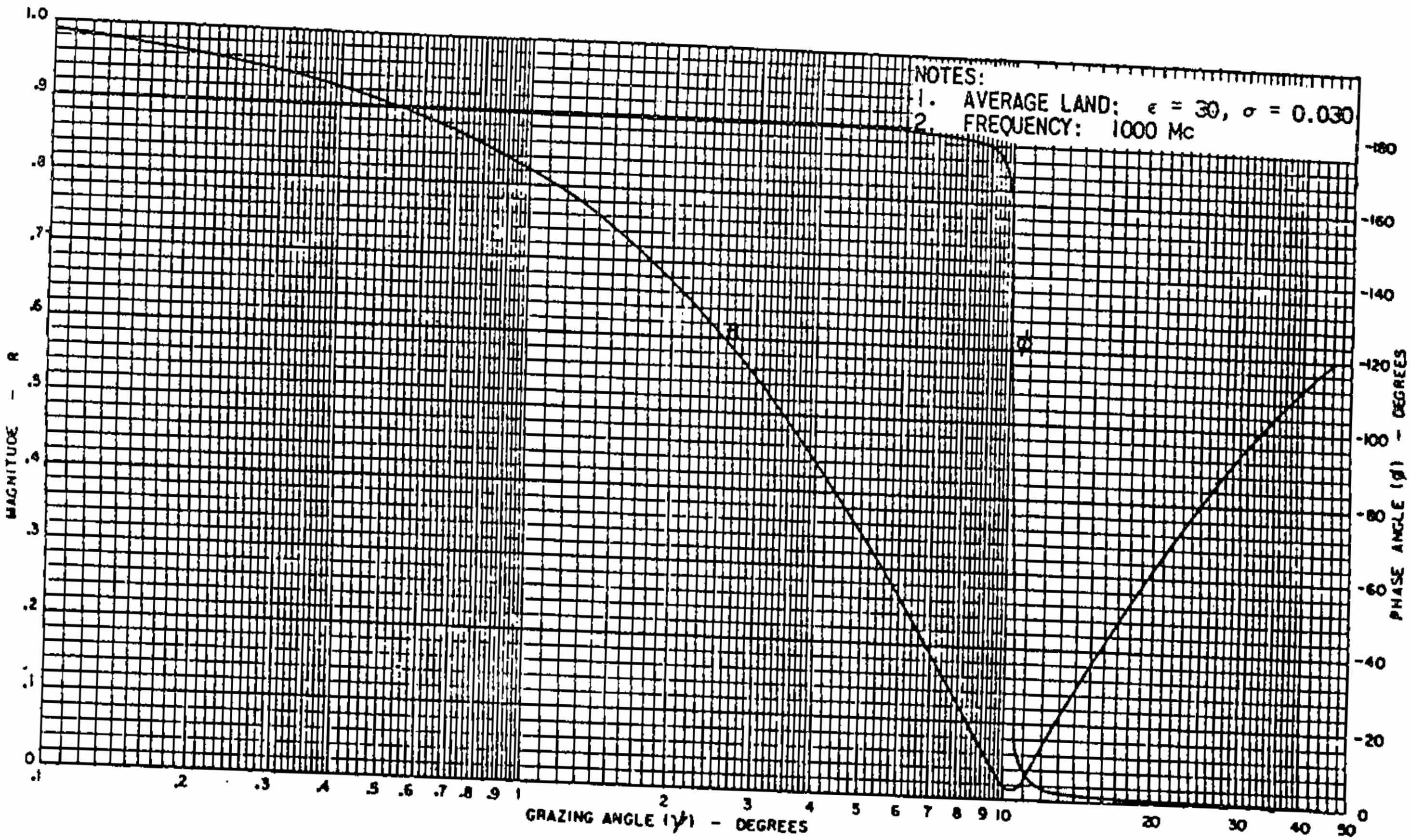


FIGURE 6-27. REFLECTION COEFFICIENT FOR AVERAGE LAND, ε = 30

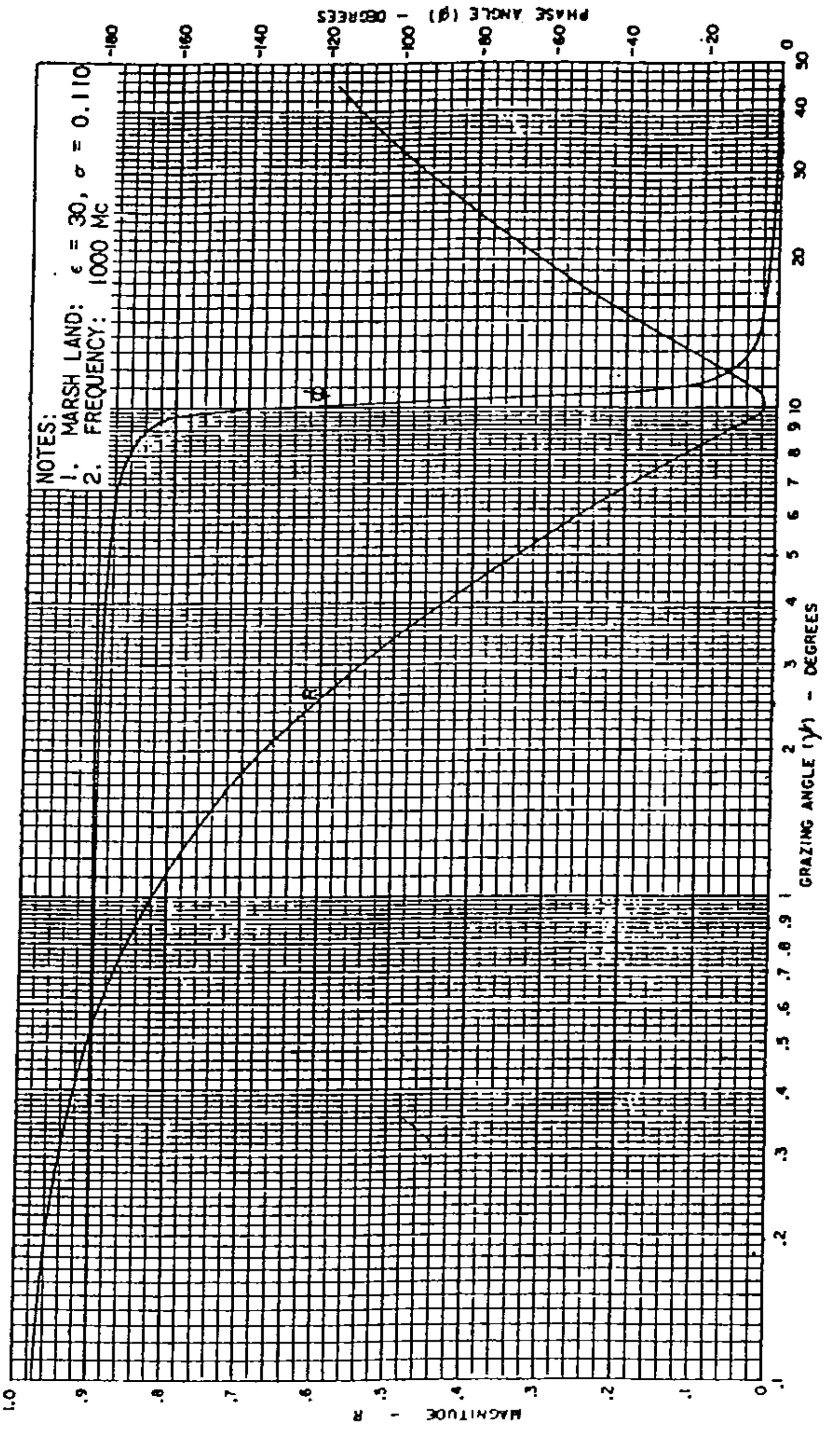


FIGURE 6-28. REFLECTION COEFFICIENT FOR MARSH LAND

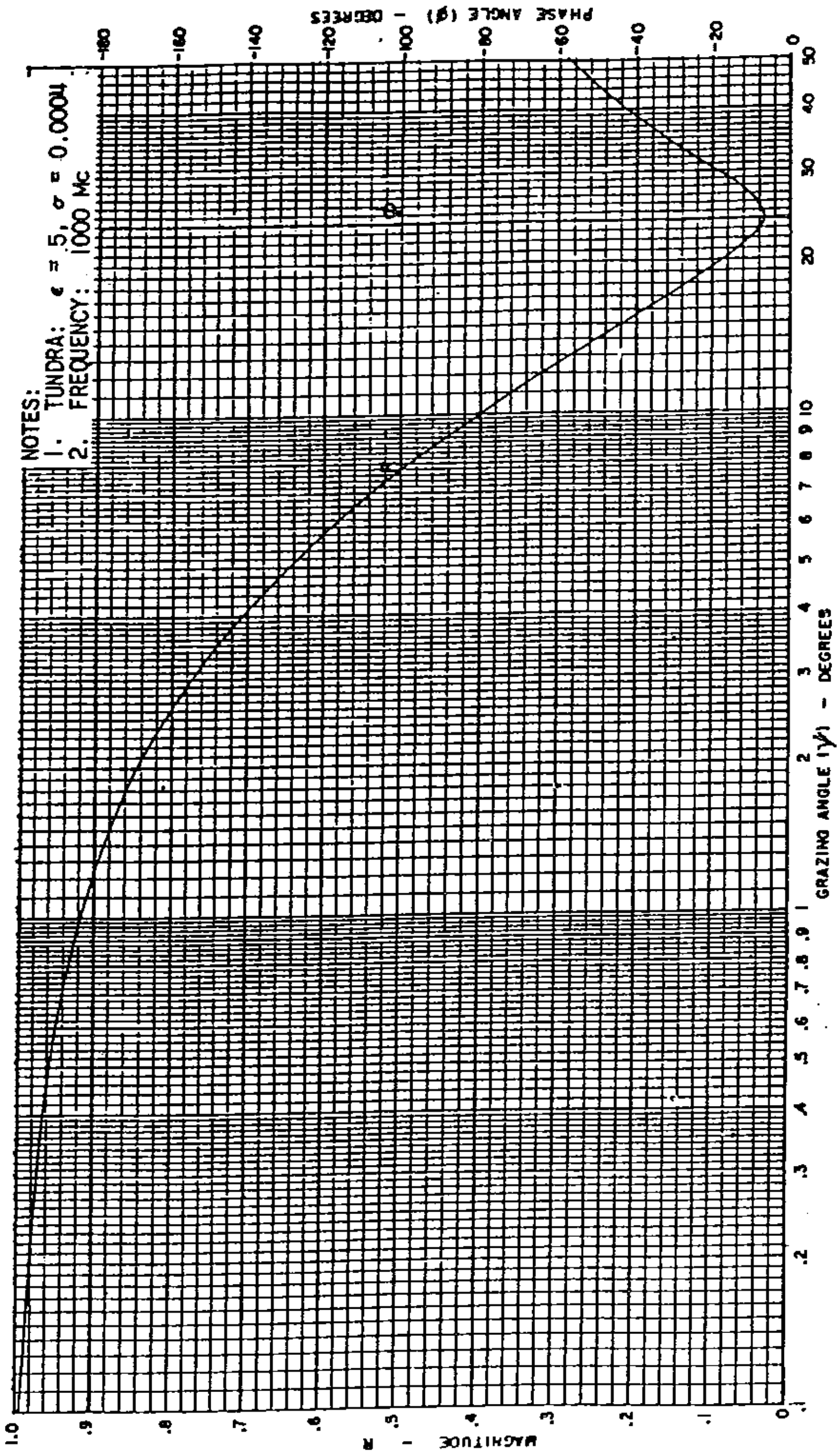


FIGURE 6-29. REFLECTION COEFFICIENT FOR TUNDRA

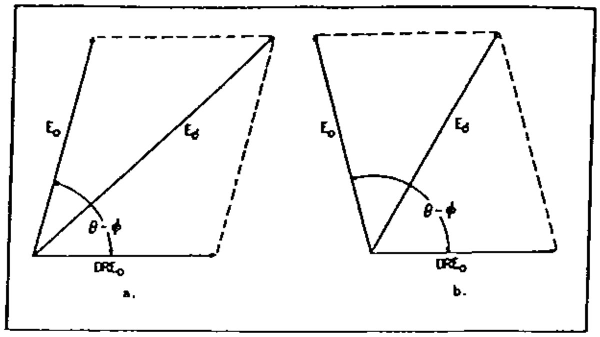


FIGURE 6-30. VECTOR SUM OF DIRECT AND REFLECTED FIELD COMPONENTS

employs, the excursions of the maximums and the depth of the nulls are not as great as they are with horizontal polarization. The earth-gain function, $g(\Theta)$, may be graphically represented as shown in figure 6-31 where $g(\Theta)$ is plotted as the ordinate and height of the receiving antenna, h_2 as the abscissa. Since the physical location in space where the two signals from the transmitter combine is directly related to the grazing angle, Ψ, the abscissa may just as well use Ψ as the variable. The curve depicts the variation of the $g(\Theta)$ function for the simple case of an isotropic transmitting antenna located as a fixed height above ground and radiating vertically polarized waves. A curve, such as figure 6-31, is very useful to the system planner or engineer in locating the position of troublesome nulls.

b. Radiation Characteristics in the Interference Region.

(1) The null positions are numbered consecutively starting from radio horizon, and they are referred to as number of the null. The starting point for the problem of determining null positions is found in the earth-gain or $g(\Theta)$ function,

$$g(\Theta) = \left[1 + DR^2 + 2DR \cos(\Theta - \phi)\right]^{\frac{1}{2}}$$

A null in the radiation pattern occurs when $\cos(\Theta - \phi)$ has the value -1, provided D and R remain constant. Under these conditions,

$$g(\Theta) = \sqrt{1 - 2DR + \overline{DR}^2} = 1 - DR$$

It would now appear to be a simple matter to determine the value of grazing angle Ψ that will produce this condition. However, due to the variation of both D and R with Ψ, a null in the pattern occurs when $\cos(\Theta - \phi)$ has a value slightly different from -1, and the actual minimums of $g(\Theta)$ do not lie on the (1 -DR) locus. When considering grazing angles below Brewster's angle (the neck in the curve of figure 6-31), a minimum is to the left of the point of contact of the $g(\Theta)$ curve with the locus (1 -DR), and for angles above Brewster's angle, a minimum is to the right of the point of contact. Computerized data are used to first determine the minimums of $g(\Theta)$ accurately, and then the corresponding grazing angle, Ψ, and null number, $n_{\sin\Psi}$. This approach is necessary in order to establish a useful parameter by which the position of any particular null may be calculated.

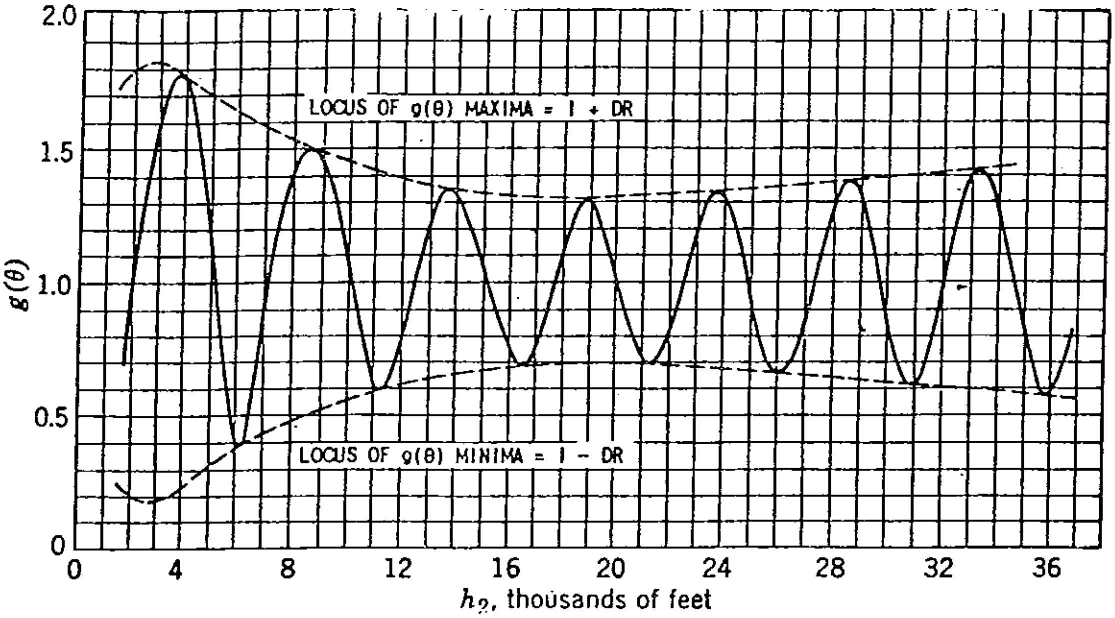


FIGURE 6-31. EARTH-GAIN FUNCTION, $g(\Theta)$, OF AN ISOTROPIC RADIATOR

(2) The null number, used to determine the number of nulls within a given grazing angle Ψ, is given very nearly by either of the two following expressions. First by,

$$n_{\Delta r} = \frac{\Delta r \; f_{MHz}}{984}$$

where Δr is the path-length difference in feet. Alternately,

$$n_{\Delta r} = \frac{\Delta r \; f_{MHz}}{300}$$

where Δr is the path-length difference in meters. Secondly, it is given by

$$n_{\sin\psi} = \frac{h_1 \; f_{MHz} \; \sin\psi}{492}$$

where h_1 is in feet or alternately

$$n_{\sin\psi} = \frac{h_1 \; f_{MHz} \; \sin\Psi}{150}$$

where h_1 is in meters

$n_{\sin\Psi}$ will be referred to as the null number.

The null positions can be defined by means of the null numbers and the particular behavior of the null numbers for variations in antenna height, frequency, and environmental conditions makes the null number a useful parameter in the solution for null positions. The null number is an integer plus (or sometimes minus) a decimal; that is,

$$n = y + z$$

where y is the integral number of the null, and z is the difference (a decimal) between n and y.

For nulls that occur at angles greater than Brewster's angle, the decimal (z) is nearly 0.50. For nulls which occur at angles less than Brewster's angle, the decimal is approximately ± 0.05, except for high antenna heights (greater than about 70 feet). Table 6-3 gives the number of nulls in the radiation pattern below Brewster's angle, $_B$, and also the number in the angle between Brewster's angle and a 45° elevation, for a number of selected antenna heights and the two frequencies of 1000 and 1180 megahertz. Table 6-4 contains all the values of n for the nulls in the radiation pattern below Brewster's angle up to number 18. When n exceeds 18 but is less than the Brewster n, use the integral number of the null plus the decimal which is indicated as average z. For nulls which occur at angles greater than Brewster's angle, use the integral number of the null plus z, as further presented in table 6-4. The dashed, stepped line appearing in each table 6-4 variation represents the dividing line between "below and above" Brewster's angle, and the smaller null numbers are always those below Brewster's angle. Table 6-4 also lists a number of earth surface parameters to be expected in TACAN operation, together with the values of Brewster's angle for 1000 and 1180 MHz operation. For low antennas (up to about 20 feet), the first few nulls will have null numbers slightly less than the number of the null, and in these cases, the (z) would be negative. For instance, when propagating at 1000 MHz over fresh water from an antenna height 10 feet above the water surface, we have:

Number of the Null	Null Number	z
1	0.9840	-0.0160
2	1.9288	-0.0712

NOTE: Reference to table 2-1 and figure 2-6 will reveal that for the vast majority of sites there are only a limited number of heights for DME and TACAN antennas that need be used and only a limited range of grazing angles involved.

TABLE 6-3. BREWSTER'S ANGLE, Ψ_B, AND NUMBER OF NULLS FOR SELECTED SURFACE CONDITIONS

	Surface Constants		Brewster's Angle	
Surface Type	ϵ_r	σ	$f_{Mc} = 1000$	$f_{Mc} = 1180$
Sea Water	81	5.0	5.19	5.42
Fresh Water	81	0.005	6.34	6.34
Marsh Land	30	0.110	10.34	10.34
Average Land	30	0.030	10.41	10.34
Average Land (Dry)	15	0.030	14.47	14.47
Desert Land	3	0.011	30.0	30.0
Glacial Ice	3	0.000025	30.0	30.0
Tundra	5	0.0004	24.0	24.0
Arctic Ice	10	0.0001	32.8	32.8

Conductivity, σ, in mho-m/sq m

NUMBER OF NULLS BELOW BREWSTER'S ANGLE AND IN 45 DEGREES

h_1	ϵ	σ	ψ_B	45°	h_1	ϵ	σ	ψ_B	45°
5	81	5.0	None	6	5	81	0.005	1	6
10	81	5.0	1	13	10	81	0.005	2	13
20	81	5.0	3	19	20	81	0.005	4	28
40	81	5.0	7	57	30	81	0.005	7	42
60	81	5.0	11	85	40	81	0.005	9	56
100	81	5.0	18	143	60	81	0.005	13	85
175	81	5.0	33	250	100	81	0.005	22	143
					175	81	0.005	39	251
5	30	0.110	2	6	5	30	0.030	2	6
10	30	0.110	4	13	10	30	0.030	3	13
20	30	0.110	7	20	20	30	0.030	7	29
40	30	0.110	14	56	40	30	0.030	15	56
60	30	0.110	21	85	60	30	0.030	21	85
80	30	0.110	28	114	100	30	0.030	35	143
100	30	0.110	36	143	175	30	0.030	63	250
175	30	0.110	63	250					

TABLE 6-3. NUMBER OF NULLS BELOW BREWSTER'S ANGLE AND IN 45 DEGREES (continued)

f = 1000 Mc k = 1.333

h_1	ϵ	σ	ψ_B	45°	h_1	ϵ	σ	ψ_B	45°
5	15	0.030	3	6					
10	15	0.030	5	13					
20	15	0.030	10	28					
30	15	0.030	15	42					
40	15	0.030	20	56					
50	15	0.030	25	71					
60	15	0.030	30	85					
80	15	0.030	40	114					
100	15	0.030	50	143					
175	15	0.030	88	250					

f = 1180 Mc k = 1.333

h_1	ϵ	σ	ψ_B	45°	h_1	ϵ	σ	ψ_B	45°
5	81	5.0	None	7	5	81	0.005	1	7
10	81	5.0	2	16	10	81	0.005	2	16
20	81	5.0	4	33	20	81	0.005	5	33
40	81	5.0	8	67	30	81	0.005	8	50
60	81	5.0	13	101	40	81	0.005	11	67
100	81	5.0	22	169	60	81	0.005	16	101
175	81	5.0	39	296	100	81	0.005	26	169
					175	81	0.005	46	296

h_1	ϵ	σ	ψ_B	45°	h_1	ϵ	σ	ψ_B	45°
5	30	0.110	2	7	5	30	0.030	2	7
10	30	0.110	4	16	10	30	0.030	4	16
20	30	0.110	8	33	20	30	0.030	9	33
30	30	0.110	12	50	30	30	0.030	13	50
40	30	0.110	17	67	40	30	0.030	17	67
60	30	0.110	25	101	60	30	0.030	25	101
80	30	0.110	34	135	100	30	0.030	42	169
100	30	0.110	42	169	175	30	0.030	74	296
175	30	0.110	76	296					

TABLE 6-3. NUMBER OF NULLS BELOW BREWSTER'S ANGLE AND IN 45 DEGREES (continued)

f = 1180 Mc   k = 1.333

h_1	ϵ	σ	ψ_B	45°
5	15	0.030	3	7
10	15	0.030	6	16
20	15	0.030	11	33
30	15	0.030	17	50
40	15	0.030	23	67
50	15	0.030	29	84
60	15	0.030	35	101
80	15	0.030	47	135
100	15	0.030	59	169
175	15	0.030	104	296

TABLE 6-4. NULL NUMBERS BELOW AND ABOVE BREWSTER'S ANGLE AT 1000 and 1180 MC FOR SELECTED SURFACE CONDITIONS AND k = 1.333

Sea Water (ϵ = 81, σ = 5.0)
f_{Mc} = 1000

Nulls below Brewster's angle are above dashed enclosure

h_1=5	10	20	40	60	100	175
1.3955	1.0809	1.0362	1.0335	1.0535	1.1361	1.3842
2.4491	2.3446	2.0882	2.0493	2.0579	2.1225	2.3640
3.4642	3.4164	3.1924	3.0707	3.0681	3.1199	3.3438
4.4714	4.4399	4.3147	4.0995	4.0805	4.1218	4.3302
5.4759	5.4522	5.3769	5.1393	5.0963	5.1261	5.321[illegible]
6.4790	6.4595	6.4062	6.1927	6.1161	6.1317	6.3160
	7.4649	7.4242	7.2534	7.1405	7.1392	7.3127
	8.4683	8.4351	8.3065	8.1698	8.1474	8.3114
	9.4709	9.4429	9.3461	9.2055	9.1573	9.3117
	10.4730	10.4491	10.3737	10.2443	10.1693	10.3127
	11.4744	11.4533	11.3928	11.2824	11.1818	11.3136
	12.4758	12.4571	12.4068	12.3162	12.1970	12.3162
	13.4766	13.4599	13.4179	13.3441	13.2140	13.3191
		14.4621	14.4259	14.3663	14.2332	14.3224
		15.4640	15.4325	15.3833	15.2537	15.3268
		16.4655	16.4377	16.3975	16.2757	16.3315
		17.4668	17.4423	17.4085	17.2981	17.3368
		18.4678	18.4459	18.4173	18.3200	18.3424

Average z 3688

Nulls Above Brewster's Angle

h_1=5	10	20	40	60	100	175
0.4559	0.4611	0.4384	0.4527	0.4539	0.4752	0.5675

TABLE 6-4. NULL NUMBERS BELOW AND ABOVE BREWSTER'S ANGLE AT 1000 and 1180 MC FOR SELECTED SURFACE CONDITIONS AND k = 1.333 (continued)

Sea Water ($\epsilon = 81, \sigma = 5.0$)

$f_{Mc} = 1180$

Nulls below Brewster's angle are above dashed enclosure

h_1=5	10	20	40	60	100	175
1.3362	1.0506	1.0283	1.0329	1.0604	1.1626	1.4514
2.4404	2.2451	2.0591	2.0423	2.0591	2.1434	2.4355
3.4590	3.3923	3.1152	3.0562	3.0651	3.1361	3.4121
4.4682	4.4276	4.2192	4.0734	4.0723	4.1342	4.3937
5.4734	5.4447	5.3212	5.0963	5.0823	5.1349	5.3809
6.4767	6.4540	6.3760	6.1271	6.0935	6.1372	6.3717
7.4790	7.4603	7.4044	7.1674	7.1078	7.1411	7.3652
	8.4645	8.4214	8.2184	8.1243	8.1451	8.3607
	9.4677	9.4326	9.2713	9.1446	9.1509	9.3577
	10.4702	10.4406	10.3164	10.1697	10.1573	10.3558
	11.4721	11.4466	11.3504	11.1996	11.1649	11.3545
	12.4735	12.4512	12.3748	12.2328	12.1729	12.3542
	13.4747	13.4548	13.3931	13.2675	13.1821	13.3546
	14.4756	14.4579	14.4061	14.3001	14.1930	14.3555
	15.4763	15.4603	15.4161	15.3282	15.2054	15.3570
	16.4769	16.4621	16.4267	16.3523	16.2189	16.3583
		17.4637	17.4310	17.3720	17.2343	17.3609
		18.4651	18.4365	18.3874	18.2510	18.3632
Average z					0.1936	0.4043

Nulls Above Brewster's Angle

h_1=5	10	20	40	60	100	175
0.4476	0.4593	0.4564	0.4514	0.4545	0.4805	0.5881

TABLE 6-4. NULL NUMBERS BELOW AND ABOVE BREWSTER'S ANGLE AT 1000 and 1180 MC FOR SELECTED SURFACE CONDITIONS AND k = 1.333 (continued)

Fresh Water ($\epsilon = 81$, $\sigma = .005$)

$f_{Mc} = 1000$

Nulls below Brewster's angle are above dashed enclosure

h_1=5	10	20	30	40	60	100	175
0.9047	0.9840	0.9986	1.0064	1.0149	1.0411	1.1282	1.3786
1.5399	1.9288	1.9941	2.0034	2.0117	2.0336	2.1078	2.3544
2.5062	2.5660	2.9864	3.0006	3.0097	3.0307	3.0980	3.3304
3.5010	3.5105	3.9567	3.9974	4.0074	4.0282	4.0920	4.3130
4.4993	4.5033	4.6306	4.9913	5.0045	5.0262	5.0885	5.3000
5.4984	5.5006	5.5198	5.9712	6.0029	6.0247	6.0853	6.2904
6.4975	6.4992	6.5080	6.7432	6.9980	7.0239	7.0833	7.2826
	7.4984	7.5043	7.5319	7.9851	8.0223	8.0812	8.2768
	8.4977	8.5023	8.5136	8.8628	9.0196	9.0797	9.2715
	9.4969	9.5010	9.5086	9.5472	10.0173	10.0780	10.2674
	10.4964	10.4997	10.5060	10.5210	11.0136	11.0771	11.2644
	11.4957	11.4988	11.5044	11.5144	12.0074	12.0757	12.2611
	12.4952	12.4982	12.5034	12.5110	12.9764	13.0747	13.2583
	13.4947	13.4973	13.5023	13.5094	13.6375	14.0732	14.2558
		14.4967	14.5016	14.5080	14.5425	15.0721	15.2530
		15.4963	15.5006	15.5071	15.5304	16.0700	16.2513
		16.4956	16.4999	16.5062	16.5273	17.0683	17.2491
		17.4950	17.4992	17.5055	17.5245	18.0669	18.2479
Average z						.0770	.2557

Nulls Above Brewster's Angle

h_1=5	10	20	30	40	60	100	175
0.5071	0.5046	0.5020	0.4960	0.4965	0.5015	0.5208	0.6112

TABLE 6-4. NULL NUMBERS BELOW AND ABOVE BREWSTER'S ANGLE AT 1000 and 1180 MC FOR SELECTED SURFACE CONDITIONS AND k = 1.333 (continued)

Fresh Water ($\epsilon = 81, \sigma = .005$)

$f_{Mc} = 1180$

Nulls below Brewster's angle are above dashed enclosure

h_1=5	10	20	30	40	60	100	175
0.9387	0.9878	1.0013	1.0092	1.0196	1.0514	1.1570	1.4471
1.5738	1.9632	1.9975	2.0058	2.0153	2.0417	2.1327	2.4289
2.5090	2.6990	2.9929	3.0036	3.0132	3.0376	3.1200	3.4028
3.5021	3.5203	3.9842	4.0018	4.0117	4.0353	4.1127	4.3822
4.4999	4.5075	4.9364	4.9983	5.0097	5.0335	5.1076	5.3665
5.4986	5.5024	5.5789	5.9924	6.0075	6.0319	6.1041	6.3545
6.4980	6.5003	6.5177	6.9796	7.0059	7.0305	7.1016	7.3454
7.4971	7.4987	7.5082	7.8468	8.0032	8.0297	8.0988	8.3378
	8.4979	8.5045	8.5416	8.9964	9.0281	9.0970	9.3318
	9.4973	9.5126	9.5180	9.9720	10.0263	10.0952	10.3266
	10.4967	10.5009	10.5112	10.6785	11.0247	11.0938	11.3220
	11.4961	11.5000	11.5072	11.5325	12.0226	12.0927	12.3176
	12.4954	12.4992	12.5061	12.5195	13.0202	13.0910	13.3149
	13.4951	13.4986	13.5047	13.5151	14.0156	14.0901	14.3123
	14.4945	14.4977	14.5033	14.5125	14.9984	15.0888	15.3097
	15.4938	15.4969	15.5027	15.5107	15.8354	16.0877	16.3067
	16.4933	16.4963	16.5020	16.5096	16.5609	17.0863	17.3051
		17.4956	17.5013	17.5087	17.5394	18.0848	18.3031
Average z						.0930	.3683

Nulls Above Brewster's Angle

h_1=5	10	20	30	40	60	100	175
0.5112	0.5126	0.4987	0.5028	0.4947	0.4995	0.5244	0.6833

TABLE 6-4. NULL NUMBERS BELOW AND ABOVE BREWSTER'S ANGLE AT 1000 and 1180 MC FOR SELECTED SURFACE CONDITIONS AND k = 1.333 (continued)

Average Land ($\epsilon_r = 15$, $\sigma = 0.030$)

$f_{Mc} = 1000$

Nulls below Brewster's angle are above dashed enclosure

$h_1 = 5$	10	20	30	40
0.9886	0.9981	1.0034	1.0083	1.0167
1.9668	1.9952	2.0030	2.0072	2.0138
2.8556	2.9925	3.0036	3.0063	3.0129
3.5011	3.9863	4.0032	4.0056	4.0119
4.5003	4.9259	5.0034	5.0053	5.0116
5.4976	5.5185	6.0032	6.0050	6.0110
6.4970	6.5005	7.0038	7.0043	7.0106
	7.4973	8.0043	8.0041	8.0098
	8.4959	9.0061	9.0041	9.0094
	9.4952	10.0180	10.0044	10.0092
	10.4943	10.4950	11.0039	11.0092
	11.4938	11.5000	12.0046	12.0088
		12.5020	13.0069	13.0086
		13.5020	14.0112	14.0086
		14.5030	15.0906	15.0095
		15.5030	16.4836	16.0107
		16.5040	17.4892	17.0116
		17.5040	18.4903	18.0141

Average z 0170

Nulls Above Brewster's Angle

$h_1 = 5$	10	20	30	40
0.4990	0.4994	0.5030	0.4881	0.4880

TABLE 6-4. NULL NUMBERS BELOW AND ABOVE BREWSTER'S ANGLE AT 1000 and 1180 MC FOR SELECTED SURFACE CONDITIONS AND k = 1.333 (continued)

Average Land ($\epsilon_r = 15, \sigma = 0.030$)

$f_{Mc} = 1180$

Nulls below Brewster's angle are above dashed enclosure

h_1=5	10	20	30	40
0.9915	0.9990	1.0037	1.0107	1.0206
1.9809	1.9971	2.0029	2.0088	2.0172
2.8761	2.9944	3.0022	3.0078	3.0154
3.5253	3.9929	4.0010	4.0070	4.0145
4.5037	4.9843	5.0002	5.0067	5.0140
5.4990	5.9073	6.0006	6.0063	6.0133
6.4971	7.5008	7.0001	7.0058	7.0127
7.4967	8.4978	7.9989	8.0059	8.0121
	9.4963	8.9997	9.0048	9.0120
	10.4954	9.9988	10.0048	10.0117
	11.4944	10.9985	11.0039	11.0108
	12.4938	12.4915	12.0046	12.0106
	13.4932	13.4938	13.0046	13.0107
	14.4928	14.4932	14.0042	14.0100
	15.4925	15.4941	15.0053	15.0098
	16.4918	16.4931	16.0069	16.0101
		17.4931	17.0135	17.0104
		18.4922	18.4658	18.0103

Average z 0.0136

Nulls Above Brewster's Angle

h_1=5	10	20	30	40
0.5044	0.4949	0.4904	0.4862	0.4847

TABLE 6-4. NULL NUMBERS BELOW AND ABOVE BREWSTER'S ANGLE AT 1000 and 1180 MC FOR SELECTED SURFACE CONDITIONS AND k = 1.333 (continued)

Average Land (ϵ = 15, σ = 0.030)

f_{Mc} = 1000

Nulls Below Brewster's Angle

50	60	80	100	175
1.0275	1.0418	1.0785	1.1282	1.3790
2.0232	2.0348	2.0654	2.1080	2.3550
3.0214	3.0321	3.0600	3.0984	3.3308
4.0202	4.0303	4.0568	4.0930	4.3131
5.0194	5.0291	5.0547	5.0892	5.3004
6.0189	6.0285	6.0530	6.0867	6.2910
7.0182	7.0277	7.0519	7.0849	7.2836
8.0175	8.0271	8.0510	8.0830	8.2774
9.0170	9.0267	9.0501	9.0817	9.2727
10.0167	10.0260	10.0494	10.0806	10.2685
11.0165	11.0253	11.0485	11.0794	11.2650
12.0162	12.0248	12.0479	12.0787	12.2621
13.0160	13.0242	13.0476	13.0779	13.2591
14.0156	14.0241	14.0467	14.0769	14.2569
15.0156	15.0238	15.0464	15.0761	15.2547
16.0149	16.0232	16.0459	16.0755	16.2529
17.0152	17.0235	17.0452	17.0746	17.2509
18.0157	18.0229	18.0447	18.0740	18.2493

Average z

0.0191	0.0310	0.0489	0.0786	0.2371

Nulls Above Brewster's Angle

50	60	80	100	175
0.4901	0.4900	0.5026	0.5007	0.5740

TABLE 6-4. NULL NUMBERS BELOW AND ABOVE BREWSTER'S ANGLE AT 1000 and 1180 MC FOR SELECTED SURFACE CONDITIONS AND k = 1.333 (continued)

Average Land ($\epsilon = 15, \sigma = 0.030$)

$f_{Mc} = 1180$

Nulls Below Brewster's Angle

50	60	80	100	175
1.0340	1.0517	1.0969	1.1570	1.4473
2.0280	2.0423	2.0802	2.1327	2.4283
3.0258	3.0390	3.0731	3.1204	3.4023
4.0246	4.0370	4.0690	4.1132	4.3812
5.0235	5.0355	5.0665	5.1085	5.3653
6.0228	6.0344	6.0643	6.1050	6.3534
7.0219	7.0335	7.0628	7.1026	7.3439
8.0215	8.0325	8.0617	8.1002	8.3359
9.0208	9.0320	9.0605	9.0984	9.3296
10.0205	10.0310	10.0595	10.0970	10.3244
11.0199	11.0308	11.0586	11.0961	11.3199
12.0194	12.0301	12.0578	12.0946	12.3159
13.0188	13.0296	13.0572	13.0934	13.3122
14.0185	14.0292	14.0566	14.0928	14.3095
15.0180	15.0286	15.0556	15.0916	15.3065
16.0180	16.0280	16.0549	16.0910	16.3041
17.0173	17.0273	17.0543	17.0900	17.3018
18.0169	18.0274	18.0542	18.0895	18.2997

Average z

0.0219	0.0319	0.0558	0.0898	0.2768

Nulls Above Brewster's Angle

50	60	80	100	175
0.4879	0.4853	0.5061	0.5030	0.5895

TABLE 6-4. NULL NUMBERS BELOW AND ABOVE BREWSTER'S ANGLE AT 1000 and 1180 MC FOR SELECTED SURFACE CONDITIONS AND k = 1.333 (continued)

Average Land (ϵ = 30, σ = 0.030)

f_{Mc} = 1000

Nulls below Brewster's angle are above dashed enclosure

h_1=5	10	20	40	60	100	175
0.9760	0.9952	1.0027	1.0162	1.0415	1.1282	1.3790
1.7896	1.9883	2.0017	2.0132	2.0448	2.1078	2.3546
2.5202	2.9685	2.9998	3.0121	3.0316	3.0984	3.3308
3.5035	3.6946	3.9995	4.0106	4.0298	4.0928	4.3132
4.4998	4.5145	4.9975	5.0103	5.0288	5.0892	5.3004
5.4983	5.5038	5.9919	6.0095	6.0276	6.0865	6.2909
6.4972	6.4997	6.9620	7.0089	7.0267	7.0845	7.2834
	7.4984	7.5587	8.0084	8.0261	8.0828	8.2774
	8.4976	8.5139	9.0074	9.0253	9.0813	9.2723
	9.4964	9.5079	10.0056	10.0248	10.0800	10.2683
	10.4957	10.5077	11.0063	11.0239	11.0791	11.2648
	11.4951	11.5062	12.0046	12.0232	12.0781	12.2618
	12.4946	12.5062	13.0032	13.0228	13.0767	13.2591
	13.4940	13.5062	13.9971	14.0220	14.0763	14.2568
		14.5058	14.6313	15.0220	15.0753	15.2542
		15.5050	15.5086	16.0209	16.0744	16.2526
		16.5000	16.5062	17.0208	17.0735	17.2506
		17.4910	17.5035	18.0203	18.0733	18.2490
verage z				0.0260	0.0809	0.2454

Nulls Above Brewster's Angle

h_1=5	10	20	40	60	100	175
0.5038	0.4990	0.4904	0.4923	0.4947	0.5126	0.5938

TABLE 6-4. NULL NUMBERS BELOW AND ABOVE BREWSTER'S ANGLE AT 1000 and 1180 MC FOR SELECTED SURFACE CONDITIONS AND k = 1.333 (continued)

Average Land (ϵ = 30, σ = 0.030)

f_{Mc} = 1180

Nulls below Brewster's angle are above dashed enclosure

h_1=5	10	20	30	40	60	100	175
0.9821	0.9965	1.0033	1.0102	1.0204	1.0517	1.1570	1.4473
1.9133	1.9916	2.0014	2.0082	2.0164	2.0425	2.1237	2.4285
2.5454	2.9834	3.0003	3.0067	3.0150	3.0387	3.1204	3.4023
3.5082	3.9466	3.9980	4.0059	4.0136	4.0364	4.1132	4.3814
4.5013	4.5656	4.9968	5.0049	5.0131	5.0349	5.1083	5.3653
5.4989	5.5097	5.9937	6.0043	6.0116	6.0338	6.1050	6.3532
6.4976	6.5028	6.9911	7.0033	7.0116	7.0327	7.1023	7.3435
7.4969	7.4992	7.9755	8.0030	8.0110	8.0320	8.1002	8.3357
	8.4982	8.6652	9.0009	9.0098	9.0309	9.0982	9.3294
	9.4972	9.5134	9.9994	10.0089	10.0299	10.0971	10.3242
	10.4965	10.5036	10.9971	11.0084	11.0297	11.0954	11.3194
	11.4957	11.5003	11.9903	12.0084	12.0287	12.0941	12.3157
	12.4949	12.4994	12.8676	13.0075	13.0282	13.0931	13.3122
	13.4944	13.4982	13.5168	14.0068	14.0275	14.0919	14.3093
	14.4938	14.4974	14.5059	15.0051	15.0272	15.0909	15.3061
	15.4935	15.4967	15.5028	16.0034	16.0267	16.0905	16.3038
	16.4930	16.4956	16.5014	16.9830	17.0262	17.0893	17.3015
		17.4984	17.5004	17.5217	18.0255	18.0885	18.2994
Average z					0.0302	0.0915	0.2878

Nulls Above Brewster's Angle

h_1=5	10	20	30	40	60	100	175
0.5006	0.4974	0.4939	0.4919	0.4915	0.4939	0.5153	0.6113

TABLE 6-4. NULL NUMBERS BELOW AND ABOVE BREWSTER'S ANGLE AT 1000 and 1180 MC FOR SELECTED SURFACE CONDITIONS AND k = 1.333 (continued)

Marsh Land (ϵ = 30, σ = 0.110)

f_{Mc} = 1000

Nulls below Brewster's angle are above dashed enclosure

h_1=5	10	20	40	60	80	100	175
0.9799	0.9964	1.0033	1.0167	1.0420	1.0798	1.1286	1.3790
1.7949	1.9932	2.0021	2.0143	2.0353	2.0663	2.1084	2.3547
2.5088	2.9861	3.0021	3.0137	3.0326	3.0609	3.0988	3.3311
3.4982	3.6700	4.0019	4.0131	4.0312	4.0581	4.0938	4.3137
4.4965	4.4985	5.0028	5.0130	5.0305	5.0557	5.0904	5.3010
5.4955	5.4951	6.0062	6.0132	6.0295	6.0543	6.0875	6.2913
6.4949	6.4941	7.0409	7.0133	7.0291	7.0535	7.0857	7.2843
	7.4938	8.4833	8.0137	8.0292	8.0529	8.0846	8.2781
	8.4935	9.4885	9.0148	9.0289	9.0523	9.0833	9.2735
	9.4930	10.4897	10.0162	10.0288	10.0516	10.0821	10.2694
	10.4929	11.4909	11.0189	11.0289	11.0510	11.0814	11.2660
	11.4925	12.4913	12.0240	12.0293	12.0508	12.0807	12.2631
	12.4924	13.4909	13.0358	13.0302	13.0506	13.0799	13.2606
	13.4918	14.4910	14.0927	14.0302	14.0505	14.0797	14.2585
		15.4909	15.4465	15.0315	15.0505	15.0789	15.2560
		16.4907	16.4755	16.0330	16.0500	16.0789	16.2545
		17.4905	17.4846	17.0358	17.0502	17.0782	17.2527
		18.4901	18.4878	18.0392	18.0509	18.0782	18.2512
Average z				0.0342	0.0573	0.0891	0.2589

Nulls Above Brewster's Angle

h_1=5	10	20	40	60	80	100	175
0.4988	0.4939	0.4898	0.4854	0.4880	0.4944	0.5051	0.5861

TABLE 6-4. NULL NUMBERS BELOW AND ABOVE BREWSTER'S ANGLE AT 1000 and 1180 MC FOR SELECTED SURFACE CONDITIONS AND k = 1.333 (continued).

Marsh Land (ϵ = 30, σ = 0.110)

f_{Mc} = 1180

Nulls below Brewster's angle are above dashed enclosure

h_1=5	10	20	40	60	80	100	175
0.9874	0.9984	1.0037	1.0208	1.0520	1.0980	1.1572	1.4473
1.9298	1.9964	2.0034	2.0174	2.0431	2.0812	2.1329	2.4285
2.5292	2.9923	3.0026	3.0163	3.0393	3.0740	3.1207	3.4023
3.5009	3.9780	4.0023	4.0156	4.0372	4.0700	4.1136	4.3816
4.4972	4.5240	5.0020	5.0151	5.0358	5.0674	5.1092	5.3657
5.4964	5.4967	6.0037	6.0146	6.0352	6.0656	6.1059	6.3539
6.4956	6.4960	7.0048	7.0148	7.0344	7.0641	7.1033	7.3443
7.4948	7.4948	8.0186	8.0149	8.0342	8.0627	8.1012	8.3368
	8.4940	9.4810	9.0149	9.0340	9.0618	9.0996	9.3303
	9.4935	10.4878	10.0152	10.0330	10.0609	10.0985	10.3253
	10.4933	11.4908	11.0158	11.0328	11.0602	11.0973	11.3205
	11.4931	12.4907	12.0172	12.0326	12.0598	12.0960	12.3168
	12,4924	13.4912	13.0180	13.0324	13.0592	13.0950	13.3133
	13.4922	14.4914	14.0224	14.0322	14.0586	14.0942	14.3103
	14.4917	15.4912	15.0285	15.0327	15.0584	15.0937	15.3076
	15.4914	16.4915	16.0467	16.0333	16.0584	16.0928	16.3054
	16.4911	17.4912	17.2958	17.0331	17.0578	17.0925	17.3029
		18.4907	18.4630	18.0343	18.0573	18.0918	18.3009
Average z				0.0381	0.0665	0.1028	0.3054

Nulls Above Brewster's Angle

h_1=5	10	20	40	60	80	100	175
0.5023	0.4957	0.4897	0.4853	0.4870	0.4958	0.5082	0.6054

(3) Beacon distance, r_o, is the radio distance from transmitting source to the airborne receiver. The expression for r_o is given in paragraph 23.a.(6).

(4) In order to accurately evaluate the field strength in space, the angle chi, χ, (see figure 6-32) formed by the direct ray and a line parallel to the ground at the transmitting antenna position, must be known.

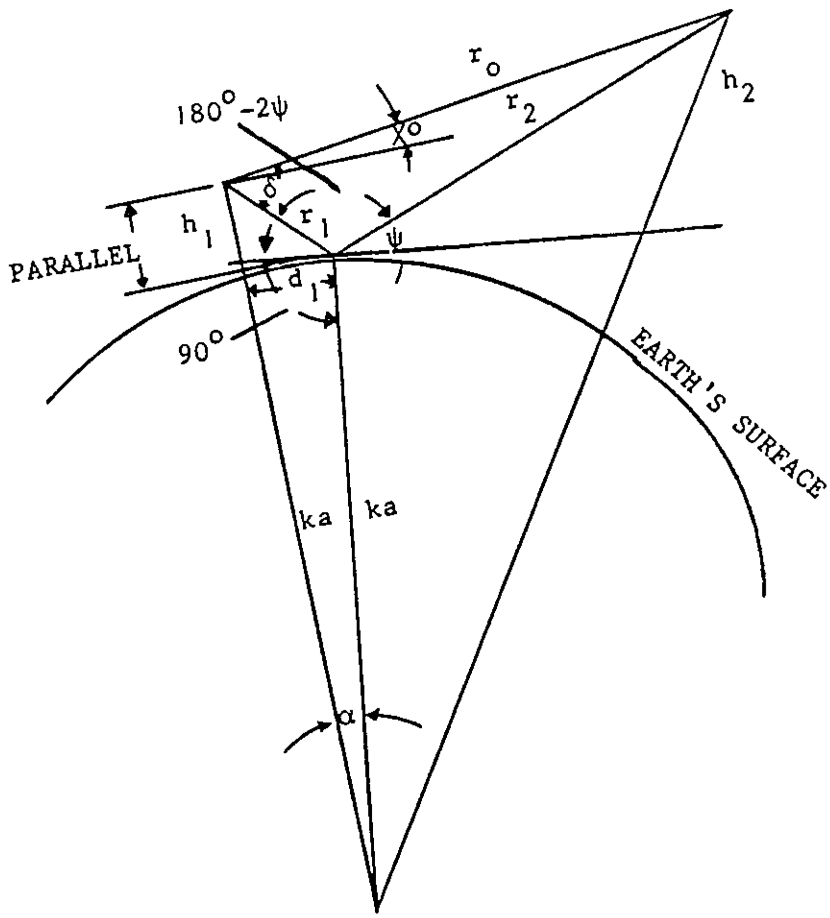


FIGURE 6-32. GEOMETRY FOR THE SOLUTION OF RADIATION ANGLE chi, χ

This angle is used to obtain the relative field strength for the direct ray from the free space antenna directivity pattern. Hence, a method of conversion from ψ^o to χ^o is necessary. The deviation from angle ψ to χ is given by,

$$\text{Deviation, } \Delta^{o} = 2\psi^{o} - \sin^{-1}\left(\frac{r_2 \sin 2\psi}{r_o}\right) + \frac{d_1}{ka}$$

and the angle chi is then given by

$$\chi^{o} = \sin^{-1}\left(\frac{r_2 \sin 2\psi}{r_o}\right) - \psi^{o} - \frac{d_1}{ka}$$

where r_o, r_2, d_1, and ka must be in the same units of measure.

(5) For the case of the TACAN antenna, it is necessary to consider the antenna's directivity in order to calculate the interference field structure. The magnitude of the direct ray will be given as $E_o E_\chi / r_o$, and the magnitude of the reflected ray by $DRE_o E_\psi / r_r$. Then the field strength at any given grazing angle and beacon distance is given by

$$E_{BD} = E_o \, (E\ ) \left[\left(\frac{1}{r_o}\right)^2 + \left(\frac{1}{r_r} \, DR \, \frac{E_\psi}{E_\chi}\right)^2 + \frac{2}{r_o r_r} \, DR \, \frac{E_\psi}{E_\chi} \cos\,(\theta - \phi)\right]^{\frac{1}{2}}$$

where E_o is the rms field strength at a unit distance, the mile, since r_o, r_1 and r_2 are expressed in statute miles, then,

$$E_o = \frac{\sqrt{30 \text{ P x G}}}{1.609} \text{ rms mv/m at 1 s.m.}$$

where:

P = radiated power in watts

G = power gain of the antenna relative to an isotropic radiator

$r_r = r_1 + r_2$, the reflected path length

E_χ is the normalized value of E as obtained from the free space antenna directivity pattern at the radiation angle χ^{o}

E_ψ is the normalized value of E as obtained from the free space directivity pattern at the grazing angle ψ^{o}

For the range of values of r_o and r_r encountered in TACAN operation it may generally be assumed that the error introduced by letting $r_r = r_o$ will be negligible and then,

$$E_{BD} = E_o \, (E_\chi) \frac{1}{r_o} \left[1 + \left(DR \, \frac{E_\psi}{E_\chi}\right)^2 + 2DR \, \frac{E_\psi}{E_\chi} \cos\,(\theta - \phi)\right]^{\frac{1}{2}} \text{ mv/m}$$

It is convenient to express the $g(\Theta)$ function, illustrated in figure 6-31, in decibels. As such, it is defined as 20 log of the ratio of the resultant field strength corresponding to a given grazing angle ψ and radial distance to the free-space field at the same angle and distance from the transmitter or

$$g(\Theta)_{db} = 20 \log \frac{E_o \dfrac{E_\chi}{r_o}\left[1 + \left(DR\dfrac{E_\psi}{E_\chi}\right)^2 + 2DR\dfrac{E_\psi}{E_\chi}\cos(\Theta - \phi)\right]^{\frac{1}{2}}}{E_o \dfrac{E_\chi}{r_o}}$$

$$= 10 \log \left[1 + \left(DR\frac{E_\psi}{E_\chi}\right)^2 + 2DR\frac{E_\psi}{E_\chi}\cos(\Theta - \phi)\right]$$

Maximums of $g(\Theta)$ occur when $\cos(\Theta - \phi) = 1$ and minimums when $\cos(\Theta - \phi) = -1$

For maximums:

$$g(\Theta)_{db} = 20 \log \left(1 + DR\frac{E_\psi}{E_\chi}\right)$$

For minimums:

$$g(\Theta)_{db} = 20 \log \left(1 - DR\frac{E_\psi}{E_\chi}\right)$$

TACAN antennas are of the tilted array type illustrated by the representative normalized directivity pattern shown in figure 6-33. The pattern is tilted up in order to discriminate against the ground reflected ray. The up-tilt is such that maximum radiation occurs at an angle, χ^o, of approximately 5^o to 15^o. Discrimination against the ground-reflected ray results in a shallow null and a field strength that is close to the free space value.

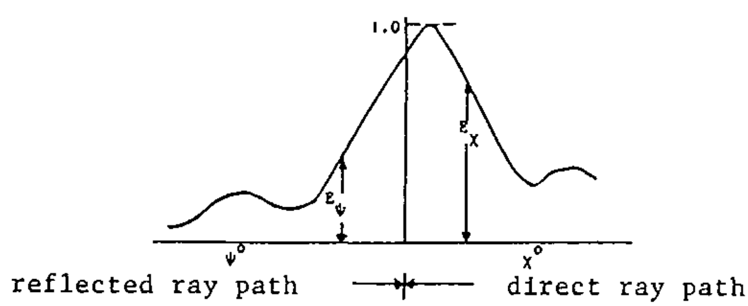


FIGURE 6-33. TYPICAL NORMALIZED FREE SPACE DIRECTIVITY PATTERN

(6) In the consideration of the wave theory of propagation each point on the expanding sphere of radiated energy may be considered as a secondary source which radiates energy in all forward directions. In the transmission of energy in free space from a transmitter to a receiver, there are, in reality, an infinite number of paths to consider. Now suppose a plane is placed perpendicular to the line between T and R (transmitter and receiver), and concentric circles are drawn which represent the loci of the origin of secondary waves traveling to R. When the radii of these circles are so chosen that the total path length from T to R via a point on the circle increases in increments of a half wavelength over the direct path from T to R, then the zones, as represented by the successive areas within the circles, are called Fresnel zones. In the volume of space between T and R, if there are no obstructing bodies such as buildings or hills, a given Fresnel zone outlines an ellipsoid of revolution having a circular cross-section centered on the axis between T and R.

(7) With transmitter and receiver located over a smooth spherical earth, it is evident that the earth will intersect certain of the Fresnel zones, depending on the elevations of T and R. The area of the earth's surface which intersects the zones (now the reflecting area) is elliptical, and most of the reflection occurs within the first Fresnel zone, the zone in which the path length via a point on the circle is one-half wavelength longer than the direct path from T to R. On the assumption that the earth is flat over the relatively small distances involved when using moderate-height transmitting and receiving antennas, the radial limits of the reflecting area (the limits of the major axis of the ellipse) for the first Fresnel zone, as measured from the transmitter location, are given by,

$$\ell_o = d_1\,(1 + 2a) - 2d_1\,\sqrt{a(1 + a)}$$

in units of d_1

$$\ell_1 = d_1\,(1 + 2a) + 2d_1\,\sqrt{a(1 + a)}$$

in units of d_1

where

$$a = \frac{\lambda}{4\,h_1 \sin \Psi} \quad \text{(dimensionless with } \lambda \text{ and } h_1 \text{ in same units)}$$

$$= \frac{246}{f_{MHz}\,h_1 \sin \Psi} \quad \text{(with } h_1\text{, transmitter height in feet)}$$

The minor axis or width of the ellipse at its center (normal to the radial) is given by,

$$w = 4h_1\,\sqrt{a(1 + a)}$$

in units of h_1

(8) In choosing a possible site for a TACAN antenna the system planner must consider the following important rule for the propagation path chosen:

The first Fresnel zone should be clear of obstructing objects in order to minimize fading.

A vertical plane profile showing the concept of first Fresnel zone clearance over a rough earth terrain is shown in figure 6-34. The radius R on the locus which establishes the ellipse, at any distance d for a path length r_o, is given by,

$$R = \left\{ \frac{\lambda}{4} \left(r_o + \frac{\lambda}{4}\right) \left[1 - \frac{4(2d - r_o)2}{(2r_o + \lambda)^2} \right] \right\}^{\frac{1}{2}}$$

or when the wavelength $\lambda < r_o$, then

$$R = \left\{ \frac{\lambda d(r_o - d)}{r_o} \right\}^{\frac{1}{2}}$$

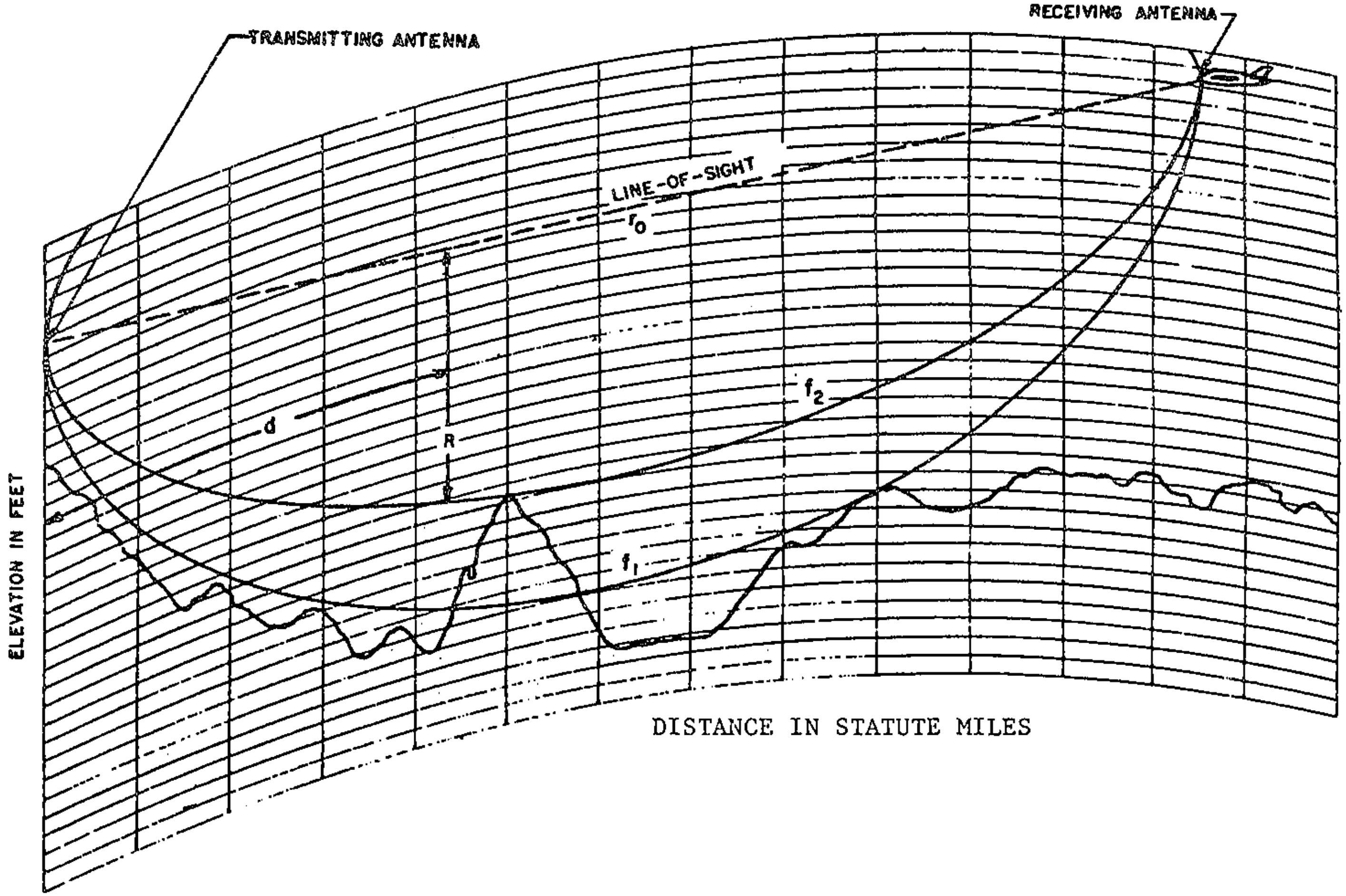
Whether the obstructions are hills or buildings does not alter the concept. A choice of site such that more than one Fresnel zone is clear of obstructions will not necessarily improve the situation, since reflection from outside the first Fresnel zone could then arrive out of phase, and the familiar lobe structure would be present, especially if these reflecting surfaces were smooth earth or water. Variations in the refractive index would then cause these lobes to shift up and down, thereby causing fading.

c. Graphic Procedure for Determining Distribution and Depth of Nulls

(1) The following nomographic procedure, to be described in detail, is appropriate for determining the distribution and depth of nulls in the TACAN vertical radiation pattern due to earth reflection:

(a) Determine the value of the earth radius factor, k.

(b) Using the curves of figures 6-35 through 6-40, determine the grazing angle ψ for arbitrarily chosen nulls. The first several nulls will usually be the deepest and are likely to be the ones that will create navigation problems.



NOTES:

1. Earth radius k used to correct for atmosphere refraction.
2. Antennas located at foci of ellipse.
3. f_2 greater than f_1.
4. d is distance to desired point on the ellipse.

FIGURE 6-34. PROFILE CHART SHOWING FIRST FRESNEL ZONE ELLIPSES

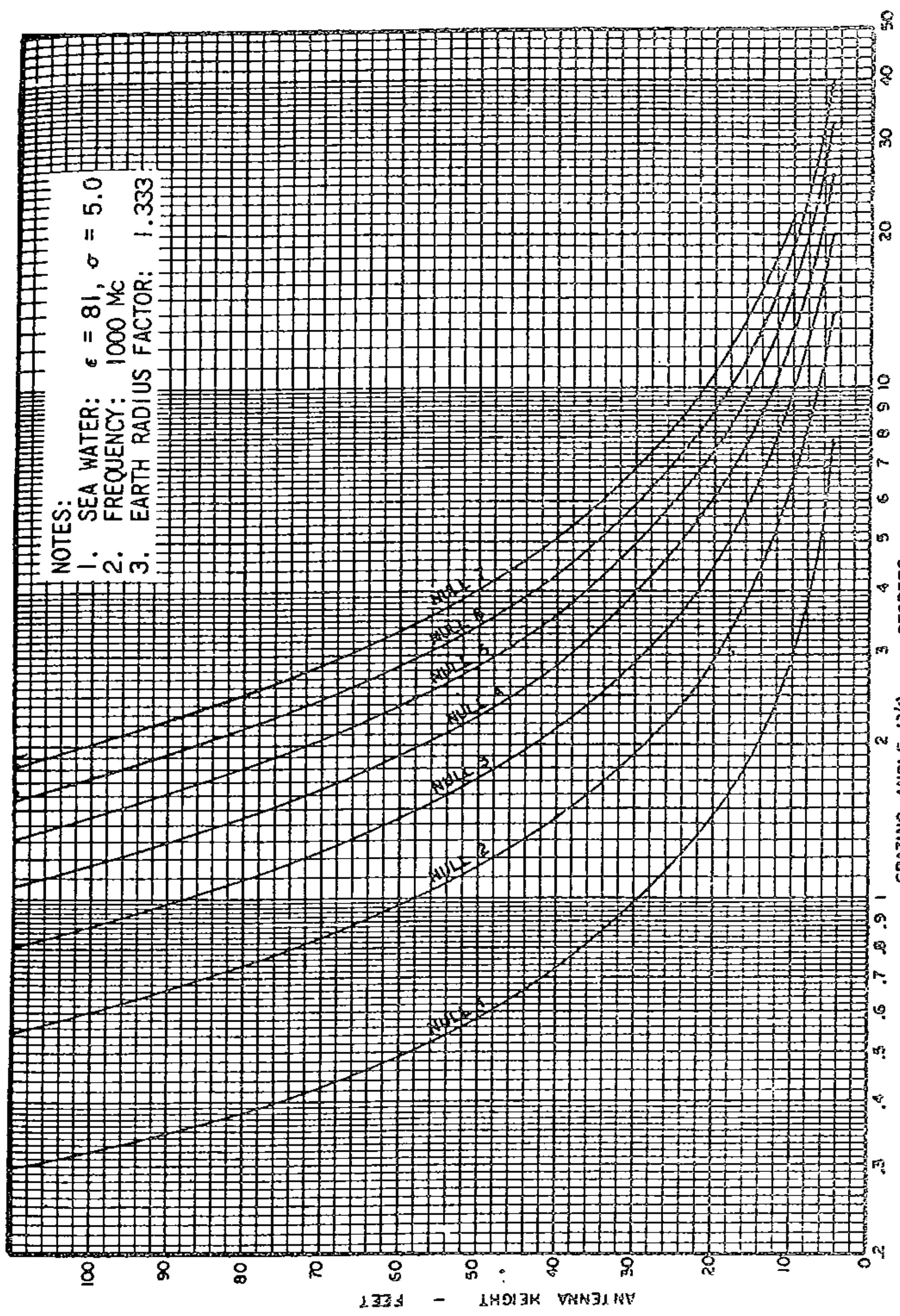


FIGURE 6-35. GRAZING ANGLES FOR NULLS AS A FUNCTION OF ANTENNA HEIGHT (FOR SEA WATER, FREQUENCY = 1000 Mc)

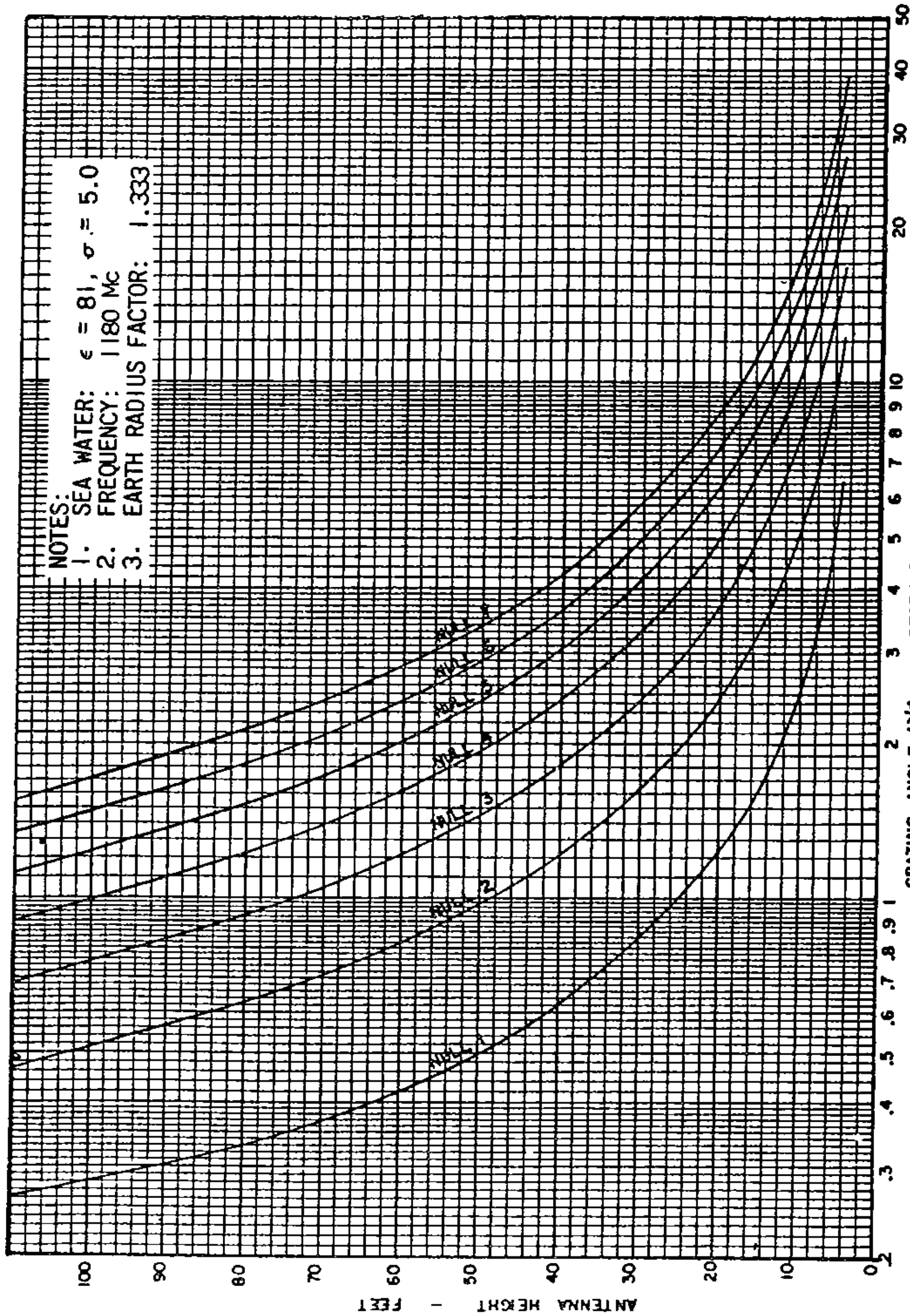


FIGURE 6-36. GRAZING ANGLES FOR NULLS AS A FUNCTION OF ANTENNA HEIGHT (FOR SEA WATER, FREQUENCY = 1180 Mc)

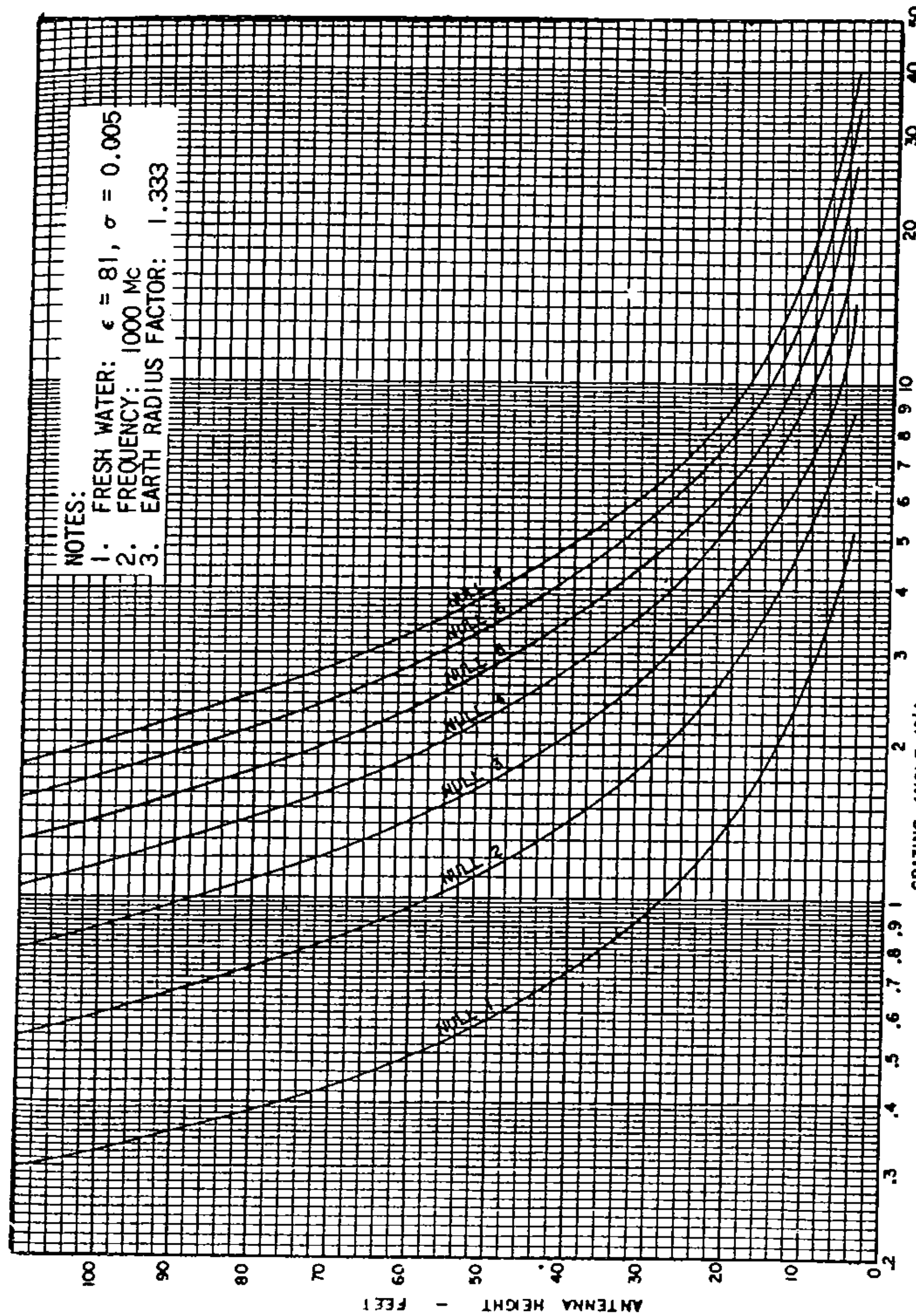


FIGURE 6-37. GRAZING ANGLES FOR NULLS AS A FUNCTION OF ANTENNA HEIGHT
(FOR FRESH WATER, FREQUENCY = 1000 Mc)

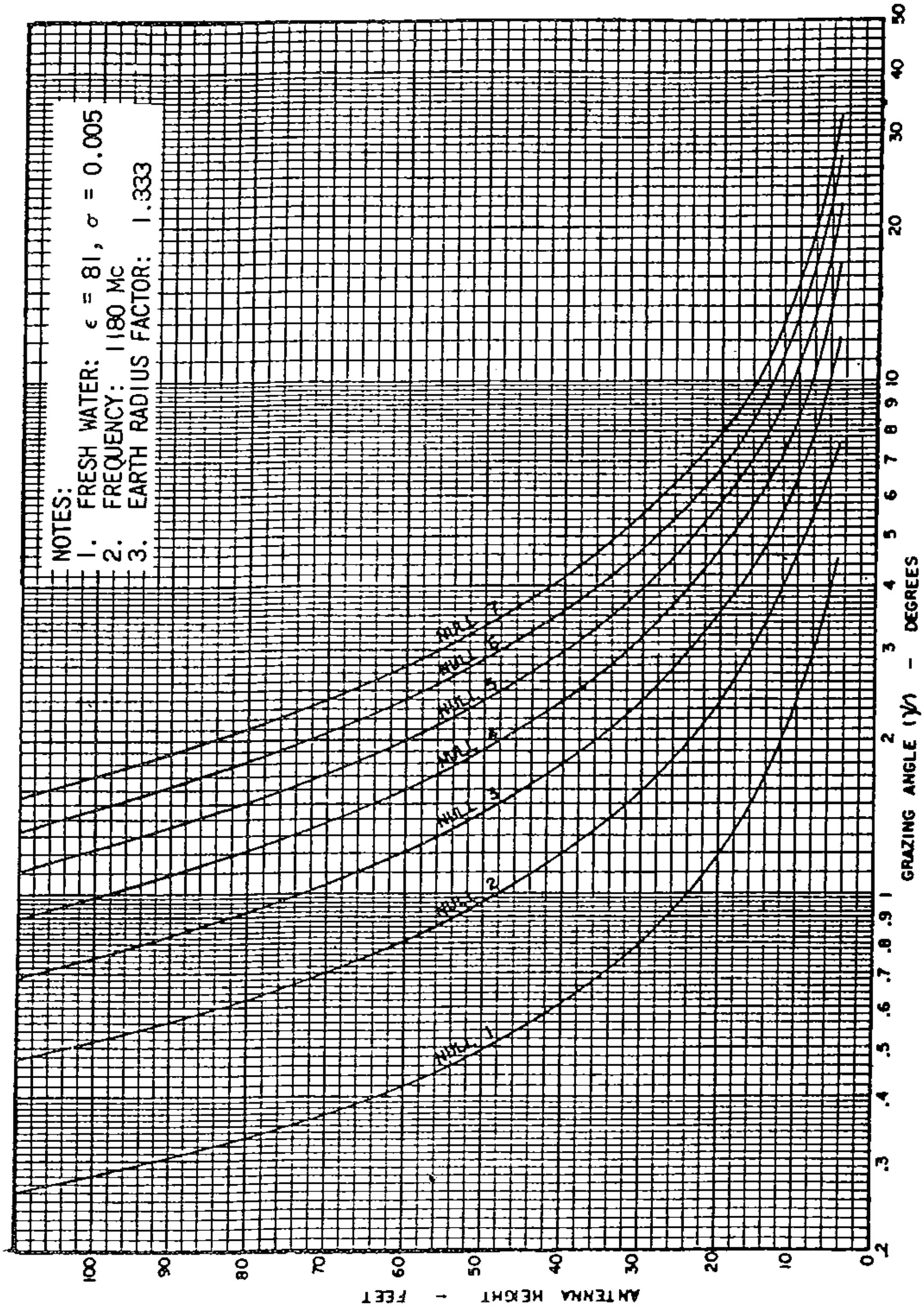


FIGURE 6-38. GRAZING ANGLES FOR NULLS AS A FUNCTION OF ANTENNA HEIGHT (FOR FRESH WATER, FREQUENCY = 1180 Mc)

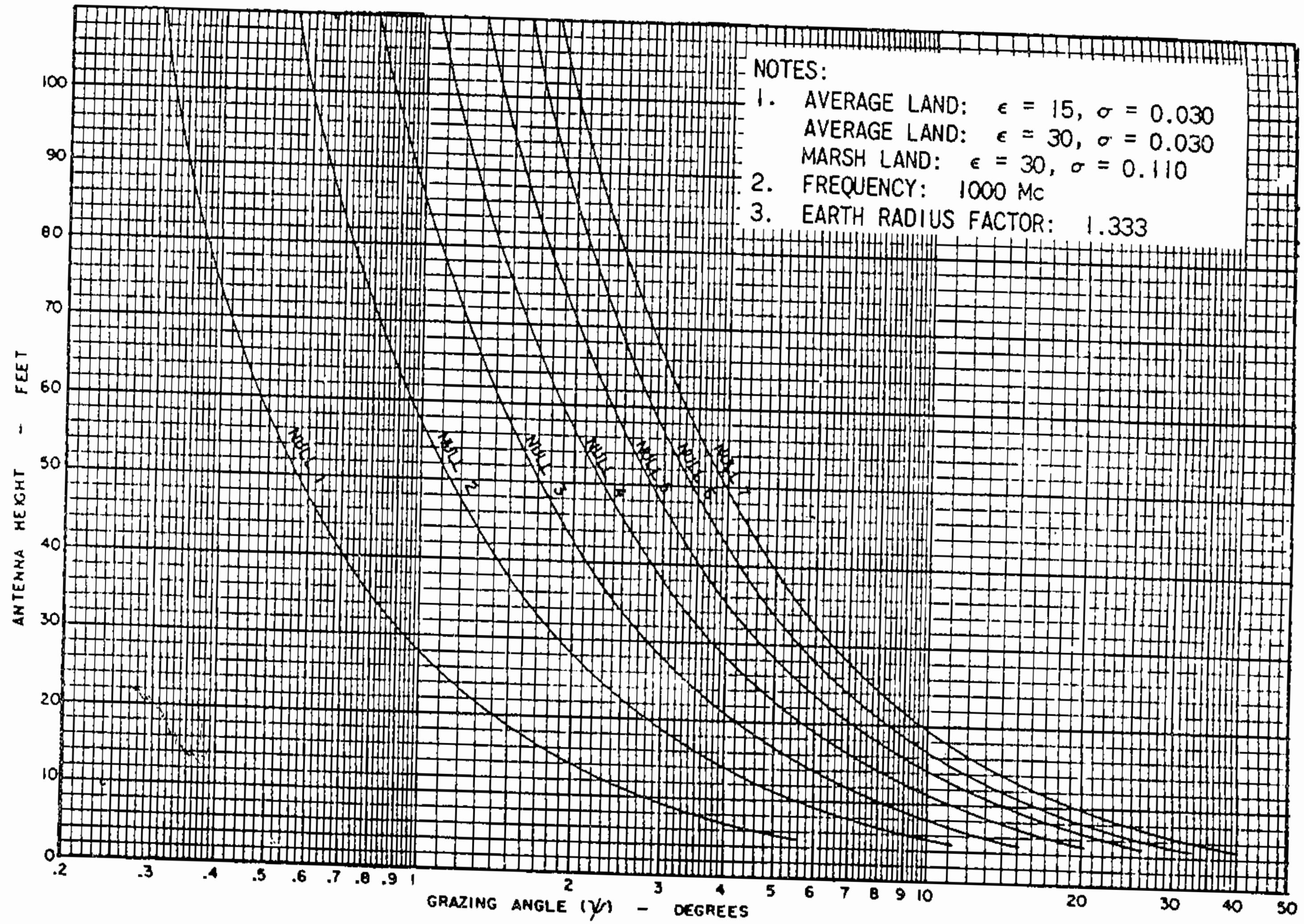


FIGURE 6-39. GRAZING ANGLES FOR NULLS AS A FUNCTION OF ANTENNA HEIGHT (FOR AVERAGE LAND, FREQUENCY = 1000 Mc)

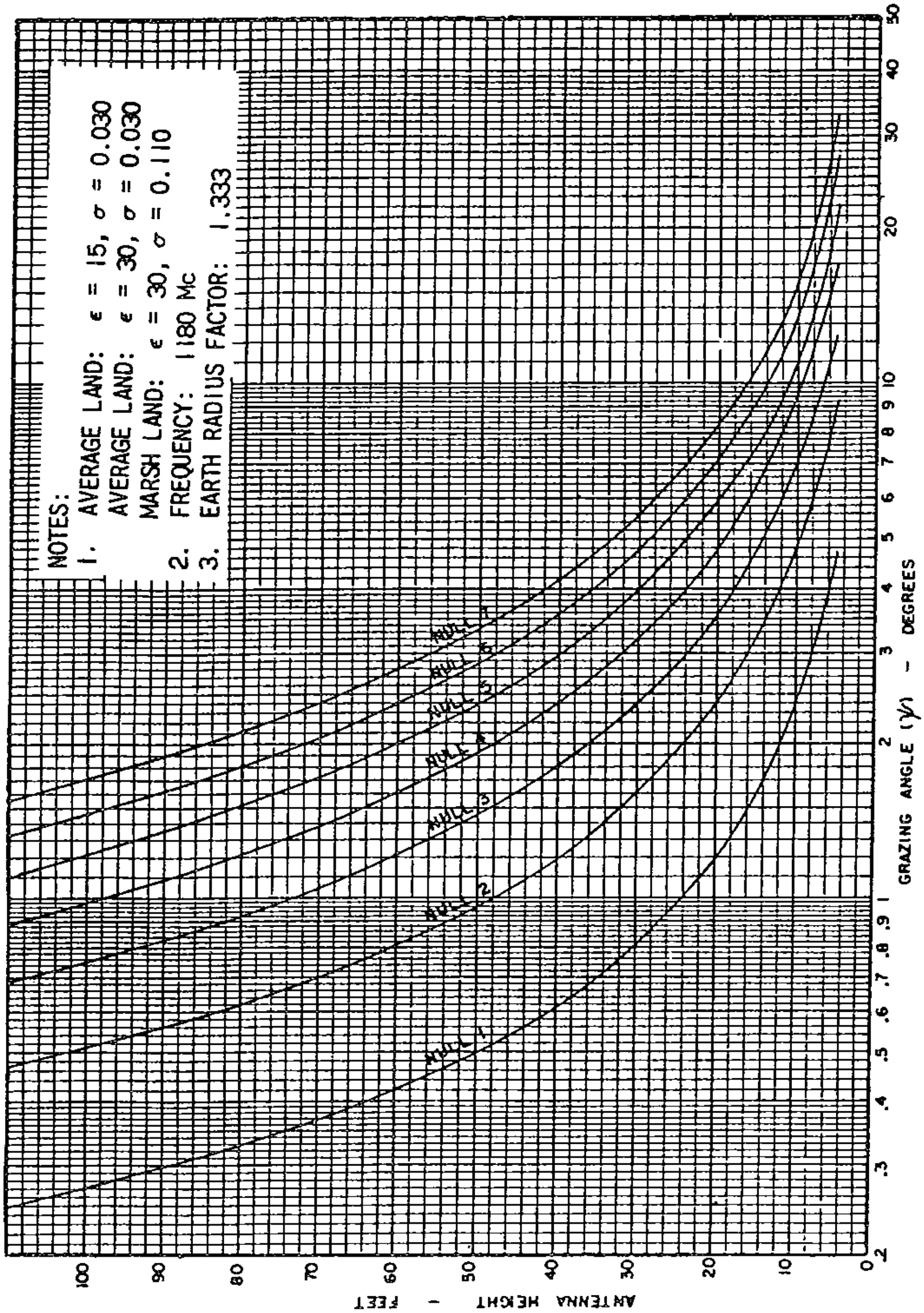


FIGURE 6-40. GRAZING ANGLES FOR NULLS AS A FUNCTION OF ANTENNA HEIGHT
(FOR AVERAGE LAND, FREQUENCY = 1180 Mc)

(c) Using the curves of figures 6-41 through 6-46, determine the distance d to the center of reflection of the Fresnel zone for the parameters under consideration.

(d) In this graphical method, obtain the value of the radiation angle χ by assuming that it is approximately equal to the grazing angle ψ. It will be shown that the error introduced by this approximation is negligible.

(e) Determine the free-space directivity of the downward directed ray corresponding to the grazing angle ψ. For this purpose, use the directivity pattern for the antenna used. Typical patterns are shown in figures 6-47 and 6-48. If the pattern for the specific antenna is not available, it is permissible to use the pattern from an antenna having the same number of active elements.

(f) Determine the free-space directivity of the upward directed direct ray using the methods just described for the downward directed ray.

(g) Determine the divergence factor D from figures 6-49a, 6-49b, and 6-49c.

(h) Using figures 6-23 through 6-29, determine the magnitude of the reflection coefficient.

(i) Determine the earth gain factor, $g(\sigma)_{dB}$, for the null under consideration using the equation

$$g(\sigma)_{dB} = 20 \log \left[1 - DR \frac{E_\psi}{E_\chi} \right] \text{(nulls)}$$

Note that neither E_ψ nor E_χ need be known -- only their relative amplitudes.

(j) Calculate points on the locus of the maxima of $g(\sigma)$ using the equation

$$g(\sigma)_{dB} = 20 \log \left[1 + DR \frac{E_\psi}{E_\chi} \right] \text{(maxima)}$$

These points do not locate lobe maxima, they are simply points on the locii of maxima.

(k) Determine the beacon distance corresponding to the grazing angle considered. Refer to figures 6-50 through 6-52.

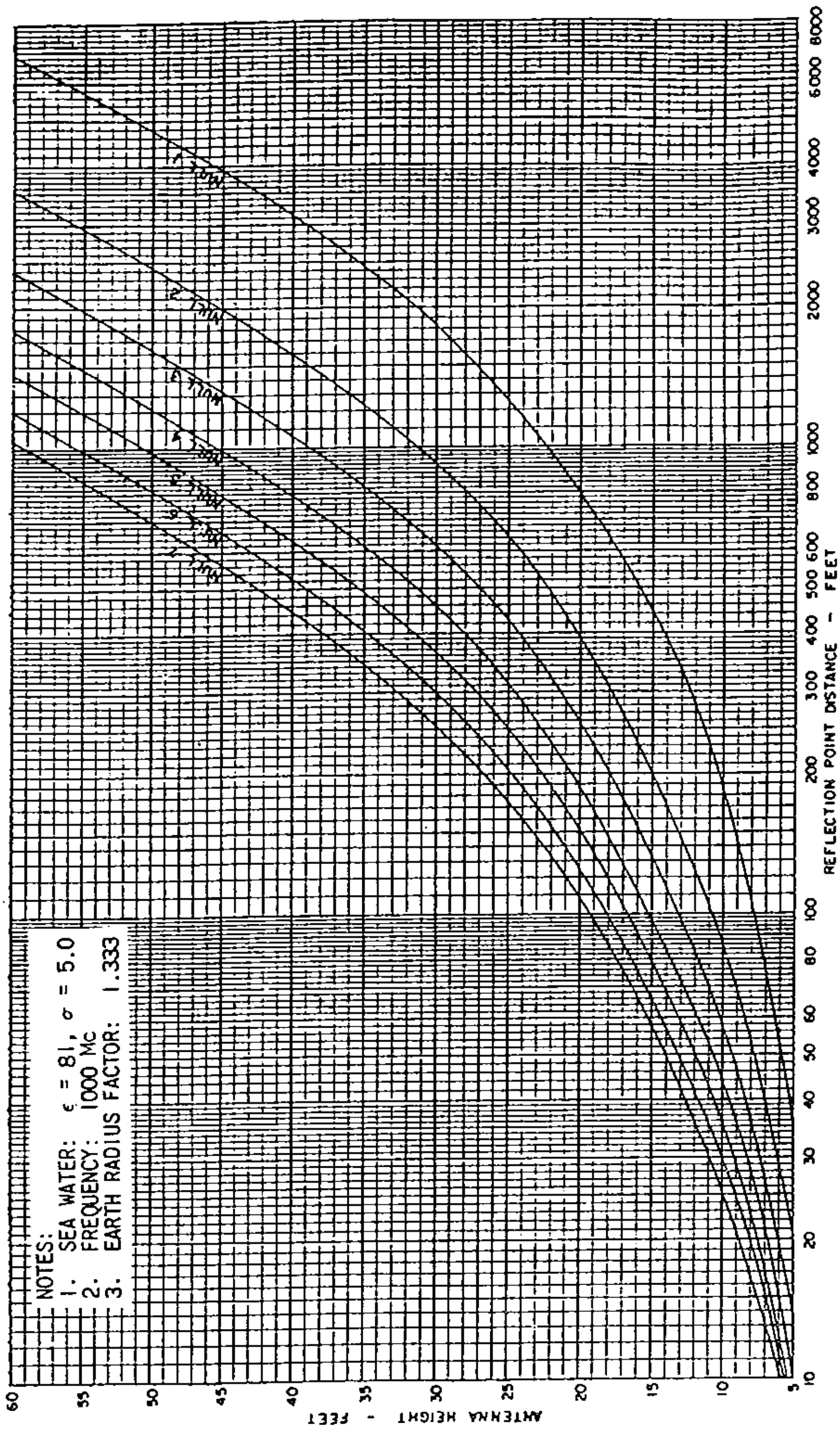


FIGURE 6-41. DISTANCE TO MEAN REFLECTION POINT FOR NULLS AS A FUNCTION OF ANTENNA HEIGHT (FOR SEA WATER, FREQUENCY = 1000 Mc)

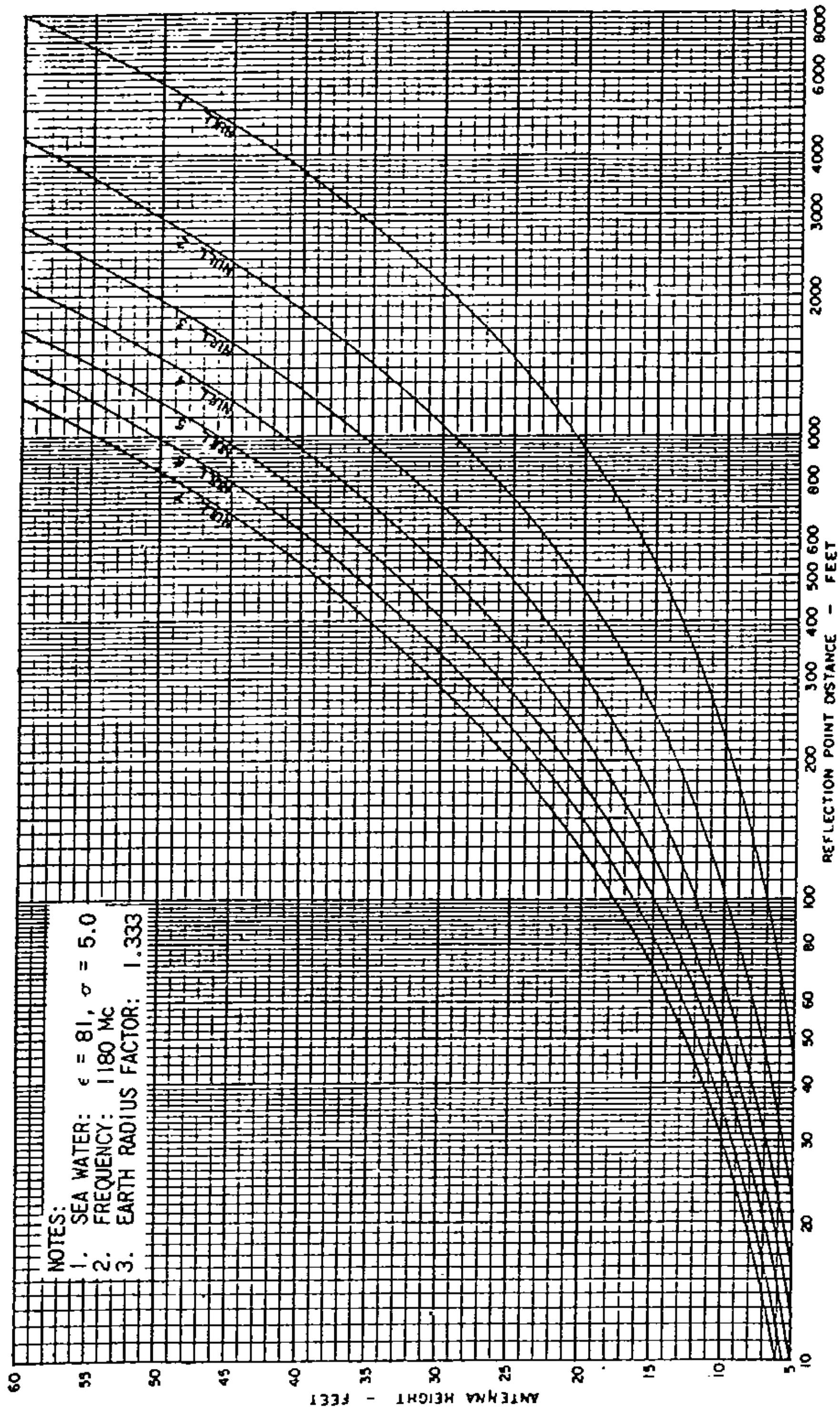


FIGURE 6-42. DISTANCE TO MEAN REFLECTION POINT FOR NULLS AS A FUNCTION OF ANTENNA HEIGHT (FOR SEA WATER, FREQUENCY = 1180 Mc)

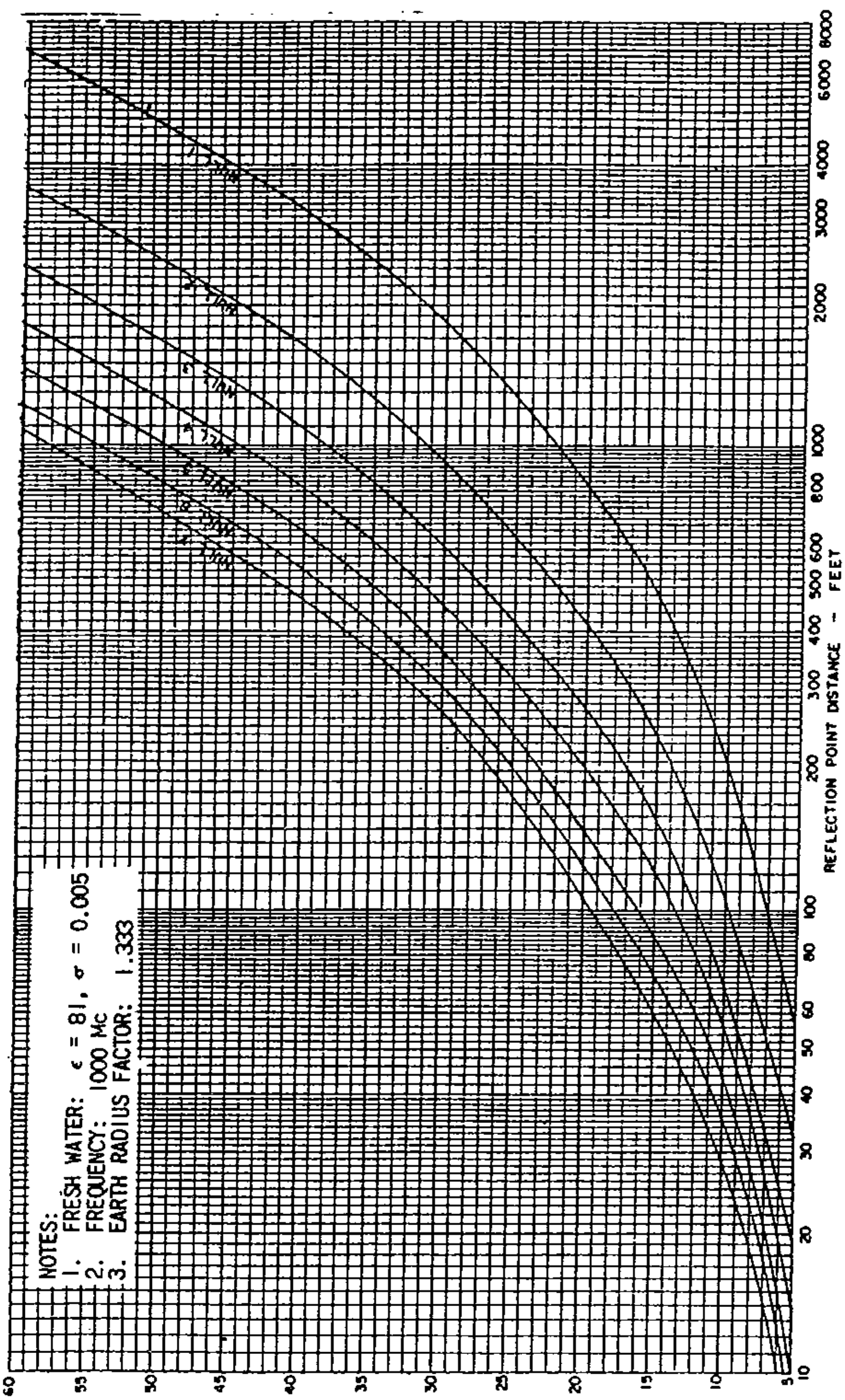


FIGURE 6-43. DISTANCE TO MEAN REFLECTION POINT FOR NULLS AS A FUNCTION OF ANTENNA HEIGHT (FOR FRESH WATER, FREQUENCY = 1000 Mc)

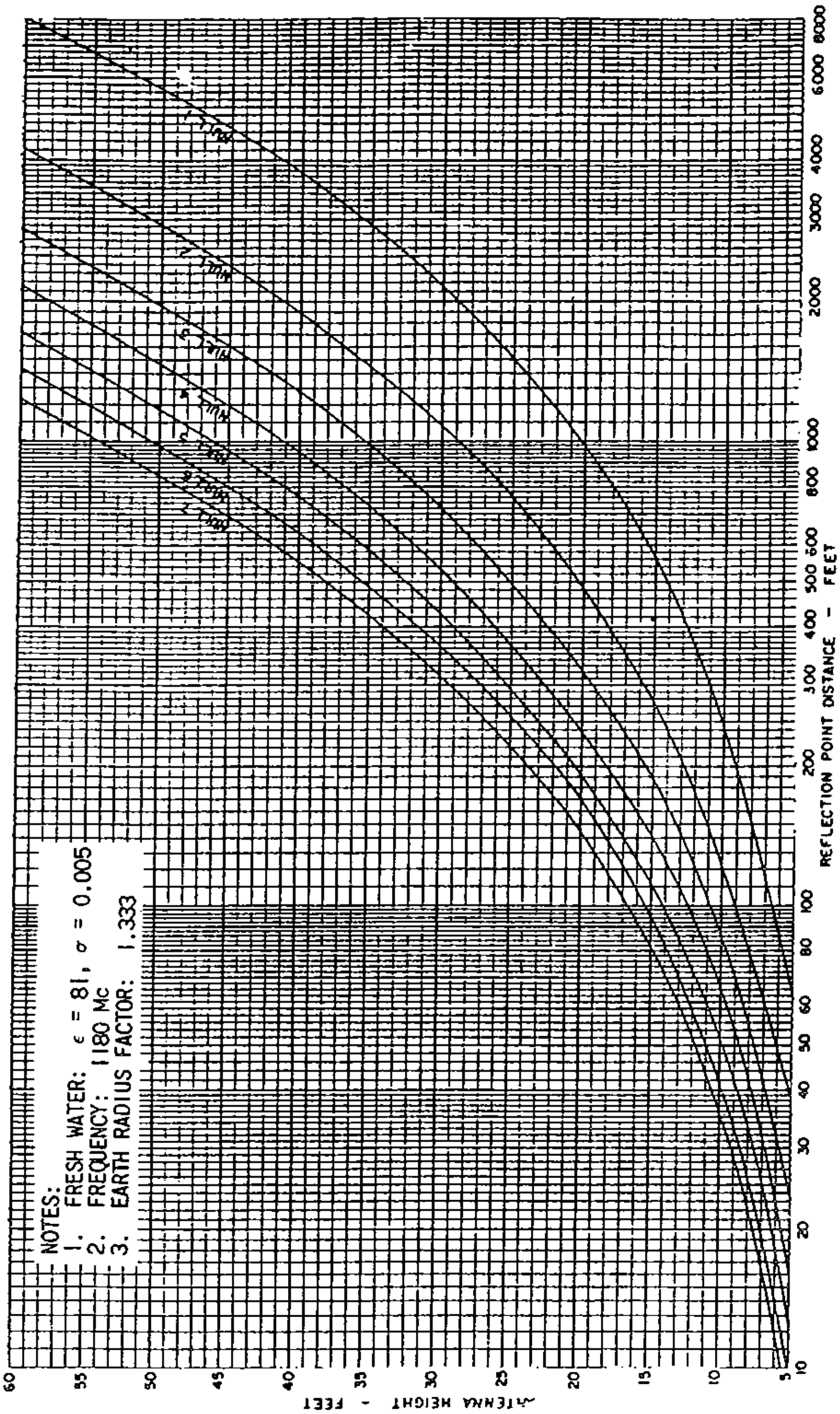


FIGURE 6-44. DISTANCE TO MEAN REFLECTION POINT FOR NULLS AS A FUNCTION OF ANTENNA HEIGHT (FOR FRESH WATER, FREQUENCY = 1180 Mc)

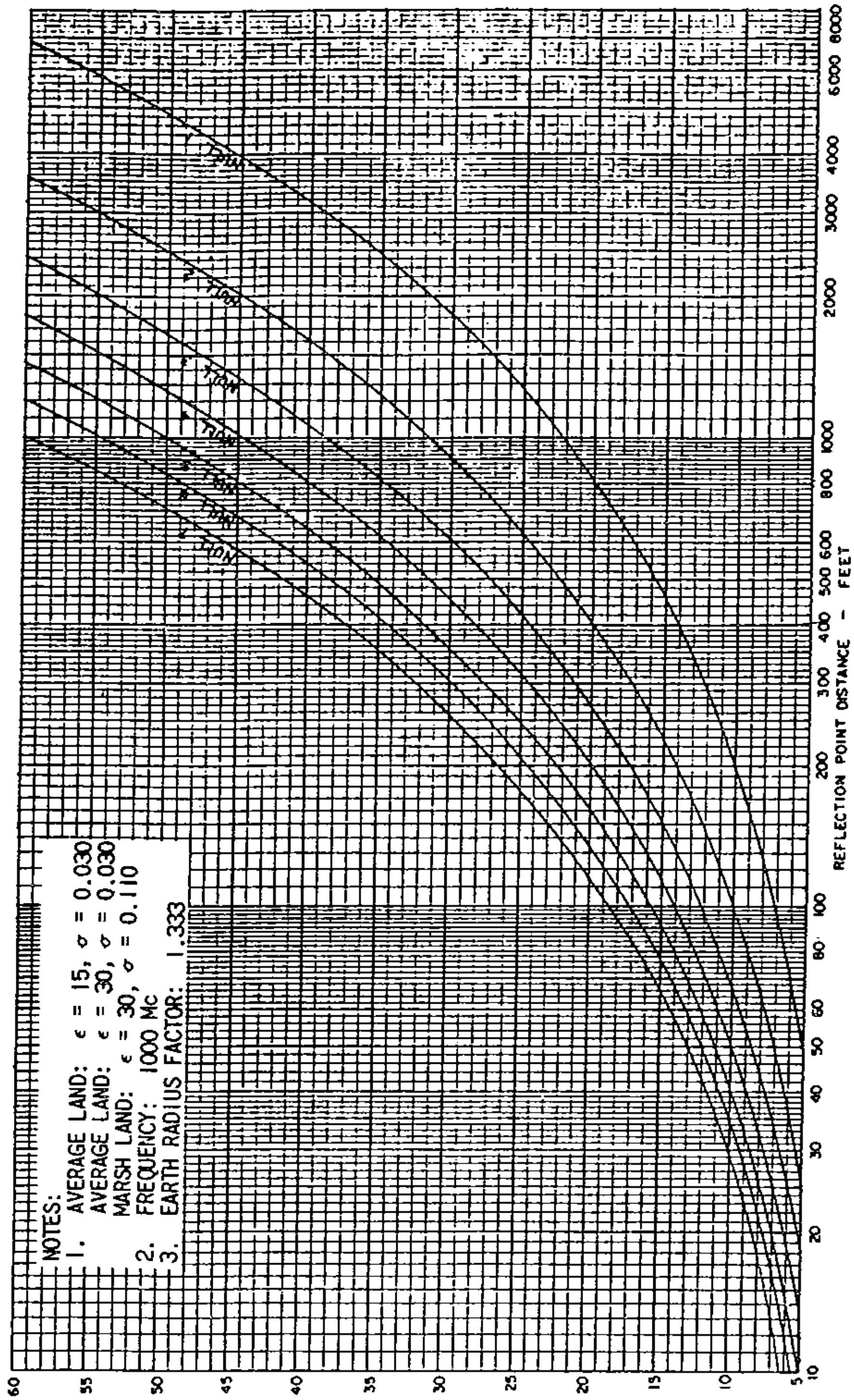


FIGURE 6-45. DISTANCE TO MEAN REFLECTION POINT FOR NULLS AS A FUNCTION OF ANTENNA HEIGHT
(FOR AVERAGE LAND, FREQUENCY = 1000 Mc)

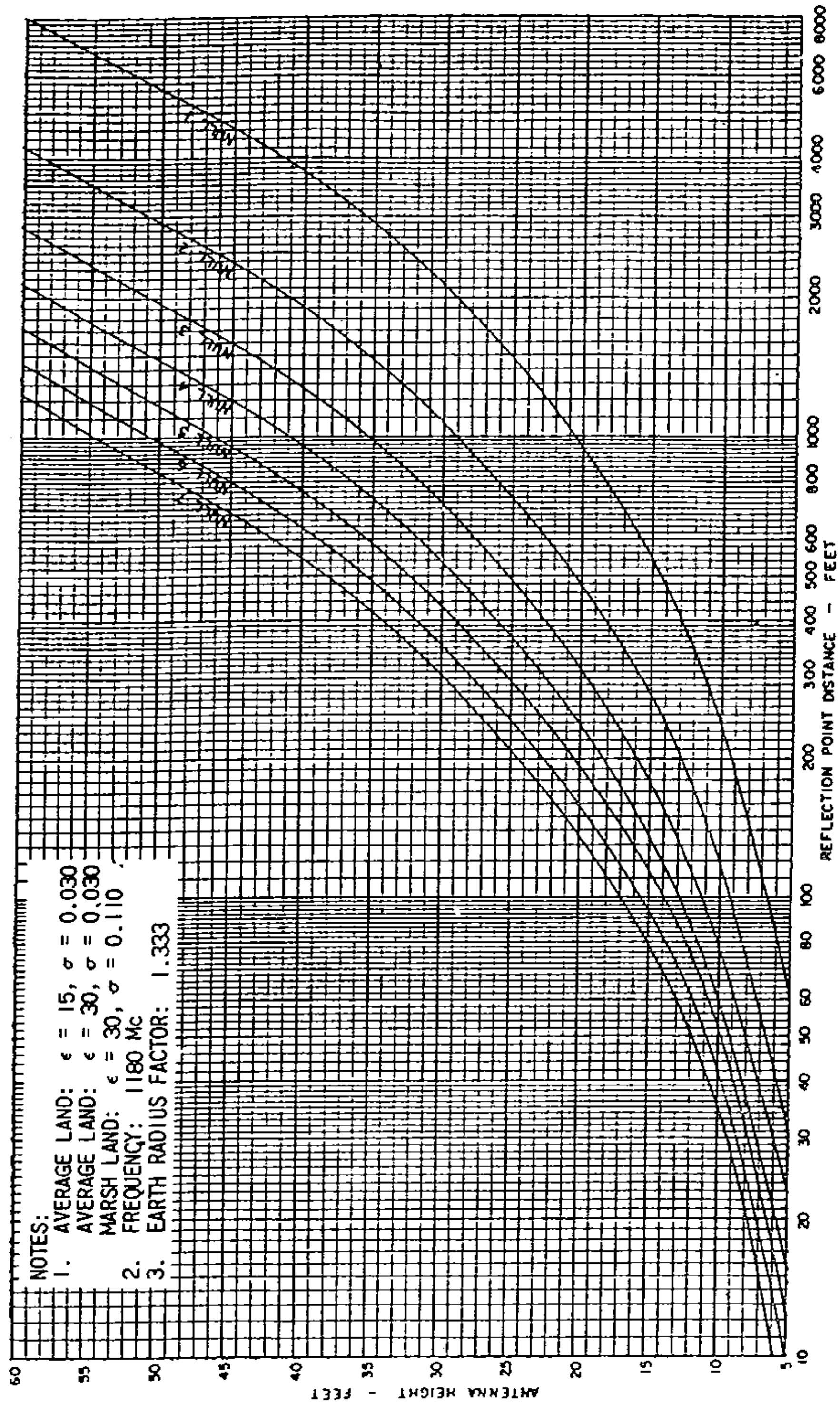


FIGURE 6-46. DISTANCE TO MEAN REFLECTION POINT FOR NULLS AS A FUNCTION OF ANTENNA HEIGHT (FOR AVERAGE LAND, FREQUENCY = 1180 Mc)

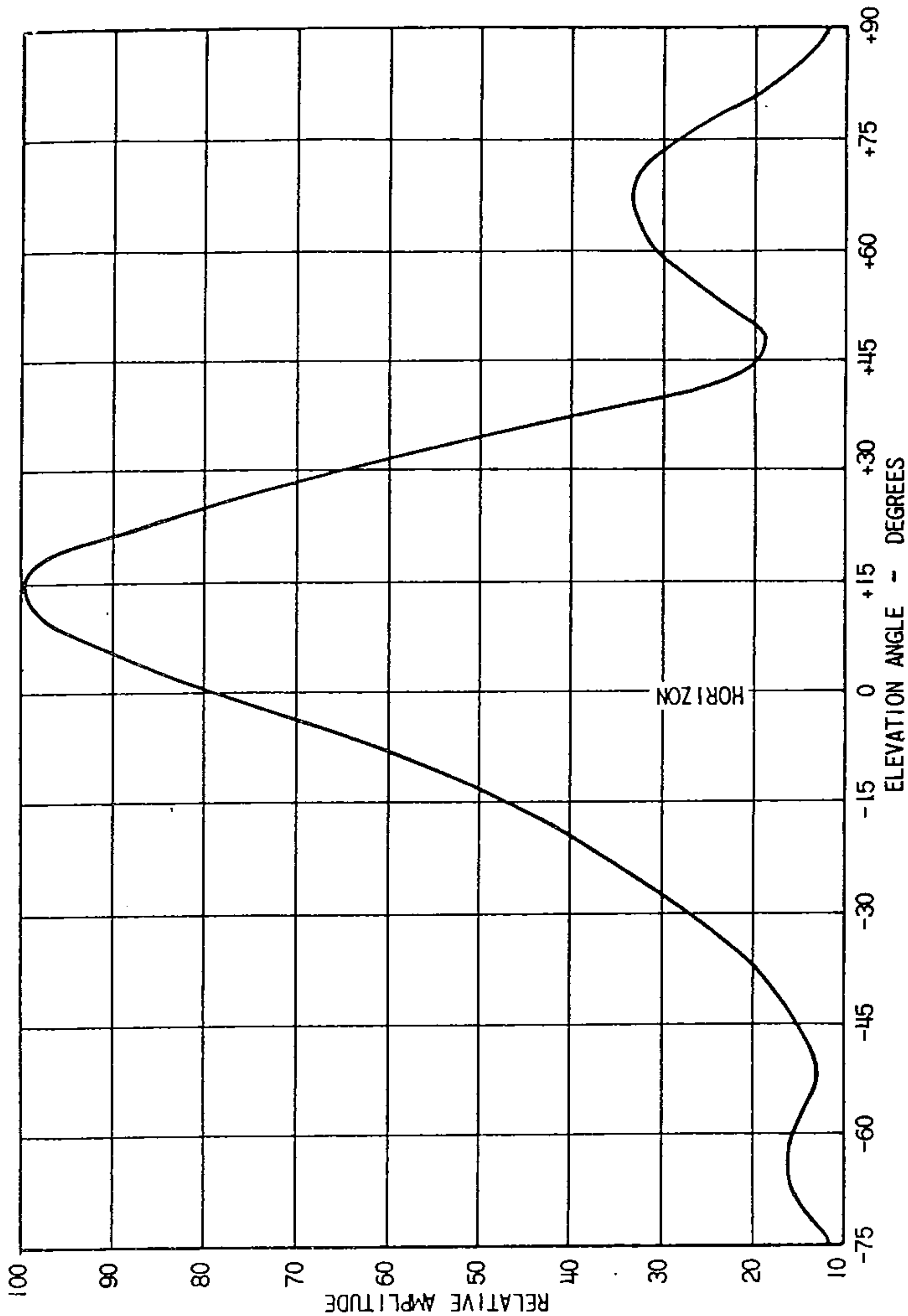


FIGURE 6-47. FREE SPACE DIRECTIVITY PATTERN FOR THE AT-1056/GRA-60 AT 992 Mc

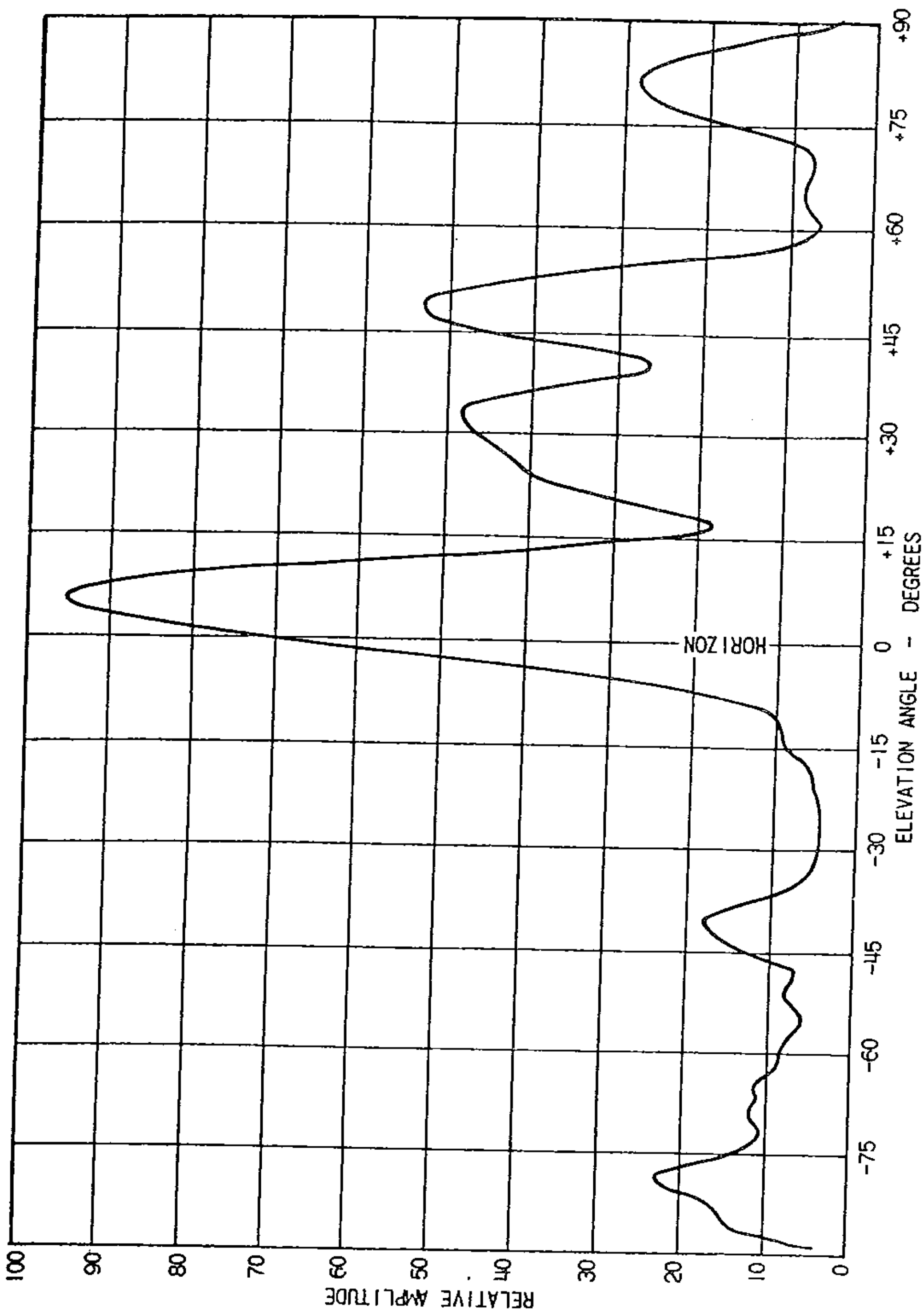


FIGURE 6-48. FREE SPACE DIRECTIVITY PATTERN FOR THE OA-592/URN-3 AT 992 Mc

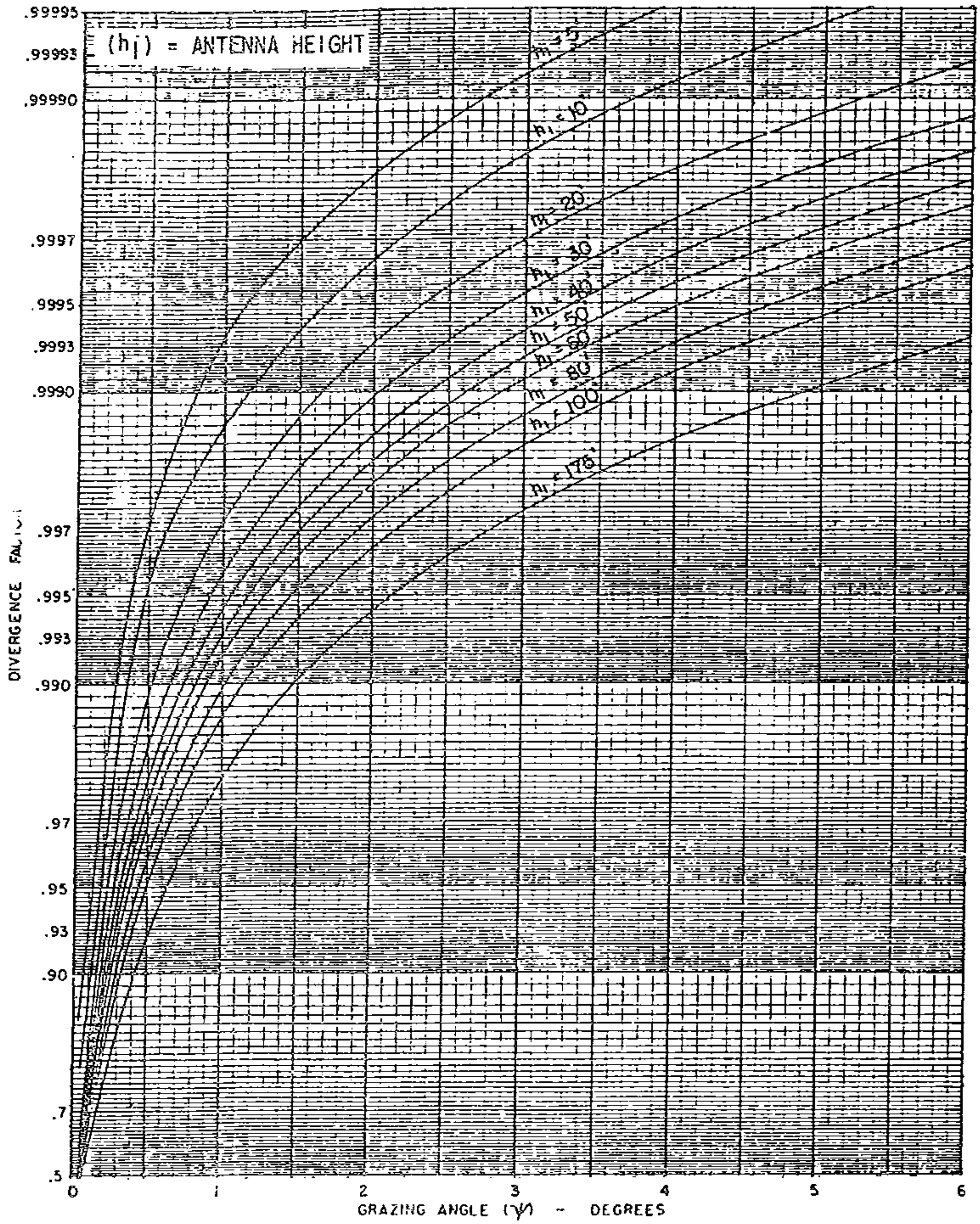


FIGURE 6-49a. DIVERGENCE FACTOR FOR AN EARTH-RADIUS FACTOR OF 1.166

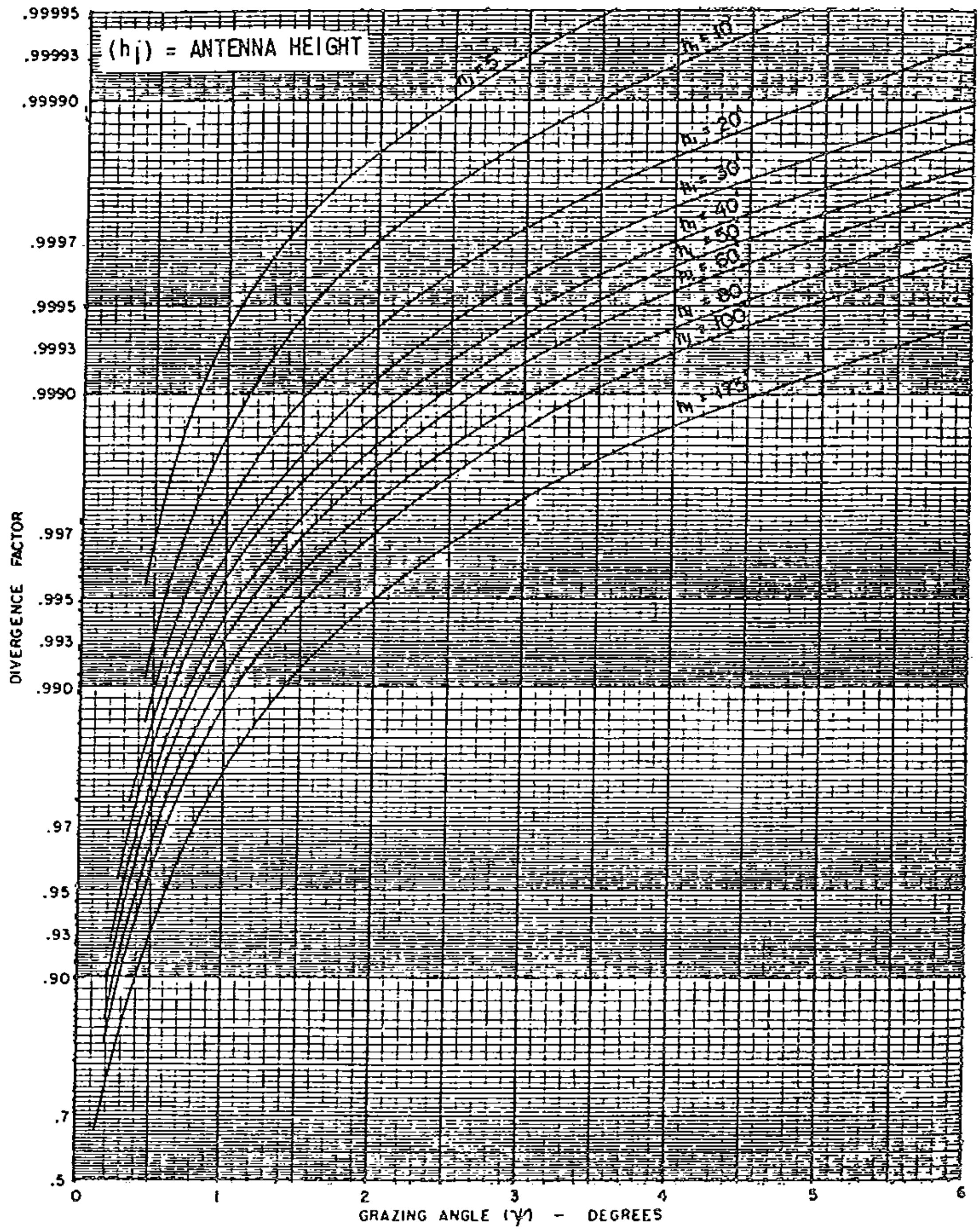


FIGURE 6-49b. DIVERGENCE FACTOR FOR AN EARTH-RADIUS FACTOR OF 1.333

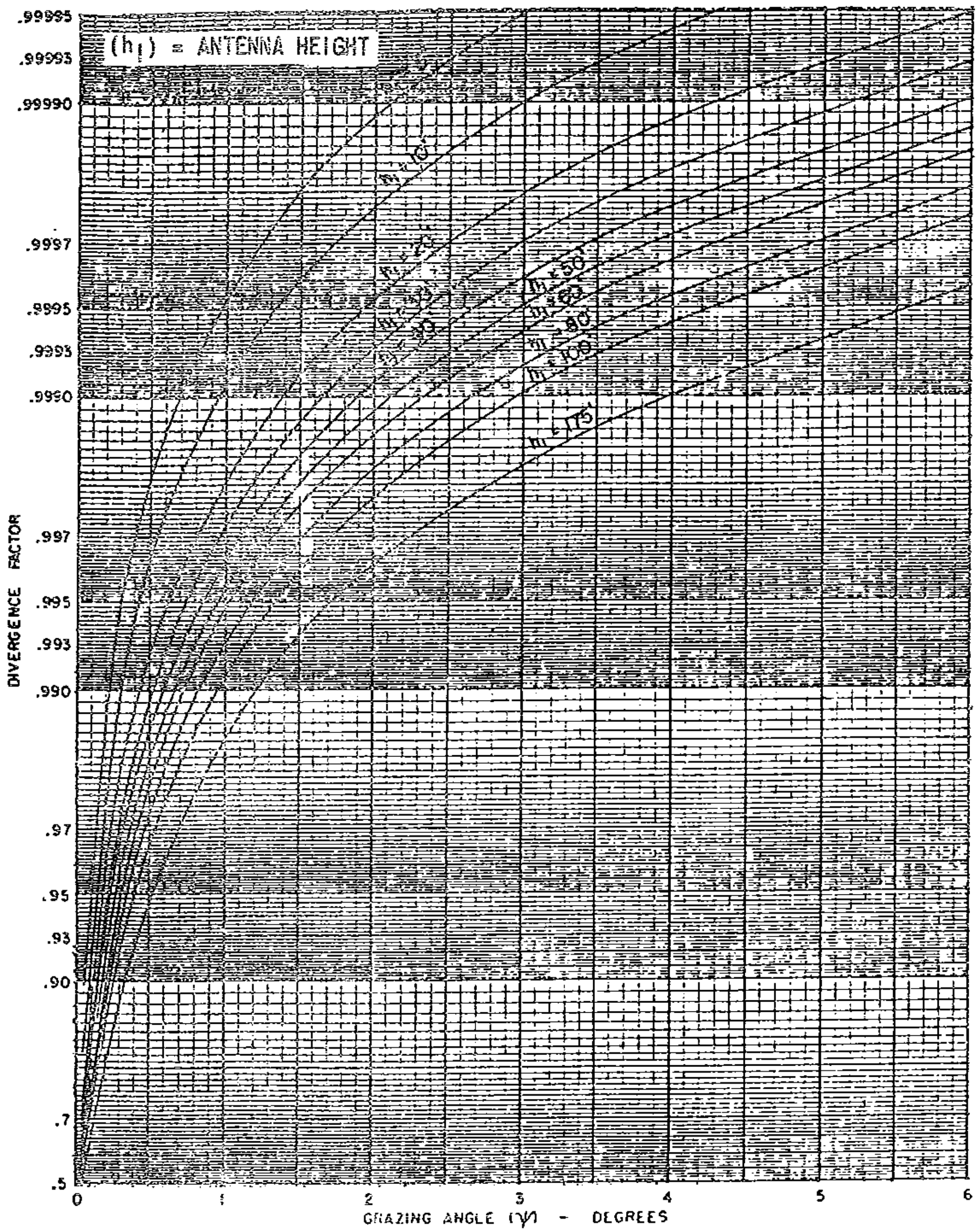


FIGURE 6-49c. DIVERGENCE FACTOR FOR AN EARTH-RADIUS FACTOR OF 1.766

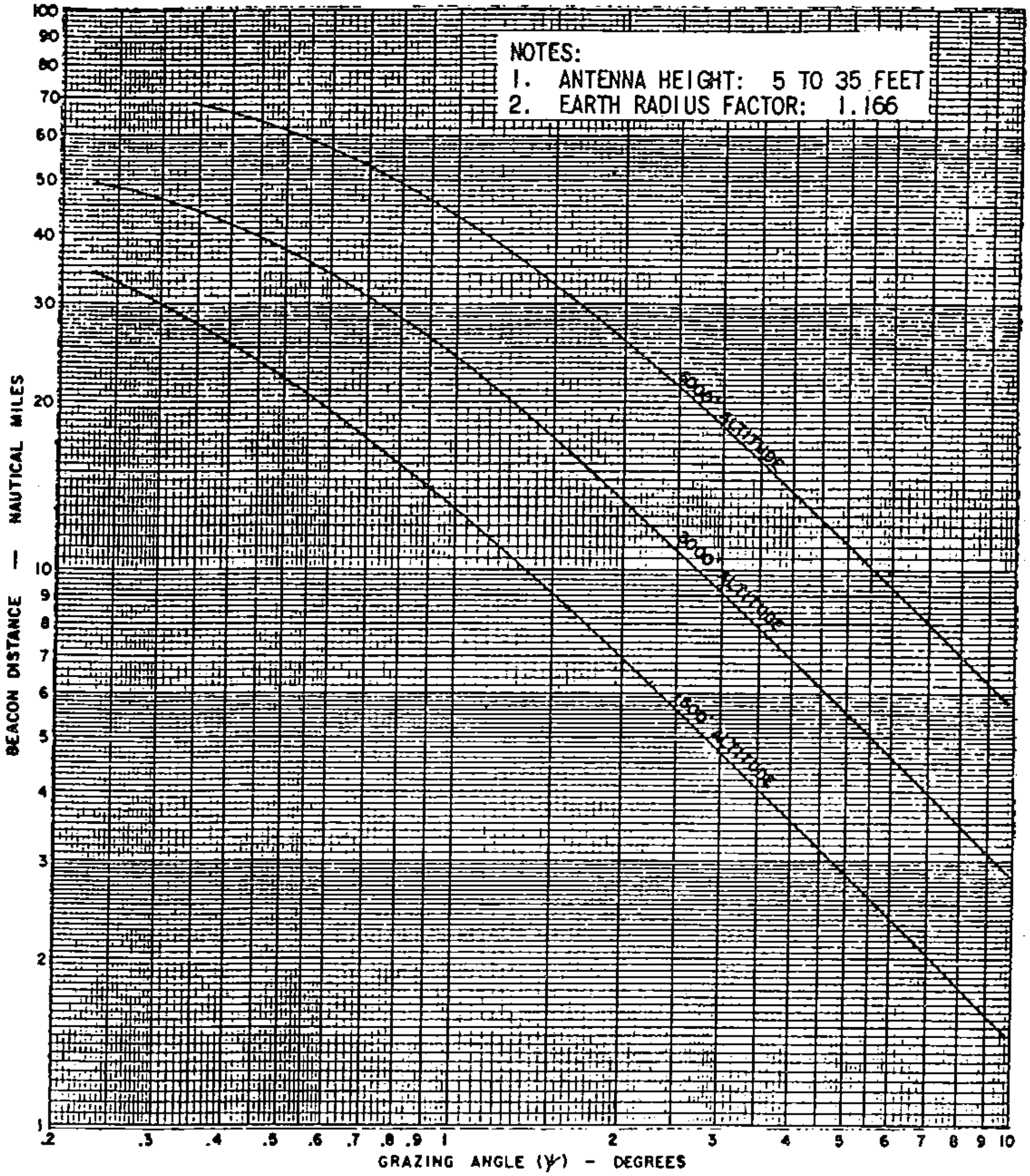


FIGURE 6-50a. BEACON DISTANCE AS A FUNCTION OF GRAZING ANGLE (ANTENNA HEIGHT 5 to 35 FEET, EARTH-RADIUS FACTOR OF 1.166)

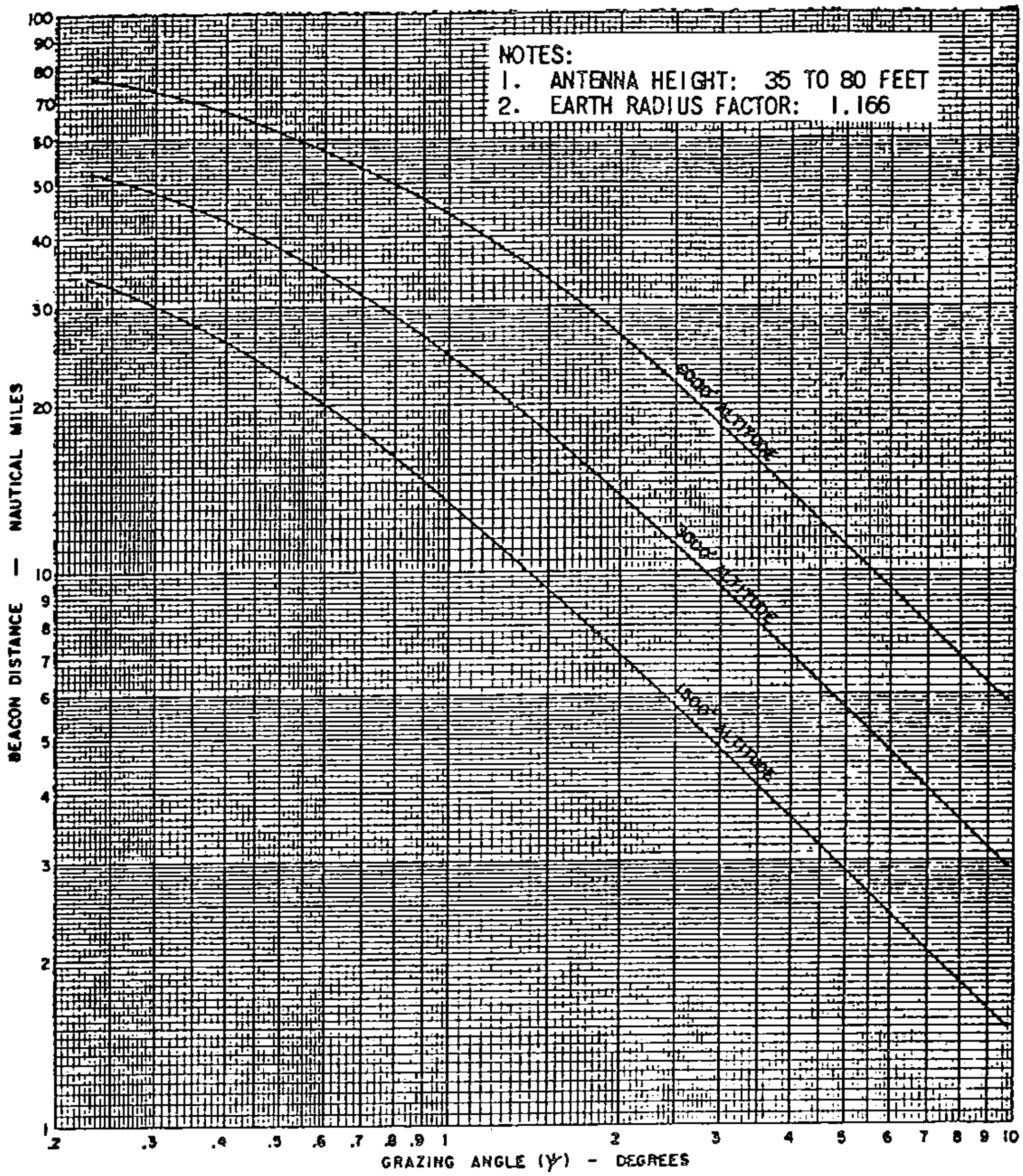


FIGURE 6-50b. BEACON DISTANCE AS A FUNCTION OF GRAZING ANGLE (ANTENNA HEIGHT 35 to 80 FEET, EARTH-RADIUS FACTOR OF 1.166)

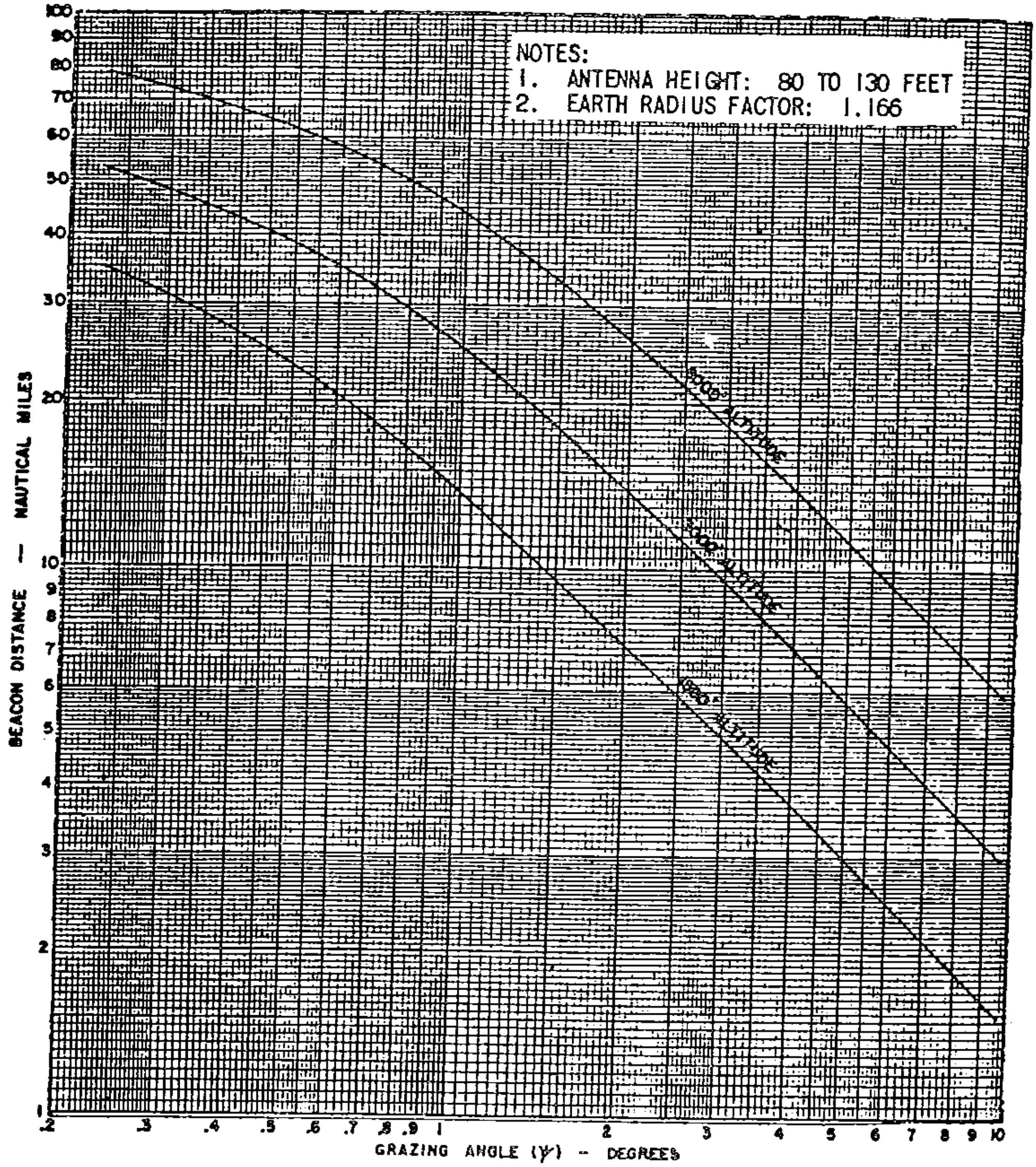


FIGURE 6-50c. BEACON DISTANCE AS A FUNCTION OF GRAZING ANGLE (ANTENNA HEIGHT 80 to 130 FEET, EARTH-RADIUS FACTOR OF 1.166).

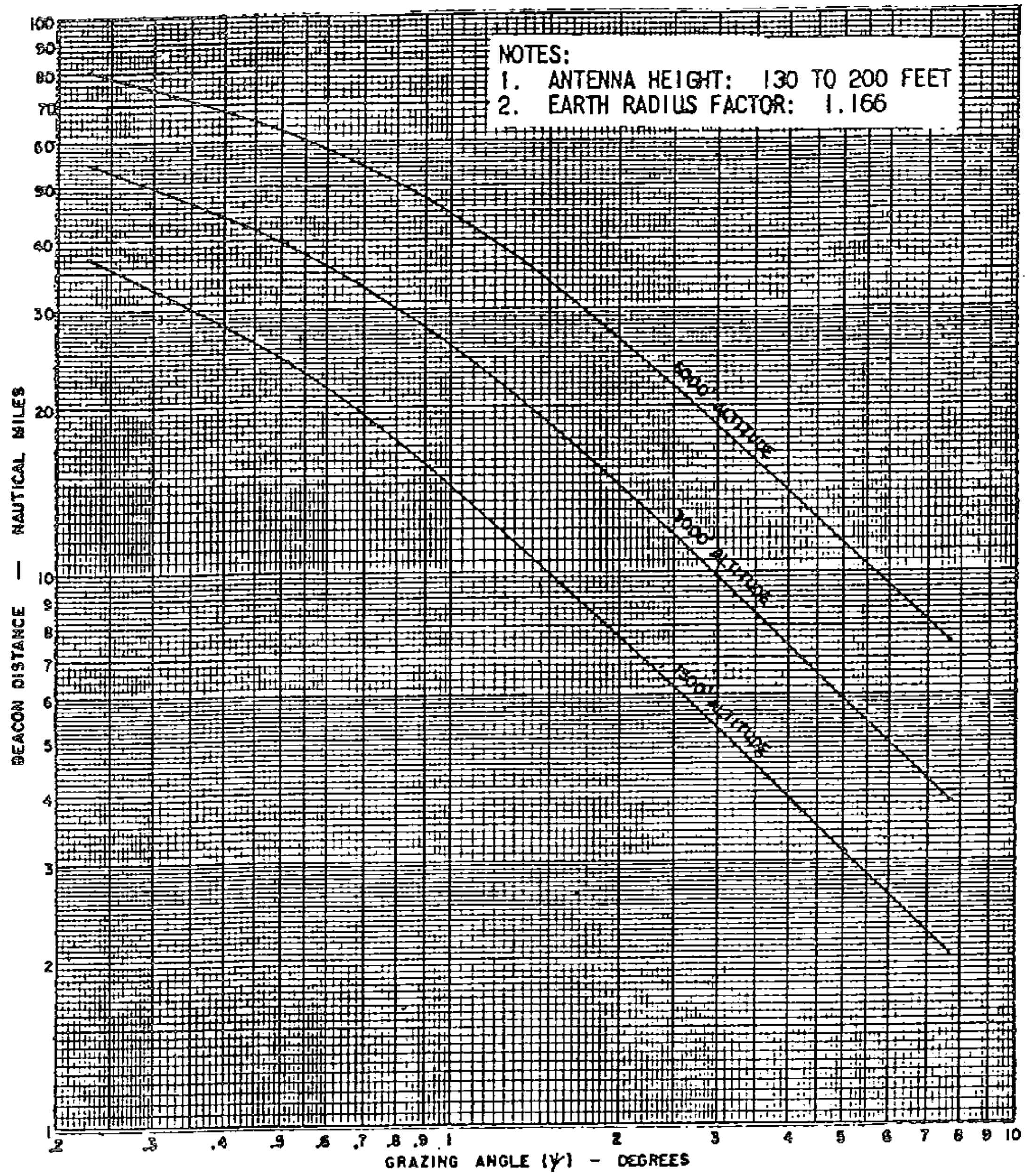


FIGURE 6-50d. BEACON DISTANCE AS A FUNCTION OF GRAZING ANGLE (ANTENNA HEIGHT 130 to 200 FEET, EARTH-RADIUS FACTOR OF 1.166)

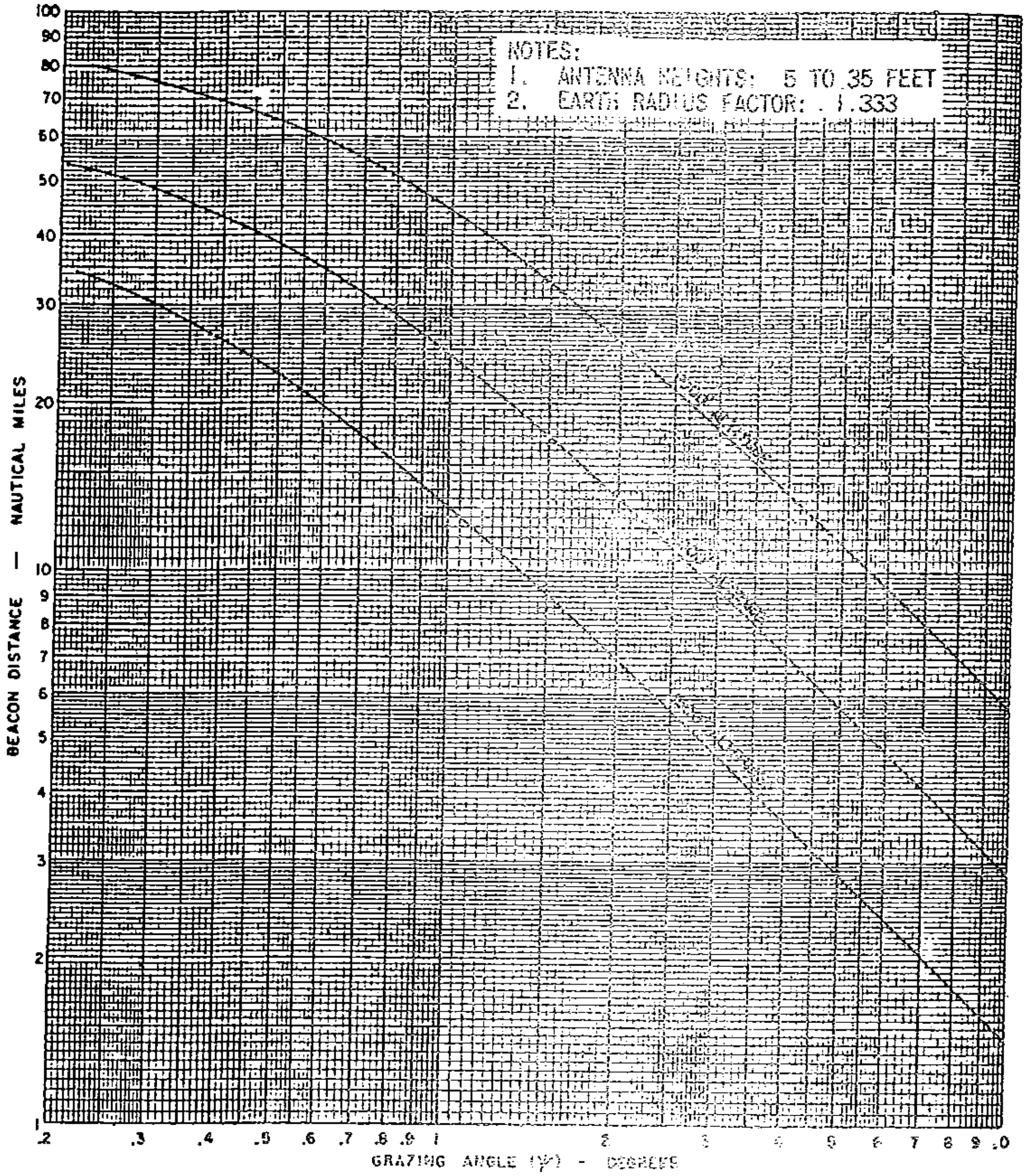


FIGURE 6-51a. BEACON DISTANCE AS A FUNCTION OF GRAZING ANGLE (ANTENNA HEIGHT 5 to 35 FEET, EARTH-RADIUS FACTOR OF 1.333)

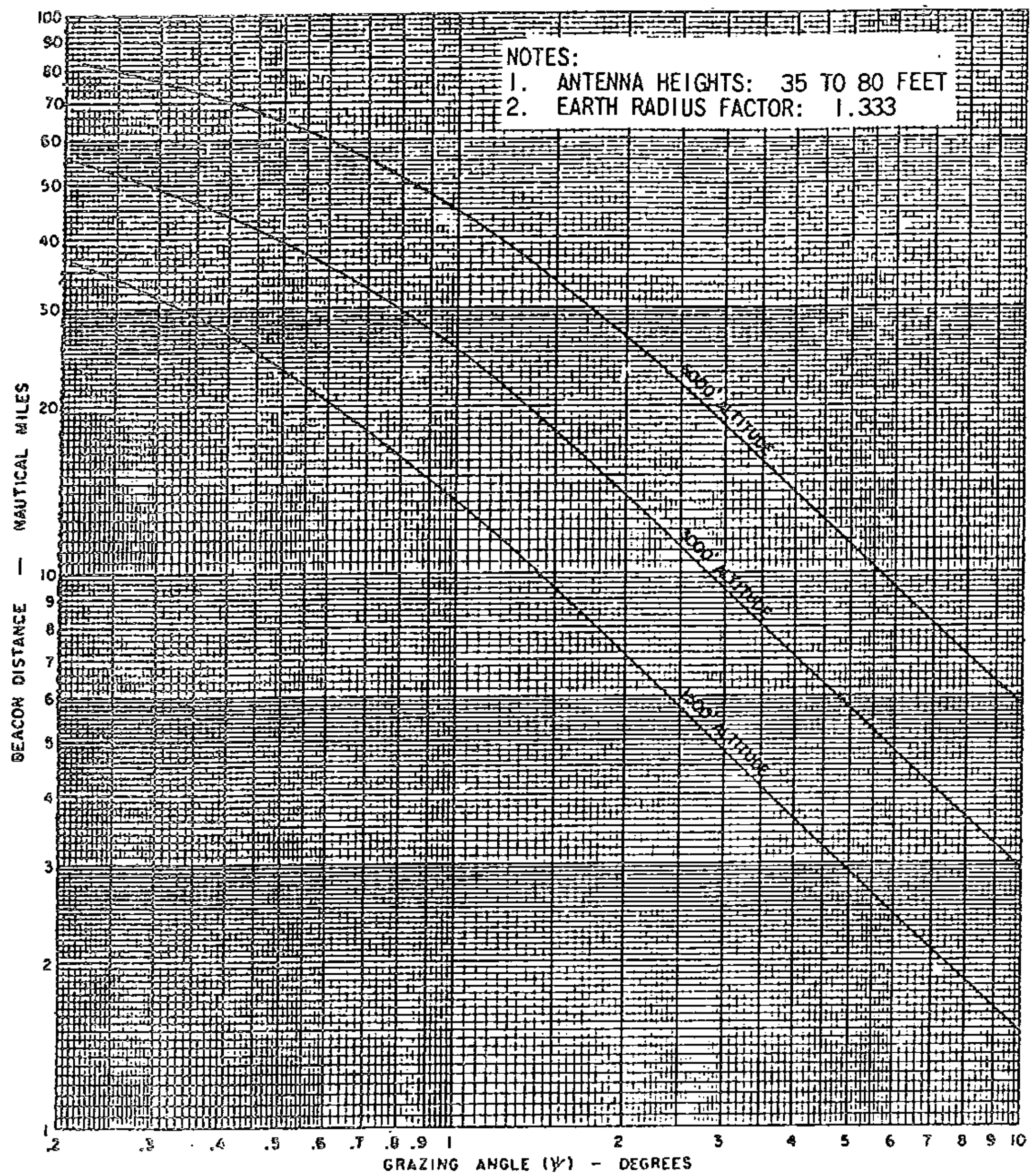


FIGURE 6-51b. BEACON DISTANCE AS A FUNCTION OF GRAZING ANGLE (ANTENNA HEIGHT 35 to 80 FEET, EARTH-RADIUS FACTOR OF 1.333)

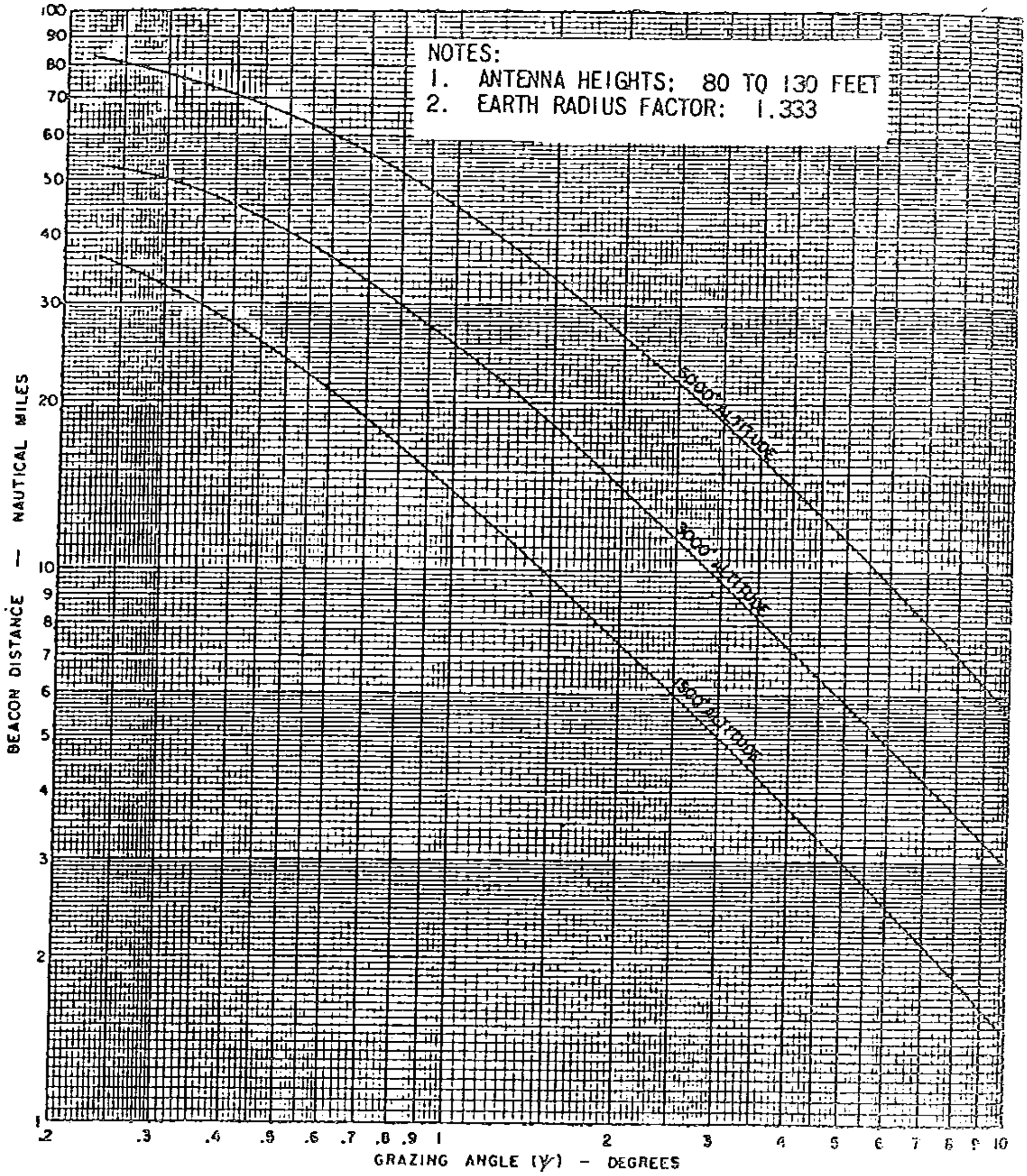


FIGURE 6-51c. BEACON DISTANCE AS A FUNCTION OF GRAZING ANGLE (ANTENNA HEIGHT 80 to 130 FEET, EARTH-RADIUS FACTOR OF 1.333)

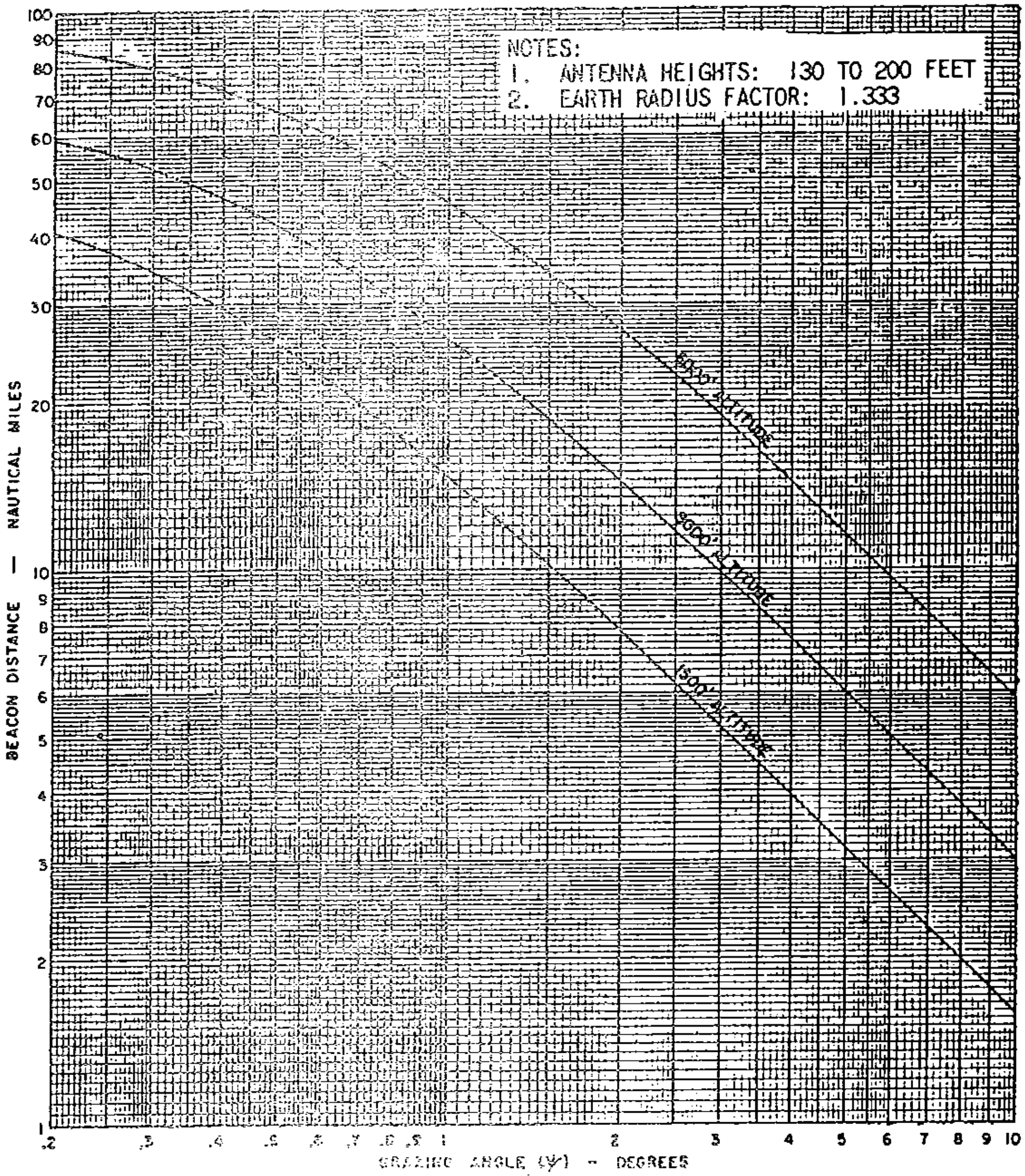


FIGURE 6-51d. BEACON DISTANCE AS A FUNCTION OF GRAZING ANGLE (ANTENNA HEIGHT 130 to 200 FEET, EARTH-RADIUS FACTOR OF 1.333)

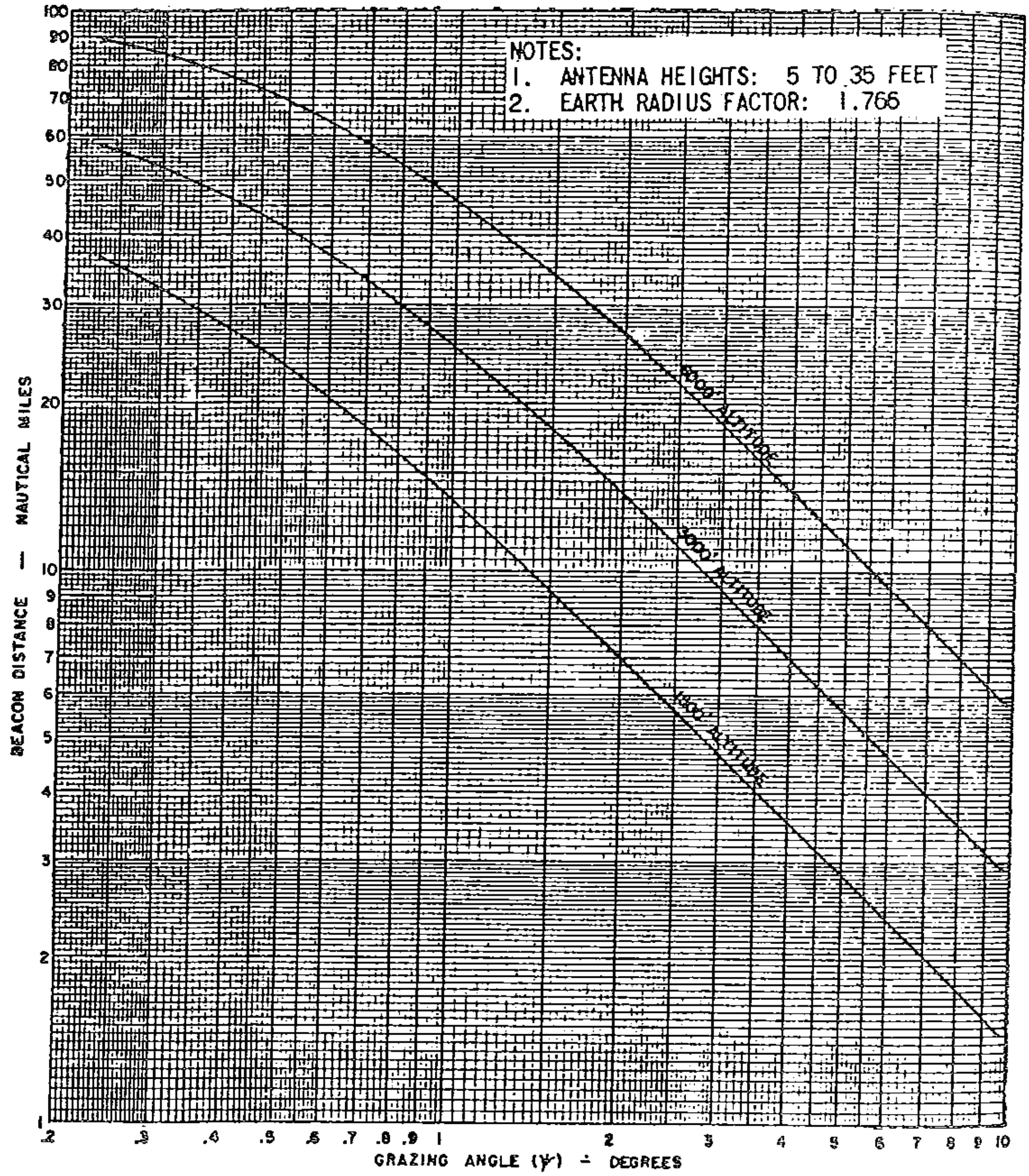


FIGURE 6-52a. BEACON DISTANCE AS A FUNCTION OF GRAZING ANGLE (ANTENNA HEIGHT 5 to 35 FEET, EARTH-RADIUS FACTOR OF 1.766)

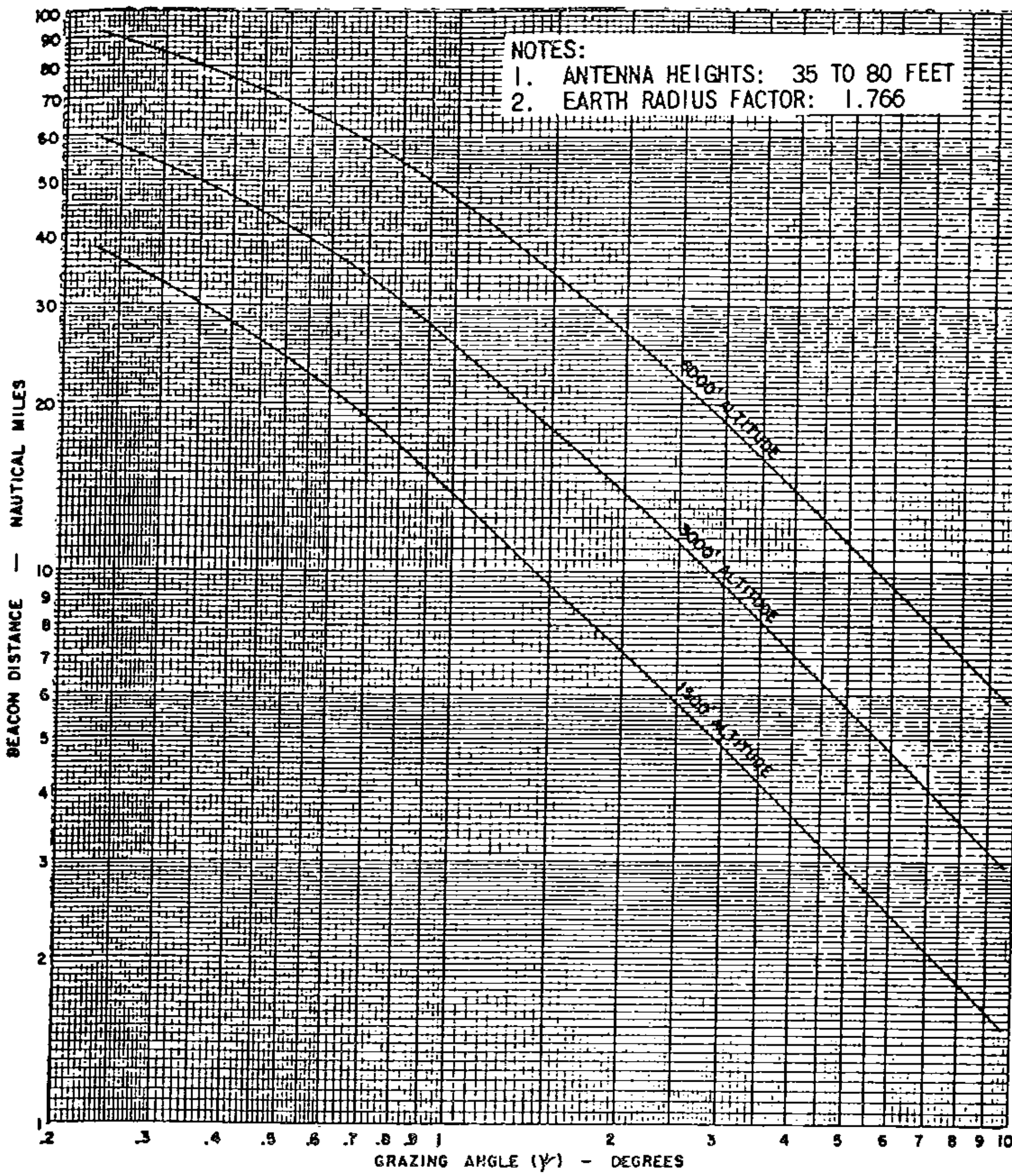


FIGURE 6-52b. BEACON DISTANCE AS A FUNCTION OF GRAZING ANGLE (ANTENNA HEIGHT 35 to 80 FEET, EARTH-RADIUS FACTOR OF 1.766)

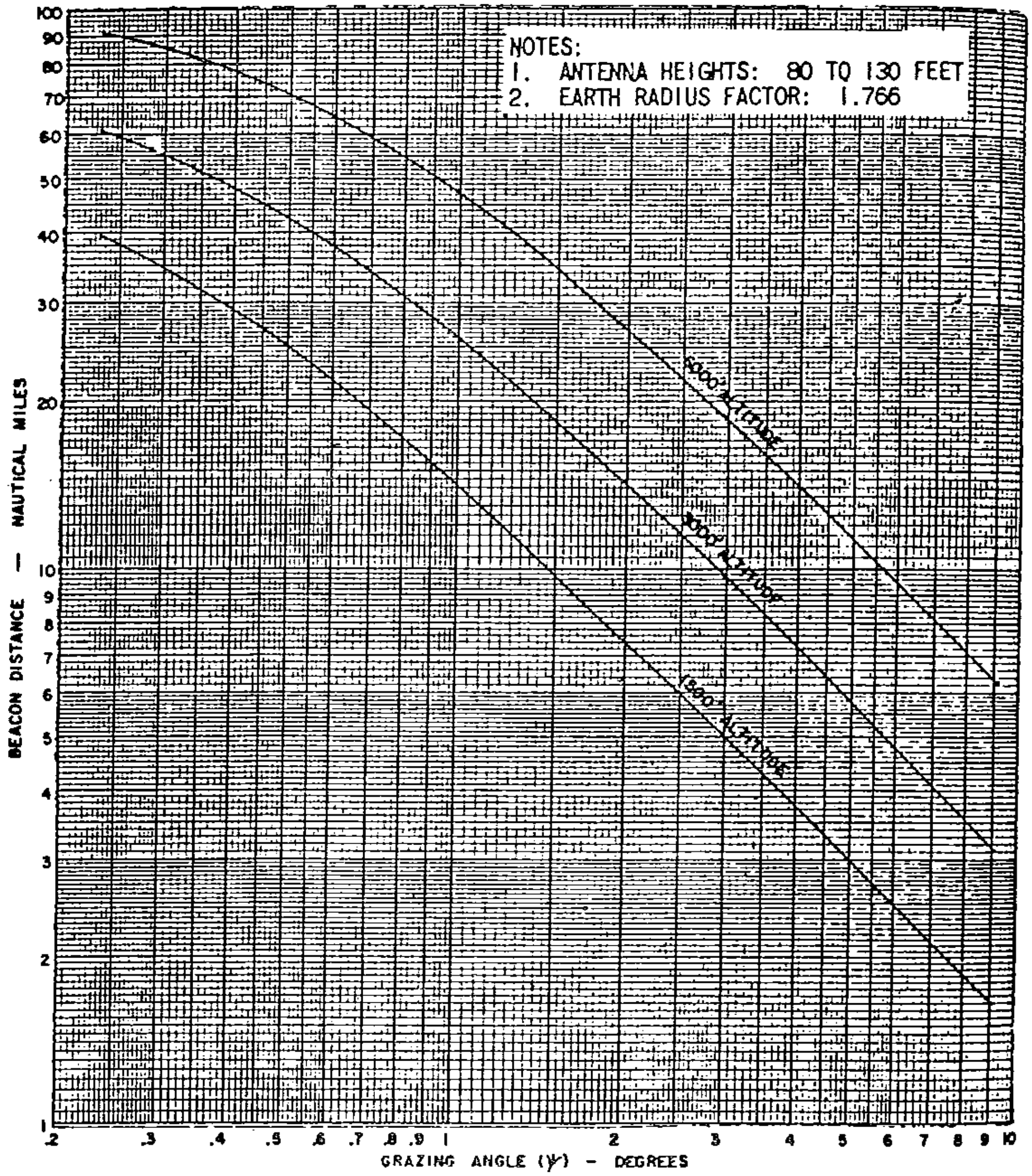


FIGURE 6-52c. BEACON DISTANCE AS A FUNCTION OF GRAZING ANGLE (ANTENNA HEIGHT 80 to 130 FEET, EARTH-RADIUS FACTOR OF 1.766)

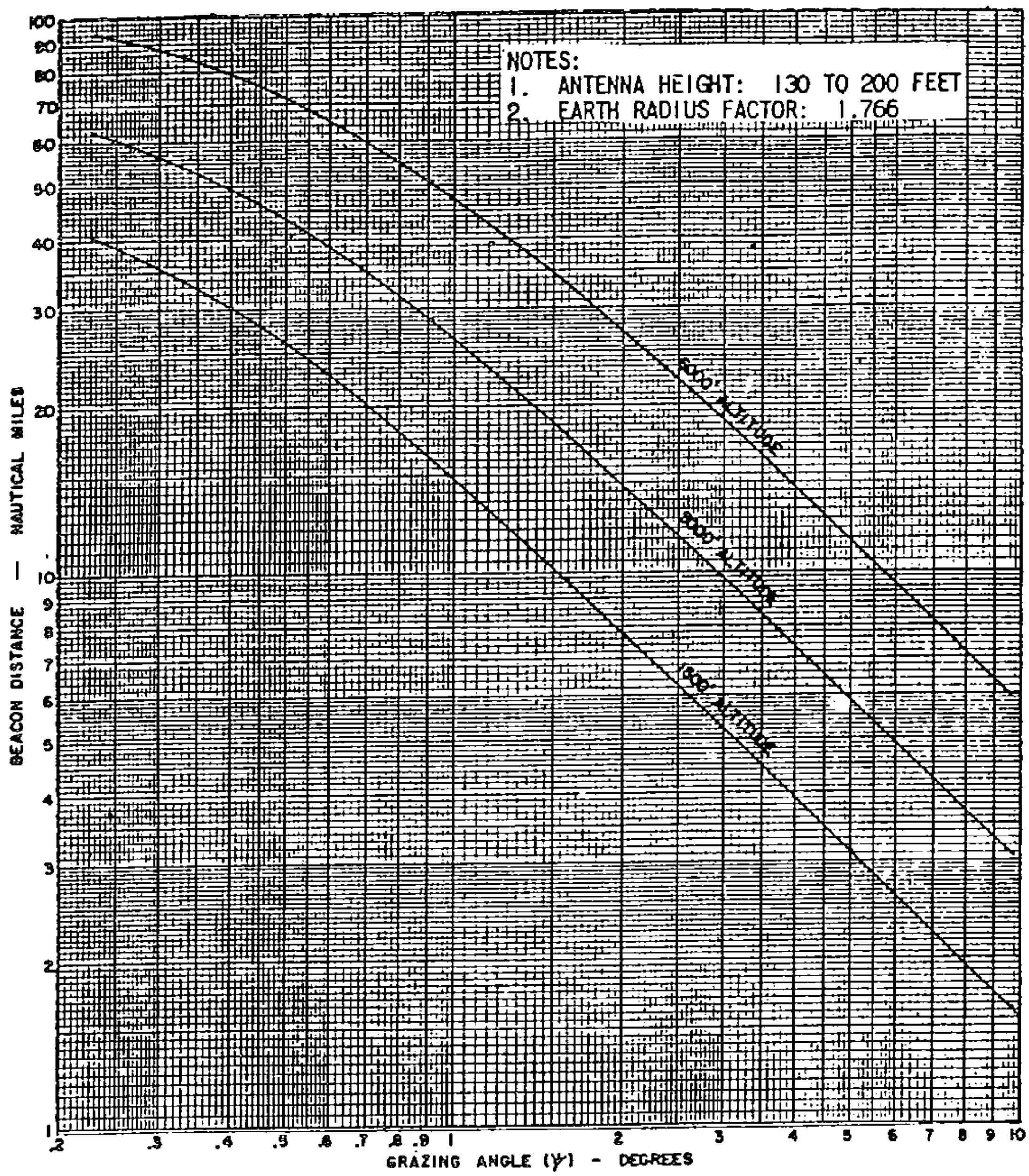


FIGURE 6-52d. BEACON DISTANCE AS A FUNCTION OF GRAZING ANGLE (ANTENNA HEIGHT 130 to 200 FEET, EARTH-RADIUS FACTOR OF 1.766)

CHAPTER 7. CONSIDERATIONS OF LATERAL MULTIPATH

28. GENERAL.

a. Recall the comparison between longitudinal and lateral multipath presented in Section 4. Recall also the overview discussion of lateral multipath presented in Section 6. The material just referenced provides an overview and summary for the subject of lateral multipath.

b. Fundamental to a discussion of reflection and re-radiation is a knowledge of the dimensions required to provide a substantial re-radiated signal. As with longitudinal multipath, the first Fresnel zone is primarily responsible for producing the interfering wave. Figure 7-1 shows the geometry and the equations for calculating the first Fresnel zone size. Figures 7-2, 7-3, and 7-4 provide graphic values of the Fresnel zone dimensions. Interfering wave energy is primarily dependent upon the dimension PD, where P is the point of reflection satisfying the law of reflection; i.e., angle of incidence equals angle of reflection, and D is the forward point at which travel distance from navaid to aircraft is Y/2 longer than along the path involving point P.

c. Distortion of course information due to lateral multipath manifests itself, in the case of VOR, as course scalloping on the aircraft VOR receiver indicator. Course scalloping is a periodic variation of the indicated azimuth about the correct azimuth, where the frequency (or period of oscillation) varies with position in space.

(1) Two terms associated with scalloping are bends and roughness. A bend is a single scalloping cycle, or part thereof, of sufficiently low frequency (a long period in time) to appear as a permanent course displacement on the aircraft receiver indicator. Roughness is a combination of two or more scalloping frequencies originating from separate interfering wave sources. Separating roughness into its individual scalloping frequency components is another complexity in propagation interference analysis.

(2) Course scalloping derives its name from the shape of the curve resulting from a plot (as observed by an airborne receiver) of the magnitude (in degrees) of the deviation of indicated azimuth from true azimuth, as a function of azimuth (in degrees). This curve frequently has a sinusoidal shape, hence the term scalloping. Because of this shape, standard waveform terminology is used in discussing scalloping; i.e., "scalloping amplitude." While the pilot is concerned with the magnitude of his specific course deviation, the ground engineer is concerned with the frequency and amplitude of the scalloping.

d. Re-radiators are divided, for purposes of discussion, into specular and diffuse reflectors. See figure 2-4 for sketches contrasting these types of surfaces. In the material to be presented, specular and directional reflectors will be seen to have the following characteristics with regard to scalloping amplitude.

(1) Scalloping amplitude is a function of the angle of incidence between interfering wave and reflector.

(2) Maximum scalloping amplitude occurs at the angle of incidence approaching 55 degrees.

(3) Half-power scalloping amplitude occurs at angles of incidence of 35 and 73 degrees.

(4) Angles of incidence below 35 and above 73 degrees have relatively small scalloping amplitude compared to the maximum.

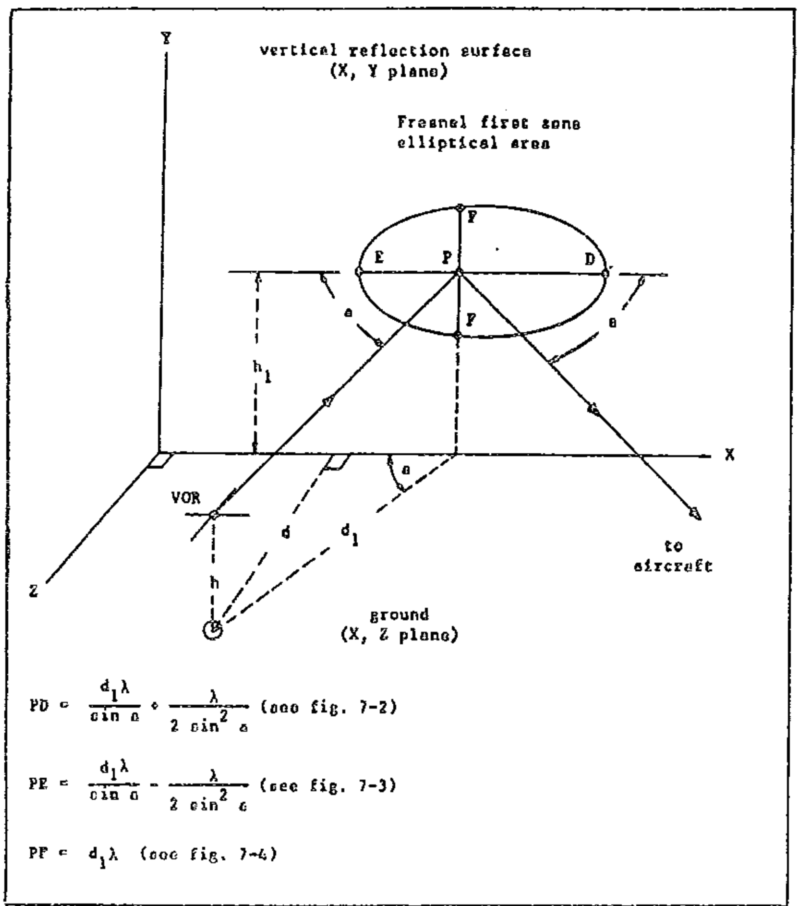


FIGURE 7-1. REFLECTOR SURFACE DIMENSIONS (FRESNEL FIRST ZONE) CONTRIBUTING TO SCALLOPING

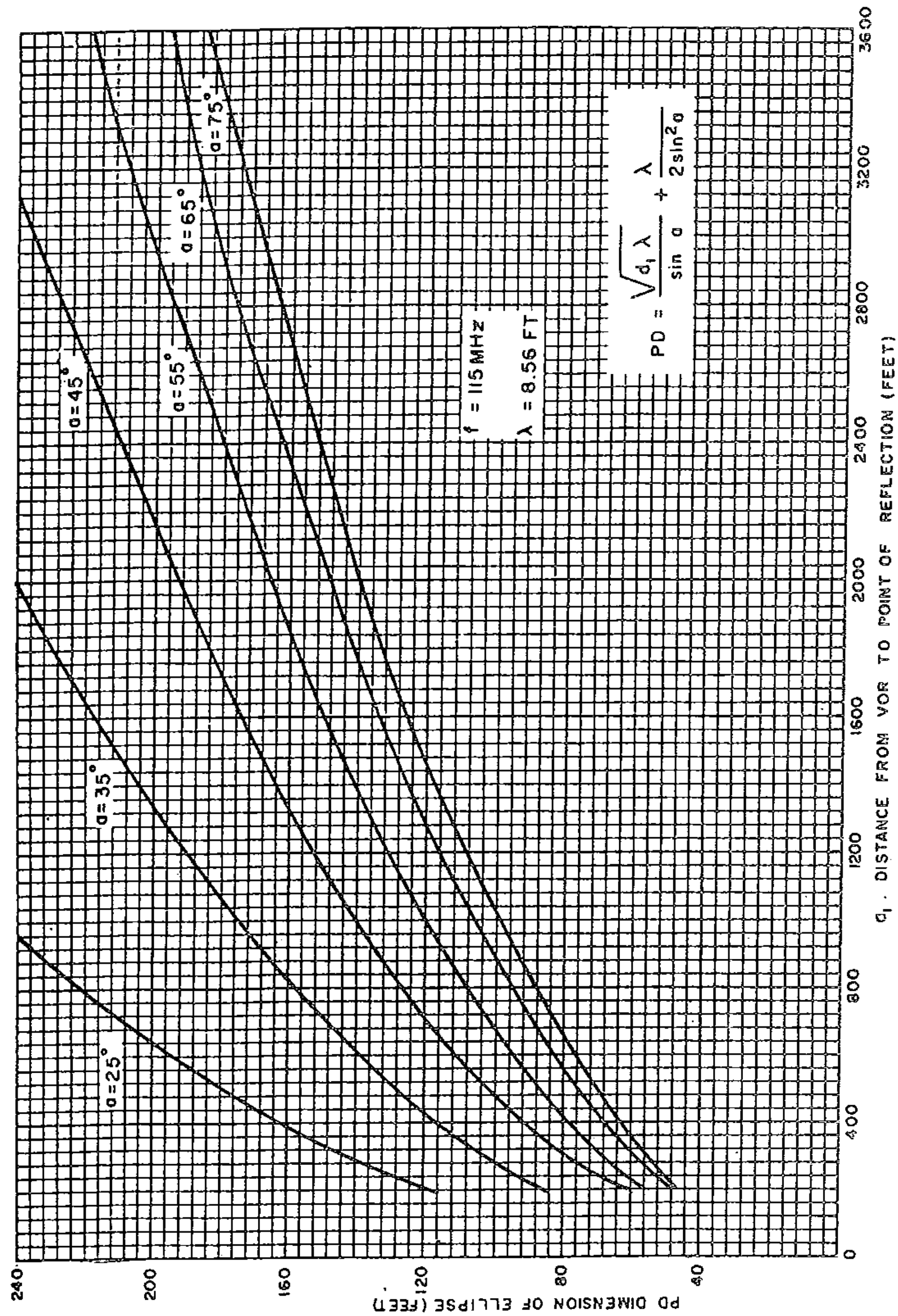


FIGURE 7-2. GRAPHIC VALUES OF PD

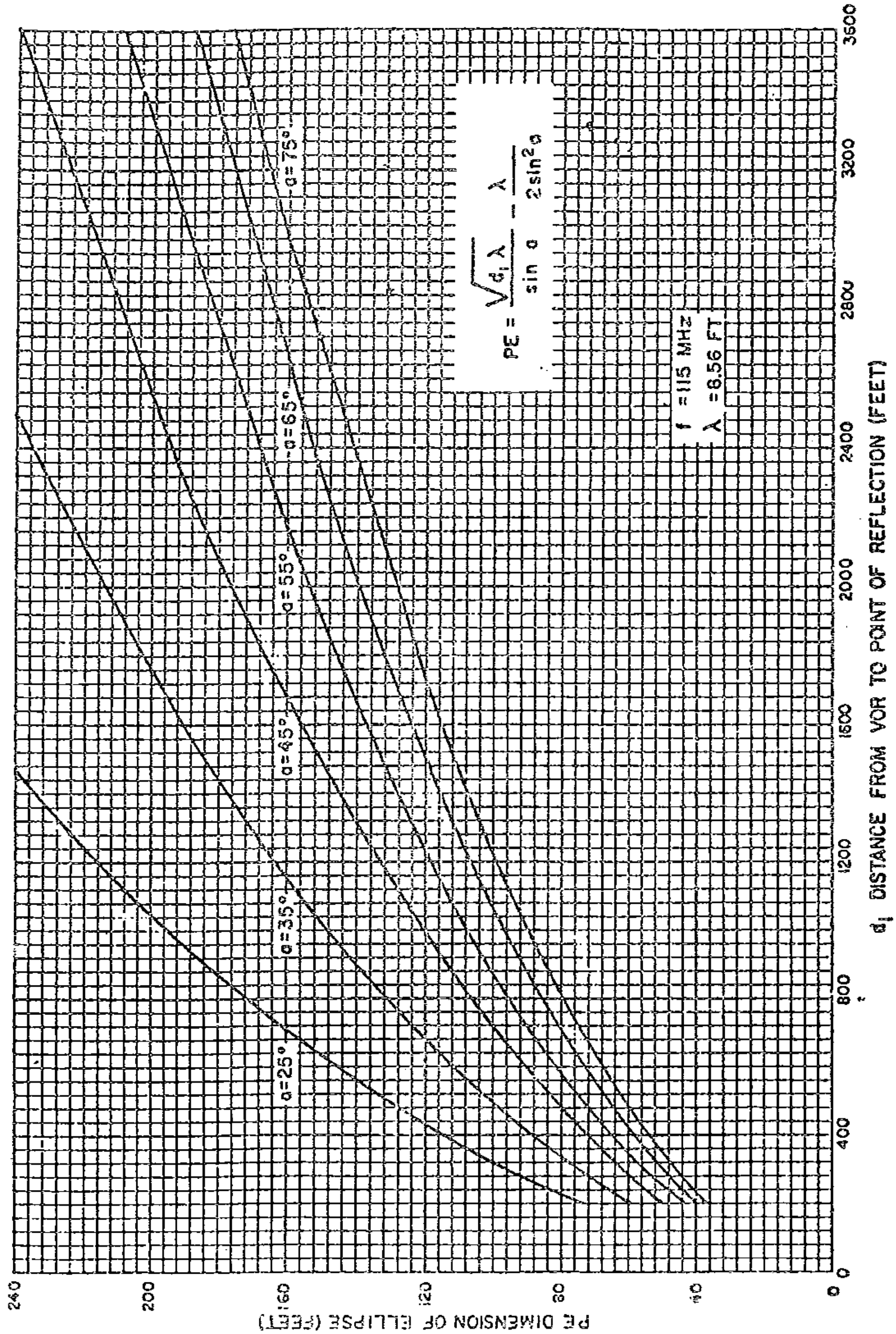


FIGURE 7-3. GRAPHIC VALUES OF PE

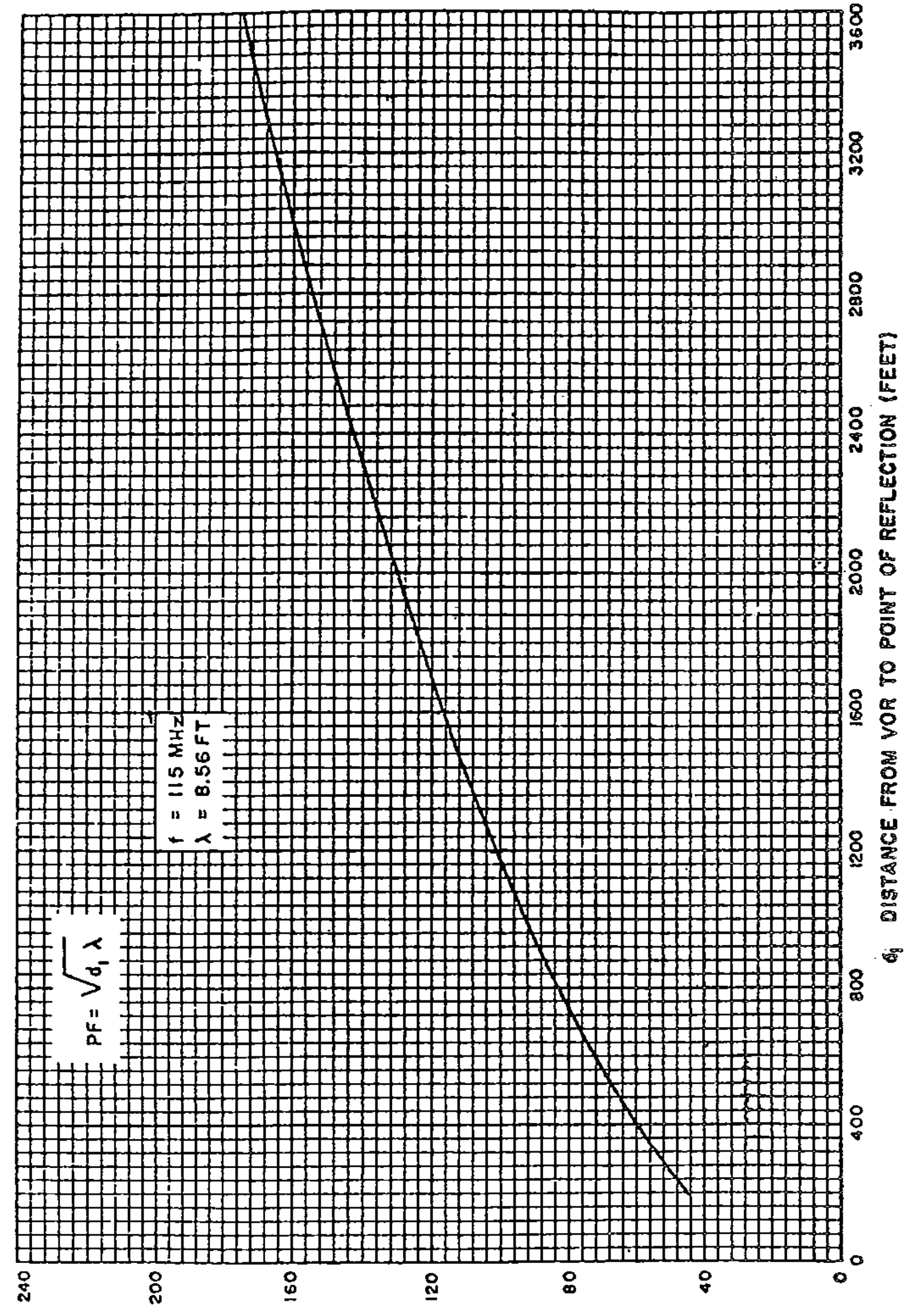


FIGURE 7-4. GRAPHIC VALUES OF PF

(5) Angle of incidence is zero at all points along a reflector in radial alignment with the VOR, thus causing no course scalloping.

(6) Scalloping amplitude is approximately inversely proportional to the square of distances between interfering object and VOR over a large range of distance ratios.

(7) Scalloping amplitude is approximately proportional to the square of heights of interfering objects over a large range of height ratios.

e. Diffuse reflectors have the following characteristics with regard to scalloping amplitudes.

(1) Scalloping amplitude is maximum along a bearing line 90 degrees from the azimuth of the re-radiating object.

(2) Scalloping amplitude decreases in a sinusoidal manner with azimuth displacement from the maximum scalloping bearing line.

(3) Scalloping amplitude approaches zero along the azimuth of the re-radiating object.

(4) Scalloping amplitude is proportional to the ratio of re-radiated signal amplitude to direct signal amplitude at the aircraft receiver.

f. A number of general conclusions with regard to scalloping frequency can be derived from the material to be presented.

(1) When approaching the VOR, the frequency of scalloping is lowest when closest to the re-radiating object.

(2) The frequency of scalloping increases with an increase in distance between the re-radiating object and the VOR.

(3) Scalloping frequency is maximum along a bearing line where:

(a) Angle of reflection ($\Theta_0 - \Theta_1$) equals 90 degrees for a nondirectional re-radiation. Note this is also the angle of maximum scalloping amplitude.

(b) Angle of incidence (a) equals 45 degrees for a directional reflector.

(4) Scalloping frequencies encountered on radial flight are appreciably lower than those on an orbital flight at similar aircraft locations.

g. During radial flight, a zero-frequency scalloping error may be experienced. The magnitude of this error may be determined from a knowledge of scalloping amplitude at other frequencies and the VOR receiver scalloping frequency response curve.

29. AMPLITUDE OF COURSE SCALLOPING

a. General. The amplitude of course scalloping is measured in degrees and, for obvious practical reasons, it is desirable to know this amplitude as presented to the pilot in his Course Deviation Indicator. Re-radiating surfaces have already been discussed as specular and diffuse reflectors (see figure 2-4). In connection with lateral multipath and course scalloping, we use different but related terms for re-radiating surfaces and speak of directional and diffuse re-radiators. Directional radiators include all re-radiators which re-radiate the infringing EM energy in a preferred direction. These include smooth surfaces which support specular reflection, wires and fences which radiate directionally because of resonance effects, and groupings of objects such as trees or wires which radiate directionally because of the interferometer effect. Note that a surface may be smooth for one angle of ray arrival and rough for another angle. Additionally, a surface may be rough for DME and VORTAC frequencies and smooth at the lower frequency of VOR. See figure 2-6 for a summary of the roughness criterion. The interferometer or periodicity effect is presented in figure 2-5.

b. Scalloping Amplitude Due to Directional Radiators.

(1) The equation for amplitude of scalloping is given below. It applies to both short and long directional reflectors. The geometries are illustrated in figures 7-5 and 7-6.

$$S = \pm \text{ arc tan } \left[\sqrt{2}\ A \sin a \sin 2a\right] \quad \text{(degrees)}$$

Where A = Amplitude of Er/Amplitude of Ed. Figure 7-7 is a plot of this equation for a single value of A.

(2) For short-length reflectors, the spread of azimuths which are susceptible to scalloping will be small. Short is defined as involving a small spread of azimuth coverage as seen from the VOR site. See figure 7-8.

(3) For long reflectors, the ratio of scalloping at any angle compared to that at the angle of maximum scalloping is shown graphically in figure 7-9 for a particular value of A, and is described analytically in the following equation.

$$\frac{S_o}{S_{MAX}} = \frac{\pm \text{ arc tan } \left[\sqrt{2}\ A \sin \Theta_o \sin 2\Theta_o\right]}{\pm \text{ arc tan } \left[\sqrt{2}\ A \sin \Theta_{o_{MAX}} \sin 2\Theta_{MAX}\right]}$$

Note that figure 7-9 may be used to illustrate the scalloping of a long reflector regardless of its orientation to the VOR site. Simply make the appropriate azimuthal correction for the direction of the bearing normal to the reflector and apply that correction to the azimuthal indications on figure 7-9.

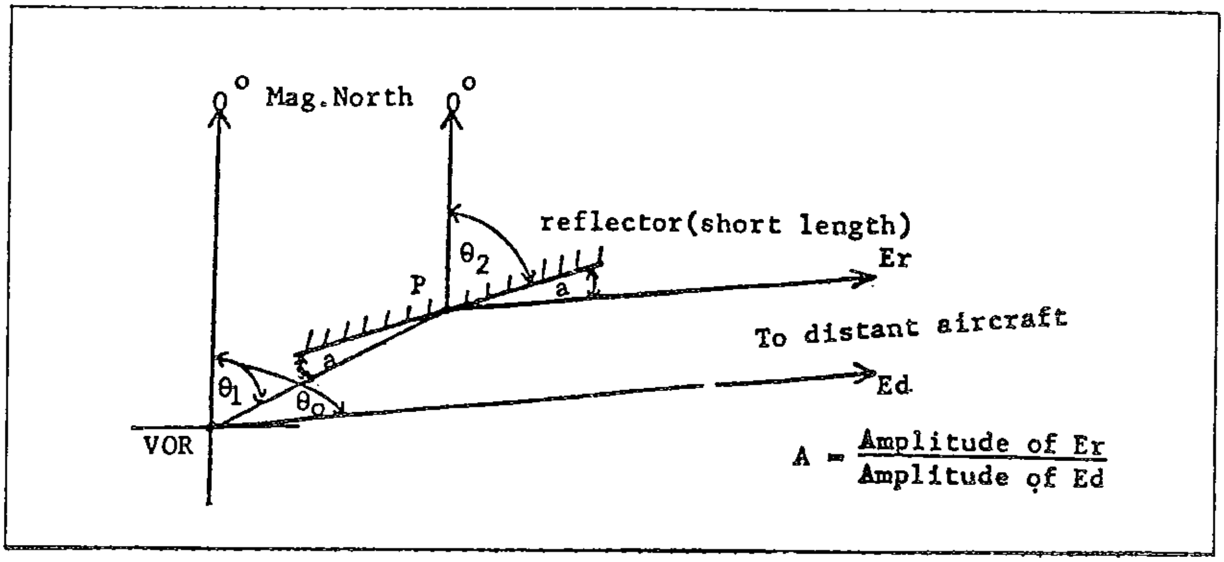


FIGURE 7-5. DIRECTIONAL REFLECTOR (SHORT LENGTH)

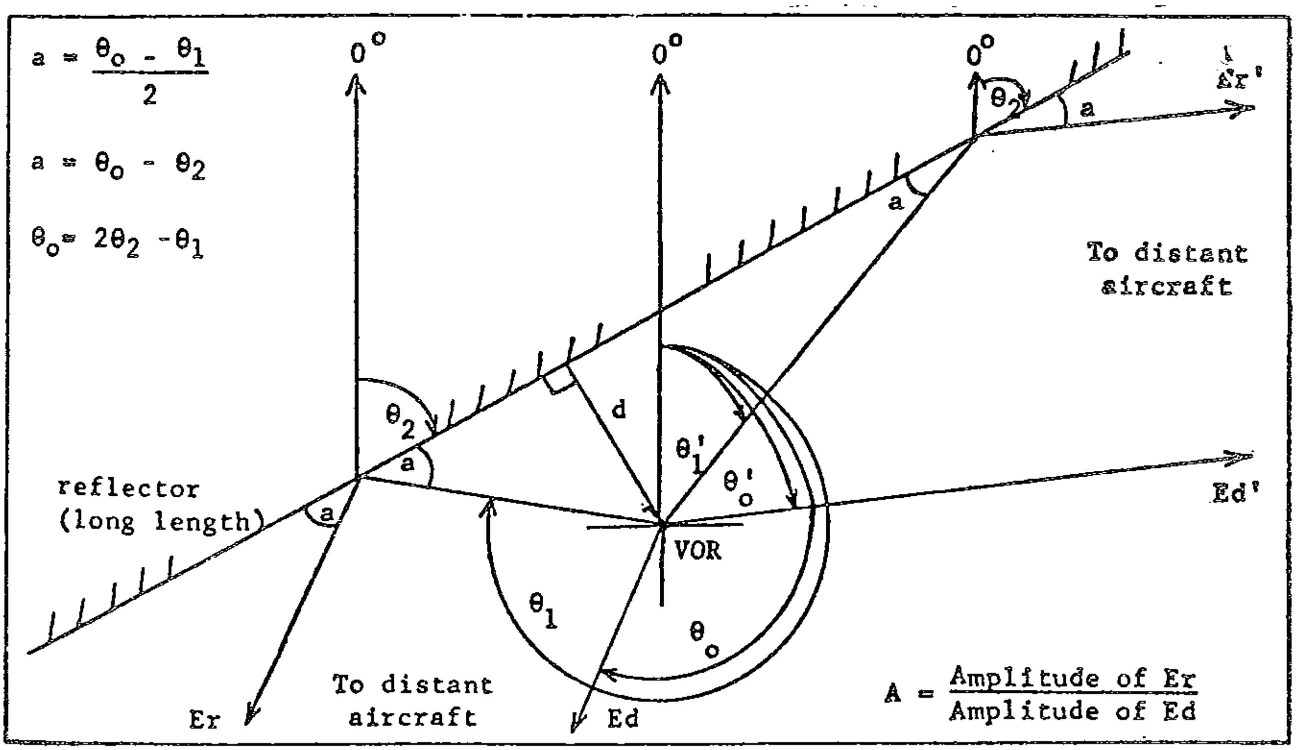


FIGURE 7-6. DIRECTIONAL REFLECTOR (LONG LENGTH)

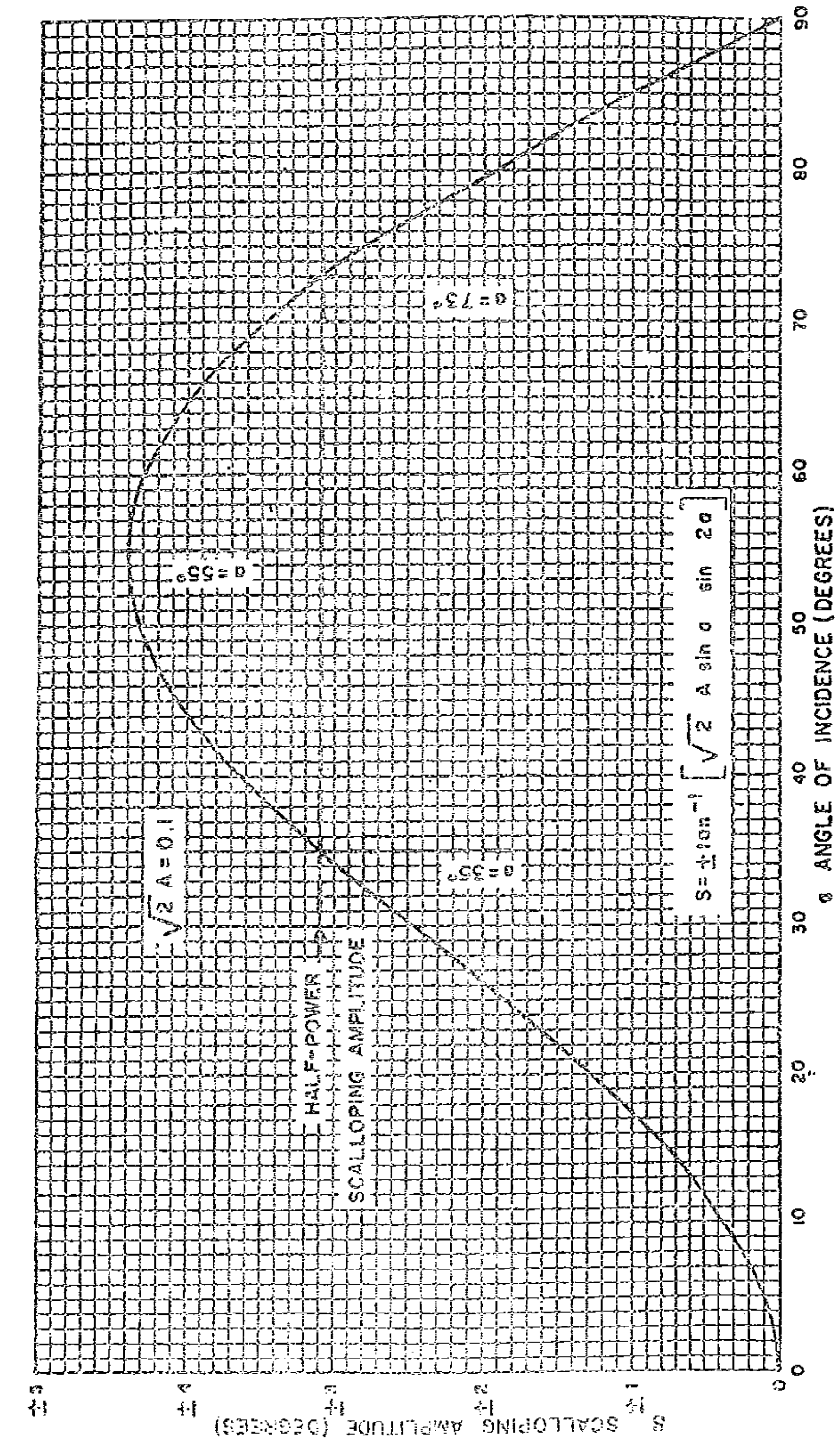
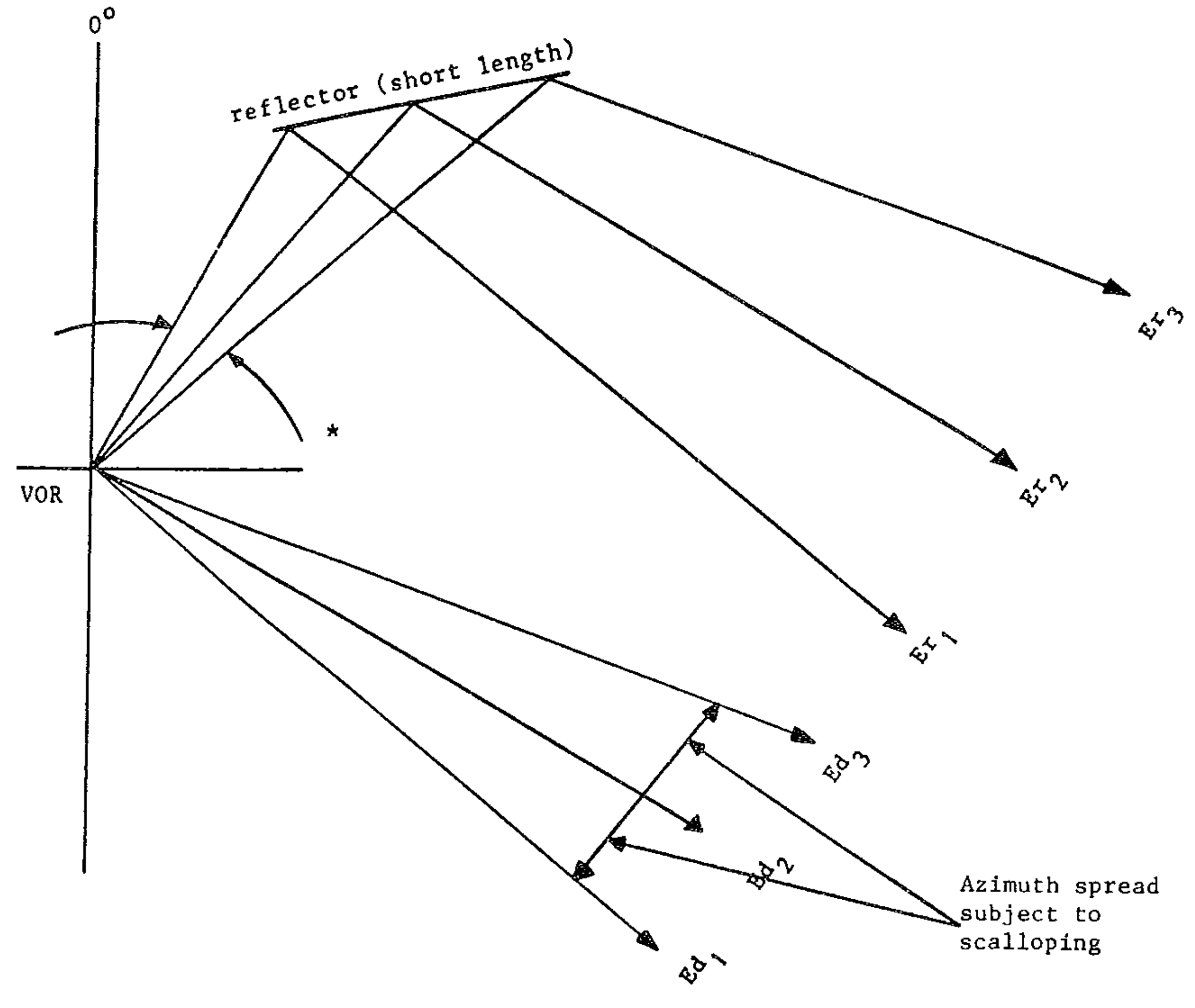


FIGURE 7-7. SCALLOPING AMPLITUDE VERSUS ANGLE OF INCIDENCE



* Relatively small azimuth spread for "short" reflector.

FIGURE 7-8. SPREAD OF COURSE SCALLOPING AMPLITUDE

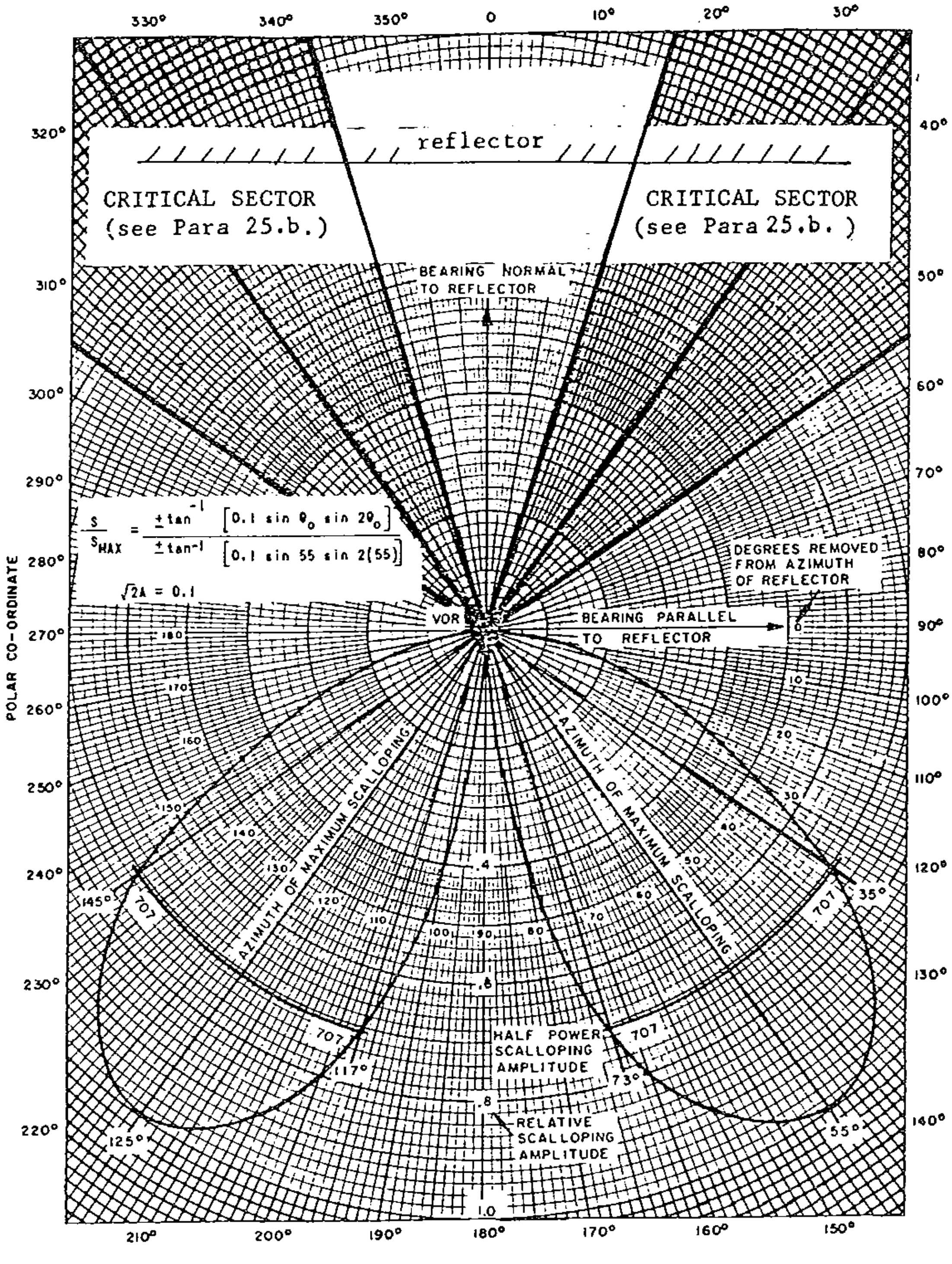


FIGURE 7-9. RELATIVE SCALLOPING AMPLITUDE DUE TO LONG REFLECTORS

c. Diffuse Radiators. Figure 7-10 is a graphic presentation of the amplitude of scalloping for the angular parameters defined in figure 7-11. The analytic relationship is described by the equation below.

$$S = \pm \text{arc tan} \left[A \sin (\theta_0 - \theta_1) \right] \text{ (degrees)}$$

where

A = Amplitude of Er/Amplitude of Ed

d. Effect of Geometry on Scalloping Amplitude.

(1) The amount of signal re-radiated from the interfering object is a function of the location of the object with respect to the VOR/VORTAC site. This signal magnitude in turn determines the parameter A which appears in the expressions for scalloping for both directional and diffuse reflectors. It is difficult to determine A in absolute terms, but it is easier and useful to determine A in relative terms for variations in the geometry. Using the parameters defined in figure 7-12, the scalloping amplitude in terms of an undetermined constant can be expressed as shown in the equation associated with that figure. Figures 7-13, 7-14, and 7-15 present graphically the variation in scalloping amplitude as the parameters of the geometry are varied.

(2) The equation presented in figure 7-12 can be used to predict scalloping amplitude under one set of conditions when the amplitude is known for another set of conditions. For example, if scalloping amplitude S (in degrees) is known for d_1, then the amplitude S^1 for the changed distance d_1 is presented graphically in figure 7-16 and is expressed analytically as shown in the equation included with the figure. Similarly, if a change of height only is involved, the new scalloping amplitude can be determined as shown graphically and in analytic form in figure 7-17.

(3) Additionally and within certain limits, an approximate relationship may be used for changes in both height and distance.

$$S' \simeq S \left[\frac{d_1 h_1'}{d_1' h_1} \, 2 \right] \text{(degrees)}$$

when $\frac{h_1}{d_1}$ and $\frac{h_1}{d_1'}$ are less than 0.1

$\frac{h\,h_1}{d_1}$ and $\frac{h\,h_1'}{d_1}$ are less than 1.0 foot

(4) In application of these equations and graphs, height of interfering objects is taken as the uppermost portion of the object such as the top of a fence or the peak of a tower. In considering distance changes with directional reflectors, the angle of incidence of the interfering wave is assumed to remain constant. Where this condition does not prevail, an additional factor can be applied in accordance with the basic equation presented in figure 7-12.

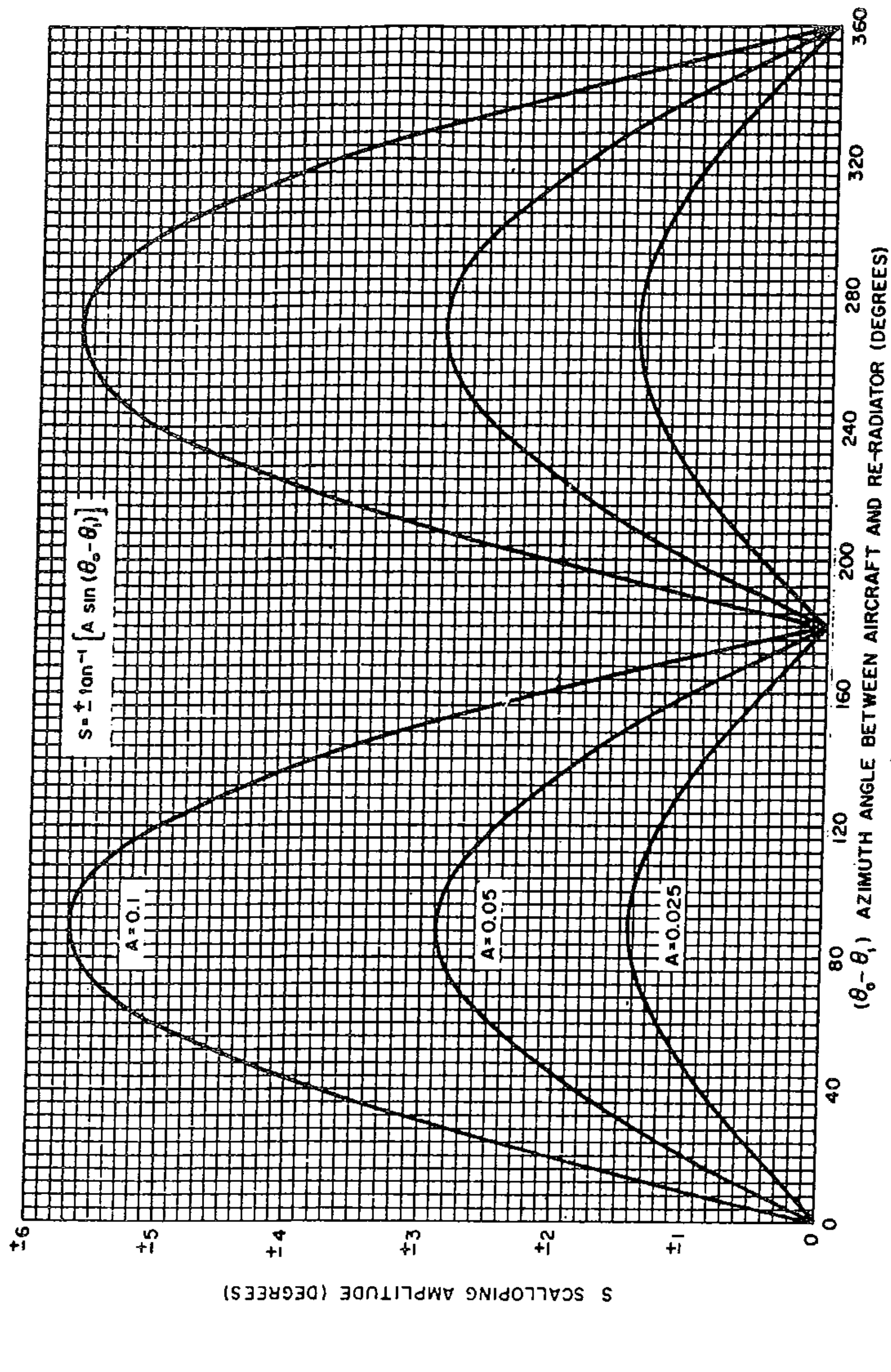


FIGURE 7-10. SCALLOPING AMPLITUDE VERSUS AZIMUTH ANGLE BETWEEN AIRCRAFT AND RE-RADIATOR

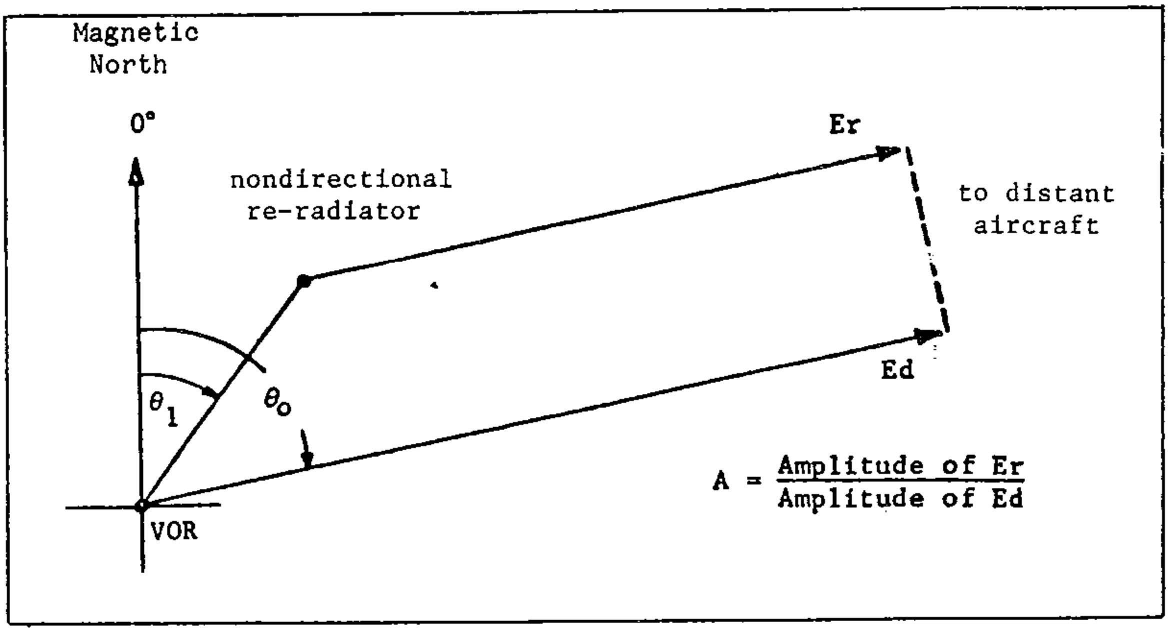
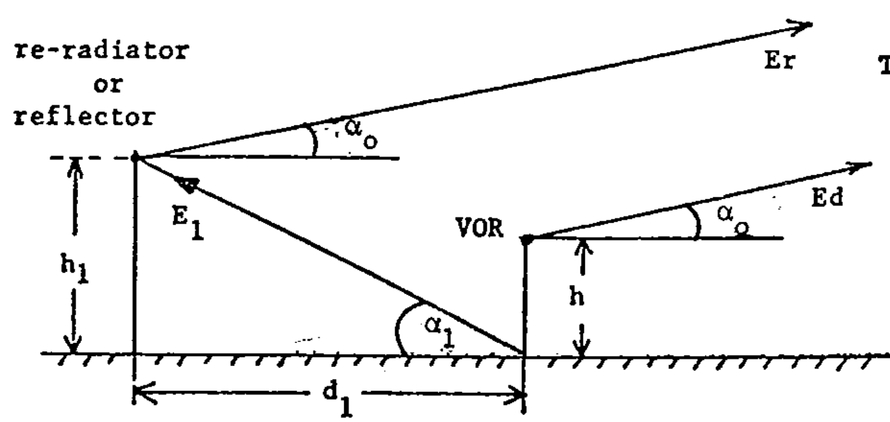


FIGURE 7-11. NONDIRECTIONAL RE-RADIATOR



$$S = \pm \frac{K \sin\left(\frac{2\pi}{\lambda}\frac{h\ h_1}{d_1}\right)\ \sin\left(\frac{2\pi}{\lambda} h_1 \sin \alpha_o\right)}{d_1 \sin\left(\frac{2\pi}{\lambda} h \ \sin \alpha_o\right)} \quad \text{(degrees)}$$

where K is a constant dependent upon the coefficient of re-radiation.

FIGURE 7-12. SCALLOPING AS A FUNCTION OF GEOMETRY

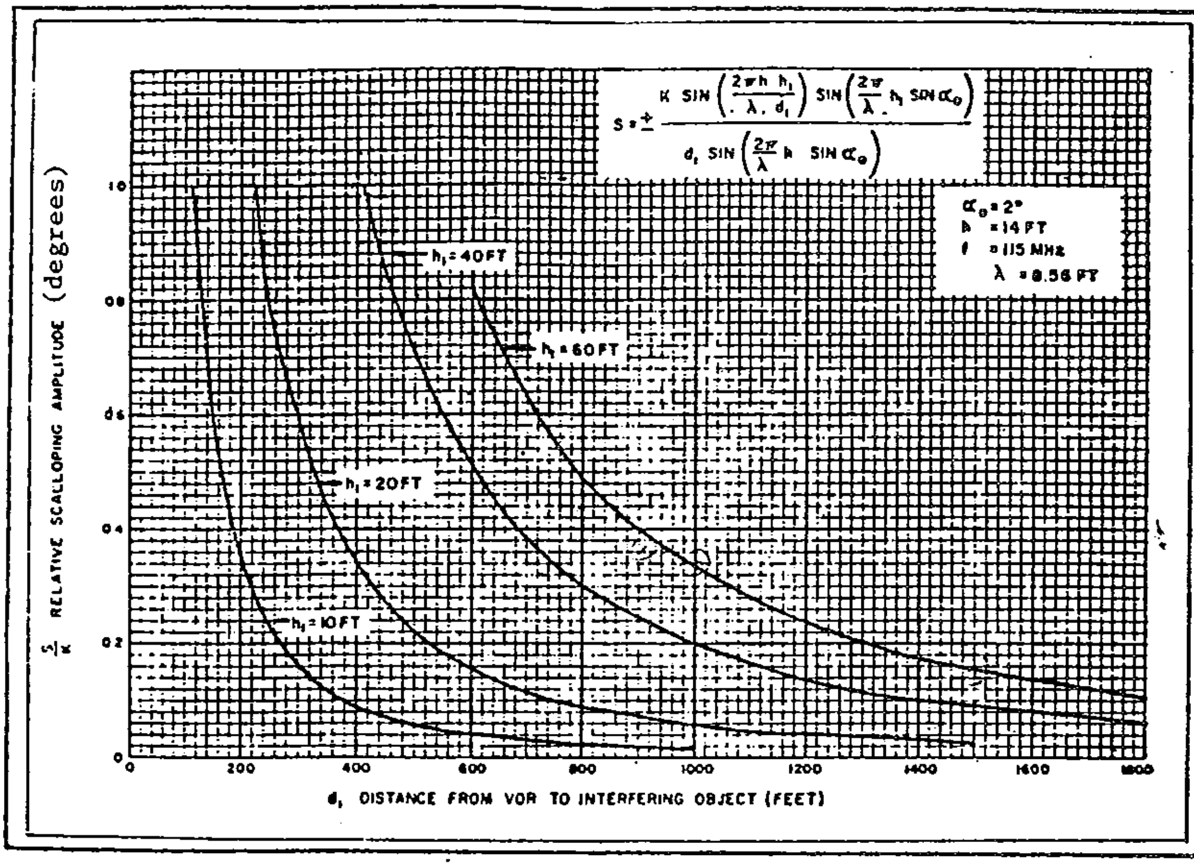


FIGURE 7-13. RELATIVE SCALLOPING AMPLITUDE VERSUS HEIGHT AND DISTANCE OF INTERFERING OBJECT

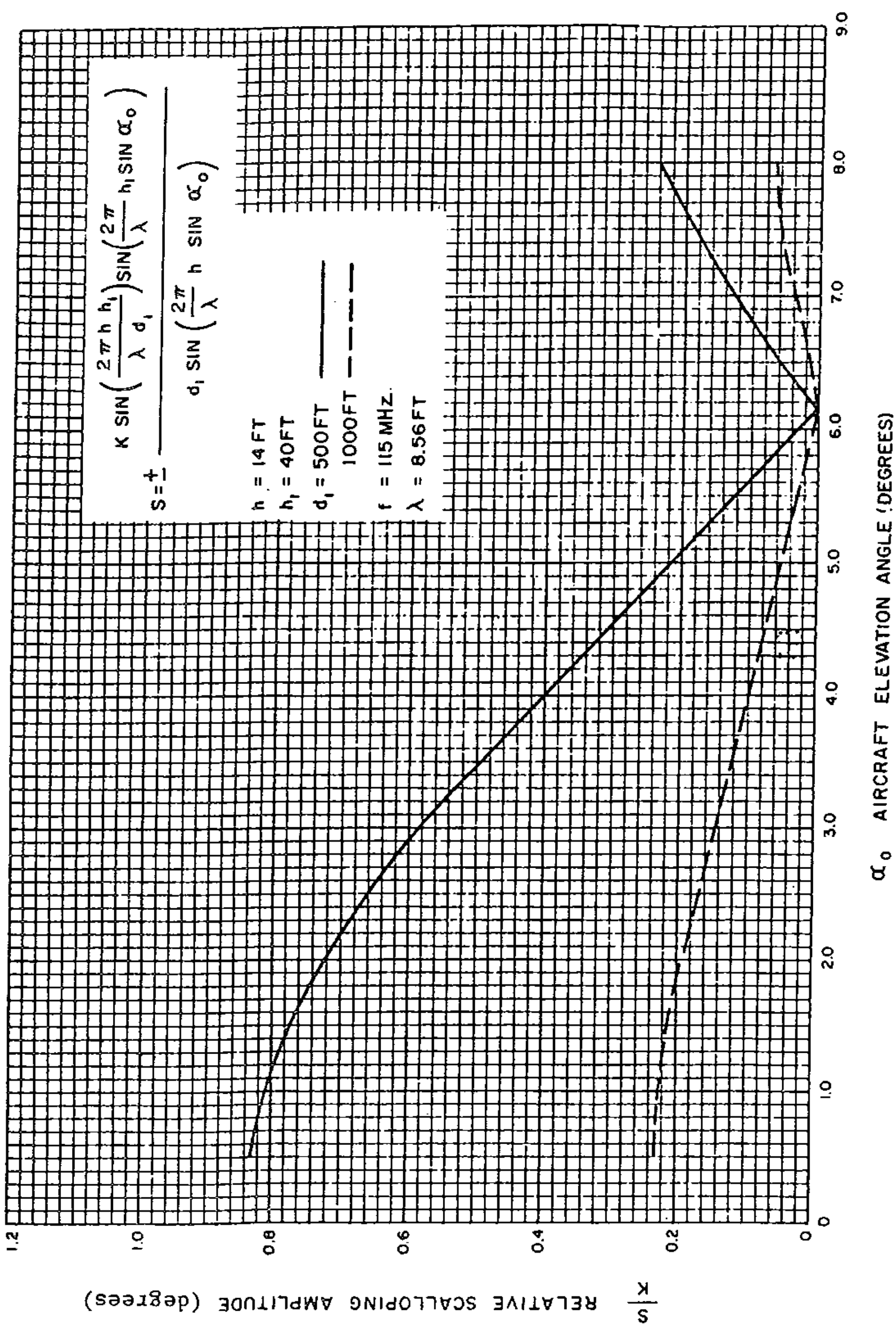


FIGURE 7-14. RELATIVE SCALLOPING AMPLITUDE VERSUS AIRCRAFT ELEVATION ANGLE

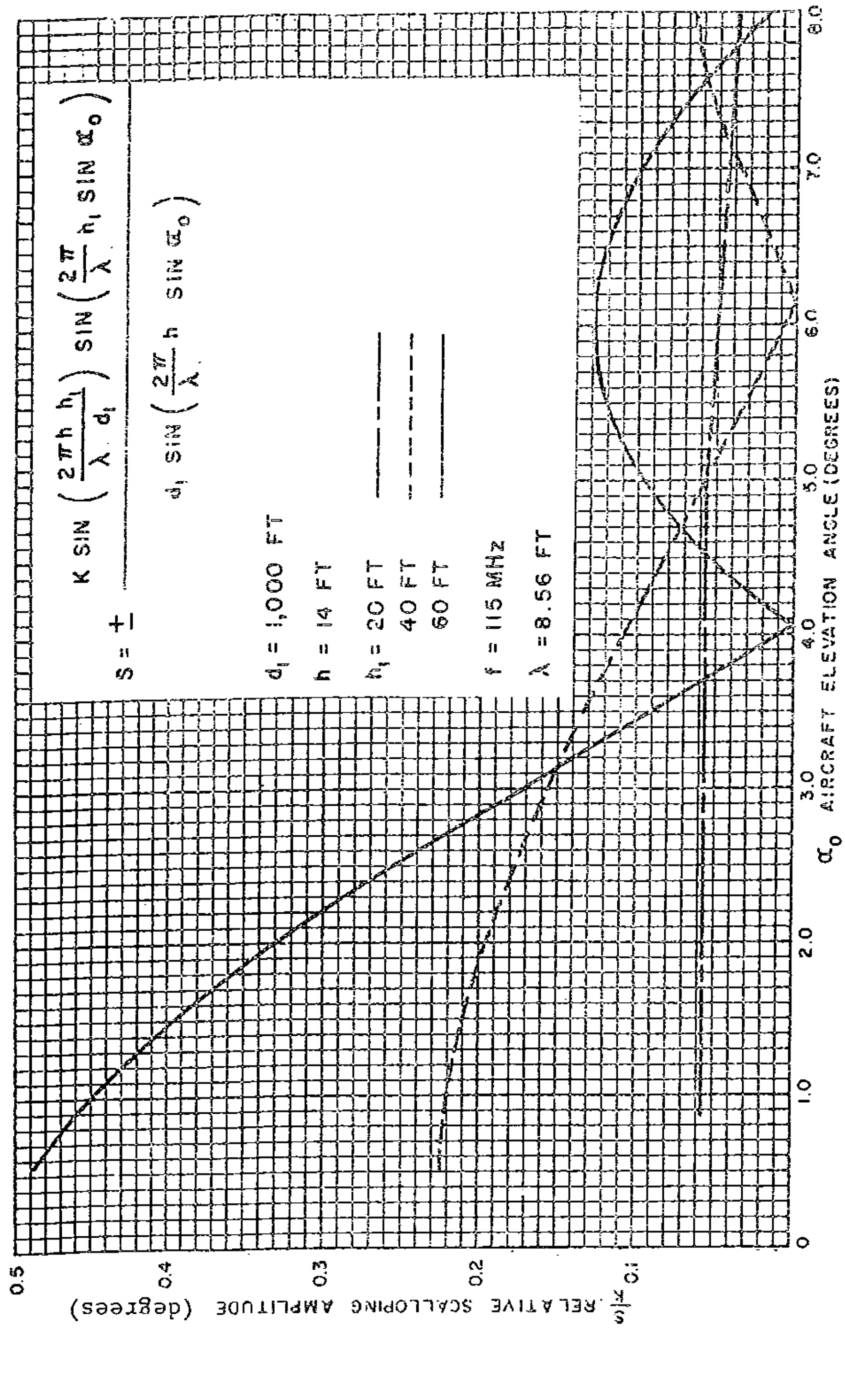


FIGURE 7-15. RELATIVE SCALLOPING AMPLITUDE VERSUS AIRCRAFT ELEVATION ANGLE AND HEIGHT OF INTERFERING OBJECT

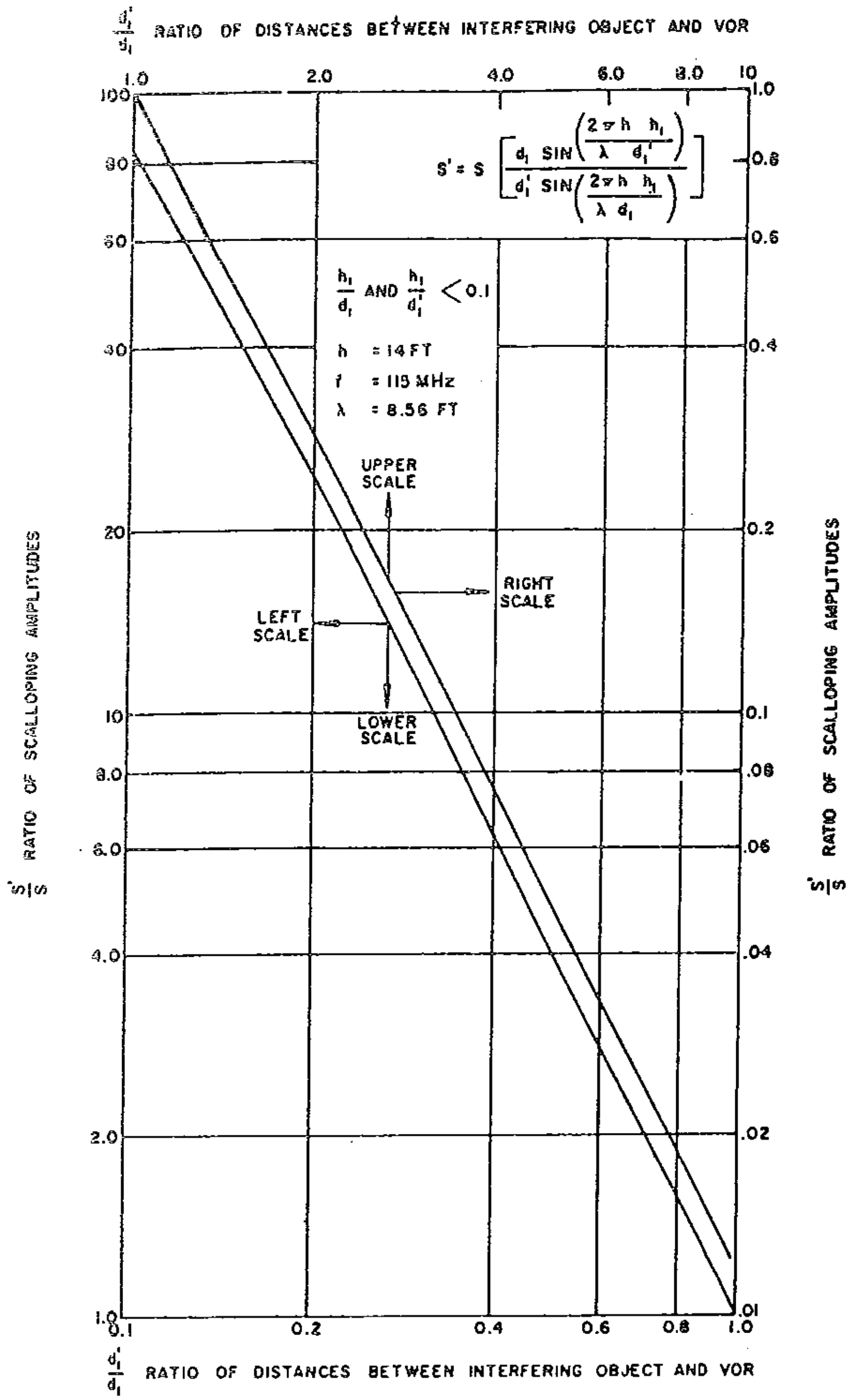


FIGURE 7-16. RELATIONSHIPS BETWEEN DISTANCES AND SCALLOPING AMPLITUDE

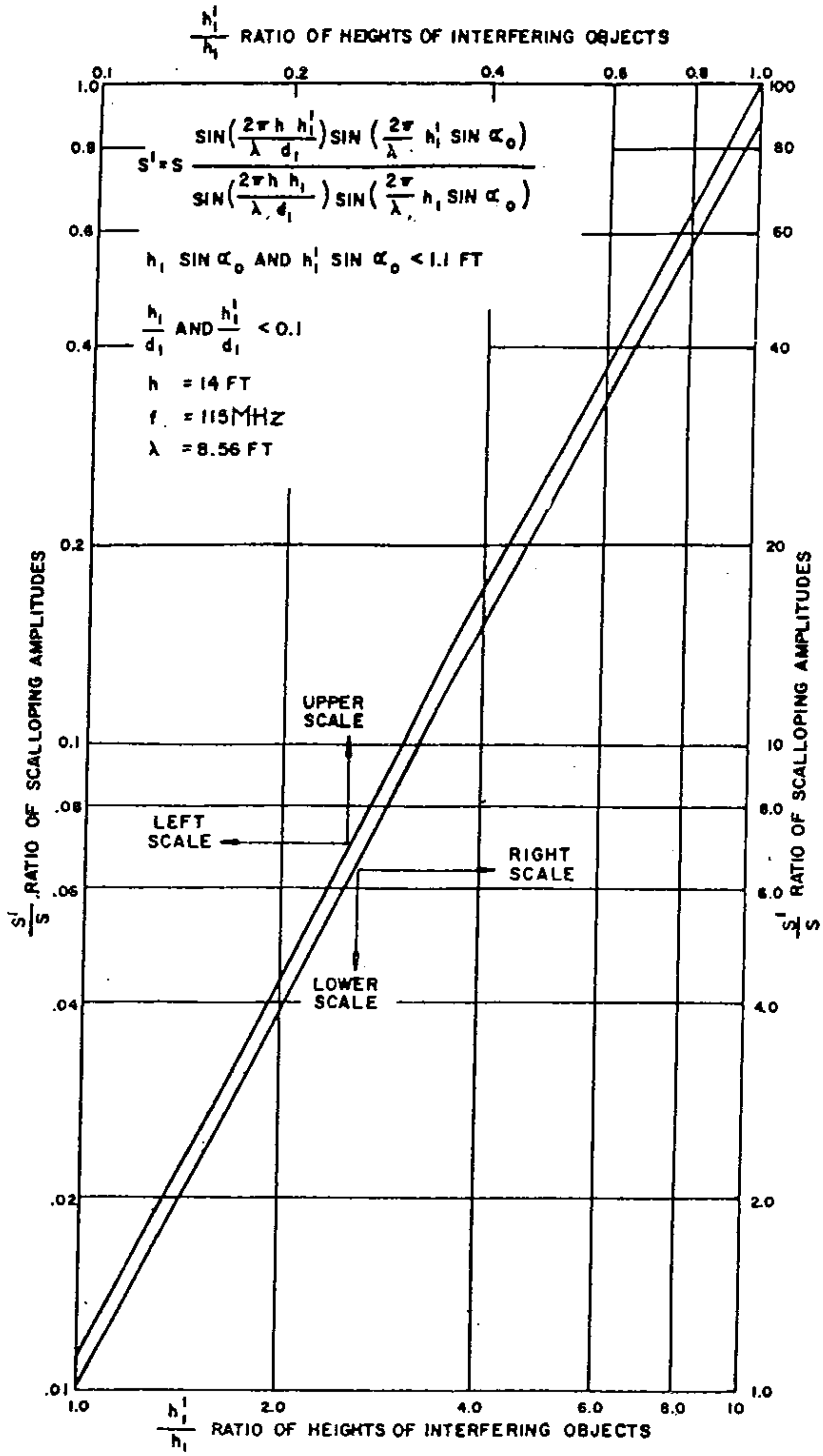


FIGURE 7-17. RELATIONSHIPS BETWEEN INTERFERING OBJECTS HEIGHTS AND SCALLOPING AMPLITUDE

30. FREQUENCY OF COURSE SCALLOPING.

a. General. Scalloping frequency for an aircraft in orbital flight and for an aircraft in radial flight are treated separately in the material which follows. In both discussions it is assumed that the aircraft travels at a constant speed of 140 knots. As already mentioned, the VOR scalloping amplitude presented to the pilot is a function of the scalloping frequency response of the VOR receiver. An illustrative example is developed after the discussion of scalloping frequency to show how to convert scalloping amplitudes at one frequency to another frequency, taking the receiver response into account.

b. Scalloping Frequency - Orbital Flight.

(1) The geometry for a nondirectional re-radiator causing scalloping is shown in figure 7-18, where the analytic expression for f_s, the scalloping frequency, is also presented. By inspection, the scalloping frequency is a maximum when the angle $(\Theta_o-\Theta_1)$ is 90 degrees or 270 degrees. The analytic expression can be written for a special case as follows:

$$f_s = \frac{27.55 \sin (\Theta_o-\Theta_1)}{r_o/d_1}$$

where

$$Va = 140 \text{ knots} = 140(1.688) \text{ ft/sec} = 236 \text{ ft/sec}$$

$$\lambda(115 \text{ MHz}) = 984/115 = 8.56 \text{ ft}$$

$$N = 236/8.56 = 27.55 \text{ wavelengths per sec}$$

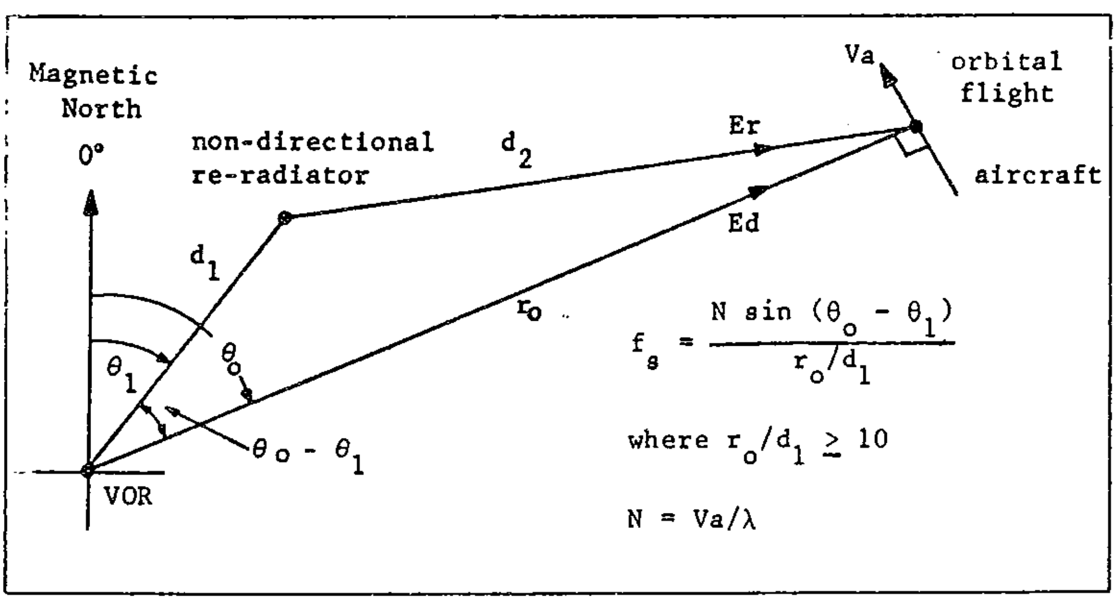


FIGURE 7-18. NONDIRECTIONAL RE-RADIATOR

Using the foregoing numerical expression, graphic presentations of the variation in scalloping frequency are presented in figures 7-19 through 7-22 for variations in r_o/d_1 and for variations in the angle $(\Theta_o-\Theta_1)$.

(2) The geometry for a directional re-radiator causing scalloping is shown in figure 7-23 where the analytic expression for f_s, the scalloping frequency, is also presented. Using the same numerical parameters as before, the analytic expression may be written:

$$f_s = \frac{27.55 \sin 2a}{r_o/d_1}$$

where

$$Va = 140 \text{ knots}$$

$$\lambda = \lambda(115 \text{ MHz})$$

Note that the scalloping frequency is a maximum when a is 45 degrees. Using the numerical parameters above, graphic presentations of the variation in scalloping frequency are presented in figures 7-24 through 7-27 for variations in r_o/d_1 and a.

(3) With respect to course scalloping characteristics, a long-length directional reflector may be viewed as a continuous string of short-length directional reflectors. Course scalloping equations are identical for both types of reflectors, and conclusions pertinent to short reflectors apply as well to long reflectors. However, an angle of incidence between interfering wave and reflector occurring at 55 degrees, corresponding to maximum scalloping amplitude, is more likely with a long-length reflector than with a short one. In situations where a short-length reflector location and orientation are recognized, equations shown in figure 7-23 can be useful in calculating the angle of incidence to be encountered and the VOR courses susceptible to scalloping.

c. <u>Scalloping Frequency - Radial Flight.</u>

(1) Using, for a nondirectional radiator, the same geometry and nomenclature as before, the analytic expression for f_s, the scalloping frequency for orbital flight is as shown in figure 7-28. This expression for an aircraft speed of 140 knots, a VOR carrier frequency of 115 MHz and $(\Theta_o-\Theta_1)$ of 90 degrees or 270 degrees is as written below.

$$F_s = 27.55 \left[1 - \frac{(r_o/d_1)}{\sqrt{1 + (r_o d_1)^2}} \right]$$

Graphic presentations of the variation of f_s, the scalloping frequency, with variations in r_o/d_1 are included as figures 7-29 and 7-30.

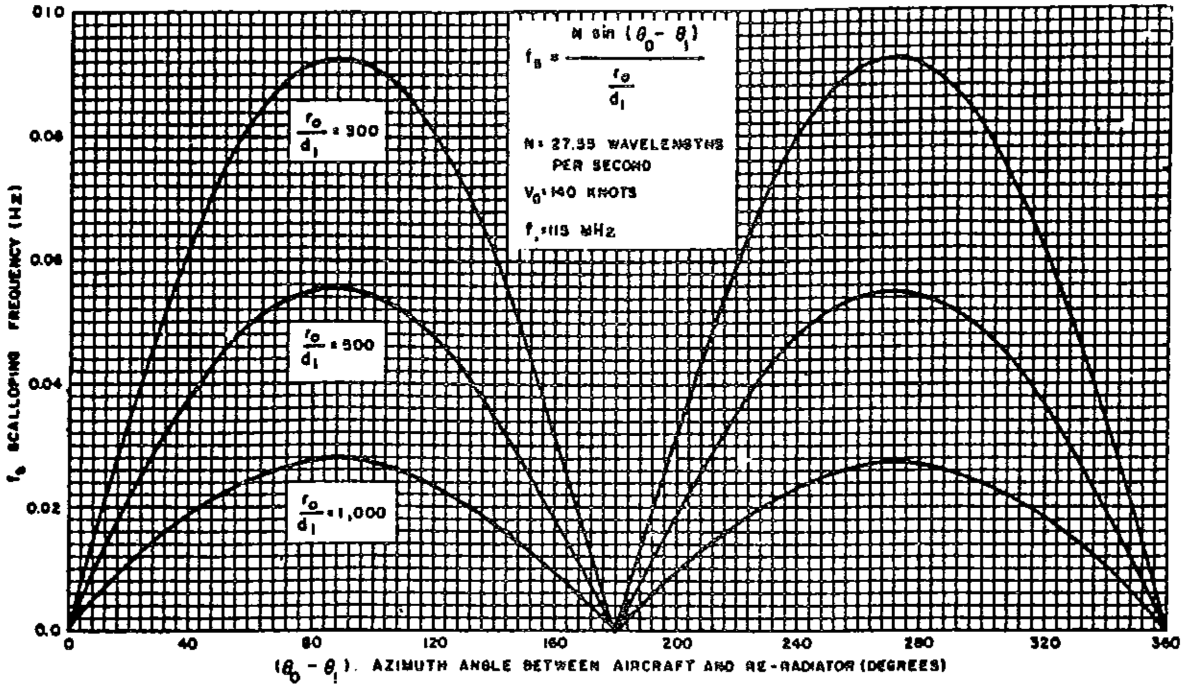


FIGURE 7-19. VARIATION IN SCALLOPING FREQUENCY WITH CHANGE IN VALUE OF r_0/d_1

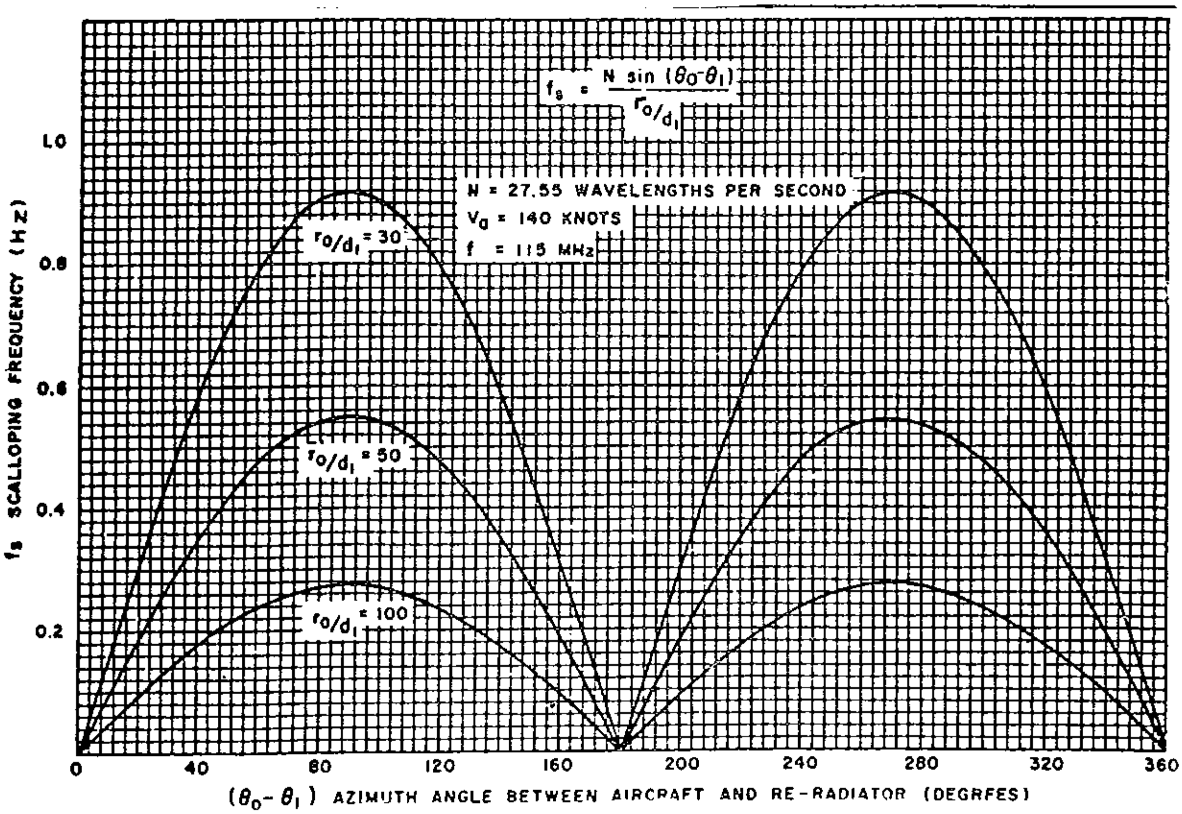


FIGURE 7-20. FURTHER VARIATION IN f_s WITH CHANGE IN VALUE OF r_0/d_1

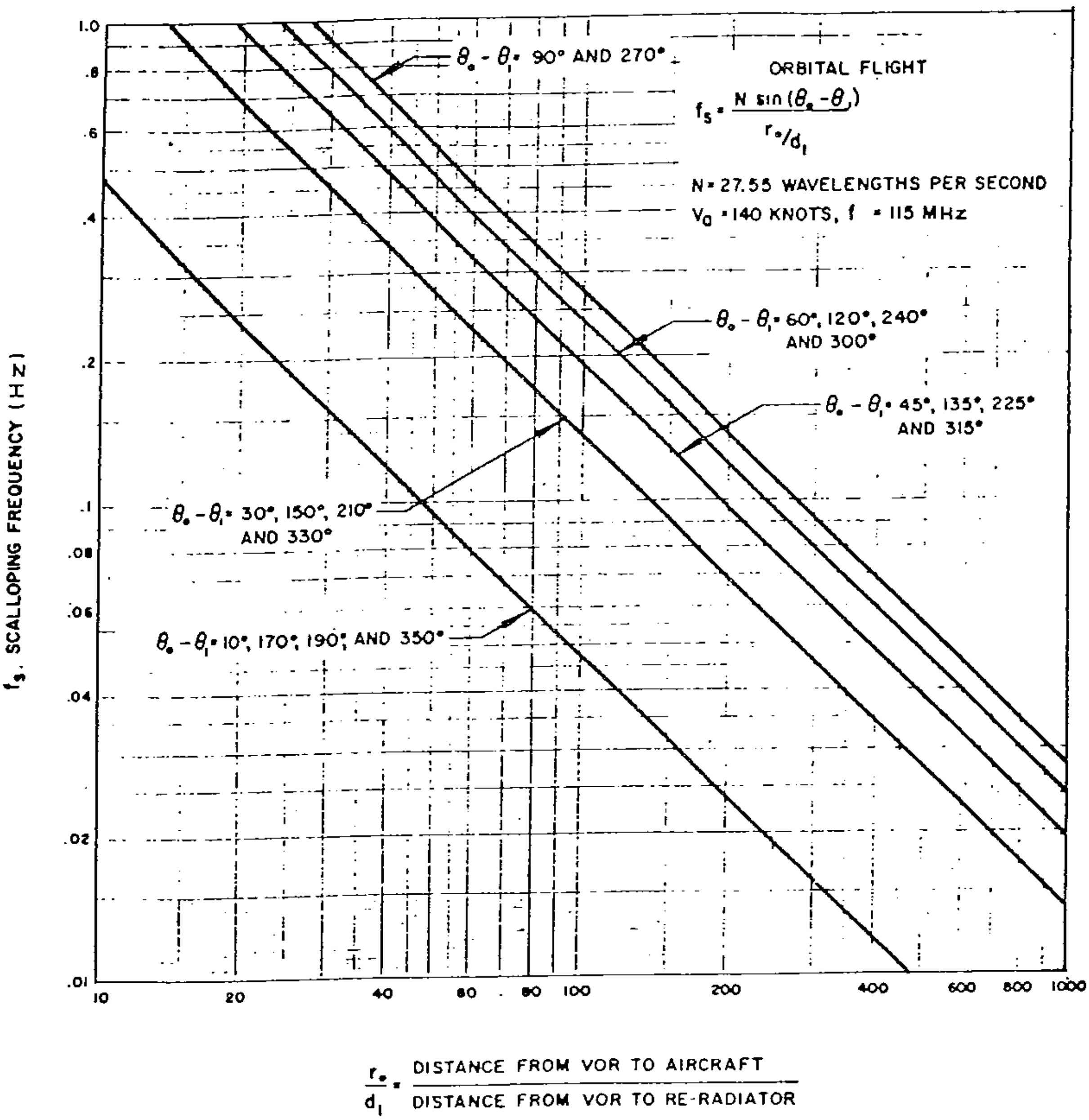


FIGURE 7-21. SCALLOPING FREQUENCY VARIATION WITH CHANGE IN AIRCRAFT AZIMUTH

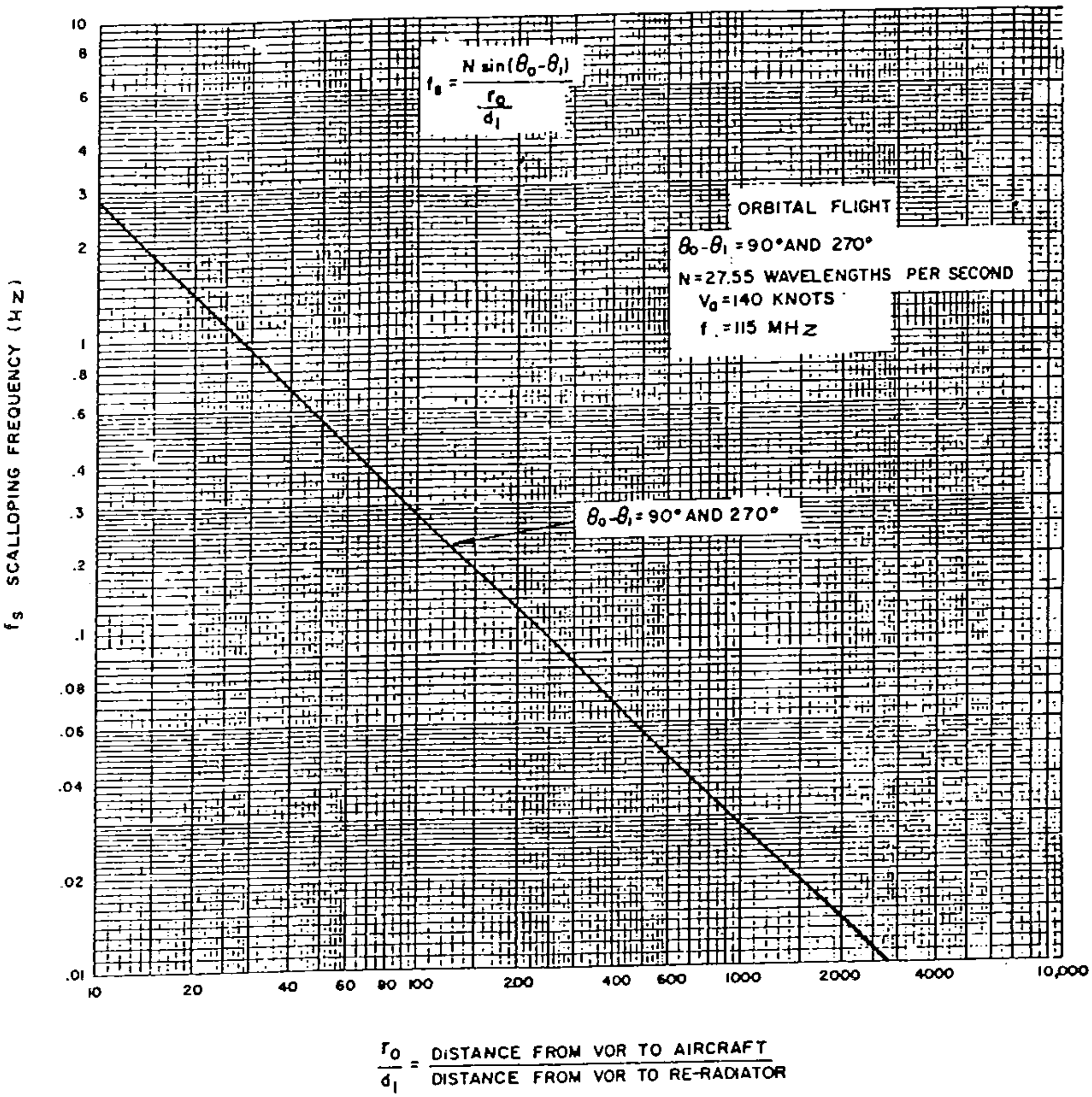


FIGURE 7-22. SCALLOPING FREQUENCY VARIATION ALONG LINE OF MAXIMUM SCALLOPING AMPLITUDE

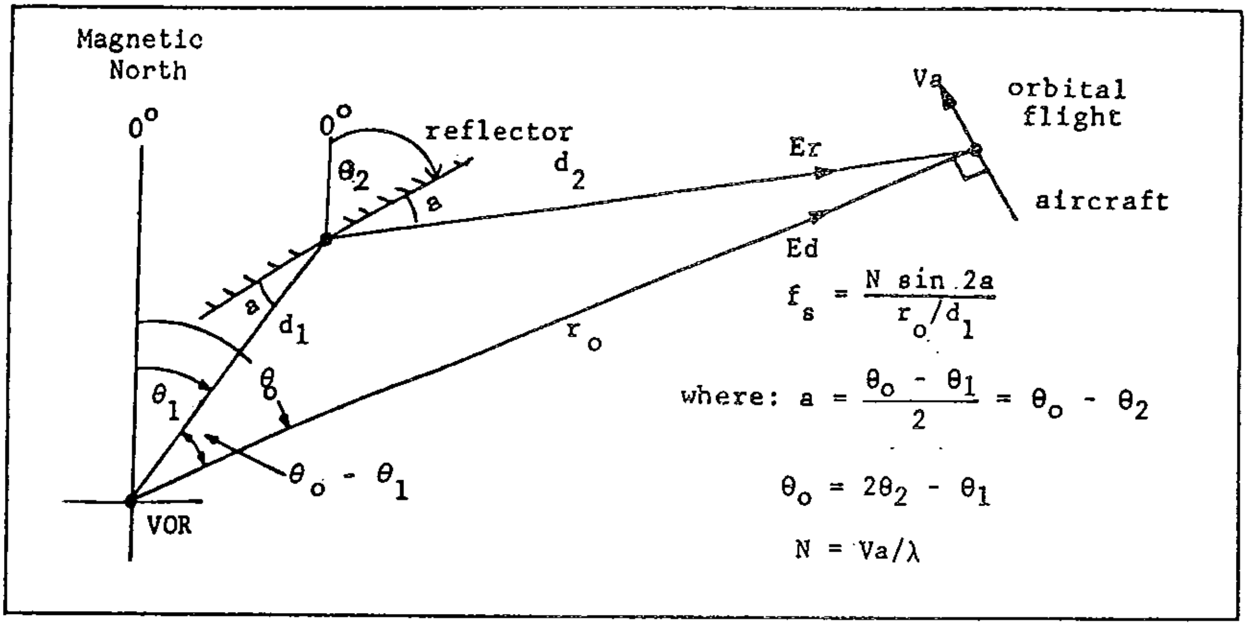


FIGURE 7-23. DIRECTIONAL REFLECTOR

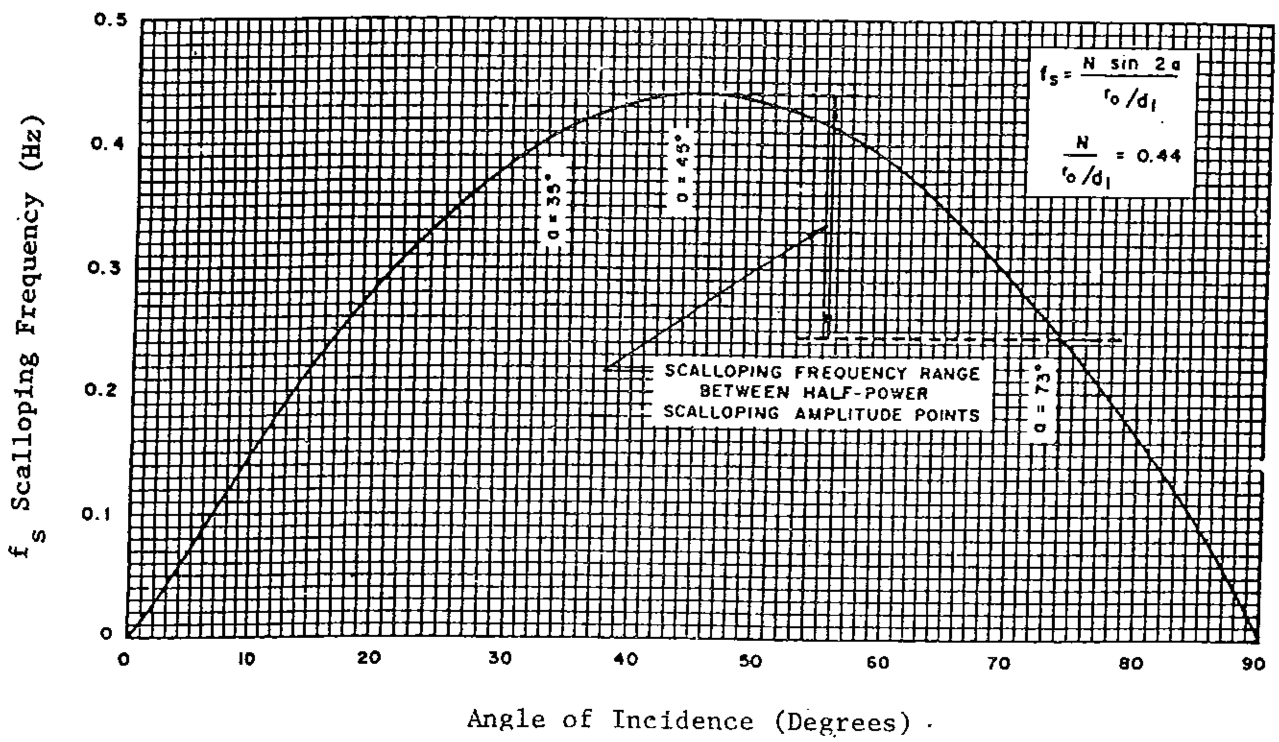
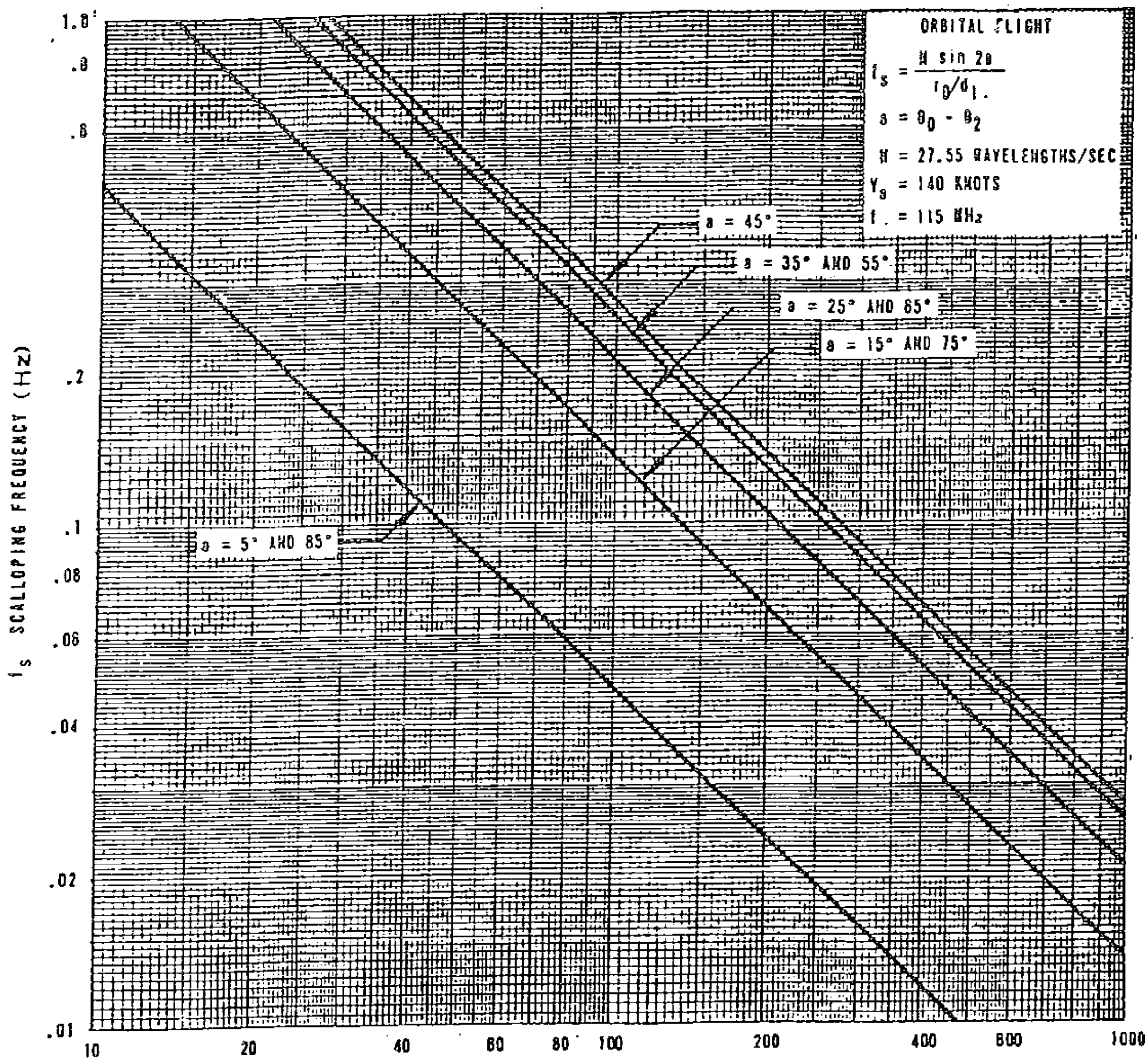


FIGURE 7-24. SCALLOPING FREQUENCY ON ORBITAL FLIGHT AS A FUNCTION OF ANGLE OF INCIDENCE



$$r_o/d_1 = \frac{\text{Distance from VOR to aircraft}}{\text{Distance from VOR to point of reflection}}$$

FIGURE 7-25. VARIATION IN SCALLOPING FREQUENCY FOR VARIOUS ANGLES OF INCIDENCE

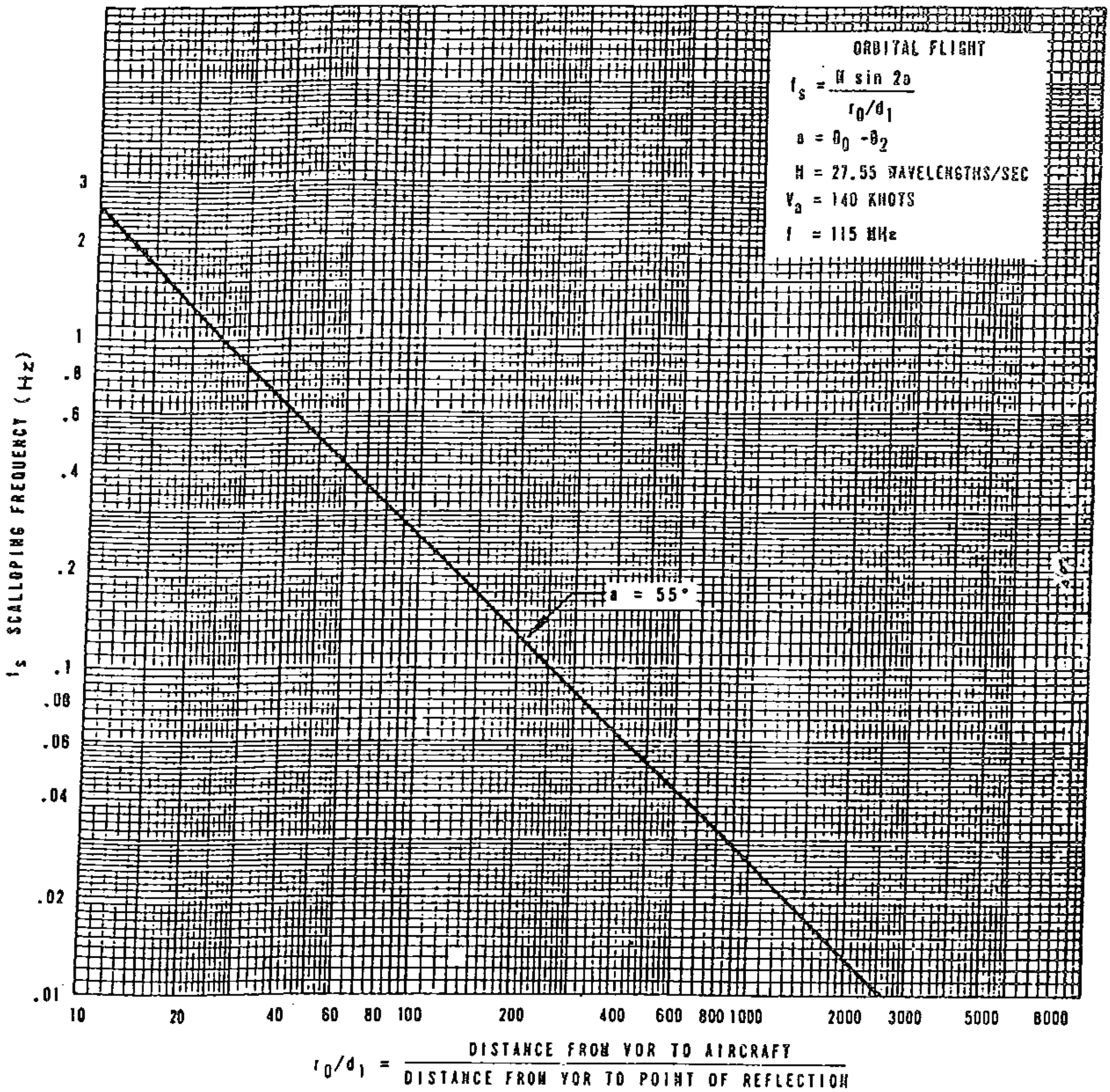


FIGURE 7-26. VARIATION IN SCALLOPING FREQUENCY AT THE ANGLE OF INCIDENCE OF 55 DEGREES

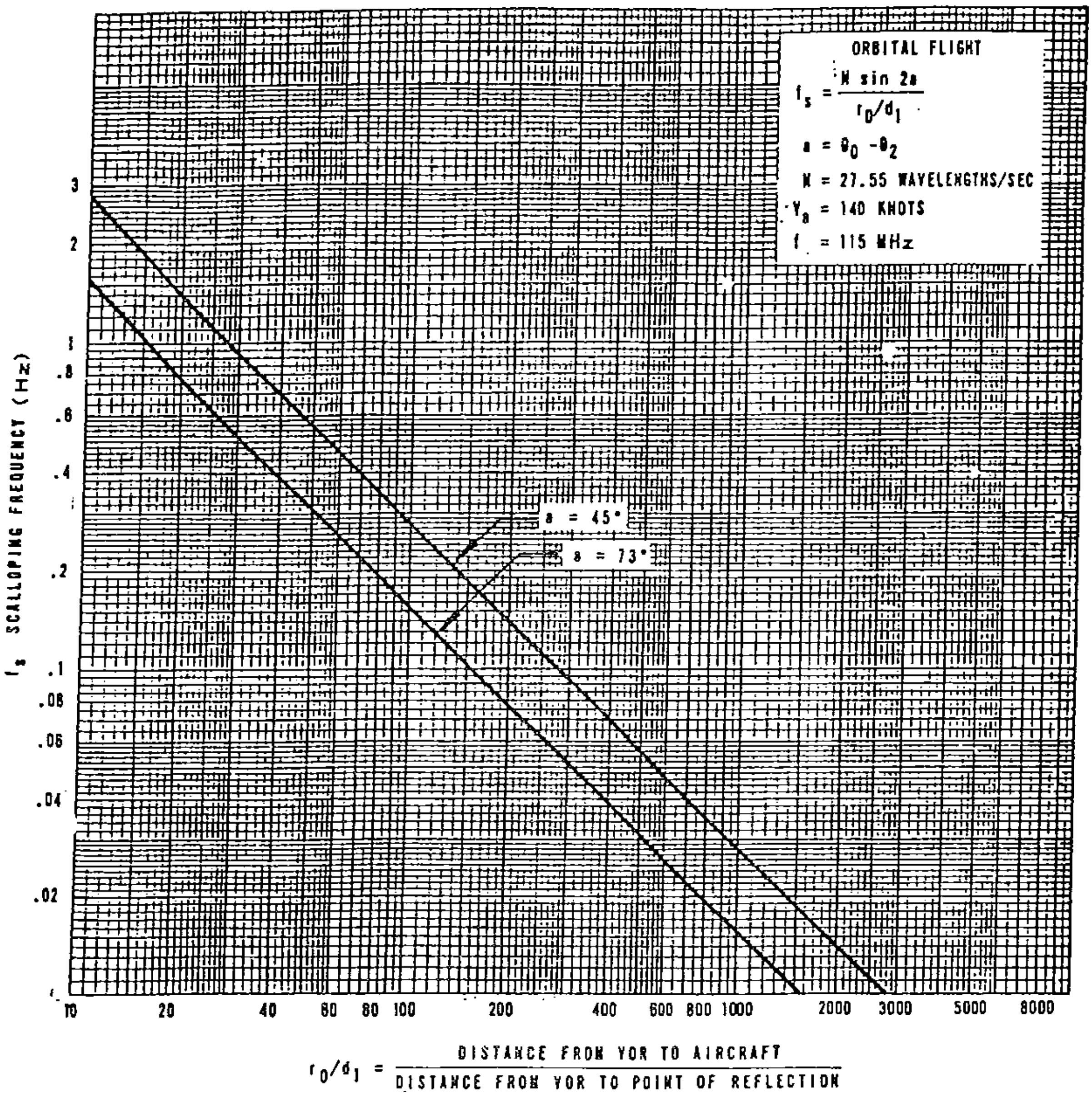
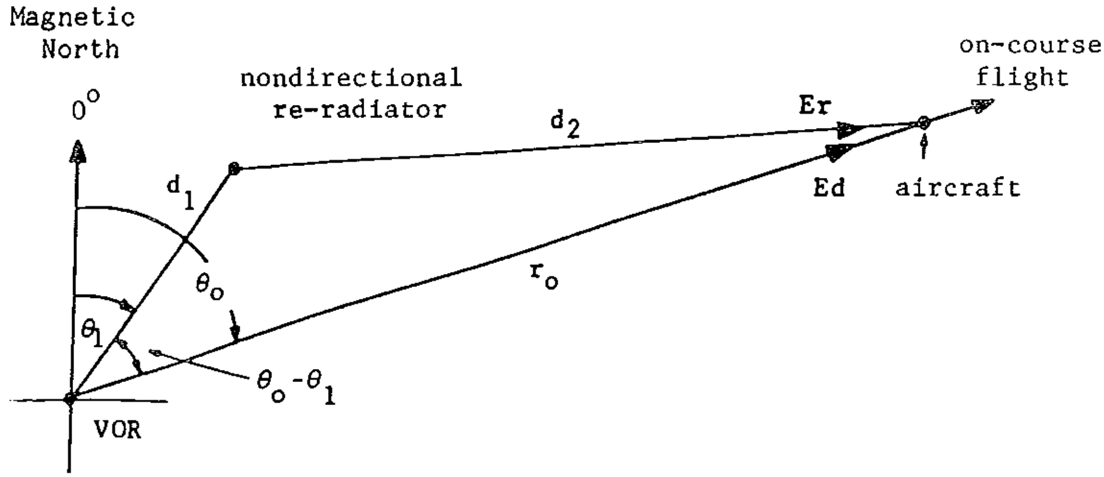


FIGURE 7-27. VARIATION IN SCALLOPING FREQUENCY AT THE ANGLES OF INCIDENCE OF 45 DEGREES AND 73 DEGREES



$$f_s = N\left[1 - \frac{\left(\frac{r_o}{d_1}\right) - \cos\,(\theta_o - \theta_1)}{\sqrt{1 + \left(\frac{r_o}{d_1}\right)^2 - 2\left(\frac{r_o}{d_1}\right)\cos\,(\theta_o - \theta_1)}}\right]$$

FIGURE 7-28. NONDIRECTIONAL RE-RADIATOR

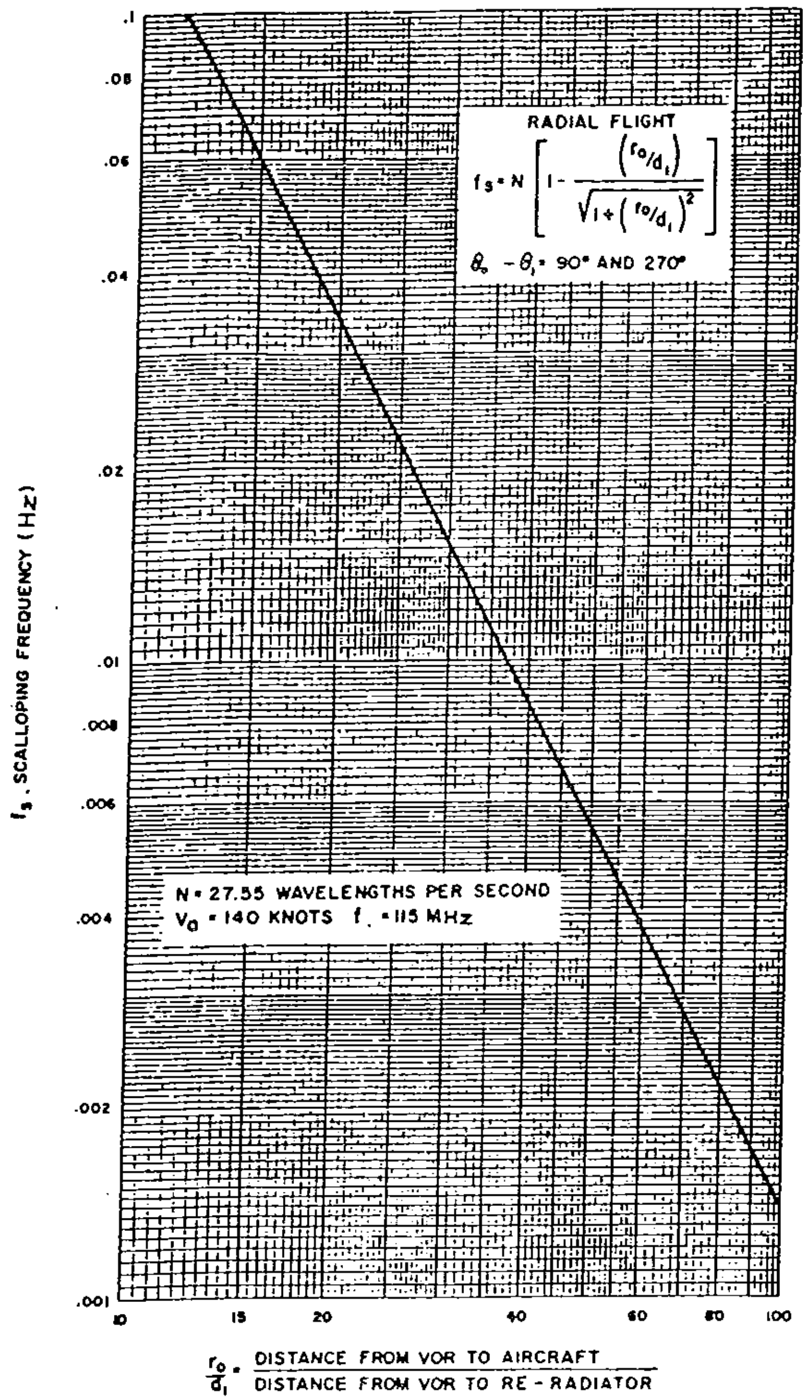
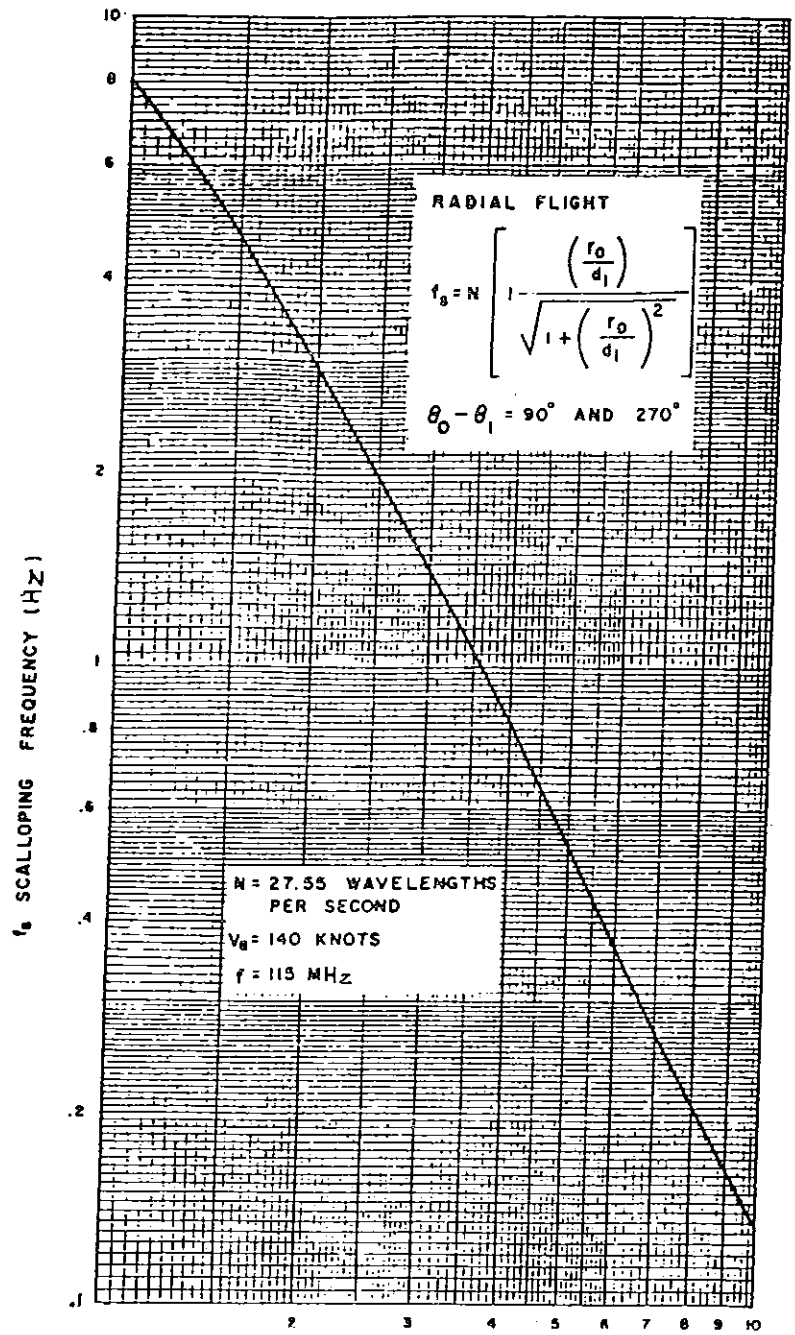


FIGURE 7-29. SCALLOPING FREQUENCY ALONG RADIAL OF MAXIMUM SCALLOPING AMPLITUDE; $r_o d_1$ = 10 TO 100



$$\frac{r_o}{d_1} = \frac{\text{Distance from VOR to aircraft}}{\text{Distance from VOR to re-radiator}}$$

FIGURE 7-30. SCALLOPING FREQUENCY ALONG RADIAL OF MAXIMUM SCALLOPING AMPLITUDE; $r_o d_1$ = 1 TO 10

d. Scalloping Amplitudes Presented to the Pilot

(1) Figure 7-31, which is a typical scalloping response curve for a VOR receiver, may be used to estimate the radial flight scalloping frequency response that will be experienced from knowledge of the orbital flight scalloping frequency that has been measured.

(2) During radial flight, a very slow scalloping frequency, approaching zero, will be experienced and it is useful to determine the amplitude of this scalloping. Figures 7-32a and 7-32b reveal that, along the 310-degree radial at the Washington National Airport, a scalloping amplitude and frequency of ± 0.6 degrees and 1.28 Hz, respectively, were measured. From figure 7-31, the VOR receiver has a nine percent response to 1.28 Hz on a scale normalized to zero frequency response. Hence, the zero frequency scalloping amplitude can be expected to be ± 6.67 degrees as shown below.

$$S_{of} = \frac{\text{Scalloping Amplitude}}{\text{Relative Scalloping Amplitude Percent}}$$

$$= \frac{\pm 0.6^{\circ}}{.09} = \pm\ 6.67^{\circ}$$

(3) The frequency of scalloping, f_s, as seen by an aircraft on a radial flight and in the presence of a directional re-radiator is as shown below.

$$f_s = N \left[1 - \frac{\left(\frac{r_o}{d_1}\right) - \cos 2a}{\sqrt{1 + \left(\frac{r_o}{d_1}\right)^2 - 2\left(\frac{r_o}{d_1}\right) \cos 2a}} \right]$$

Refer to figures 7-5 and 7-6 for the geometry. Along the azimuth of maximum f_s, a = 45 degrees, and for the parameters of 140 knots and 115 MHz, this expression reduced to the one obtained in the previous paragraph is

$$f_s = 27.55 \left[1 - \frac{(r_o/d_1)}{\sqrt{1 + (r_o d_1)^2}} \right]$$

which is plotted in figures 7-29 and 7-30.

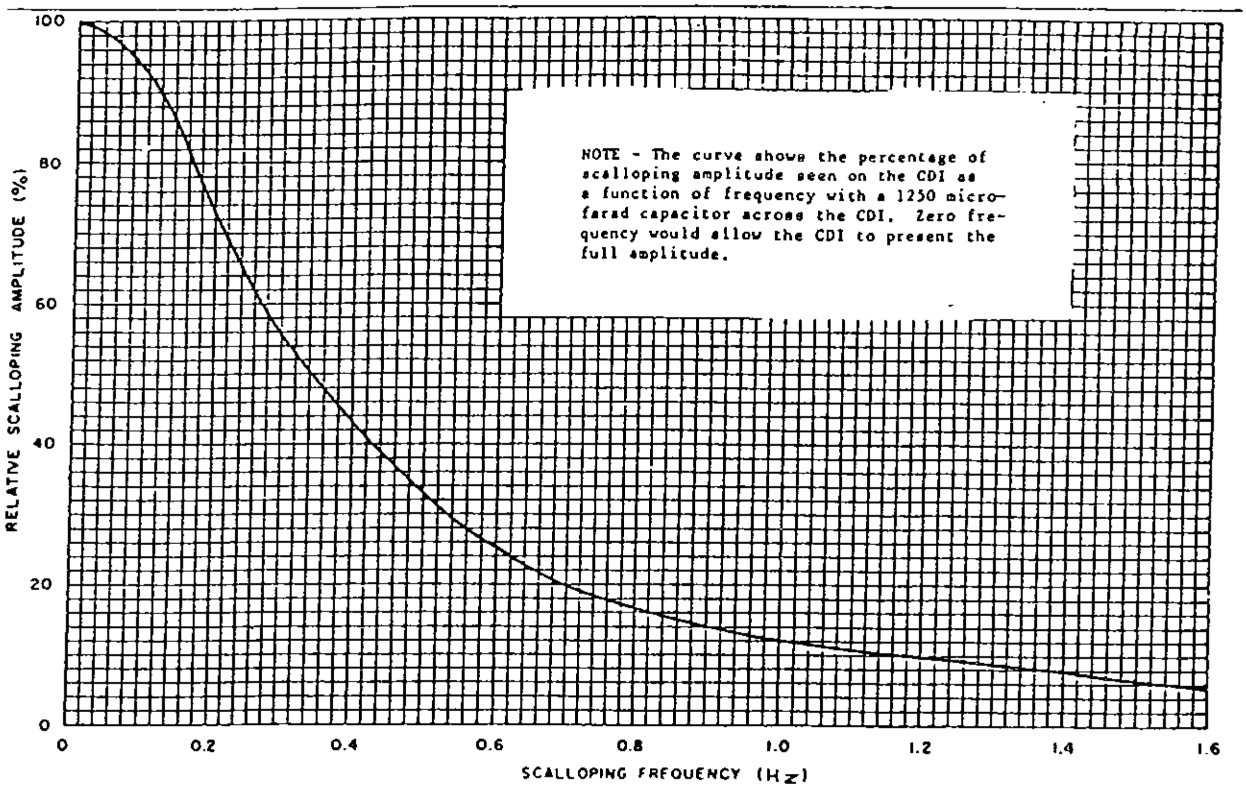


FIGURE 7-31. TYPICAL SCALLOPING RESPONSE FOR VOR RECEIVER

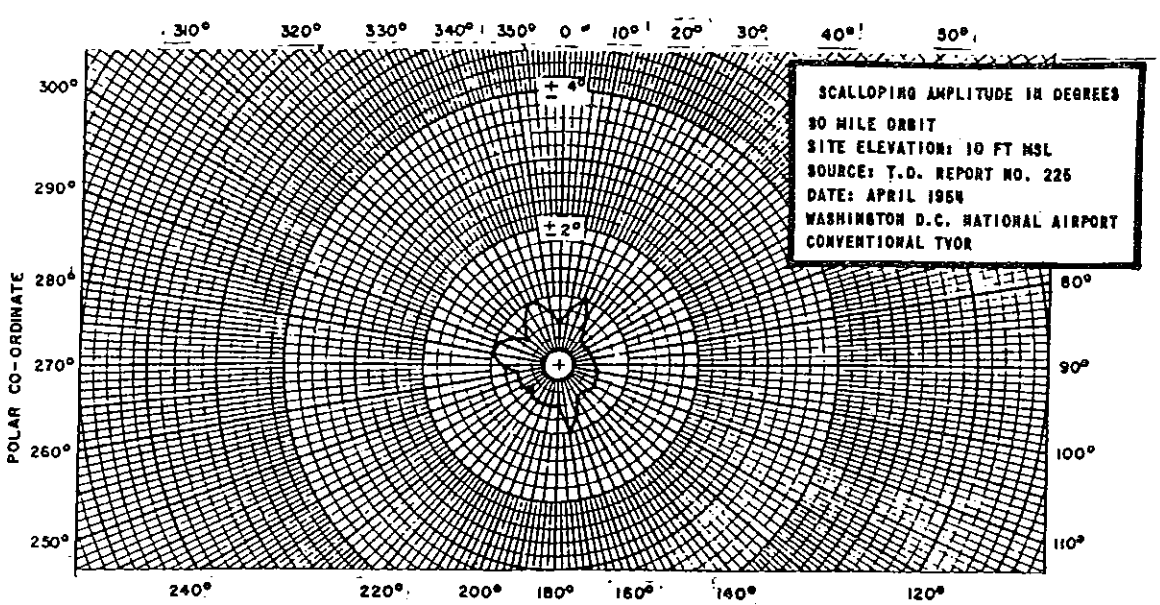


FIGURE 7-32a. SCALLOPING AMPLITUDE

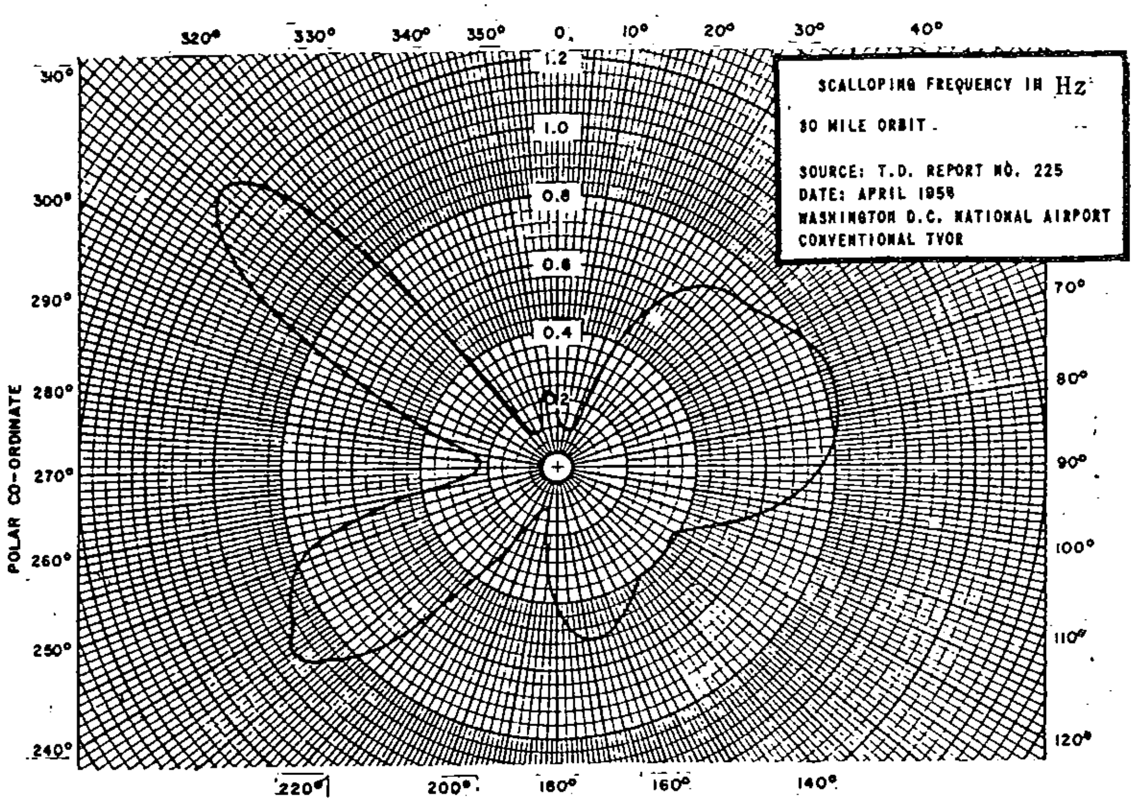


FIGURE 7-32b. SCALLOPING FREQUENCY

CHAPTER 8. SCATTERING SIMULATIONS

31. GENERAL.

a. Previous chapters have presented various practical and theoretical approaches to siting VOR, VOR/DME, and VORTAC facilities. This chapter and its related appendix provide access to simulation tools to assist in evaluating the potential effects of specific types of obstructions on the performance of only the VOR facilities. The types of obstructions considered here are thin-wire obstacles (i.e., utility lines and fences) and metallic obstacles shaped as bodies of revolution (i.e., water tanks and silos).

b. The use of these simulations is most suited for established facilities, particularly where construction of a potential obstacle is planned in the vicinity of the site, or where it is desired to identify the magnitude of error arising from a given obstacle. For new facilities, flight testing of candidate sites provides more comprehensive and reliable information than is presently possible with simulations.

c. The purpose of this chapter is to describe the available programs and to provide guidance on the inputs required to properly utilize each program. Full description of the program methodology and theoretical basis is beyond the scope of this order, but is available in the following reports:

(1) "Effects of Scattering by Obstacles in the Field of a VOR/DVOR," Report No. FAA-RD-74-153, Harry Gruenberg and Bradley J. Strait, July 1974.

(2) "Effects of Scattering by Obstacles in the Field of a VOR/DVOR," Report No. FAA-RD-76-21, Harry Gruenberg and Kazuhiro Hirasawa, February 1976.

The programs were originally run on an IBM 360 and have since been rewritten to be used on the CDC 6600, Scope 3.4, Fortran Extended System which is available to FAA.

d. The programs are available in card decks through:

Navigation Program, APM-420
Federal Aviation Administration
Washington, DC 20591
(202) 426-1944 (Commercial)

e. Appendix 2 contains sample data input cards and the resultant program output for each of the programs described. This will enable users to verify that their installation of the programs is running correctly.

f. The following discussion assumes a basic knowledge of computer programming in general and FORTRAN in particular.

32. LONG-WIRE COMPUTATION PROGRAM (LONGSY).

a. The program LONGSY provides a means for analyzing the scalloping effects of a wire more than 200 feet in length in the field of a VOR. Up to three parallel wires are accommodated by the program, provided that wire-to-wire spacing does not exceed three feet. The input parameters for this program are as follows:

b. Card 1. The number of segments of wires. The variable name in the program is IMP and the input is an integer up to ten digits (I10). Figure 8-1 illustrates a four-segment wire.

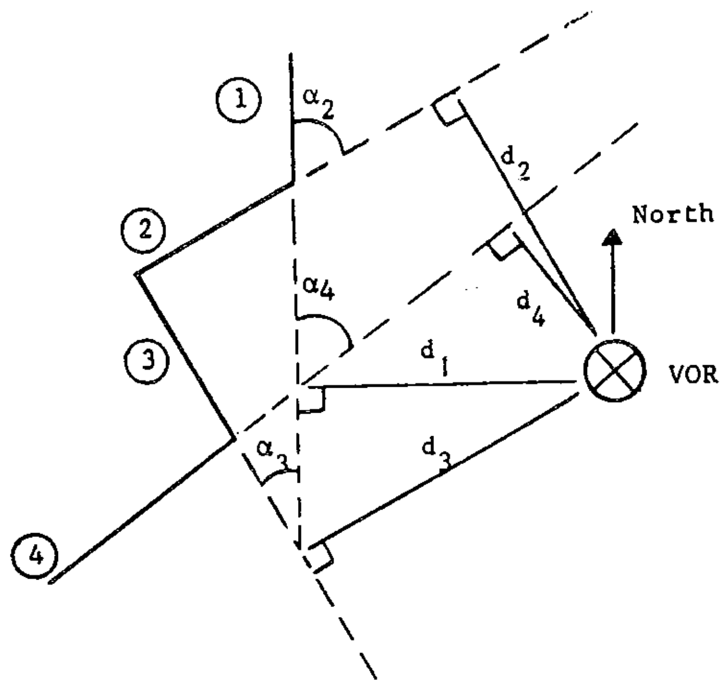


FIGURE 8-1. SAMPLE WIRE PROBLEM

c. Card 2.

(1) The spacing of the wire configuration in feet. The variable name is D3 and requires an F10.4 input field. If wire spacing exceeds three feet, then run the program for a single wire, and multiply the result by the number of wires.

(2) The number of wires in the configuration. The variable name is N and requires an I10 input field. The number of wires can be one to three. If more than three wires are in the configuration, the program will require the following general formula:

$$\left| \sum_{i=1}^{N} (Kh_i)^2 \sin (Kh_d\varepsilon)/Kh_i\varepsilon \exp -j \left[Kd_i(1+\sin\phi)+(Kh_i{}^2/2D)\right] \right|$$

d. Card 3.

(1) The height of the counterpoise above ground. The variable name is H and requires an F10.2 input field.

(2) The height of the four loops above the counterpoise. The variable name is SH and requires an F10.2 input field.

(3) The radius of the counterpoise in feet. The variable name is R and requires an F10.2 input field.

(4) The carrier frequency in megahertz. The variable name is FRM and requires an input field of F10.2.

e. Card 4.

(1) The radius of the circular aircraft orbit in miles. The variable name is SR and requires an F10.2 input field.

(2) The altitude of the aircraft in feet (HA), with an F10.2 input field.

(3) The aircraft speed in miles per hour (V), with an F10.2 input field.

(4) The time constant of the 30 Hz signal of the receiver, between 0.3 and 0.4. The variable name is FO and requires an input field of F10.2.

f. Card 5. Three inputs, the initial azimuth angle in degrees (SPH), the final azimuth angle in degrees (EPH) (less than 180 degrees) and the increment in degrees (AINC). All use an F10.2 input field.

g. Cards 6 and 7. These cards provide the description of each wire segment, and there should be one pair (cards 6 & 7) for each segment specified in Card 1.

(1) Card 6 contains the normal distance from the VOR to the wire in feet (D), the location of the first endpoint of the wire in feet (AL1), and the location of the second endpoint of the wire in feet (AL2). These each require an input field of F10.2. Figure 8-2 shows how these values are determined. Using wire segments from figure 8-1 as an example, figure 8-2a shows for segment 1 the measurement of AL1 and AL2 as being positive to the north or right of the perpendicular from the VOR. This convention should be followed for each segment. Figure 8-2b illustrates this convention for segment 2, where both AL1 and AL2 are negative.

(2) The remaining two inputs on Card 6 are the radius of the wire in feet (A), which requires an F10.6 input field, and the height of the wire above ground in feet (H1), which requires an F10.2 input field.

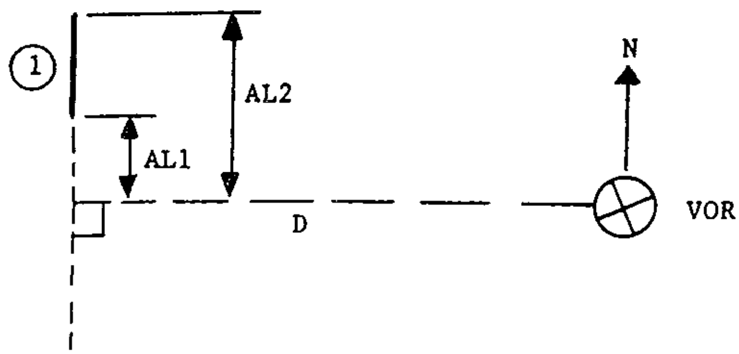


FIGURE 8-2a. LENGTH OF WIRE SEGMENTS (SEGMENT 1)

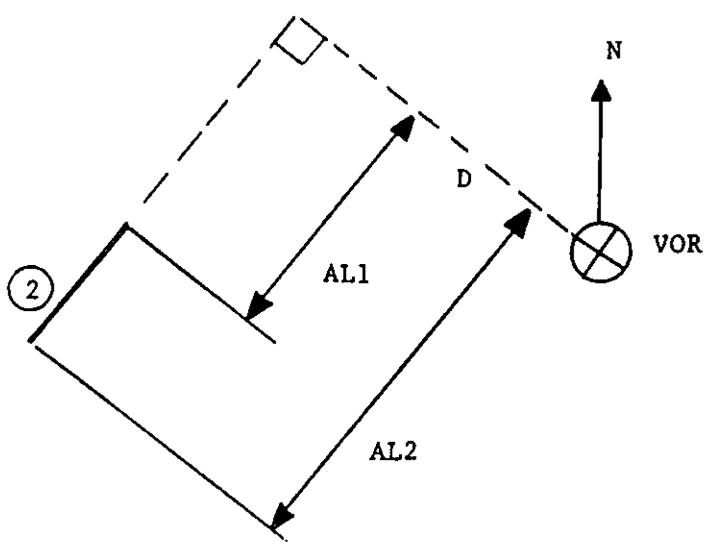


FIGURE 8-2b. LENGTH OF WIRE SEGMENTS (SEGMENT 2)

h. Card 7. This card contains the angular difference of wire position, in degrees from north, for the wire segment described in Card 6. Clockwise is positive and counterclockwise is negative, and the card requires an input field of F10.2. Referring to figure 8-1, segment 1 is oriented north-south, and therefore $\alpha_1 = 0$. Segment 2 will have a positive α_2 rotation, and segment 3 will have a negative α_3 rotation. Running this program for a wire of more than one segment will yield an error prediction for each wire segment. In order to find the total error, the errors for each segment must be summed at each azimuthal point, providing a composite error curve for the entire wire.

33. BODIES-OF-REVOLUTION COMPUTATION PROGRAM (CYLPI and CYLP2).

a. The programs CYLPI and CYLP2 are used to calculate errors in a VOR field due to bodies of revolution; i.e., obstructions such as water tanks or silos. Program CYLPI calculates the admittance matrix of the obstruction, and program CYLP2 uses this matrix to calculate the error due to the obstruction. The obstruction is assumed to have an axis running through its center and perpendicular to the X-axis (90- and 270-degree radials) of the VOR station. It is also assumed that the obstruction is symmetrical about this axis.

b. The program CYLPI requires five input cards.

(1) Card 1 has two inputs. The first is the number of points which define the contour (NP), with an I5 input field. There should be 21 points for each wavelength of the contour. Therefore, if the contour is two wavelengths high, then 42 points must be used. The second input is the VOR frequency in megahertz (FRM), with an F10.2 input field.

(2) Cards 2 and 3 describe the locations of the points that define the contour. The reference is to the first point in the contour and to the central axis, and the unit of measurement is the wavelength of the VOR signal. For a VOR operating at 115 MHz, the wavelength is 2.6 meters, or approximately 8.5 feet. Figure 8-3 illustrates this for a cylinder 0.5 wavelength in diameter and 0.375 wavelength high. Since the body is less than one wavelength high, only 15 points are used to define the contour.

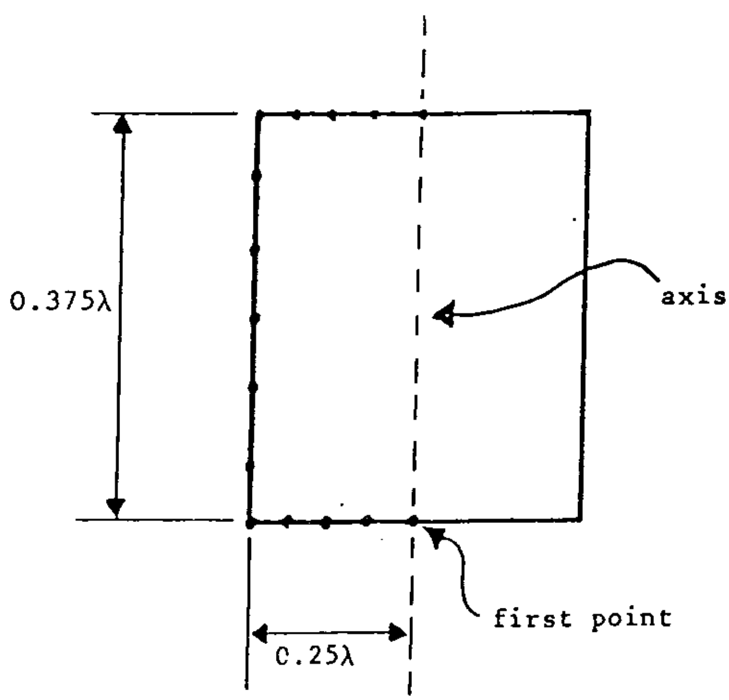


FIGURE 8-3. BODY OF REVOLUTION

(a) Card 2 contains the distance of each specified point on the contour from the central axis. This variable is named RH(I), I = 1 to NP, and requires an input field of 10F8.4. There may be a maximum of 43 points, and since each card contains 10 points, there can be up to five cards of this type.

(b) Card 3 contains the elevation of each point with respect to the first point, and the variable is called ZH(I), and requires an input field of 10F8.4. The limits are the same as for Card 2.

(3) Card 4 is the number of modes, called NTR, and requires an I/O input field. The number of modes should be at least three per wavelength.

(4) Card 5 contains the mode number (NM) in an I5 input field, and the subdivisions of the mode to be used for the calculations (NPHI) also in an I5 input field. The modes and their associated number of subdivisions are:

NM	NPHI
0	8
1	12
2	16
3	20
4	20
.	.
.	.
.	.

c. After the program CYLPI has been successfully run, the resulting admittance matrix, ADDPAR, is stored for use by CYLP2. CYLP2 is then run to calculate the error due to the obstruction. This program requires seven types of input cards:

(1) Card 1.

(a) Number of modes (NX), input field of I10, same as NTR in CYLPI.

(b) Number of points to define the contour (NP), input field of I10, same as NP in CYLPI.

(c) Frequency of VOR in MHz (FRM), input field of F10.2, same as FRM in CYLPI.

(2) Card 2.

(a) The perpendicular distance in feet from the VOR to the centerline of the obstruction (XX), input field of F10.1.

(b) The distance of the obstruction above the ground in feet (ZZ), input field of F10.2.

(3) Card 3.

(a) Height of the counterpoise above the ground in feet (HH), input field of F10.2.

(b) Height of the four-loops above the counterpoise in feet (SH), input field of F10.2.

(c) Radius of the counterpoise in feet (RR), input field of F10.2.

(4) Card 4. Same as type 2 card(s) in CYLPI.

(5) Card 5. Same as type 3 card(s) in CYLPI.

(6) Card 6.

(a) Altitude of the aircraft in feet (HS), input field of F10.2.

(b) Radius of the aircraft orbit in miles (DIT), input field of F10.2.

(7) Card 7.

(a) Starting azimuth in degrees (SPH), input field of F10.2.

(b) Ending azimuth in degrees (EPH), input field of F10.2.

(c) Increment in degrees (AINC), input field of F10.2.

34. SHORT WIRE COMPUTER PROGRAM (FRANK).

a. The program FRANK is designed to estimate the bearing errors introduced into the VOR system when a short wire, less than 200 feet in length, is in the VOR field. The program is generalized so that it can be readily modified to handle up to four wires. The input cards required for this program are described below, with comments regarding variations for multiple wires included where appropriate. Following the input description is a review of the required changes for running analyses of more than four wires, and for variations on configurations.

b. Figure 8-4 provides a schematic description of a wire in a VOR field, and the input descriptions will refer to this figure.

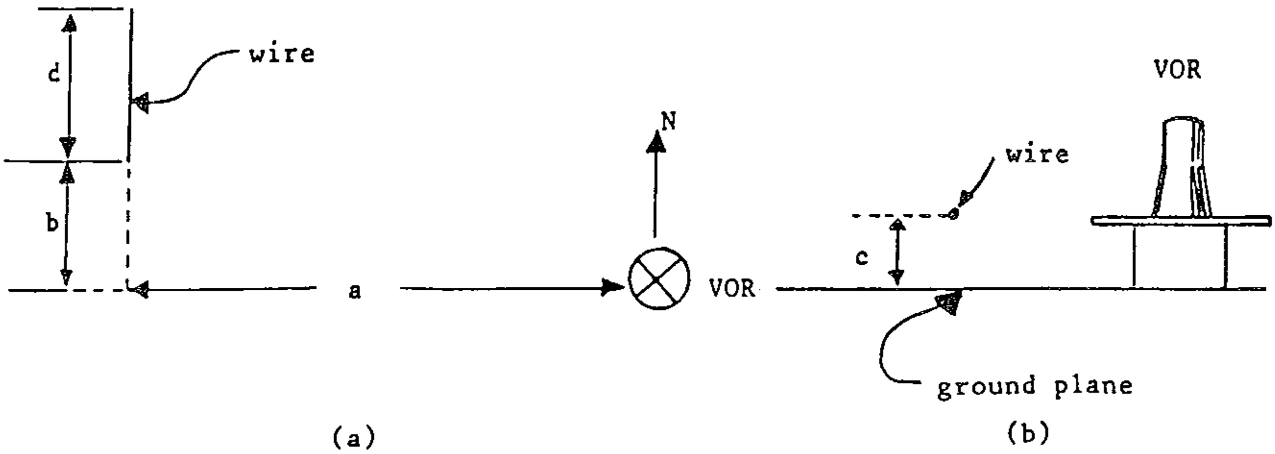


FIGURE 8-4. SHORT WIRE IN A VOR FIELD

(1) Card 1.

(a) The perpendicular distance in feet from the VOR to the wire(s) in question. This is labeled "a" in figure 8-4a. In the program the variable is named XNP1 and requires an input field of F10.4. The first wire is the closest to the VOR, when more than one wire is being considered.

(b) Distance of the wire(s) offset from the X-axis (90- and 270-degree radials) of the VOR. This is labeled "b" in figure 8-4a. In the program the variable is named YNP1 and requires an F10.4 input field.

(c) Elevation of the wire(s) above the ground. This is labeled "c" in figure 8-4b. In the program the variable is named ZNP1 and requires an F10.4 input field.

(d) Length of the wire(s). This is labeled "d" in figure 8-4a. In the program the variable is named XLEN and requires an F10.4 input field.

(2) Card 2.

(a) The number of wires in the configuration (NW), with an I4 input field.

(b) The number of points to describe the wire(s) (NP), with an I4 input field. To determine the number of points required to define the wire(s), divide the length of the wire by the wavelength of the VOR signal, multiply by 20, and add 3. The maximum number that can be used is 281, so if the result is more than that, use 281 points.

(c) The number of different radii encountered on the wire(s) (NR), with an I4 input field.

(d) The frequency of the VOR in MHz (FRM), with an F7.4 input field.

(3) Card 3. First points for each wire (LL(I)), with a 20I4 input field. If more than one wire is being considered, then the number of points must be divided among the wires. This procedure yields a number which is the first point on each wire. For example, if 124 points are being used to describe a two wire configuration, then the first points would be 1 and 62 for the first and second wires, respectively.

(4) Card 4. First points for each radius change (LR(I)), with a 20I4 input field.

(5) Card 5. Radius of wire in meters (RAD(I)), with a 5E14.7 input field. More than one card may be used to complete this input (if NR from Card 2 is more than 5).

(6) Card 6.

(a) Elevation of the aircraft in feet (HS), with an F10.1 input field.

(b) Radius of the orbit of the aircraft in miles (DIT), with an F10.2 input field.

(7) Card 7.

(a) Height of the counterpoise above ground in feet (H), with an F10.2 input field.

(b) Height of the four loops above the counterpoise in feet (SH), with an F10.2 input field.

(c) Radius of the counterpoise in feet (R), with an F10.2 input field.

(8) Card 8. Number of loads (NL), with a 20I4 input field.

(9) Card 9. This card is optional, depending on Card 8. For information, see Report FAA-RD-F4-153.

(10) Card 10.

(a) Starting azimuth in degrees (SPH), with an F10.3 input field.

(b) Ending azimuth in degrees (EPH), with an F10.3 input field.

(c) Increment in degrees (AINC), with an F10.3 input field.

c. The program FRANK is configured to run an error estimate based on one wire in the VOR field. In order to run calculations for more than one wire, several modifications must be made to the program. These are:

(1) Modification of the DO 50 loop. There is a loop in the program that begins with the line "DO 50 I=1, NP" and goes to the line "50 CONTINUE". This loop is generalized for up to four wires and requires only the addition of another data card after Card 2 if more than one wire is being analyzed. This card should contain the distance between the wires in feet (DBW(I)) in an 8F10.4 format, and there may be more than one card for more than nine wires. If there are more than four wires, the loop itself must be modified by the addition of one set of the following four lines for each wire over four:

```
IF (NW.EQ. K-1 ) GO TO 50
IF (I.LE.(LL(K)-1) GO TO 50
PX(I)=(XNP1+DBW( K-1 )*0.3048
PY(I)=YNP1*0.3048+3.5*300.0/FRM*(AI-(LL(K)-1))/(NP/NW)-1)
```

Where K=5,6,etc. is substituted in the underlined places in each expression. The loop will then be generalized for up to that many wires.

(2) Modification of CALZ and ROW subroutines. The subroutines CALZ and ROW are generalized for arbitrary wires. If the wire is a parallel or straight wire, then the CALZ routine for straight or parallel wires must be substituted for the general CALZ routine. If the wire is parallel to the ground plane, then the ROW subroutine for wires parallel to the ground plane must be substituted for the general ROW subroutine.

APPENDIX 1. LIST OF ABBREVIATIONS, ACRONYMS, AND COMMONLY USED TERMS

am	amplitude modulation
BER	Bearing Error Report
beta (β)	deviation ratio in fm. β is the ratio of maximum excursion of the modulated frequency to maximum modulating frequency. In VOR and DVOR, β = 480 Hz/30 Hz = 16
CDI	Course Deviation Indicator
carrier	refers to the radio frequency energy which is modulated with the information-bearing signal
counterpoise	counterpoise is the term commonly used for the metal ground plane used with the VOR/DME/TACAN antenna system
course deviations	errors in VOR bearing indication are detected by means of the Course Deviation Indicator (CDI) and may be recorded on strip recorders. The categories of deviations are itemized below: <u>course roughness</u> - a series of rapid irregular deviations <u>course bends</u> - a series of very slow smooth rhythmic deviations <u>course scalloping</u> - a series of smooth rhythmic deviations <u>scalloping amplitude</u> - is half the peak to peak deviation of the CDI recording, measured in degrees. It is usually measured by taking half the peak to peak value over a ten degree azimuth sector. <u>scalloping frequency</u> - is the number of complete cycles of the CDI pointer (as recorded on the strip recorder) in one second
CSM	Center of Symmetry Method
deviation ratio	see beta (β)
dB	decibel
DME	distance measuring equipment, a navaid
DSB-SC	double sideband suppressed carrier; this is conventional amplitude modulation
DSBDVOR	double sideband Doppler VOR, a navaid

DVOR	Doppler VOR, a navaid
EIS	Environmental Impact Statement
em	electromagnetic
envelope	refers to the information bearing signal which modulates the rf carrier
FAA	Federal Aviation Administration
fm	frequency modulation
fm capture	refers to the capability of fm to selectively reject the weaker of two signals and so improve the signal-to-interference ratio when, initially, the ratio is 6 dB or more
FONSI	Finding of No Significant Impact
GHz	gigahertz, billions of Hertz
ground plane	see counterpoise
Hz	Hertz
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
interferometer	refers to the characteristic of regularly spaced effect objects, such as trees, to re-radiate signal most strongly in specified preferred directions
kHz	kilohertz
LOPs	Lines of Position
LORAN-C	Long Range Navigation (Model C)
MHz	Megahertz
MTBF	Mean Time Between Failures
multipath	multipath usually refers to the phenomenon of a wave of em energy reaching the receiver by reflection or re-radiation from an intermediate object and interfering with the wave that traveled directly from the same source <u>lateral multipath</u> - a wave of em energy radiated at one azimuth which is redirected to another azimuth by interaction with an object such as a tree or a wire-line and which, as a result, contributes to error in the navigational information presented to the pilot

	<u>longitudinal multipath</u> - a wave of em energy which is re-radiated after impacting on the ground. It can, if the geometry is appropriate, interact at the receiver with the direct ray and cause a signal null
NAS	National Airspace System
navaid	navigational aid
nm	nautical mile
NOTAM	Notice to Airmen
reference	refers to that signal in a VOR or DVOR system whose phase phase is azimuth independent
reflection	refers to the re-radiation of em energy from a surface that is sufficiently smooth that the incident and re-radiated energy are in the same plane and, in their angular relationships, satisfy the law of sines. See also re-radiation
re-radiation	refers to the action of em energy in infringing on a surface sufficiently irregular that the em energy radiated back into the atmosphere exhibits a random spatial distribution. In the strict sense, reflected energy is also re-radiated but the more common term reflection is usually applied
rf	radio frequency
SAFI	Semi-Automated Flight Inspection
scalloping	see course deviation
space modulation	the technique used in VOR to create a DSB-LC modulation by radiating three separate signals which combine within the airborne receiver to form the composite carrier plus modulation
SSBDVOR	single sideband Doppler VOR, a navaid
SSV	Standard Service Volume
TACAN	tactical air navigation system, a navaid
variable phase	refers to that signal in a VOR or DVOR system whose phase varies degree for degree with the azimuth
vhf	very high frequency, the radio band from 30 MHz to 300 MHz
uhf	ultra high frequency, the radio band from 300 MHz to 3,000 MHz

Units	<u>Meters</u> (1 foot = 0.305 meters)
	<u>Nautical miles</u> (1 nmi = 1.85 km = 6080 feet = 1.15 statute miles)
	<u>Statute miles</u> (1 mile = 1.60 km = 5,280 feet = 0.87 nmi)
USNO	United States Naval Observatory
VOR	very high frequency omnidirectional radio range, a navaid
VORTAC	VOR tactical air navigation

APPENDIX 2. INPUT AND OUTPUT EXAMPLES FOR COMPUTER SIMULATIONS

1. Chapter 8 provides detailed input instructions for programs that calculate bearing errors resulting from three types of obstructions in a VOR field. This appendix contains sample data input cards and the resultant program output for each of the three types of calculations.

2. The lists of input and output in this appendix were produced from files containing the actual input and output values for each program. The files were edited in order to label the input cards and to conserve space in the printing of the output data. As a consequence, the input card lists contain the correct sequence, number, and values for the input, but the column spacing has been compressed in some cases to facilitate printing. Similarly, the output is compressed into arrays rather than the long single columns that result from an actual computer run. Below are descriptions of the various inputs and their respective outputs, with the edited input and output following as figures 1 through 8.

a. Bodies of Revolution. The programs CLYPI and CYLP2 are used to calculate bearing errors due to objects such as water towers or silos in a VOR field. Figure 1 shows the CYLPI input for a sample problem involving an upright cylinder 3/8 of a wavelength in height and 1/2 a wavelength in diameter, 150 feet from the VOR. The output for CYLPI is not given, as it is an intermediate result for use by CYLP2. The CYLP2 input is given in figure 2. The result of the CYLP2 calculations is given in figure 3. In this example, for each azimuth, from 1 degree to 356 degrees at 5-degree intervals, the bearing error is given in degrees. For the actual output, the results are in two long columns; here the results are folded into two arrays, azimuth above and the corresponding errors below.

b. Short Wires. The program FRANK calculates bearing errors resulting from short wires in the VOR field. Figure 4 shows the input data cards for a single wire. No output is given for this data. Figure 5 gives the input data for a two-wire problem. Figure 6 shows the results of running FRANK with the data of figure 5. As with the CYLP2 output, the results will actually come out as long columns, but for presentation here, the columns have been folded into arrays. For each azimuth given in the upper part of the figure, there is a corresponding bearing error below.

c. Long Wires. The program LONGSY is used for calculating the bearing errors resulting from wires longer than 200 feet in the field of a VOR. Figure 7 shows the input cards for a sample three-segment long-wire problem. Figure 8 is the output resulting from the figure 7 input. In the case of LONGSY, the output is reported by segment: several long columns for each segment. Figure 8 gives the results by segment: at the top, the azimuths reported for segment 1, followed by the bearing errors calculated for each azimuth for segment 1; next, the azimuths reported for segment 2, followed by the calculated errors for each of those azimuths for segment 2; finally, the azimuths reported for segment 3 and the errors calculated for each azimuth for segment 3. The error resulting from the entire wire is the sum of the errors for each segment at a given azimuth. For example, at an azimuth of 45 degrees, segment 1 shows an error of 0.228 degree, segment 2 shows an error of 0.111 degree, and segment 3 shows an error of -0.569 degree, giving a total bearing error at 45 degrees azimuth of -0.230 degree.

```
CYLPI.DATA

CARD 1
   NP       FRM
   15     115.ØØ
CARD 2
  RH(I) - 15 ENTRIES
 Ø.Ø     Ø.Ø625 Ø.125Ø Ø.1875 Ø.25ØØ Ø.25ØØ Ø.25ØØ Ø.25ØØ Ø.25ØØ Ø.25ØØ
 Ø.25ØØ Ø.1875 Ø.125Ø Ø.Ø625 Ø.Ø
CARD 3
  ZH(I) - 15 ENTRIES
 Ø.Ø     Ø.Ø     Ø.Ø     Ø.Ø     Ø.Ø     Ø.Ø625 Ø.125Ø Ø.1875 Ø.25ØØ Ø.3125
 Ø.375Ø Ø.375Ø Ø.375Ø Ø.375Ø Ø.375Ø
CARD 4
        NTR
         3
CARD 5
   NM  NPHI
    Ø     8
    1    12
    2    16
```

FIGURE 1. CYLPI INPUT DATA CARDS

```
CYLP2.DATA

CARD 1
        NX          NP     FRM
         3          15     115.
CARD 2
      XX         ZZ
   -150.0      19.00
CARD 3
      HH          SH          RR
     12.00       4.00       26.00
CARD 4 (same as card 2 for CYLPI)
  RH(I) - 15 ENTRIES
 Ø.Ø     Ø.Ø625 Ø.125Ø Ø.1875 Ø.25ØØ Ø.25ØØ Ø.25ØØ Ø.25ØØ Ø.25ØØ Ø.25ØØ
 Ø.25ØØ Ø.1875 Ø.125Ø Ø.Ø625 Ø.Ø
CARD 5 (same as card 3 for CYLPI)
  ZH(I) - 15 ENTRIES
 Ø.Ø     Ø.Ø     Ø.Ø     Ø.Ø     Ø.Ø     Ø.Ø625 Ø.125Ø Ø.1875 Ø.25ØØ Ø.3125
 Ø.375Ø Ø.375Ø Ø.375Ø Ø.375Ø Ø.375Ø
CARD 6
      HS         DIT
    4ØØØ.Ø      15.ØØ
CARD 7
      SPH       EPH          AINC
      1.ØØ     36Ø.ØØ        5.ØØ
```

<u>FIGURE 2. CYLP2 INPUT DATA CARDS</u>

CYLP2.OUTPUT.DATA

AZIMUTH (DEGREES)

1.ØØ	6.ØØ	11.ØØ	16.ØØ	21.ØØ	26.ØØ	31.ØØ	36.ØØ	41.ØØ	46.ØØ
51.ØØ	56.ØØ	61.ØØ	66.ØØ	71.ØØ	76.ØØ	81.ØØ	86.ØØ	91.ØØ	96.ØØ
1Ø1.ØØ	1Ø6.ØØ	111.ØØ	116.ØØ	121.ØØ	126.ØØ	131.ØØ	136.ØØ	141.ØØ	146.ØØ
151.ØØ	156.ØØ	161.ØØ	166.ØØ	171.ØØ	176.ØØ	181.ØØ	186.ØØ	191.ØØ	196.ØØ
2Ø1.ØØ	2Ø6.ØØ	211.ØØ	216.ØØ	221.ØØ	226.ØØ	231.ØØ	236.ØØ	241.ØØ	246.ØØ
251.ØØ	256.ØØ	261.ØØ	266.ØØ	271.ØØ	276.ØØ	281.ØØ	286.ØØ	291.ØØ	296.ØØ
3Ø1.ØØ	3Ø6.ØØ	311.ØØ	316.ØØ	321.ØØ	326.ØØ	331.ØØ	336.ØØ	341.ØØ	346.ØØ
351.ØØ	356.ØØ								

ERROR (DEGREES)

Ø.Ø4Ø	Ø.234	Ø.473	Ø.73Ø	Ø.813	1.Ø27	1.118	1.178	1.267	1.381
1.532	1.722	1.9Ø5	2.Ø93	2.32Ø	2.499	2.667	2.782	2.849	2.86Ø
2.8Ø7	2.7Ø9	2.545	2.351	2.131	1.862	1.6ØØ	1.351	1.11Ø	Ø.882
Ø.684	Ø.538	Ø.383	Ø.272	Ø.157	Ø.Ø65	Ø.Ø25	Ø.121	Ø.214	Ø.29Ø
Ø.466	Ø.577	Ø.751	Ø.982	1.22Ø	1.459	1.698	1.959	2.232	2.431
2.615	2.756	2.934	2.862	2.829	2.741	2.6Ø5	2.427	2.239	1.96
1.831	1.657	1.481	1.341	1.241	1.174	1.1Ø6	Ø.919	Ø.8Ø3	Ø.583
Ø.451	Ø.223								

FIGURE 3. RESULTS OF CYLPA CALCULATIONS

```
FRANK3.DATA

(Sample input for a single-wire problem)

CARD 1
        XNP1       YNP1       ZNP1      XLEN
      -100.00    300.00      30.00    200.00
CARD 2
       NW  NP   NR   FRM
        1 203    1 115.00
CARD 3
      LL(I)
        1
CARD 4
      LR(I)
        1
CARD 5
       RAD(I)
      0.00206
CARD 6
            HS          DIT
        4000.00       15.00
CARD 7
            H            SH          R
          12.00         4.00       26.00
CARD 8
       NL
        0
CARD 9
   (None, since on card 8 NL=0)
CARD 10
           SPH        EPH          AINC
          0.00      360.00        5.00

(Note: Sample output is given only for the two-wire problem.)
```

FIGURE 4. FRANK INPUT FOR A SINGLE SHORT WIRE

```
FRANK4.DATA

(Sample input for a two-wire problem)

CARD 1
         XNP1         YNP1         ZNP1         XLEN
       -150.00      150.00        30.00        35.00
CARD 2
        NW   NP   NR    FRM
         2  122    1  115.00
CARD 2A
          DBW(I)
          5.0000
CARD 3
       LL(I)  -  2 POINTS
         1   62
CARD 4
       LR(I)
         1
CARD 5
        RAD(I)
       0.00206
CARD 6
              HS         DIT
          4000.00       15.00
CARD 7
              H            SH           R
           12.00          4.00        26.00
CARD 8
        NL
         0
CARD 9
     (None; since on card 8 NL=0)
CARD 10
             SPH        EPH          AINC
            0.00      360.00         5.00
```

FIGURE 5. FRANK INPUT FOR TWO SHORT WIRES

FRANK.OUTPUT.DATA

TWO-WIRE PROBLEM

AZIMUTH (DEGREES)

Ø.Ø	5.ØØ	1Ø.ØØ	15.ØØ	2Ø.ØØ	25.ØØ	3Ø.ØØ	35.ØØ	4Ø.ØØ	45.ØØ
5Ø.ØØ	55.ØØ	6Ø.ØØ	65.ØØ	7Ø.ØØ	75.ØØ	8Ø.ØØ	85.ØØ	9Ø.ØØ	95.ØØ
1ØØ.ØØ	1Ø5.ØØ	11Ø.ØØ	115.ØØ	12Ø.ØØ	125.ØØ	13Ø.ØØ	135.ØØ	14Ø.ØØ	145.ØØ
15Ø.ØØ	155.ØØ	16Ø.ØØ	165.ØØ	17Ø.ØØ	175.ØØ	18Ø.ØØ	185.ØØ	19Ø.ØØ	195.ØØ
2ØØ.ØØ	2Ø5.ØØ	21Ø.ØØ	215.ØØ	22Ø.ØØ	225.ØØ	23Ø.ØØ	235.ØØ	24Ø.ØØ	245.ØØ
25Ø.ØØ	255.ØØ	26Ø.ØØ	265.ØØ	27Ø.ØØ	275.ØØ	28Ø.ØØ	285.ØØ	29Ø.ØØ	295.ØØ
3ØØ.ØØ	3Ø5.ØØ	31Ø.ØØ	315.ØØ	32Ø.ØØ	325.ØØ	33Ø.ØØ	335.ØØ	34Ø.ØØ	345.ØØ
35Ø.ØØ	355.ØØ	36Ø.ØØ							

ERROR (DEGREES)

Ø.Ø	Ø.Ø23	Ø.162	Ø.432	Ø.832	1.336	1.882	2.278	2.716	2.783
2.464	1.7Ø4	Ø.624	Ø.437	Ø.983	Ø.8Ø7	Ø.16Ø	Ø.533	Ø.661	Ø.282
Ø.248	Ø.468	Ø.312	Ø.Ø29	Ø.223	Ø.222	Ø.1Ø3	Ø.ØØ4	Ø.Ø92	Ø.21Ø
Ø.318	Ø.362	Ø.331	Ø.251	Ø.158	Ø.Ø77	Ø.ØØØ	Ø.114	Ø.3Ø2	Ø.57Ø
Ø.89Ø	1.185	1.331	1.199	Ø.732	Ø.Ø48	Ø.64Ø	Ø.932	Ø.679	Ø.Ø64
Ø.553	Ø.684	Ø.3Ø1	Ø.277	Ø.565	Ø.389	Ø.Ø99	Ø.442	Ø.455	Ø.151
Ø.256	Ø.484	Ø.423	Ø.118	Ø.29Ø	Ø.626	Ø.795	Ø.783	Ø.638	Ø.431
Ø.229	Ø.Ø76	Ø.ØØØ							

FIGURE 6. FRANK OUTPUT FOR A TWO-WIRE PROBLEM

```
LONGSY.DATA

(Sample input for a three-segment long wire problem)

CARD 1
              IMP
               3
CARD 2
          D3              N
          1.5             2
CARD 3
            H          SH         R          FRM
          12.00       4.00      26.00      114.40
CARD 4
           SR         HA          V            FO
          20.00    3000.00     165.00        0.35
CARD 5
           SPH        EPH        AINC
          00.00     179.00       1.00
CARD 6  (segment 1)
            D          AL1        AL2        A              H1
         1225.00    -400.00    2800.00   0.01910          55.00
CARD 7  (segment 1)
          (alpha)
           00.00
CARD 6  (segment 2)
            D          AL1        AL2        A              H1
         1700.00    -200.00   -1900.00   0.01910          55.00
CARD 7 (segment 2)
          (alpha)
           11.00
CARD 6 (segment 3)
            D          AL1        AL2        A              H1
         1100.00    -600.00   -1300.00   0.01910          55.00
CARD 7 (segment 3)
          (alpha)
          -12.00
```

<u>FIGURE 7. LONGSY INPUT DATA</u>

```
LONGSY.OUTPUT.DATA

(Sample output for a three-segment long wire problem)

WIRE SEGMENT 1

AZIMUTH (DEGREES)
   1.00   2.00   3.00   4.00   5.00   6.00   7.00   8.00   9.00  10.00
  11.00  12.00  13.00  14.00  15.00  16.00  17.00  18.00  19.00  20.00
  21.00  22.00  23.00  24.00  25.00  26.00  27.00  28.00  29.00  30.00
  31.00  32.00  33.00  34.00  35.00  36.00  37.00  38.00  39.00  40.00
  41.00  42.00  43.00  44.00  45.00  46.00  47.00  48.00  49.00  50.00
  51.00  52.00  53.00  54.00  55.00  56.00  57.00  58.00  59.00  60.00
  61.00  62.00  63.00  64.00  65.00  66.00  67.00  68.00  69.00  70.00
  71.00  72.00  73.00  74.00  75.00  76.00  77.00  78.00  79.00  80.00
  81.00  82.00  83.00  84.00  85.00  86.00  87.00  88.00  89.00  90.00
  91.00  92.00  93.00  94.00  95.00  96.00  97.00  98.00  99.00 100.00
 101.00 102.00 103.00 104.00 105.00 106.00 107.00 108.00 109.00 110.00
 111.00 112.00 113.00 114.00 115.00 116.00 117.00 118.00 119.00 120.00
 121.00 122.00 123.00 124.00 125.00 126.00 127.00 128.00 129.00 130.00
 131.00 132.00 133.00 134.00 135.00 136.00 137.00 138.00 139.00 140.00
 141.00 142.00 143.00 144.00 145.00 146.00 147.00 148.00 149.00 150.00
 151.00 152.00 153.00 154.00 155.00 156.00 157.00 158.00 159.00 160.00
 161.00 162.00 163.00 164.00 165.00 166.00 167.00 168.00 169.00 170.00
 171.00 172.00 173.00 174.00 175.00 176.00 177.00 178.00 179.00
ERROR (DEGREES)
-0.001 -0.004 -0.009 -0.016 -0.023 -0.027 -0.025 -0.014  0.003  0.018
 0.016  0.001  0.001 -0.042 -0.068  0.035  0.144 -0.043 -0.185  0.171
 0.034 -0.199  0.239 -0.208  0.167 -0.134  0.091 -0.024  0.014  0.089
-0.180 -0.171  0.213  0.453  0.439  0.371  0.407  0.565  0.650  0.243
-0.525 -0.233  0.516 -0.373  0.228 -0.175  0.121 -0.002 -0.040  0.233
 0.328  0.201  0.144  0.357  0.804  0.681 -0.756 -0.291  0.900 -1.035
```


FIGURE 8. LONGSY OUTPUT

0.803	0.112	-1.219	0.004	0.934	1.118	1.032	0.567	-0.531	-0.771
0.802	-0.506	0.476	-0.622	0.416	0.367	-0.092	-0.242	-0.191	-0.012
0.197	0.070	-0.141	0.112	-0.086	0.049	0.015	-0.024	-0.013	0.0
-0.013	-0.024	0.015	0.049	-0.086	0.112	-0.141	0.070	0.197	-0.012
-0.191	-0.242	-0.091	0.367	0.416	-0.622	0.476	-0.506	0.804	-0.771
-0.531	0.567	1.032	1.118	0.933	0.003	-1.219	0.113	0.802	-1.035
0.899	-0.291	-0.757	0.680	0.804	0.358	0.145	0.201	0.328	0.233
-0.040	-0.002	0.121	-0.175	0.229	-0.374	0.516	-0.233	-0.525	0.24[illegible]
0.649	0.566	0.408	0.372	0.439	0.453	0.213	-0.171	-0.179	0.089
0.014	-0.024	0.091	-0.134	0.167	-0.208	0.239	-0.199	0.034	0.171
-0.184	-0.043	0.144	0.035	-0.068	-0.042	0.001	0.001	0.016	0.018
0.003	-0.014	-0.025	-0.027	-0.023	-0.016	-0.009	-0.004	-0.001	

WIRE SEGMENT 2

AZIMUTH (DEGREES)

1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00
11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00
21.00	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00	30.00
31.00	32.00	33.00	34.00	35.00	36.00	37.00	38.00	39.00	40.00
41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00
51.00	52.00	53.00	54.00	55.00	56.00	57.00	58.00	59.00	60.00
61.00	62.00	63.00	64.00	65.00	66.00	67.00	68.00	69.00	70.00
71.00	72.00	73.00	74.00	75.00	76.00	77.00	78.00	79.00	80.00
81.00	82.00	83.00	84.00	85.00	86.00	87.00	88.00	89.00	90.00
91.00	92.00	93.00	94.00	95.00	96.00	97.00	98.00	99.00	100.00
101.00	102.00	103.00	104.00	105.00	106.00	107.00	108.00	109.00	110.00

FIGURE 8. LONGSY OUTPUT (continued)

```
111.00 112.00 113.00 114.00 115.00 116.00 117.00 118.00 119.00 120.00
121.00 122.00 123.00 124.00 125.00 126.00 127.00 128.00 129.00 130.00
131.00 132.00 133.00 134.00 135.00 136.00 137.00 138.00 139.00 140.00
141.00 142.00 143.00 144.00 145.00 146.00 147.00 148.00 149.00 150.00
151.00 152.00 153.00 154.00 155.00 156.00 157.00 158.00 159.00 160.00
161.00 162.00 163.00 164.00 165.00 166.00 167.00 168.00 169.00 170.00
171.00 172.00 173.00 174.00 175.00 176.00 177.00 178.00 179.00
ERROR (DEGREES)
-0.000 -0.001 -0.000  0.000  0.002  0.007  0.006 -0.007 -0.022 -0.009
 0.022  0.015 -0.017 -0.003  0.002 -0.012  0.002  0.022 -0.044  0.054
-0.042 -0.001  0.061 -0.068 -0.007  0.022  0.007  0.000 -0.032 -0.049
-0.011  0.109  0.188 -0.042 -0.157  0.173 -0.133  0.102 -0.051  0.000
 0.060  0.056 -0.012 -0.023  0.111  0.321  0.046 -0.335  0.370 -0.357
 0.233  0.147 -0.167 -0.188 -0.124 -0.041  0.007  0.079 -0.174  0.249
-0.262 -0.129  0.325  0.477  0.484  0.144 -0.575  0.254 -0.153  0.434
-0.552 -0.438 -0.201 -0.316 -0.520  0.080  0.228 -0.194 -0.109  0.325
 0.241  0.190  0.220  0.058 -0.147  0.119 -0.078 -0.009  0.024  0.0
 0.024 -0.009 -0.078  0.119 -0.147  0.058  0.220  0.190  0.241  0.325
-0.109 -0.193  0.228  0.080 -0.520 -0.316 -0.202 -0.439 -0.552  0.434
-0.153  0.254 -0.575  0.144  0.484  0.477  0.324 -0.129 -0.262  0.249
-0.174  0.079  0.007 -0.040 -0.124 -0.188 -0.167  0.148  0.232 -0.357
 0.370 -0.335  0.045  0.322  0.112 -0.022 -0.012  0.056  0.060  0.000
-0.051  0.102 -0.133  0.174 -0.157 -0.043  0.187  0.109 -0.011 -0.049
-0.032  0.000  0.007  0.022 -0.007 -0.068  0.061 -0.001 -0.042  0.054
-0.044  0.022  0.002 -0.012  0.002 -0.003 -0.017  0.015  0.022 -0.009
-0.022 -0.007  0.006  0.007  0.002  0.000 -0.000 -0.001 -0.000
```

FIGURE 8. LONGSY OUTPUT (continued)

WIPE SEGMENT 3

AZIMUTH (DEGREES)

1.ØØ	2.ØØ	3.ØØ	4.ØØ	5.ØØ	6.ØØ	7.ØØ	8.ØØ	9.ØØ	1Ø.ØØ
11.ØØ	12.ØØ	13.ØØ	14.ØØ	15.ØØ	16.ØØ	17.ØØ	18.ØØ	19.ØØ	2Ø.ØØ
21.ØØ	22.ØØ	23.ØØ	24.ØØ	25.ØØ	26.ØØ	27.ØØ	28.ØØ	29.ØØ	3Ø.ØØ
31.ØØ	32.ØØ	33.ØØ	34.ØØ	35.ØØ	36.ØØ	37.ØØ	38.ØØ	39.ØØ	4Ø.ØØ
41.ØØ	42.ØØ	43.ØØ	44.ØØ	45.ØØ	46.ØØ	47.ØØ	48.ØØ	49.ØØ	5Ø.ØØ
51.ØØ	52.ØØ	53.ØØ	54.ØØ	55.ØØ	56.ØØ	57.ØØ	58.ØØ	59.ØØ	6Ø.ØØ
61.ØØ	62.ØØ	63.ØØ	64.ØØ	65.ØØ	66.ØØ	67.ØØ	68.ØØ	69.ØØ	7Ø.ØØ
71.ØØ	72.ØØ	73.ØØ	74.ØØ	75.ØØ	76.ØØ	77.ØØ	78.ØØ	79.ØØ	8Ø.ØØ
81.ØØ	82.ØØ	83.ØØ	84.ØØ	85.ØØ	86.ØØ	87.ØØ	88.ØØ	89.ØØ	9Ø.ØØ
91.ØØ	92.ØØ	93.ØØ	94.ØØ	95.ØØ	96.ØØ	97.ØØ	98.ØØ	99.ØØ	1ØØ.ØØ
1Ø1.ØØ	1Ø2.ØØ	1Ø3.ØØ	1Ø4.ØØ	1Ø5.ØØ	1Ø6.ØØ	1Ø7.ØØ	1Ø8.ØØ	1Ø9.ØØ	11Ø.ØØ
111.ØØ	112.ØØ	113.ØØ	114.ØØ	115.ØØ	116.ØØ	117.ØØ	118.ØØ	119.ØØ	12Ø.ØØ
121.ØØ	122.ØØ	123.ØØ	124.ØØ	125.ØØ	126.ØØ	127.ØØ	128.ØØ	129.ØØ	13Ø.ØØ
131.ØØ	132.ØØ	133.ØØ	134.ØØ	135.ØØ	136.ØØ	137.ØØ	138.ØØ	139.ØØ	14Ø.ØØ
141.ØØ	142.ØØ	143.ØØ	144.ØØ	145.ØØ	146.ØØ	147.ØØ	148.ØØ	149.ØØ	15Ø.ØØ
151.ØØ	152.ØØ	153.ØØ	154.ØØ	155.ØØ	156.ØØ	157.ØØ	158.ØØ	159.ØØ	16Ø.ØØ
161.ØØ	162.ØØ	163.ØØ	164.ØØ	165.ØØ	166.ØØ	167.ØØ	168.ØØ	169.ØØ	17Ø.ØØ
171.ØØ	172.ØØ	173.ØØ	174.ØØ	175.ØØ	176.ØØ	177.ØØ	178.ØØ	179.ØØ	

ERROR (DEGREES)

Ø.ØØØ	-Ø.ØØ1	Ø.ØØ1	-Ø.ØØ6	Ø.Ø13	-Ø.Ø21	Ø.Ø23	-Ø.ØØ9	-Ø.Ø28	Ø.Ø8Ø
-Ø.117	Ø.Ø88	Ø.Ø23	-Ø.139	Ø.118	Ø.Ø48	-Ø.123	-Ø.ØØ8	Ø.Ø55	Ø.ØØ3
-Ø.Ø34	-Ø.115	-Ø.112	-Ø.Ø13	Ø.114	Ø.2Ø8	Ø.234	Ø.145	-Ø.1Ø9	-Ø.474
-Ø.595	-Ø.Ø47	Ø.594	Ø.ØØ9	-Ø.468	Ø.4ØØ	-Ø.191	Ø.Ø74	-Ø.Ø42	Ø.ØØØ
-Ø.133	Ø.2Ø7	Ø.191	-Ø.487	-Ø.569	-Ø.1Ø3	Ø.321	Ø.464	Ø.223	-Ø.525

FIGURE 8. LONGSY OUTPUT (continued)

```
-1.299 -Ø.431  1.374 -Ø.623 -Ø.171  Ø.413 -Ø.115 -Ø.655  1.192 -Ø.Ø91
-Ø.987 -Ø.762 -Ø.453 -Ø.416 -Ø.523 -Ø.4Ø9  Ø.1Ø2  Ø.2Ø1 -Ø.124  Ø.Ø22
-Ø.Ø52  Ø.15Ø -Ø.148 -Ø.199  Ø.158  Ø.369  Ø.425  Ø.428  Ø.251 -Ø.255
-Ø.349  Ø.4Ø1 -Ø.258  Ø.223 -Ø.278  Ø.222  Ø.Ø69 -Ø.1ØØ -Ø.Ø67  Ø.Ø
-Ø.Ø67 -Ø.1ØØ  Ø.Ø69  Ø.222 -Ø.278  Ø.223 -Ø.258  Ø.4Ø1 -Ø.349 -Ø.255

 Ø.251  Ø.428  Ø.425  Ø.369  Ø.158 -Ø.199 -Ø:148  Ø.15Ø -Ø.Ø52  Ø.Ø22
-Ø.124  Ø.2Ø1  Ø.1Ø2 -Ø.4Ø9 -Ø.523 -Ø.416 -Ø.453 -Ø.763 -Ø.987 -Ø.Ø91
 1.192 -Ø.655 -Ø.114  Ø.411 -Ø.169 -Ø.625  1.375 -Ø.429 -1.299 -Ø.526
 Ø.222  Ø.463  Ø.32Ø -Ø.1Ø5 -Ø.57Ø -Ø.486  Ø.191  Ø.2Ø7 -Ø.133  Ø.ØØØ
-Ø.Ø42  Ø.Ø74 -Ø.191  Ø.4Ø1 -Ø.468  Ø.ØØ8  Ø.595 -Ø.Ø46 -Ø.595 -Ø.474
-Ø.11Ø  Ø.144  Ø.233  Ø.2Ø7  Ø.113 -Ø.Ø14 -Ø.113 -Ø.115 -Ø.Ø34  Ø.ØØ3
 Ø.Ø55 -Ø.ØØ8 -Ø.123  Ø.Ø48  Ø.118 -Ø.14Ø  Ø.Ø23  Ø.Ø88 -Ø.117  Ø.Ø8Ø
-Ø.Ø23 -Ø.ØØ9  Ø.Ø23 -Ø.Ø21  Ø.Ø13 -Ø.ØØ6  Ø.ØØ1 -Ø.ØØ1  Ø.ØØØ
```

FIGURE 8. LONGSY OUTPUT (continued)

APPENDIX 3. LOCATING SOURCES OF SCALLOPING BY THE THEORETICAL METHOD

1. INTRODUCTION.

a. Locating an object which is a source of scalloping is accomplished by analysis of the course deviation recording taken on an orbital flight. Scalloping characteristics observed over a complete orbit indicate the type of interfering object being encountered; that is, whether it is a nondirectional re-radiator or a directional reflector. The bearing to the interfering object from the VOR site is derived from the azimuth on which maximum scalloping amplitude is recorded. The frequency of scalloping determines the distance that the interfering object lies from the VOR site.

b. Procedures employed for locating the source of scalloping require recognition of the type of interfering object being encountered. For a nondirectional re-radiator, the recording exhibits maximum scalloping amplitude along a bearing line extending from both sides of the VOR station (two azimuths displaced 180 degrees). The scalloping characteristics are symmetrical about this bearing line, as indicated in figures 1 and 2. For a directional reflector, the recording exhibits scalloping over a narrow azimuth segment as shown in figures 3 and 4.

c. Procedural outlines are given for locating nondirectional re-radiators and directional reflectors from observed scalloping. These techniques for locating scalloping sources are based upon theoretical considerations which treat each aspect of the subject in its simplest form. It is assumed that the ground plane is a smooth, level, reflection surface and that a re-radiating object propagates equally in all directions. Some approximation is introduced into the scalloping equations by limits placed on the equation parameters. Allowance may be required for these factors in practical application, and knowledge of their influence is gained with experience.

d. Other techniques and adaptations are available for locating interfering objects from recorded scalloping information. A transparent calculator, used as an overlay on a VOR site drawing, has been developed and employed for locating reflectors.

2. PROCEDURE.

a. Nondirectional Re-Radiator. Figure 5 is to be used in conjunction with the following procedural outline for locating a nondirectional re-radiator from recorded scalloping:

(1) From the aircraft course deviation indicator recording of an orbital flight, locate the azimuth bearing line that exhibits maximum scalloping amplitude. This bearing line, which is designated Line 1, includes two azimuth angles separated by 180 degrees. Where two such azimuth bearing lines exist, they should be considered one at a time.

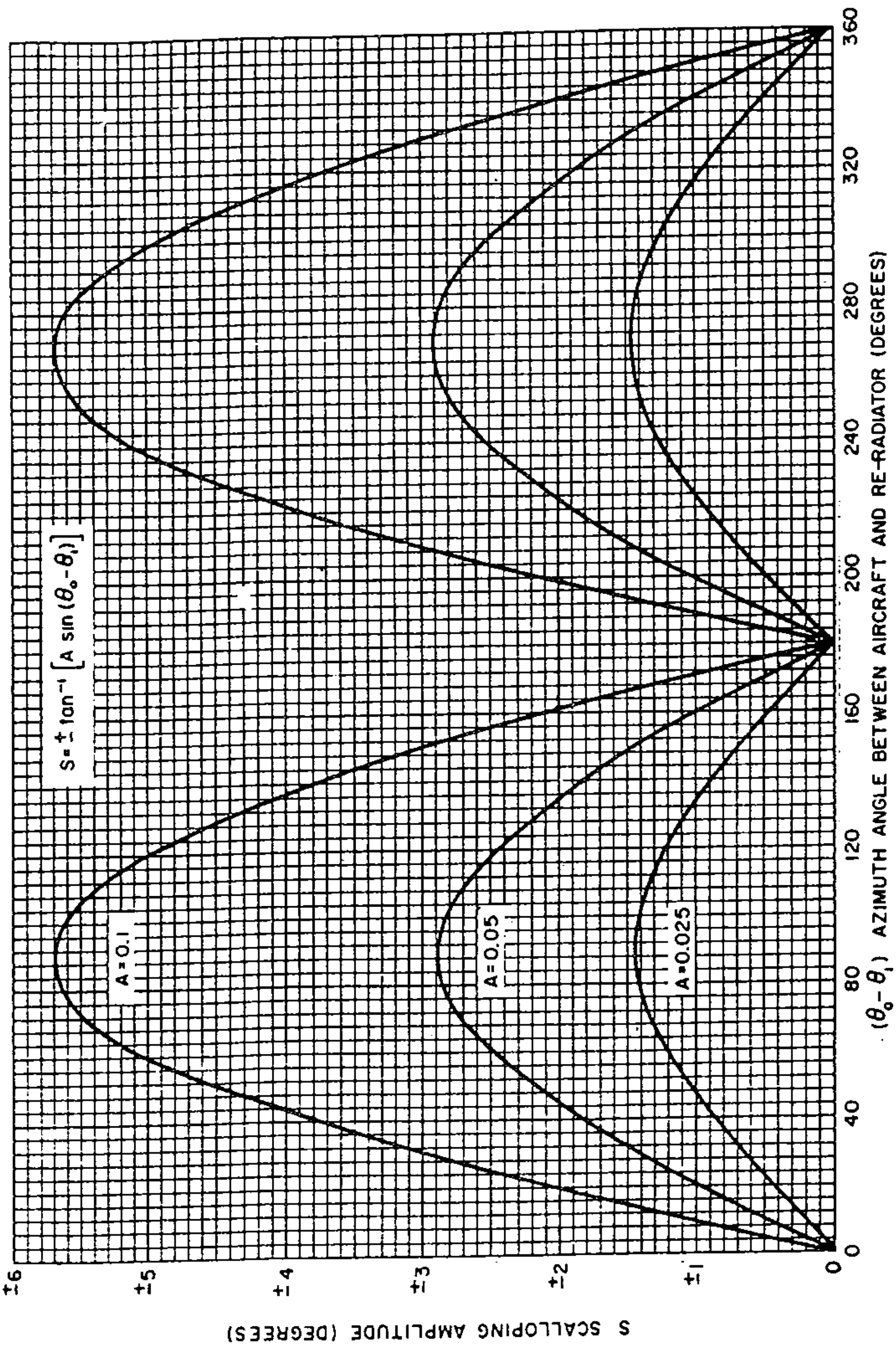


FIGURE 1. SCALLOPING AMPLITUDE VERSUS AZIMUTH ANGLE BETWEEN AIRCRAFT AND RE-RADIATOR

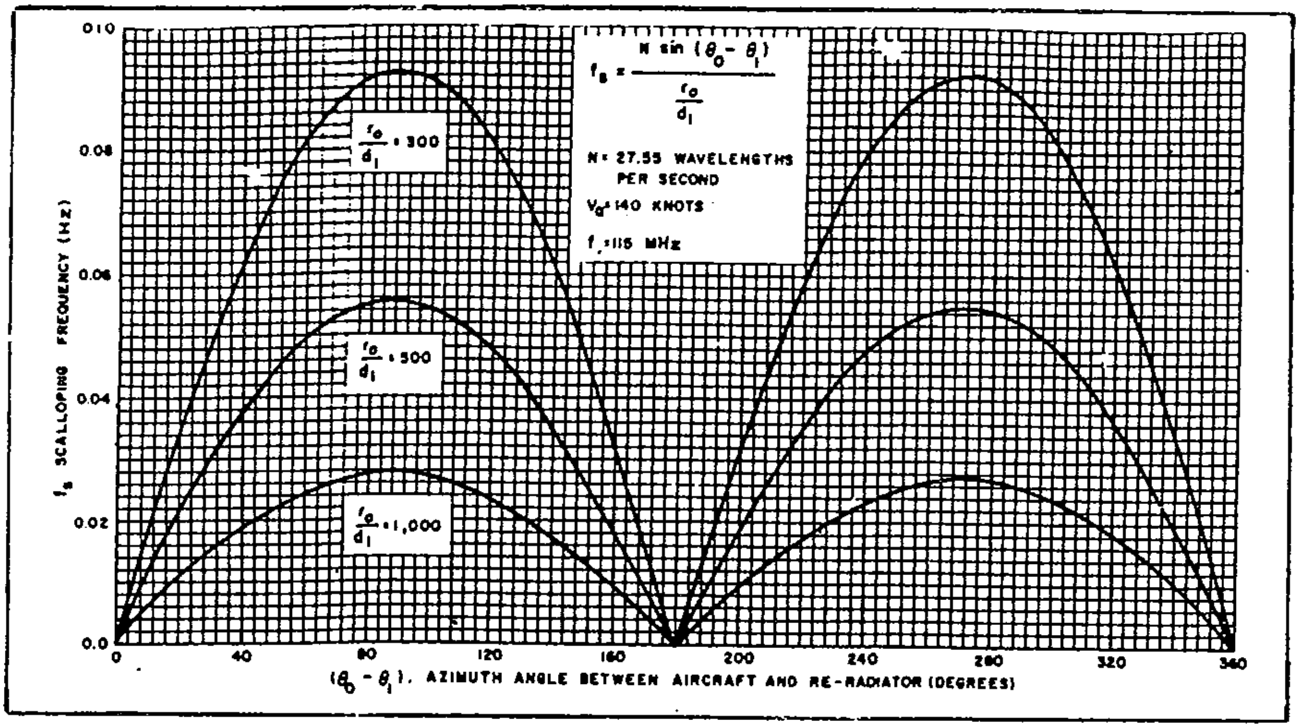


FIGURE 2. VARIATION IN SCALLOPING FREQUENCY WITH CHANGE IN VALUE OF r_0/d_1

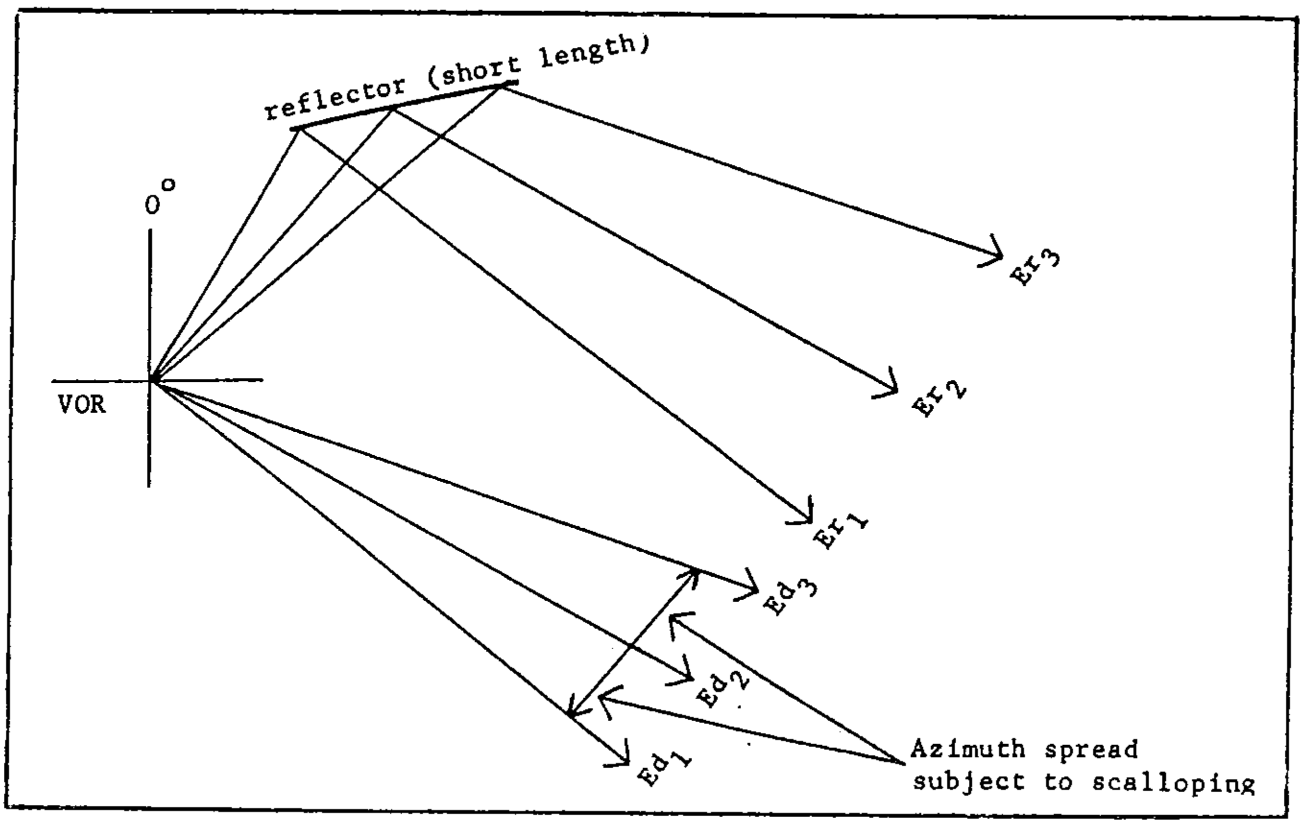


FIGURE 3. SPREAD OF COURSE SCALLOPING AMPLITUDE

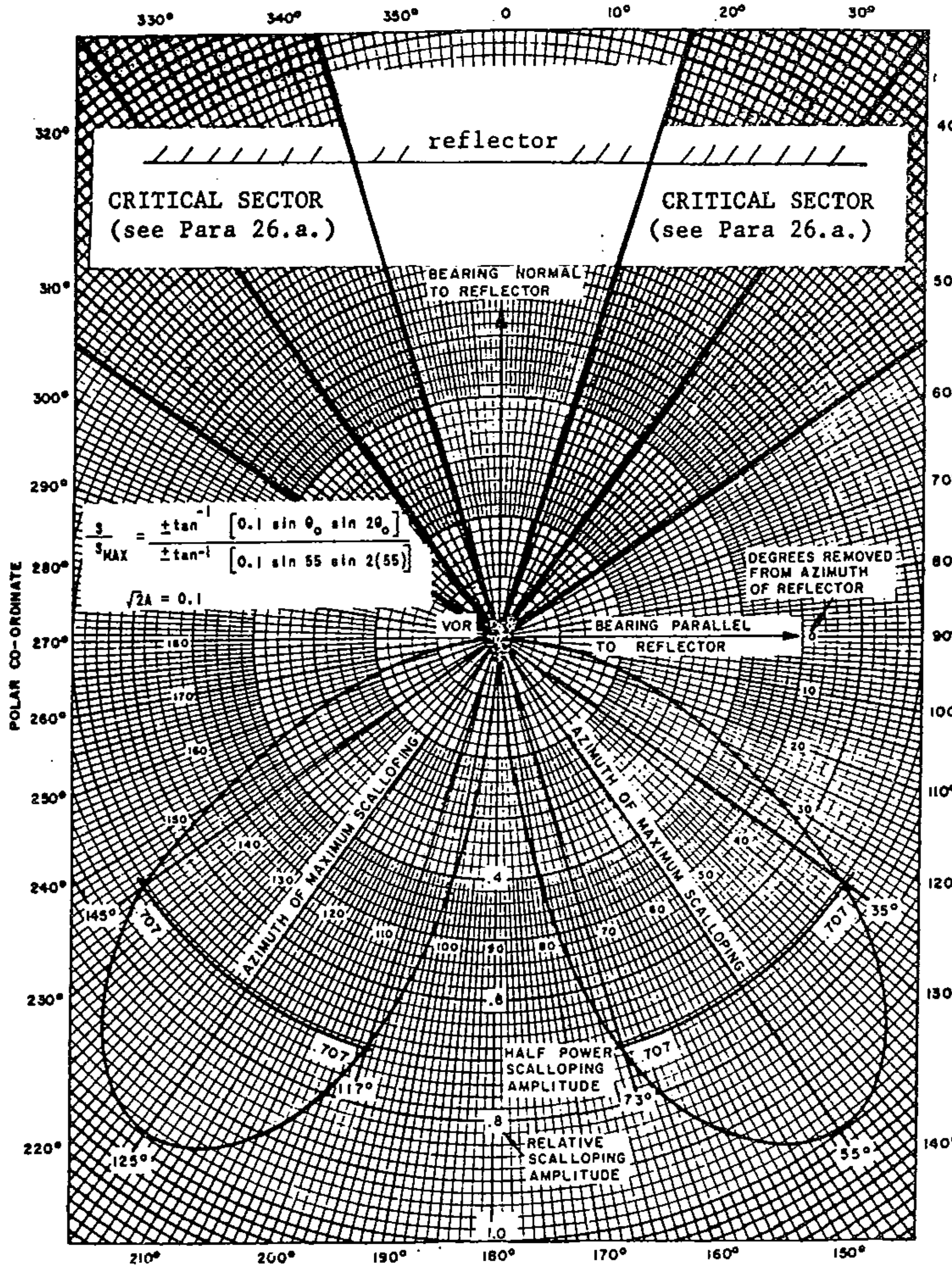
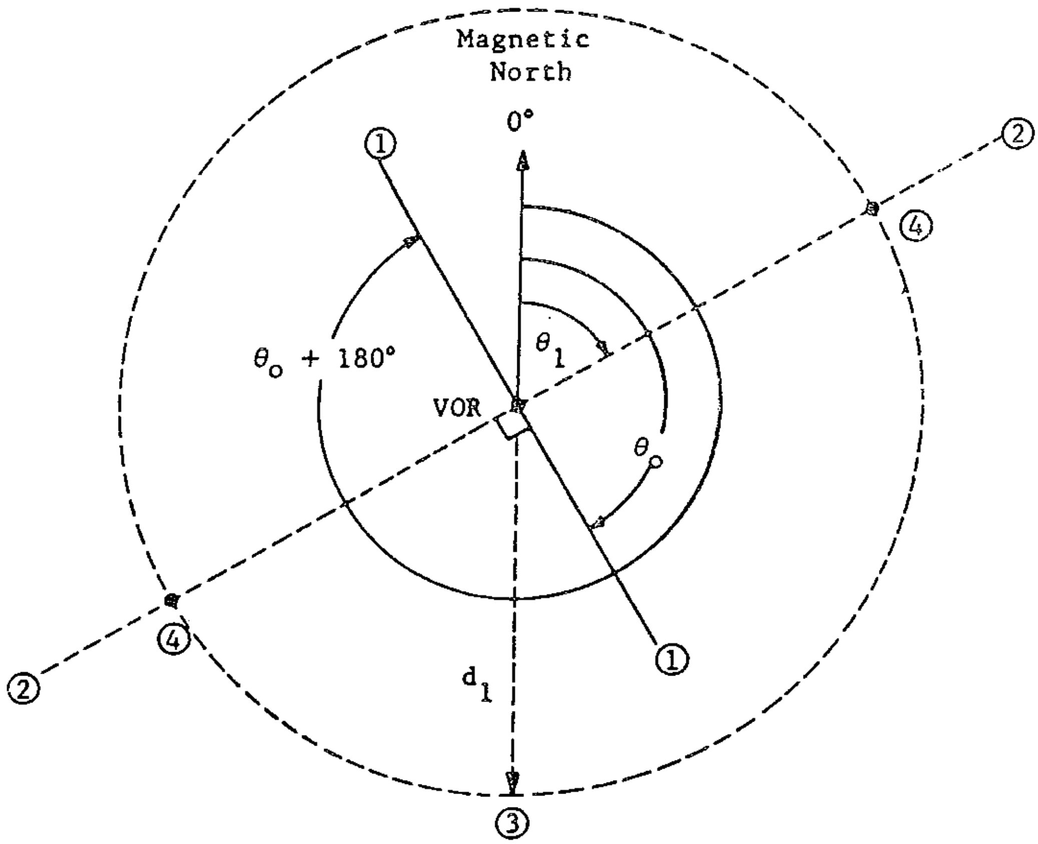


FIGURE 4. RELATIVE SCALLOPING AMPLITUDE DUE TO LONG REFLECTORS



Note:

① - Bearing line of maximum scalloping amplitude and frequency

FIGURE 5. LOCATING SOURCES OF SCALLOPING (NON-DIRECTIONAL RE-RADIATOR)

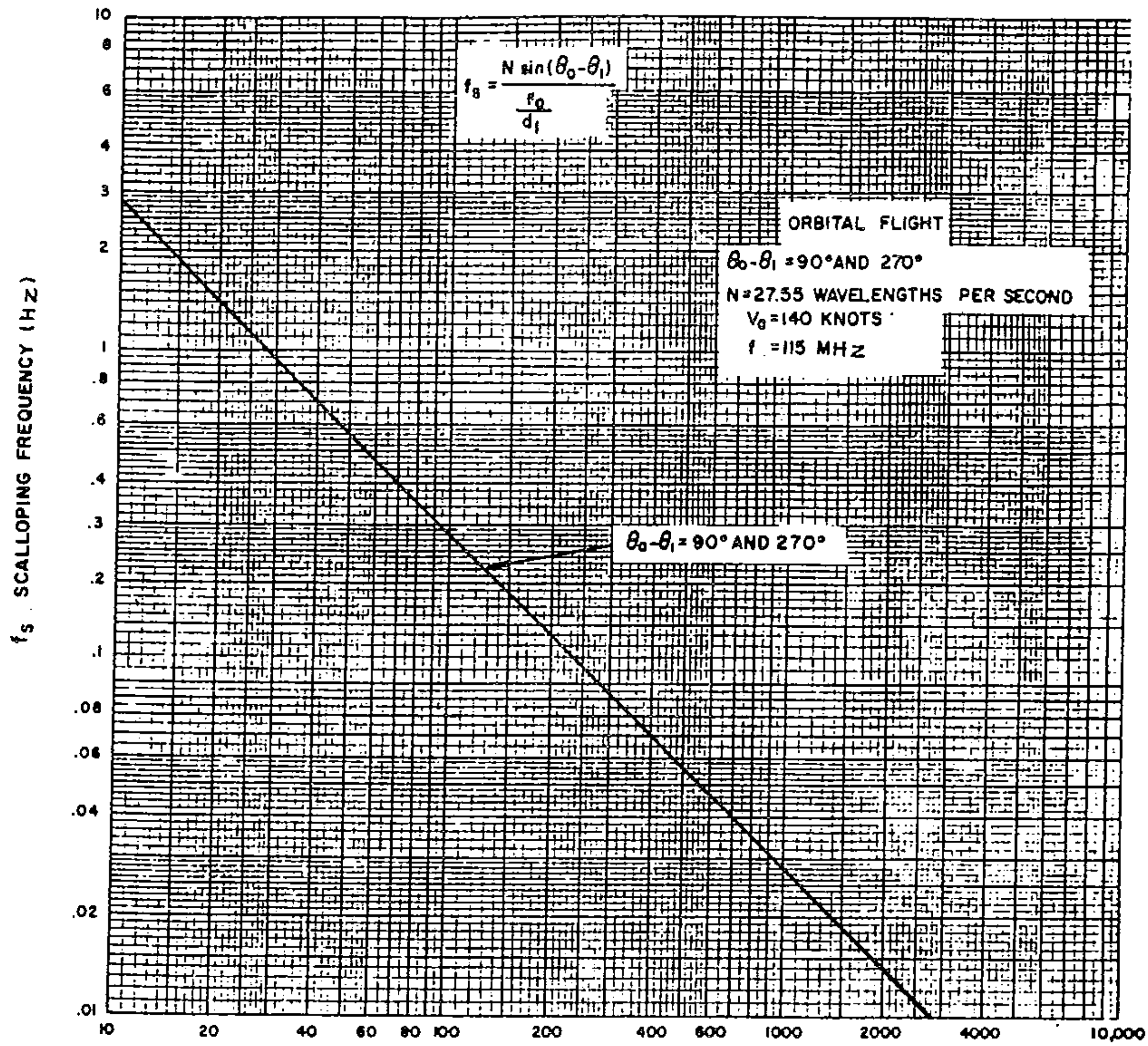
(2) Draw Line ② perpendicular to Line ①.

(3) From the same course deviation recording, determine the scalloping frequency at the maximum scalloping amplitude bearing (Line ①).

(4) Utilizing the scalloping frequency obtained in step (3), determine the ratio r_o/d_1 from figure 6.

(5) Calculate the distance (d_1) and using this as a radius (Point ③), draw a circle around the VOR site.

(6) The points where the circle drawn in step (5) intersect Line ② indicate the two possible locations of the source of re-radiation (designated these points with a ④).



$$\frac{r_0}{d_1} = \frac{\text{Distance from VOR to aircraft}}{\text{Distance from VOR to re-radiator}}$$

FIGURE 6. SCALLOPING FREQUENCY VARIATION ALONG LINE OF MAXIMUM SCALLOPING AMPLITUDE

b. Directional Reflector (long length). Figure 7 is to be used in conjunction with the following procedural outline for locating a directional reflector from recorded scalloping:

(1) From the aircraft course deviation indicator recording of an orbital flight, locate the azimuth angle that exhibits the maximum scalloping amplitude (designate Line 1). Two azimuths separated by about 70 degrees with approximately the same maximum amplitude indicates a long-length reflector (designate one as Line 1 and the other as Line 2). Where three or more azimuths of high scalloping amplitude exist, they should be considered separately; also if two azimuths of high scalloping amplitude are not separated by 70 degrees as stated above, they should be considered separately.

(2) From the same aircraft course deviation recording, determine the scalloping frequency at the azimuth of maximum scalloping amplitude (Line 1).

(3) From figure 8, obtain the ratio r_o/d_1 for an incidence angle (a) of 55 degrees.

(4) Calculate the distance (d_1) and draw a circle of this radius (designated as Point 3 around the VOR site).

(5) Draw two lines 110 degrees removed in azimuth from Line 1, and label the point where this line intersects the circle as Point 4. There are two possible locations for the theoretical point of reflection (a = 55 degrees, see figure 4).

(6) Draw two lines 145 degrees removed from Line 1 and label them Lines 5. Theoretically, one of these lines is perpendicular to the plane containing the reflector.

(7) Draw two lines (designate as Lines 6) perpendicular to Line 5 and through their respective Points 4. One of these lines 6 represents the plane of the reflector.

(8) Draw two lines 128 degrees removed from Line 1. The two points where these lines intersect Line 6 represent the points where a = 73 degrees; label these Points 7.

(9) Draw two lines 90 degrees removed from Line 1. The two points where these lines intersect Line 6 represent the points where a = 35 degrees; label these Points 8.

(10) Lines 6 between Points 7 and 8 show the two possible theoretical locations of the medium-length reflector. These approximate locations should be surveyed to find the actual location.

(11) If two lines of maximum scalloping were drawn in step (1), it is assumed to be a long-length reflector. In this case, there is only one possible plane (Line 6) that can contain the reflector. It is the one that is perpendicular to the Line 5 that is equidistant from Lines 1 and 2.

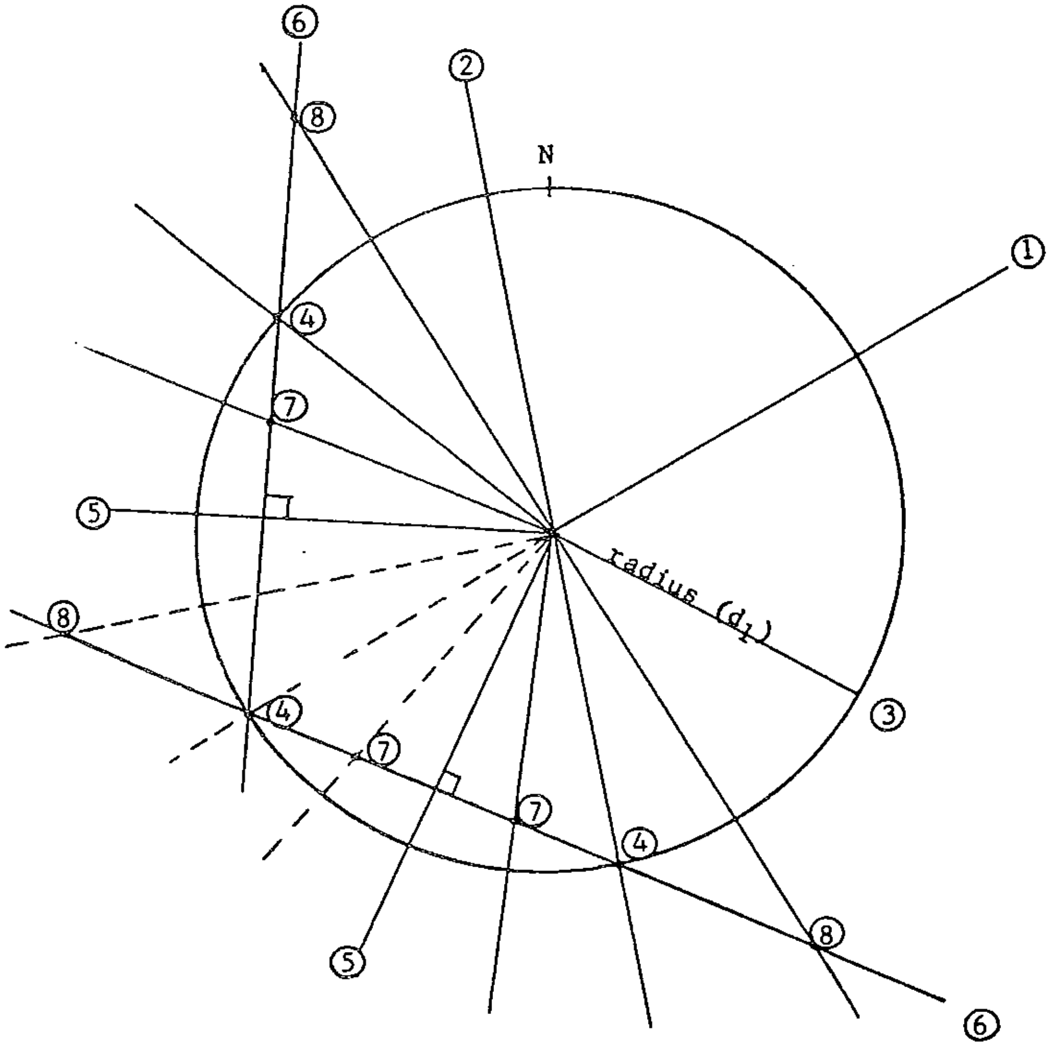


FIGURE 7. LOCATING SOURCE OF SCALLOPING (DIRECTIONAL REFLECTOR) - LONG LENGTH)

(12) The dotted lines drawn 128 degrees, 110 degrees, and 90 degrees from Line (2) and intersecting Line (6) will provide the Points (7) , (4) , and (8) which correspond to a = 73 degrees, 55 degrees, and 35 degrees, respectively.

(13) Now Line (6) between Point (8) and dotted line Point (8) shows the theoretical location and orientation of the long-length reflector.

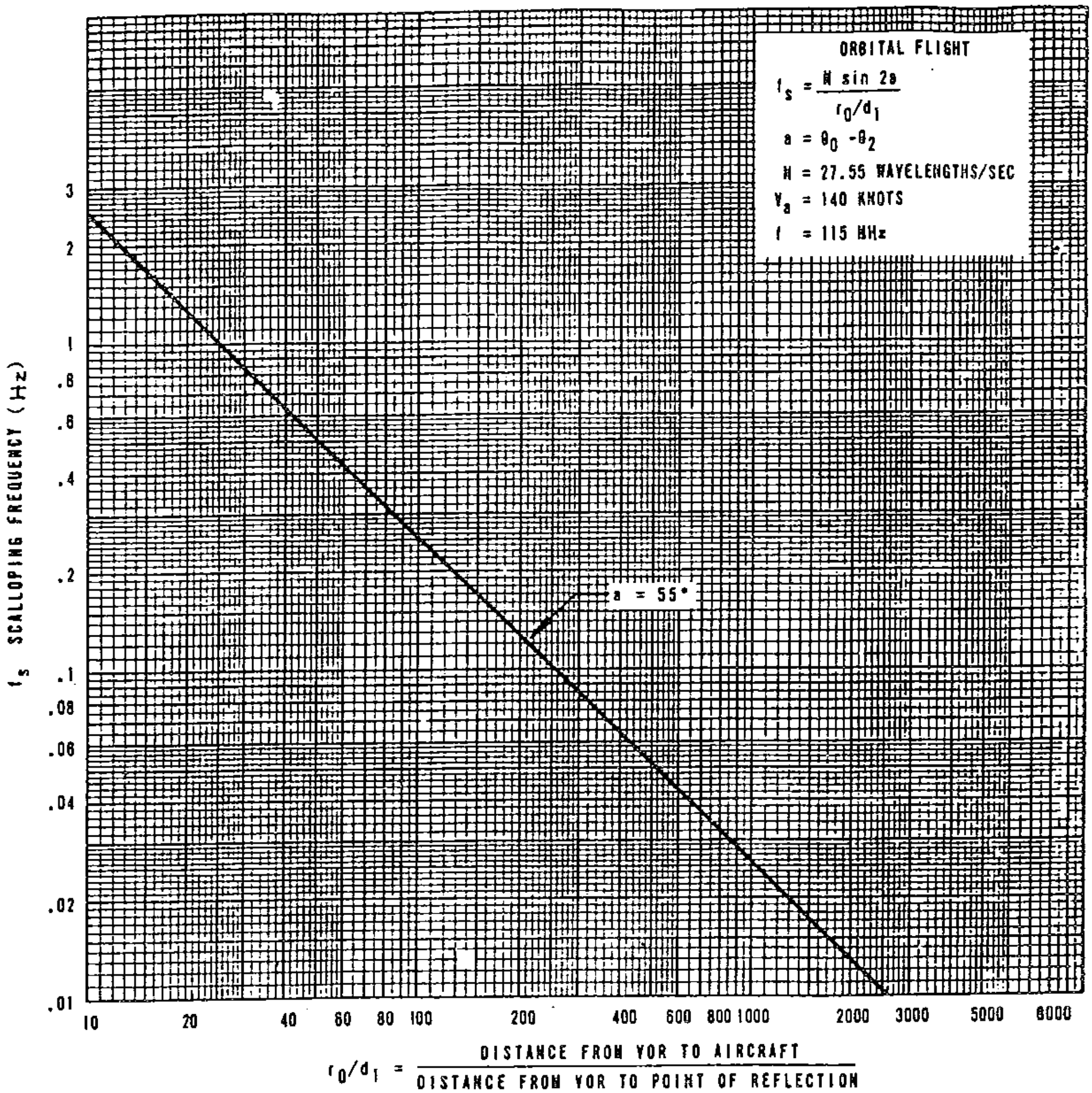


FIGURE 8. PLOT OF EQUATION FOR ANGLE OF INCIDENCE OF 55 DEGREES

c. Directional Reflectors (Short Length). Figure 9 is to be used in conjunction with the following procedural outline for locating a directional reflector from recorder scalloping:

(1) From the aircraft course deviation indicator recording of an orbital flight, locate the azimuth angle that exhibits the maximum scalloping amplitude (designate Line 1). Where two or more high scalloping amplitude azimuths exist, they should be considered one at a time.

(2) From the same aircraft course deviation recording, determine the scalloping frequency at the azimuth of maximum scalloping amplitude (Line 1).

(3) From figures 8 and 10 obtain the ratio r_o/d_1 for angles of incidence (a) of 73 degrees, 55 degrees/35 degrees, and 45 degrees.

(4) Calculate the distance (d_1) for each of these r_o/d_1 ratios. Draw three circles about the VOR with radii that are relative to the above distances. These circles represent distance where the angle of incidence (a) equals (73 degrees), (55 degrees/35 degrees), and (45 degrees) and should be designated r_1, r_2, and r_3, respectively.

(5) From figure 4, it can be seen that any azimuth bearing between 125 degrees and 163 degrees removed from Line 1 could possibly be perpendicular to the plane of the reflector. This being the case, any line between 108 degrees and 146 degrees from Line 1 could represent the line where a = 73 degrees.

(6) Draw two lines 146 degrees removed from Line 1 and label the points where they intersect the r_1 radius as Points 2.

(7) Draw two lines 108 degrees removed from Line 1 and label the points where they intersect the radius r_1 as Points 3.

(8) The arc between Points 2 and 3 represents all possible points, where (a) could equal 73 degrees.

(9) Repeat steps similar to (6) and (7) using 128 degrees and 90 degrees to determine Points 4 and 5 on radius r_2. Use 118 degrees and 80 degrees to determine Points 6 and 7 on radius r_3. Use 108 degrees (Line 3) and 70 degrees to determine Points 8 and 9 on radius r_2.

(10) The arcs between Points 4 and 5 represent all points where a = 55 degrees. The arcs between Points 6 and 7 represent all points where a = 45 degrees. The arcs between Points 8 and 9 represent all points where a = 35 degrees. Connect Points 2, 4, 6, 7, 9, 5, 3 and back to 2 and shade.

(11) The shaded areas should now be surveyed to find the actual point of reflection of the short-length reflector.

(12) Figure 9 can be used as a guide in preparing an overlay drawn to scale for site drawings. In scaling an overlay, the scalloping frequency (f_s) and the site drawing will determine the proper distances for circles r_1, r_2, and r_3.

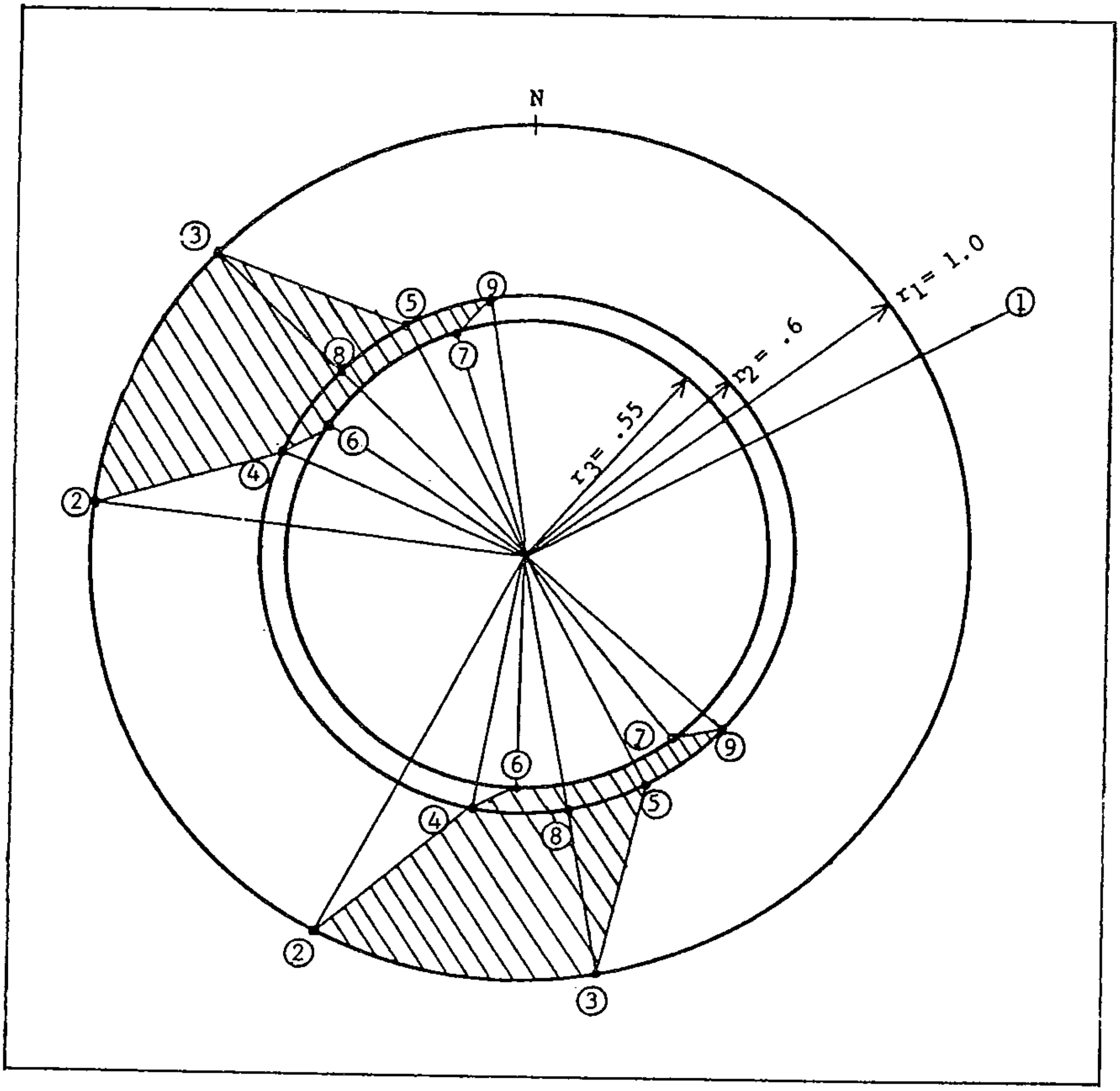


FIGURE 9. LOCATING SOURCES OF SCALLOPING (DIRECTIONAL REFLECTOR - SHORT LENGTH)

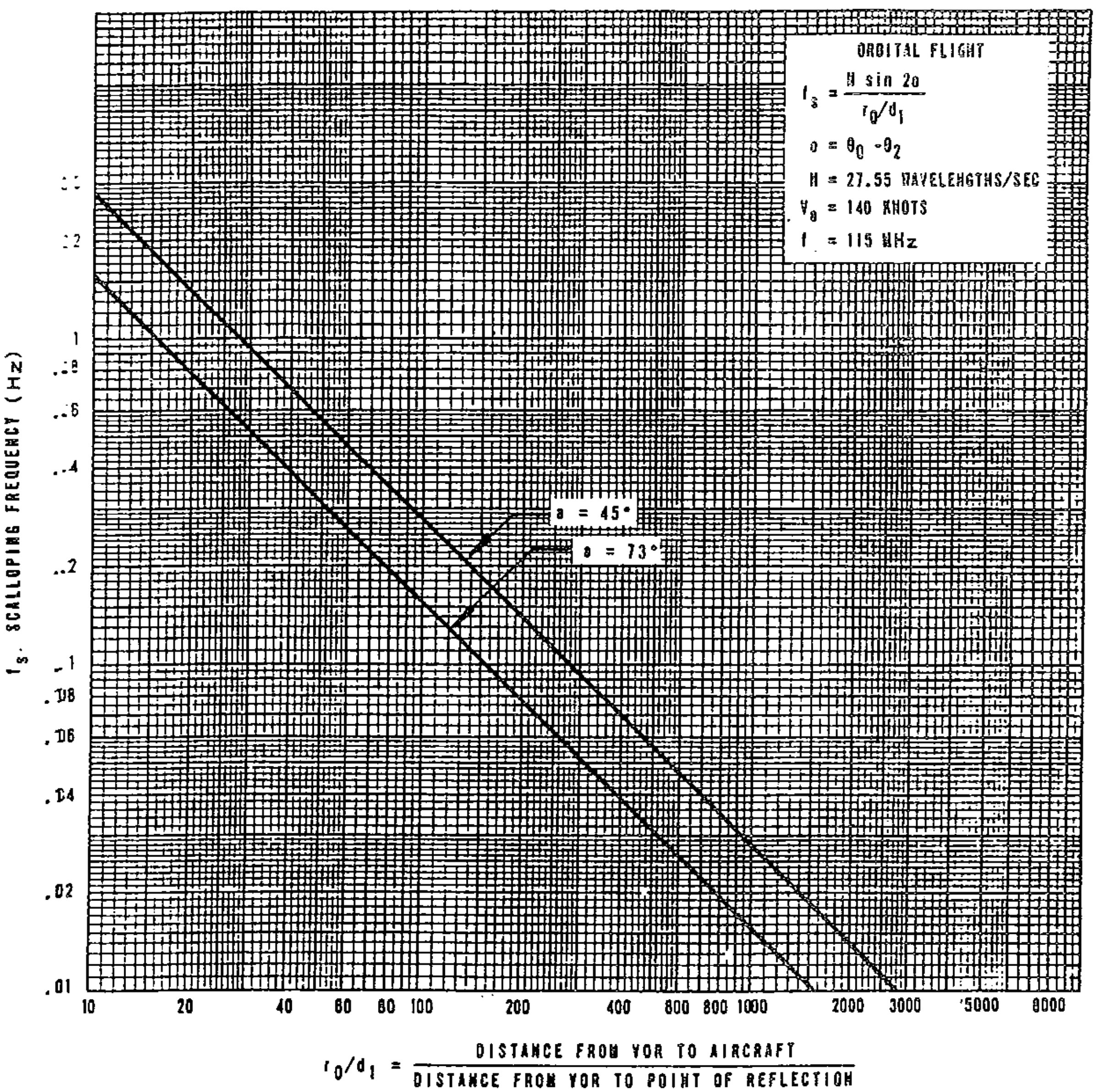


FIGURE 10. PLOT OF EQUATION FOR ANGLES OF INCIDENCE OF 45° AND 73°

LOCATING VOR SCALLOPING SOURCES
by Earl E. Palmer, ANM-431B
FAA Northwest Mountain Region

1. PURPOSE.

Locating an object which is the source of VOR scalloping is a difficult and time consuming task. This report describes two simple, analytical, and accurate methods which will conclusively locate a source of VOR scalloping. These methods have been used successfully in the Northwest Mountain Region for the past 7 years and have located sources as close as 10 feet and as far away as 6000 feet from the VOR. By using a BASIC program and the TI-771 Intelligent Terminal (available in each region Frequency Management Section) or any CP/M base microcomputer and printer, the source of VOR scalloping can usually be located in minutes, instead of hours.

VOR problems which are caused by factors other than reflectors are not discussed in this report. They include improper antenna tuneup, multiple counterpoise effect (common at mountaintop VOR's) or frequency interference. These problems must be resolved by other means. Contrary to what some believe, a VOR does not radiate scalloping. It is the environment around the VOR which causes the scalloping.

The procedures described in this report have been developed independently by the author, with assistance from other engineers in the Northwest Mountain Region. Any resemblance to other methods, if they exist, is purely coincidental.

2. DISCUSSION.

a. General Comments. The methods described in the VOR Siting Handbook, AF P 6700.11, for locating scalloping sources are difficult to use and often give inconclusive results. The methods described in this report use only orbital flight inspection data, either from Semiautomatic Flight Inspection (SAFI) or Saberliner recordings. The limitations of the recordings in locating scalloping sources will be discussed later. Both methods are graphical but provide sufficient accuracy. It should be noted that the terms reflectors, re-radiator, and scalloping source are used synonymously in this report. No distinction is required for the purpose of scalloping analysis.

The first procedure is called the Scallop Counting Method (SCM). It provides satisfactory results for reflectors from approximately 30 to 6000 feet from the VOR, and will be used for the majority of scalloping problems. The SCM is much more convenient when used with a BASIC program and a microcomputer; however, hand-plotted solutions are satisfactory. The microcomputer eliminates the human error and hand plotting. The use of the BASIC program for the TI-771 Intelligent Terminal is described in detail in Section 3 of this report. A BASIC program listing for the Compustar Model 30 is included in Enclosure 5b.

The second procedure described is the Center of Symmetry Method (CSM). This procedure uses orbital data or ground error curves and is useful for finding reflectors very near the VOR, approximately 100 feet or less. Examples are when portions of the VOR counterpoise are re-radiating, or when a VOR monitor antenna or TACAN monitor pole re-radiates. The CSM relies on the principle that the reflector (or re-radiator) causes scalloping that is symmetrical, but out of phase, on each side of the radial on which the reflector is located. All scalloping sources exhibit this property; however as the scalloping source gets farther away from the VOR, the orbital scalloping frequency becomes higher, and will be damped out and lost by the VOR bearing recording process. For VOR ground check curves, the reflector must be on or very near the counterpoise, typically less than 30 feet from the center of the antenna array. For SAFI bearing error reports the scalloping is lost when the scalloping frequency exceeds 3 or 4 scallops in a 10-degree segment. This will allow locating scalloping sources up to approximately 200 feet from the center of the VOR antenna array.

b. Description of the Scallop Counting Method. The mathematical analysis of the SCM is given in Enclosure 5a. Simply stated, the SCM uses the orbital scalloping frequency at several azimuths to determine a locus of points (straight lines) where the scalloping source could be located. The common intersection of three or more of these lines is the location of the scalloping source.

(1) Twin Falls, Idaho, Example. This is the first location where the SCM was successfully used. A hand plotted example will be described.

The procedure is to plot parallel lines on polar paper at a calculated distance each side of the VOR, which is located in the center of the paper. These lines are parallel to the VOR radial where the scallops were counted. As the flight check VOR orbital recordings incremented every 10 degrees with the DC-3 aircraft, it was arbitrarily decided to count the scallops in 10-degree segments of the orbit. At Twin Falls, severe scalloping was reported by users on the airway using the 112-degree radial. Subsequent flight checks confirmed the scalloping, and the airway was removed. Extensive analysis of the radial flight check recordings was inconclusive.

A 20-mile orbit at 4000 feet above the site elevation was flown by flight inspection. Due to the speed to the Saberliner aircraft and the damping of the VOR bearing recording, scalloping was not observed. Analysis of the VOR receiver AGC voltage recordings did show amplitude changes which were uniformly spaced and which could be counted over 10-degree segments of the orbit.

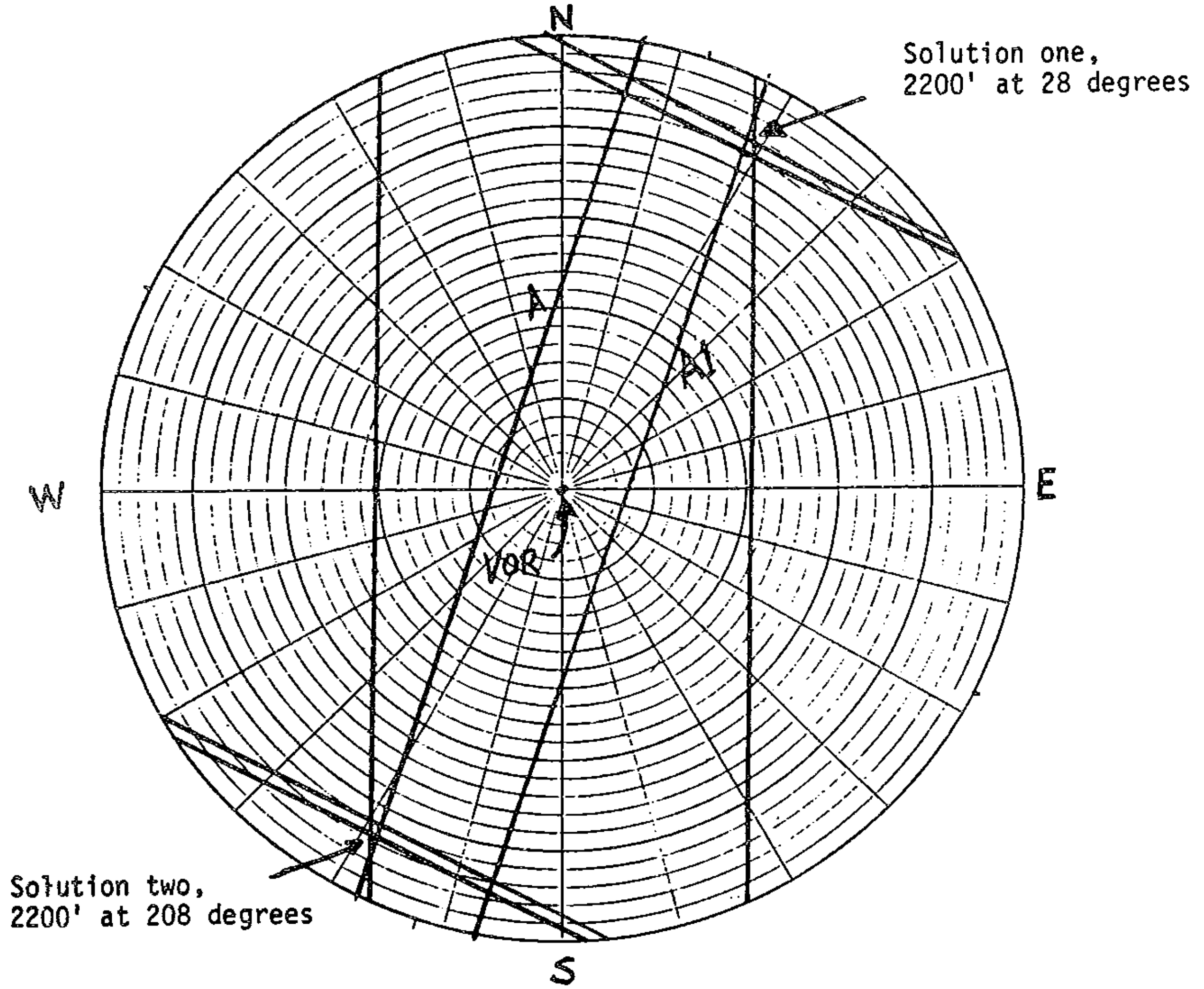
The following data were obtained from the recordings and the formula D=49N (see Enclosure 5a):

Radial in Degrees	Number of Scallops N	Distance D in Feet
20	7	343
115	44	2156
180	21	1029
295	46	2254

As shown in Figure 2-1, two lines were plotted on polar graph paper at the calculated distance D from the center of the polar graph paper, and parallel to the radial. In other words, A and A1 are parallel to the 20-degree radial, and scaled 343 feet from the 20-degree radial. The common intersection of three or more lines is the solution to the problem. Note that two solutions exist, at approximately 2200 feet from the VOR on reciprocal radials of 28 and 208 degrees. At Twin Falls the ATCT is located 2220 feet from the VOR on the 31 degree radial. Subsequent screening of the ATCT reduced the scalloping to an acceptable level, and the airway using the 112 degree radial was restored to service. A computer plot is given in Example 3e(2) of this report.

(2) Analysis of Flight Inspection Recordings. The most critical part of location scalloping sources using the SCM is the analysis of the flight inspection recordings. Many limitations of the recordings mask the scalloping and make analysis difficult. The primary limitation is the damping of the bearing recording in the flight check receiver. As the reflector gets farther away from the VOR, the scalloping frequency increases. A scallop, which is defined as one complete periodic waveform (a distorted sine wave), is damped out by the flight check receiver circuits if its rate is greater than approximately 1/2 cycle per second. To prevent this, either a larger orbit or a slower aircraft is required. Figure 2-2 is an example of VOR bearing scalloping. Note that the two bearing recordings do not track. This has been traced to the auto-calibrate circuit in the Bendix RNA-26CF (FA-4165.3A) flight inspection receiver, which realigns the receiver bearing circuits for 1 second out of every 5. When this circuit is disabled, excellent tracking of two receivers usually occurs.

Analysis of the VOR receiver AGC voltage is also useful, and can be used as the basis for locating the scalloping source. Usually much higher scalloping frequencies can be observed on the AGC recording. Figure 2-3 is an example of scalloping on the VOR AGC voltage recording.



Scale 1" = 1000'

FIGURE 2-1

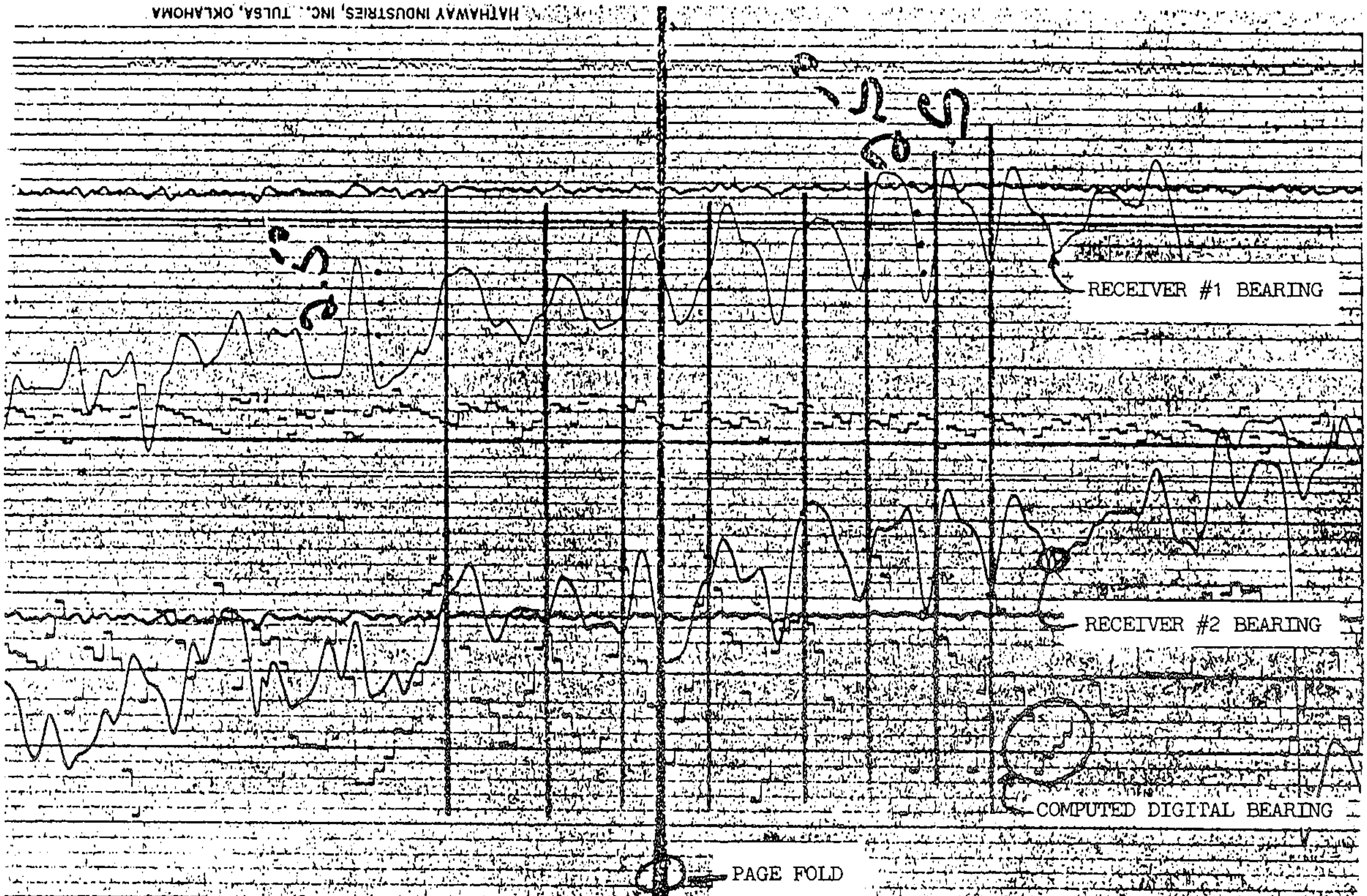


Figure 2-2 Example of VOR bearing scalloping. Note that the scalloping is approximately the same on both receivers, and that the distance between the scallops is approximately equal. The vertical lines are drawn at the peak of the computed bearing error trace, which is slightly delayed from the raw data.

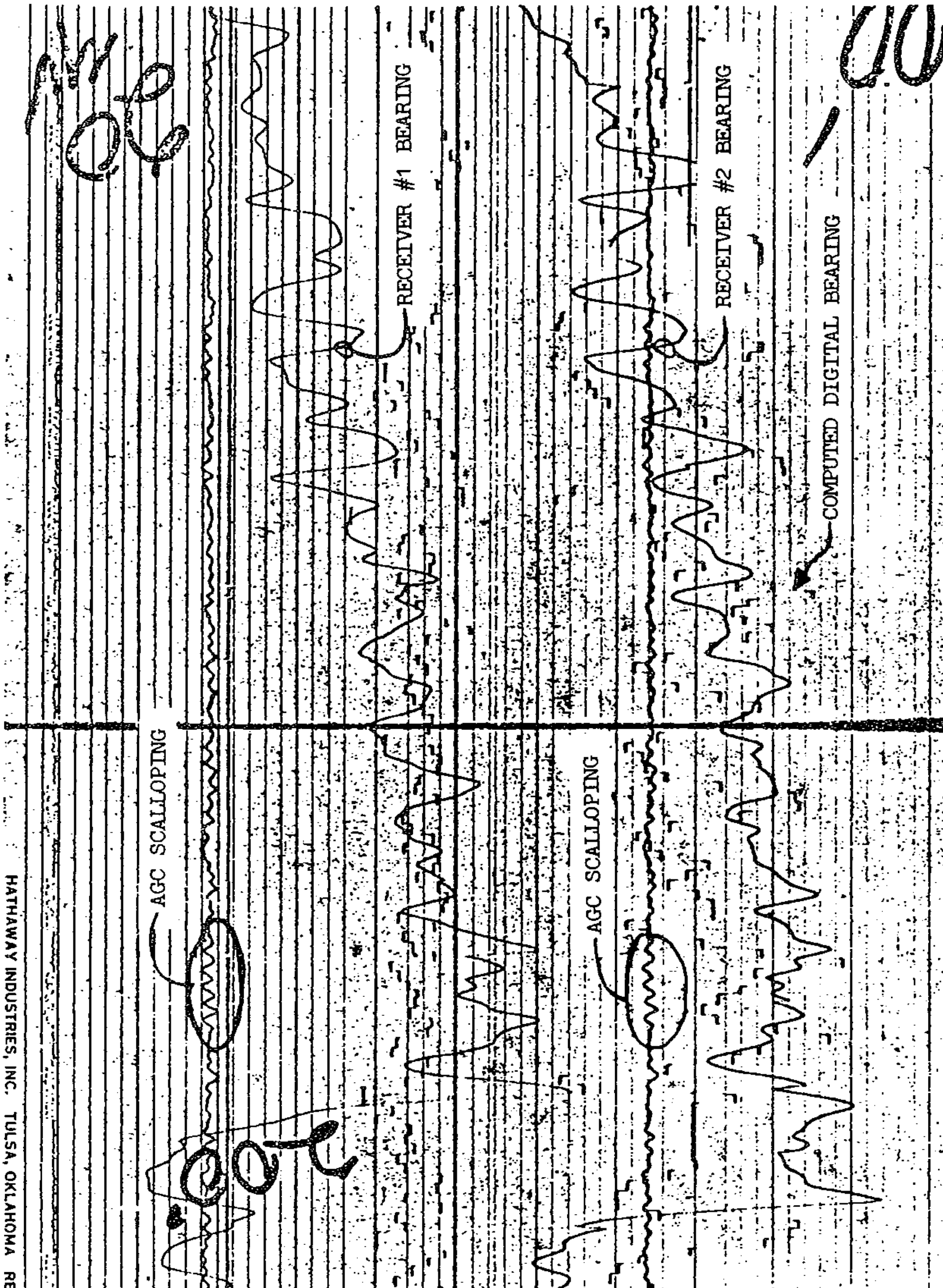


Figure 2-3 Example of VOR receiver AGC scalloping. The number of scallops is counted over a few degrees and then extrapolated out to 10 degrees. Note that the VOR bearing traces are different on each receiver. This indicates that the scalloping frequency is beyond the cutoff frequency of the filters in the bearing indicator circuits.

A similar problem occurs if the scalloping source is within 100 feet of the VOR. Then the scallops are so long that they are not apparent on the recordings. In this case, analysis of SAFI BER's will provide the best results. Scalloping analysis of BER's is shown in Examples 3e(1) and 3e(5).

Analysis of flight inspection recordings requires proper judgment as to what a scallop is, and some experience. In general, the following guidelines should be followed:

(a) Make sure the scalloping has a periodic waveform, and has a constant frequency over several cycles.

(b) If the scalloping is periodic but the duration is less that 10 degrees of the orbit, determine the number of scallops in a portion less than 10 degrees, and extrapolate the data for the full 10 degrees.

(c) If the scallop is very long, as occurs on SAFI BER's, the length of the scallop can be determined in degrees. Then the fractional part of a scallop (occurring) in 10 degrees can be determined. See Example 3e(5).

(d) Scallops should be counted on as many radials as possible. It takes a minimum of three to get a solution; however all significant scallops should be plotted.

(3) <u>Flight Inspection Preplanning</u>. In most cases, a special flight inspection is required. As flight inspections are expensive, preflight planning should be accomplished to insure that satisfactory recordings are obtained. In general the DC-3 was preferable to the Saberliner as it flew slower, and more scallops could be observed for the same orbit radius. A light aircraft with the portable flight inspection package probably would be satisfactory; however this option has not been available in the Northwest Mountain Region. With proper planning Saberliner recordings are usually acceptable.

The orbital altitude and distance are of primary concern. As the radius of the orbit is increased, scalloping from a reflector at a greater distance from the VOR can be observed. The table below gives the approximate maximum distance that scalloping can be observed on either the bearing or AGC recording.

Orbit Radius	10	20	30	40	50	Miles
DC3 Bearing	1100	2200	3300	4400	5500	Feet
DC3 AGC	2200	4400	6600	8800	11000	"
Jet Bearing	600	1200	1800	2400	3000	"
Jet AGC	1200	2400	3600	4800	6000	"

The above table is based on an air speed of 140 knots for the DC-3, 260 knots for the jet, a maximum bearing scalloping frequency of 0.5 Hz, and a maximum AGC scalloping frequency of 1.0 Hz.

The altitude of the aircraft is also very important. In general, if the altitude of the orbit is very high the scalloping is reduced as the direct signal from the VOR tends to increase in amplitude more than the signal from the scalloping source which receives a low angle VOR signal. Conversely, if the aircraft altitude is low, the signal levels are reduced and the recordings become noisy. Then it is difficult to separate the scalloping from the noise. As a general rule it is better to fly lower, where the scalloping is more apparent, as is done on a minimum coverage orbit, and then spend a little more time separating the scalloping from the noise.

Another method to determine the optimum orbit altitude is to locate where maximum scalloping exists on a radial flight. The angle of maximum scalloping can then easily be determined and extrapolated out to obtain the orbital radius altitude. It should be noted that the scalloping sources have characteristic radiation patterns, which can include nulls, minimums, and maximums. Therefore, it is possible that the flight path could be in a reflection null or minimum, and no scalloping would be observed.

With the Automatic Flight Inspection System (AFIS) of the Saberliner aircraft it is not necessary that an orbit be flown. The distance between the VOR and the aircraft does not enter into the calculations. As long as the bearing of the aircraft from the VOR is known, straight or even curved segments are satisfactory. With AFIS, several segments around the VOR may be recorded during routine travel on flight inspections when the aircraft is in the vicinity of the VOR. These may be at a greater distance than an orbit would normally be flown, and the scalloping will possibly be more apparent. Depending on the urgency of the scalloping problem, this approach may be satisfactory, and a special and expensive orbit may not be required.

c. <u>Description of the Center of Symmetry Method (CSM)</u>. The CSM uses SAFI BER's, or Saberliner orbital error plots made on FAA Form 8240-4, to locate reflectors that are less than approximately 75 feet from the VOR. For very close reflectors, the VOR ground check error curve may be used. This graphical method is very simple and usually quite conclusive. It is based on the principle that bearing errors produced by a reflector are symmetrical and out-of-phase on each side of the radial on which the reflector is located. No proof is given here for this statement; however, it is intuitive that an object will reflect a signal which has the audio phase of the space modulated 30 Hz AM signal of the particular azimuth on which it is located. This reflected signal will add to the phase of the space modulated signal at azimuths on one side of the reflector, and subtract on the other.

To accomplish a CSM analysis, a bearing error plot must be prepared on transparent paper. The plot is then cut out and taped together at the 0-, 180-, and 360-degree points to make a continuous loop. The loop is then examined on a light table so that each half can be seen superimposed on the other. For example, Ø to 18Ø degrees would be visible from the front half of the loop, and 18Ø to 36Ø degrees would be visible from the back half of the loop through the front half of the loop. The loop is then rolled so that the front and back halves move in opposite directions.

As the patterns of the curves are observed it will be obvious when the bearing errors are out-of-phase and symmetrical as shown in Figures 2-4, 2-5, and 2-6. The lobes formed are rounded and have a distinctive shape. When this pattern is observed, the scalloping source is located at the azimuth at either end where the paper is folded. Usually the scalloping source will be at the azimuth represented by the fold where the error lobes are the largest. It is possible to develop a computer analysis of the CSM; however the graphical method is very simple and quick. A computer solution would probably take a great deal of time to input all the flight inspection data unless it was automatically done by the flight inspection aircraft computer.

The CSM should only be used after a standard Fourier Analysis of the VOR error curve has been made, especially if the error curve has only a few cycles of error over the full 36Ø degrees. A bearing error from a reflector will often show up as an unusual harmonic component of the VOR Fourier Analysis. Typically it will appear as third, fifth or higher order components, if the analysis method is capable of producing them.

d. Distance to the Scalloping Source. A very simple and useful relationship exists to determine the distance to close-in reflectors. This relationship only is useful when one predominate reflector causes scalloping which is observable on the entire SAFI or Flight Inspection FAA Form 824Ø-4 bearing curves. See Figure 2-7 for an example. The distance to the reflector, from the center of the VOR array, is calculated using the formula:

$$D = (\lambda N) / 4 \text{ or } D = 2.15N \text{ @ } 115 \text{ MHz}$$

where λ = wavelength and N = the total number of scallops produced in a 36Ø-degree orbit.

In the example shown in Figure 2-7, 23 scallops are counted in 36Ø degrees, which indicates that the reflector is 49.22 feet (2.14 x 23) from the antennas radiation center. Some of the scallops are difficult to determine, however, this is not an exact science. An error of ± three scallops would still give a reasonably accurate answer. This same location is also analyzed in Example 3e(6) with the Compustar microcomputer using the scallop counting method. This procedure indicates the source is at 5Ø feet on the 43- or 223-degree radial. The Tacan monitor pole is located at 5Ø feet on the 45-degree radial at this location.

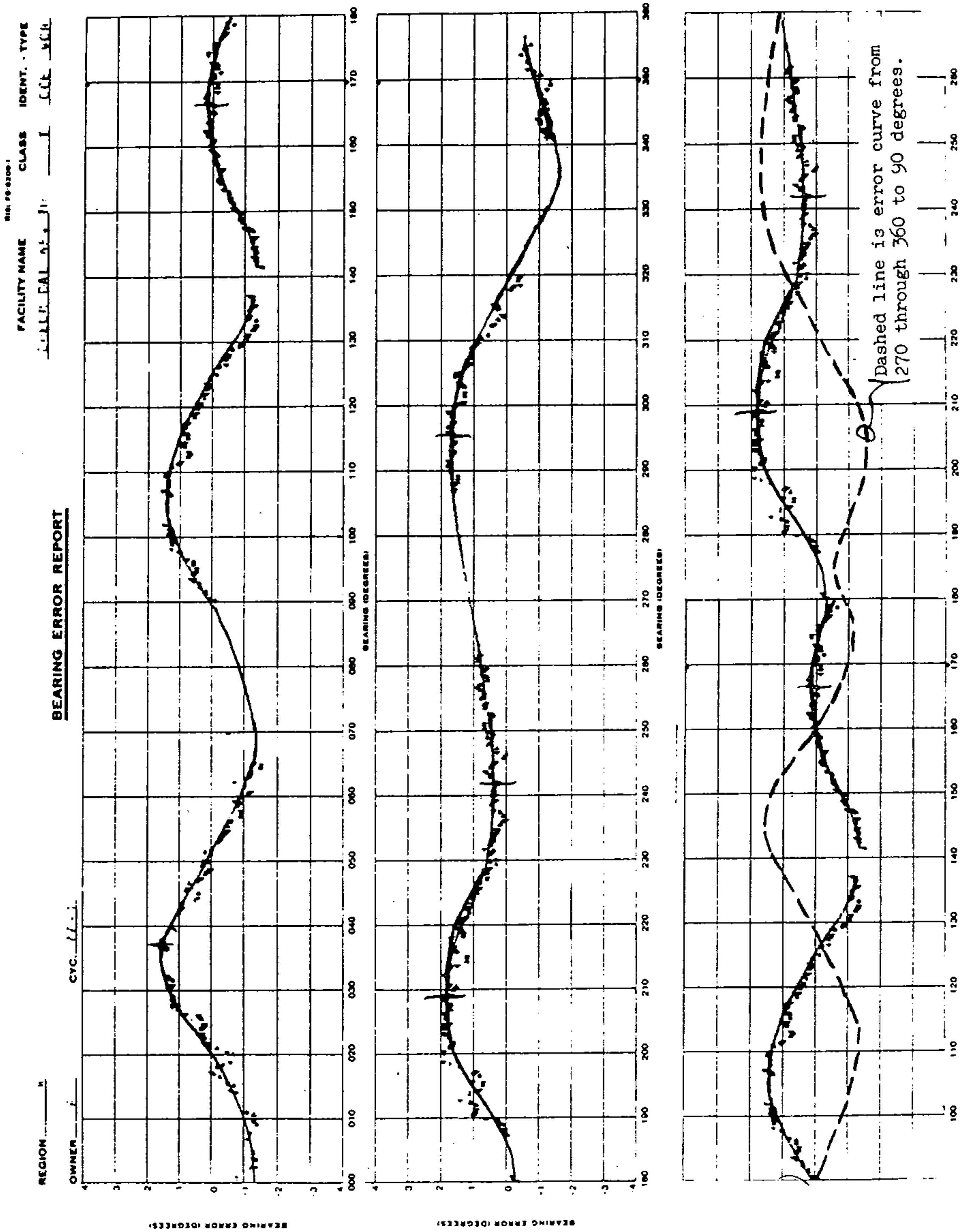
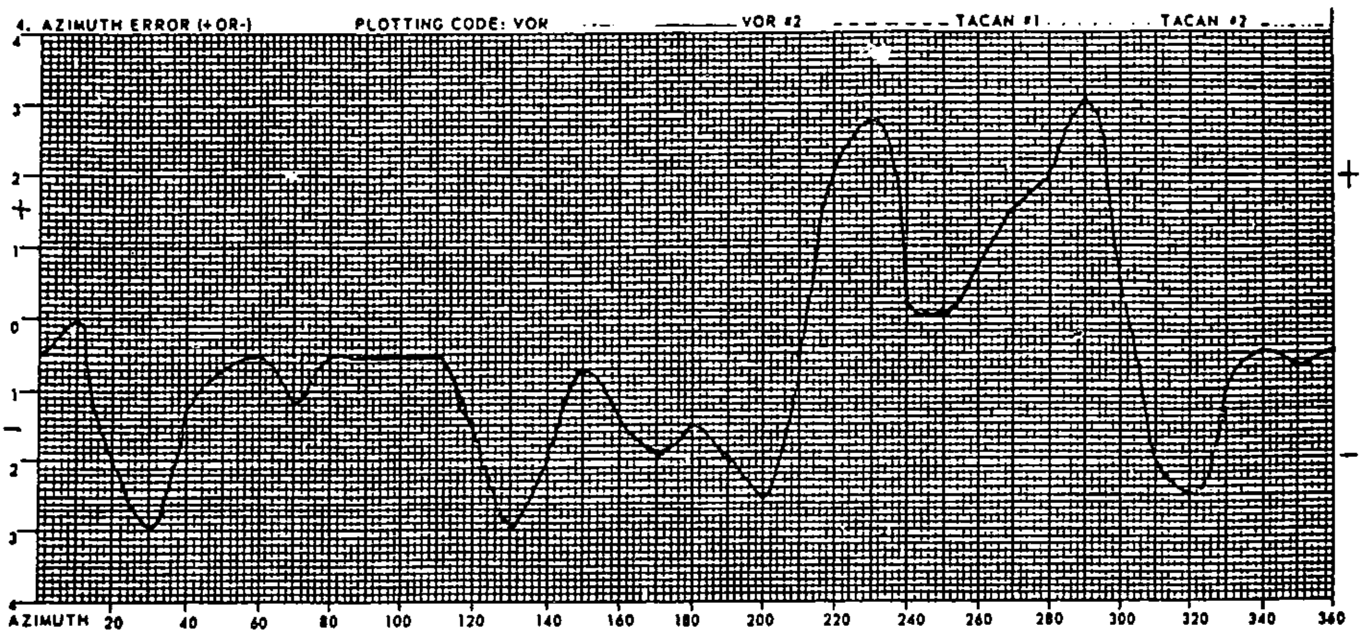
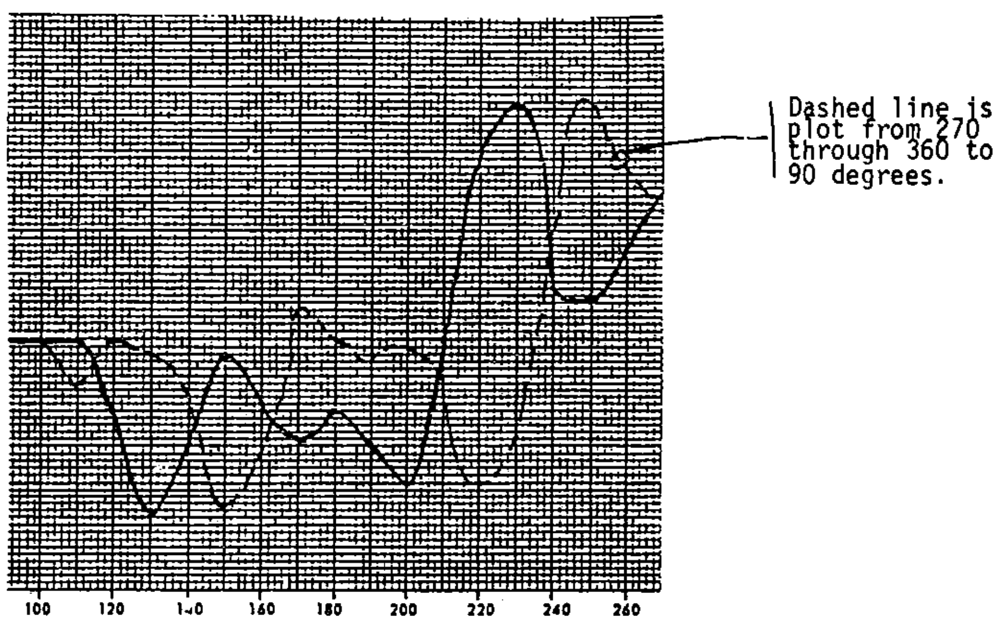

BEARING ERROR REPORT
FACILITY NAME
CLASS
IDENT. - TYPE
REGION
OWNER
CYC.
BEARING (DEGREES)
BEARING ERROR (DEGREES)
Dashed line is error curve from 270 through 360 to 90 degrees.

FIGURE 2-4

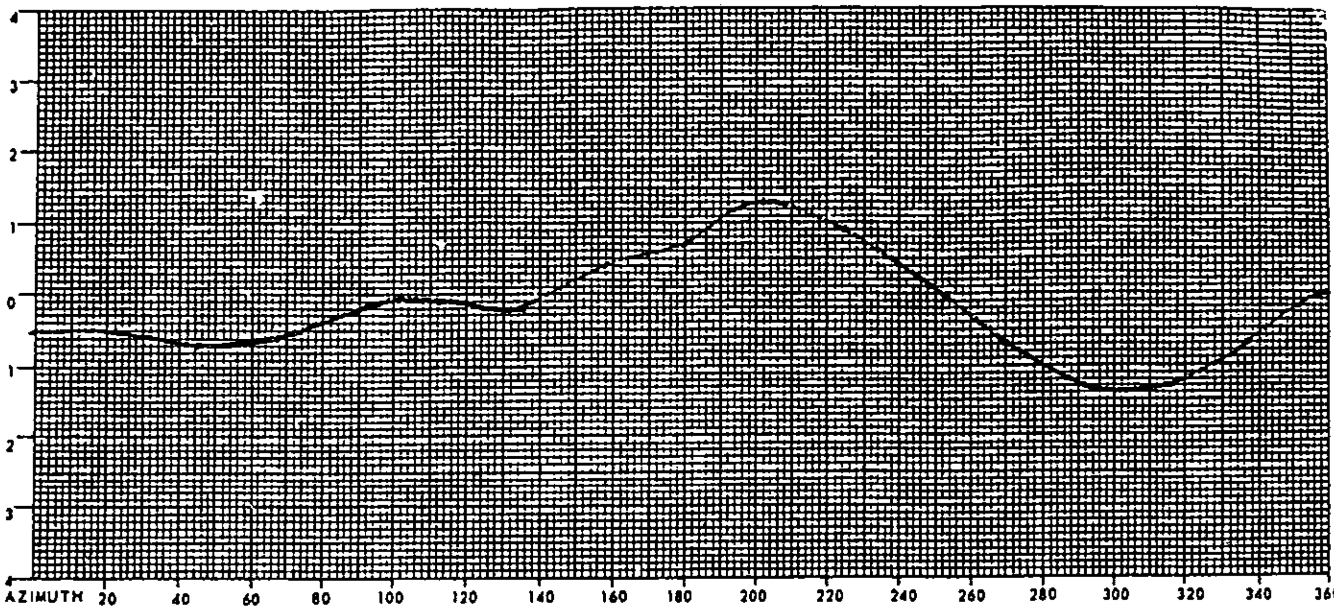


Mountain Home, Idaho, VOR error curve obtained from a FIFO Saberliner Automatic Flight Inspection, Form FAA 8280-4.

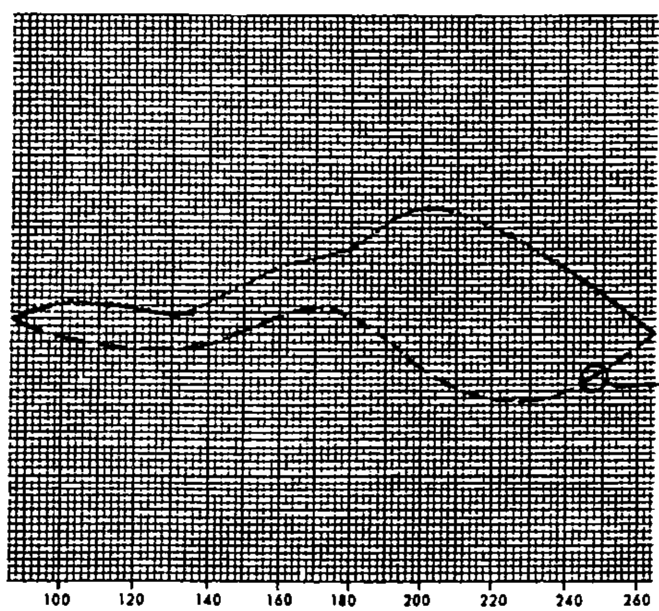


Center of symmetry solution shows the reflector is either at 90 or 270 degrees. Note that the two error curves (dashed and solid lines) are symmetrical and out of phase about 90 or 270 degrees. At Mountain Home this error curve occurred on a new Wilcox VOR facility when a large 36-inch monitor dipole was used on the 270-degree radial. Reducing the size of the dipole eliminated the problem.

FIGURE 2-5



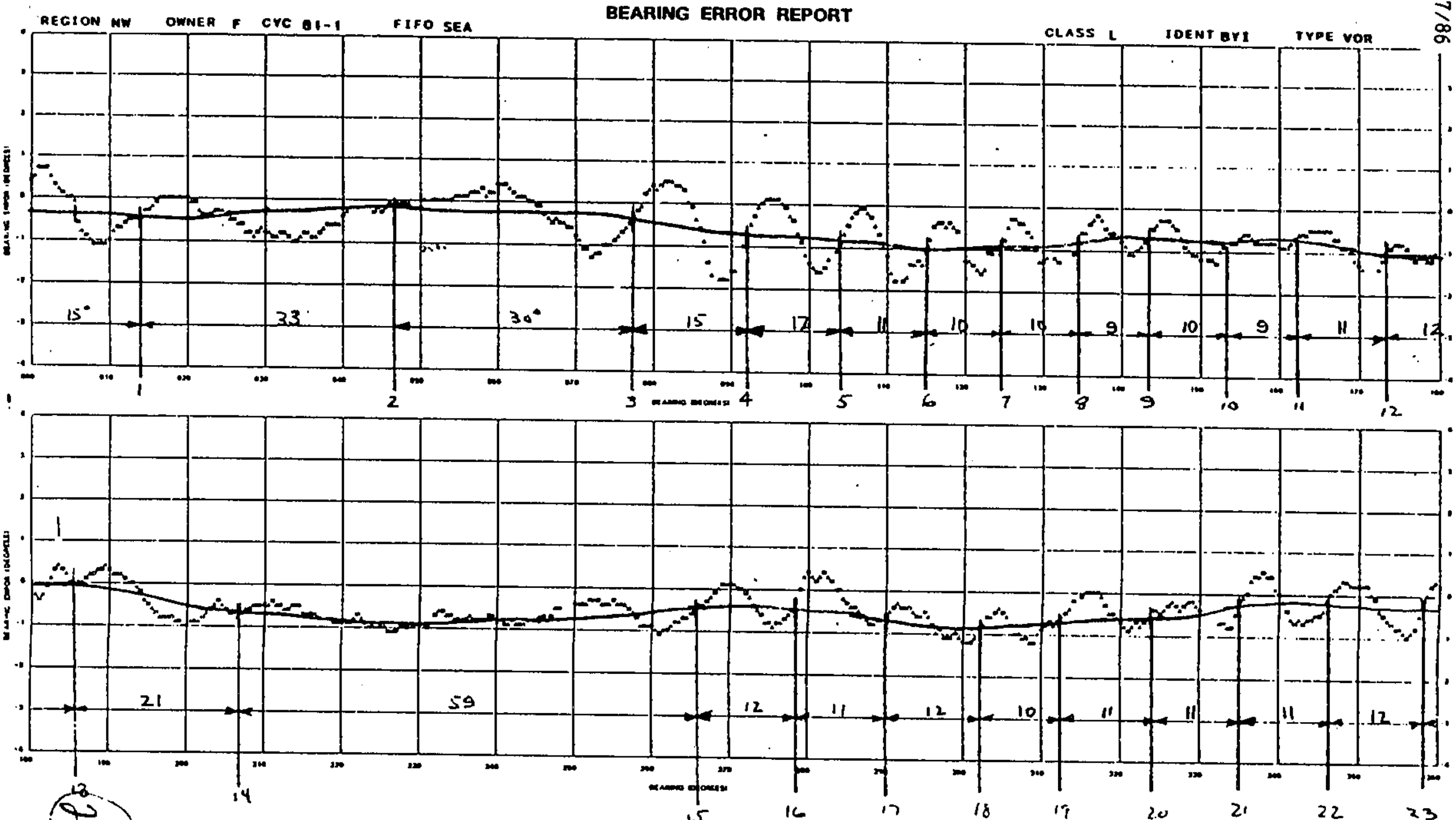
Pasco, Washington, VOR ground error curve, obtained after antenna optimization. This curve could be brought into tolerance, only by maladjusting the antenna system.



Center of symmetry solution shows a reflector is either at 85 or 265 degrees. Removal of a ladder bracket on the TACAN radome at 260 degrees completely changed the shape of the ground error curve to well within tolerance, without maladjusting the antenna system.

FIGURE 2-6

BEARING ERROR REPORT



SUMMARY HISTORY BY SECTORS

DATE	FLIGHT NO	AIR-CRAFT	ALTITUDE	BEARING START	BEARING DIR	BEARING END	DISTANCE MAX	DISTANCE MIN	DIST MEAN ERROR	AVE [illegible]	AVE [illegible]
08-03-81	613	092	25000	180.5	CW	276.0	74	49		31	27
02-04-81	609	091	23100	270.5	CW	5.5	103	68			
08-19-80	625	091	23100	186.5	CCW	91.5	71	47			
07-16-80	604	091	23100	96.5	CCW	1.5	104	70			

FACILITY CHARACTERISTICS

MEAN ERROR (DEG)	DISPERSION RANGE 68%	DISPERSION RANGE 95%	DISPERSION RANGE 99.7%
-0.5	0.0	0.4	0.7
	-1.0	-1.5	-1.8

Figure 2-7

3. COMPUTER ANALYSIS USING THE SCALLOP COUNTING METHOD.

a. General Comments. Computer analysis using BASIC programs with the TI-771 Intelligent Terminal has evolved from several more primitive methods. The first was a plot on graph paper as described in Section 2 of this report. The second method was a program on a Monroe 1666 desk top programmable calculator and PL-1 plotter. This was very satisfactory and was used successfully in the Northwest Region for 3 years. However, the Monroe calculator is generally not available to other regions. The TI-771 Intelligent Terminal and BASIC interpreter resolves this problem. The Northwest Mountain Region has two TI-771 systems available, one in Frequency Management, and the other available through Management Services. Compustar Model 30 microcomputers are also available in many sectors and regions. A Microsoft BASIC program has been written for these computers.

The BASIC program has the filename VORSCAL. The program is written in the simplest form of BASIC possible. It has been run with only minor syntax changes on a Heathkit home computer system. The Northwest Mountain Region will provide a copy of the VORSCAL program on a disc provided by any FAA user (either an 8-inch disk for the TI-770 or a 5 1/4-inch disk for the Compustar Model 30). The program is written to work with most any printer, however it should print with 10 characters per inch and 6 lines per inch for the plot scale to be correct.

b. Running the Program. Don't be awed by a microcomputer. It won't blow up if you make a mistake. It is impossible to harm the program stored on the disc from the keyboard while running the program. So if for some reason you have trouble, reset the computer and start again from the beginning. A review of the computer instruction book may be helpful, but is really not required to run the VORSCAL program.

Extreme care should be used in handling the program storage discs. Prior to using them you should be checked out by someone familiar with their use. The recording surfaces on the disc should never be touched. A minute particle of dirt or grease on the disc can destroy a program which has taken hours to produce. Also the discs should be stored in an appropriate container, not in a desk drawer or anywhere they will collect dust or dirt.

c. Using the TI-770. After the flight check recordings have been analyzed and the scallops counted at several azimuths, the VORSCAL program is run as follows:

(1) Turn on the power to the video terminal, printer, and dual disc drive.

(2) Insert the BASIC disc into disc drive 1 (the left hand drive) and the VORSCAL disc into disc drive 2. The computer will now read disc 1 and start to prompt you through the program.

(3) Press the "D" and "return" keys when asked what mode of operation is required.

(4) Enter the date and time as requested by the computer. Use the exact format as requested. When asked to give a station number, press the return key. A station number is not required in this program.

(5) Type in exactly as shown the following statement:

"DSC2:VORSCAL"

Then press the return key. The BASIC program will now prompt you through the program.

(6) Enter the location, VOR frequency, and other data as requested by the program.

(7) Analyze the plot as described on the printout. If the solution is unsatisfactory, the plot can be run again with the necessary data changes. The program automatically scales the plot; however, the scale may not be satisfactory. At the end of each plot the program asks if the scale was satisfactory. If not, the scale can be changed and another plot made.

(8) The program will print out the best solutions, based on the coincidence of three or four lines. These are solved by trial and error during the execution of the program. These answers usually are valid but may not be if a large number of scalloping bearings were entered. Visual analysis of the plot is required to verify the scalloping source location.

(9) Upon completion of the program, remove both discs and turn the power off to all three units.

d. Using the Compustar Model 30. After the flight check recordings have been analyzed and the scallops counted at several azimuths, the VORSCAL program is run:

(1) Turn on the power to the Compustar and printer.

(2) Insert the program disc with the program VORSCAL.COM recorded on it into disc drive A (the lefthand drive).

(3) Type "VORSCAL" and then press the "RETURN" key.

(4) The computer will now prompt you through the program.

(5) Analyze the computer printout as described in Steps 3b(7,8) above.

e. <u>Examples</u>. Five computer generated plots from actual scalloping problems are included as examples. All plots except the Port Angeles example were originally done with earlier plotting methods. Examples on the following pages are:

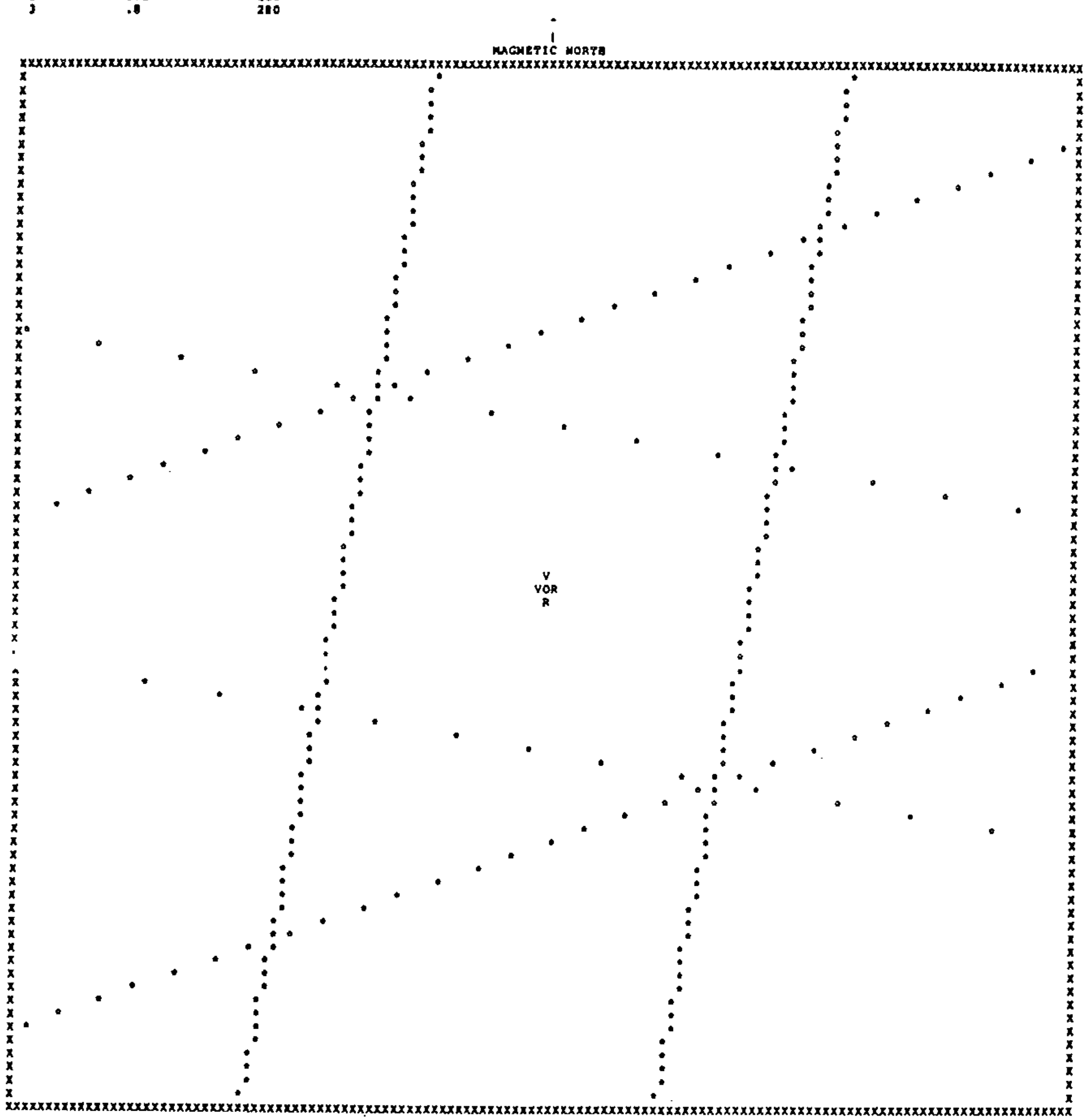
(1)	Ephrata, WA, VOR	page 17
(2)	Twin Falls, ID, VOR	page 19
(3)	Port Angeles, WA, VOR	page 20
(4)	Bay View, WA, VOR	page 21
(5)	Salmon, ID, VOR	page 22
(6)	Burley, ID, VOR	page 23

VOR SCALLOPING PROGRAM DEVELOPED BY E.E. Palmer, P.E.
FAA NORTHWEST REGION, SEATTLE, WASHINGTON
CP/M VERSION 1.0, 3-MARCH-83

LOCATION: EPHRATA, WASHINGTON
FREQUENCY: 112.6
ENGINEER: EEP
F/C AIRCRAFT: SAFI
DATE: 5-15-80
SCALE OF PLOT: 20 FEET PER INCH

THE NUMBER OF SCALLOPS COUNTED FOR EACH AZIMUTH IS:

DATA	NUMBER OF SCALLOPS	AZIMUTH
1	1	10
2	1.2	250
3	.8	280



THE PLOT SCALE IS 20 FEET PER INCH.
PHOTO REDUCED

A POSSIBLE SOLUTION USING 3 INTERSECTING LINES IS 67 FEET FROM THE VOR ON THE 139 OR 319 DEGREE RADIAL.

THE ABOVE SOLUTION(S) MAY NOT BE VALID AND SHOULD BE VERIFIED BY GRAPHICAL ANALYSIS, ESPECIALLY IF MORE THAN 4 BEARINGS ARE PLOTTED.

THE LOCATION OF THE SCALLOPING SOURCE IS AT THE COMMON INTERSECTIONS OF THE LINES OF ASTERISKS. TWO POSSIBLE SOULTIONS ARE FOUND, ONE CORRECT AND THE OTHER INCORRECT. THE TWO SOLUTIONS ARE LOCATED ON RECIPROCAL VOR BEARINGS, THE SAME DISTANCE FROM THE VOR. THE CORRECT SOLUTION MUST BE DETERMINED BY INSPECTION OF THE FACILITY.

THE ABOVE PLOT SHOULD HAVE A CONTINUOUS ROW OF X'S IN THE VERTICAL COLUMNS ON EACH SIDE OF THE PAPER. IF NOT AN ERROR IN THE PLOT HAS OCCURED.

TO MAKE THE LINES OF ASTERISKS MORE VISIBLE, USE A FELT TIP MARKER. AT ANGLES NEAR 90 OR 270 DEGREES ONLY A FEW ASTERISKS PER INCH ARE PRINTED.

REGION 36

OWNER F

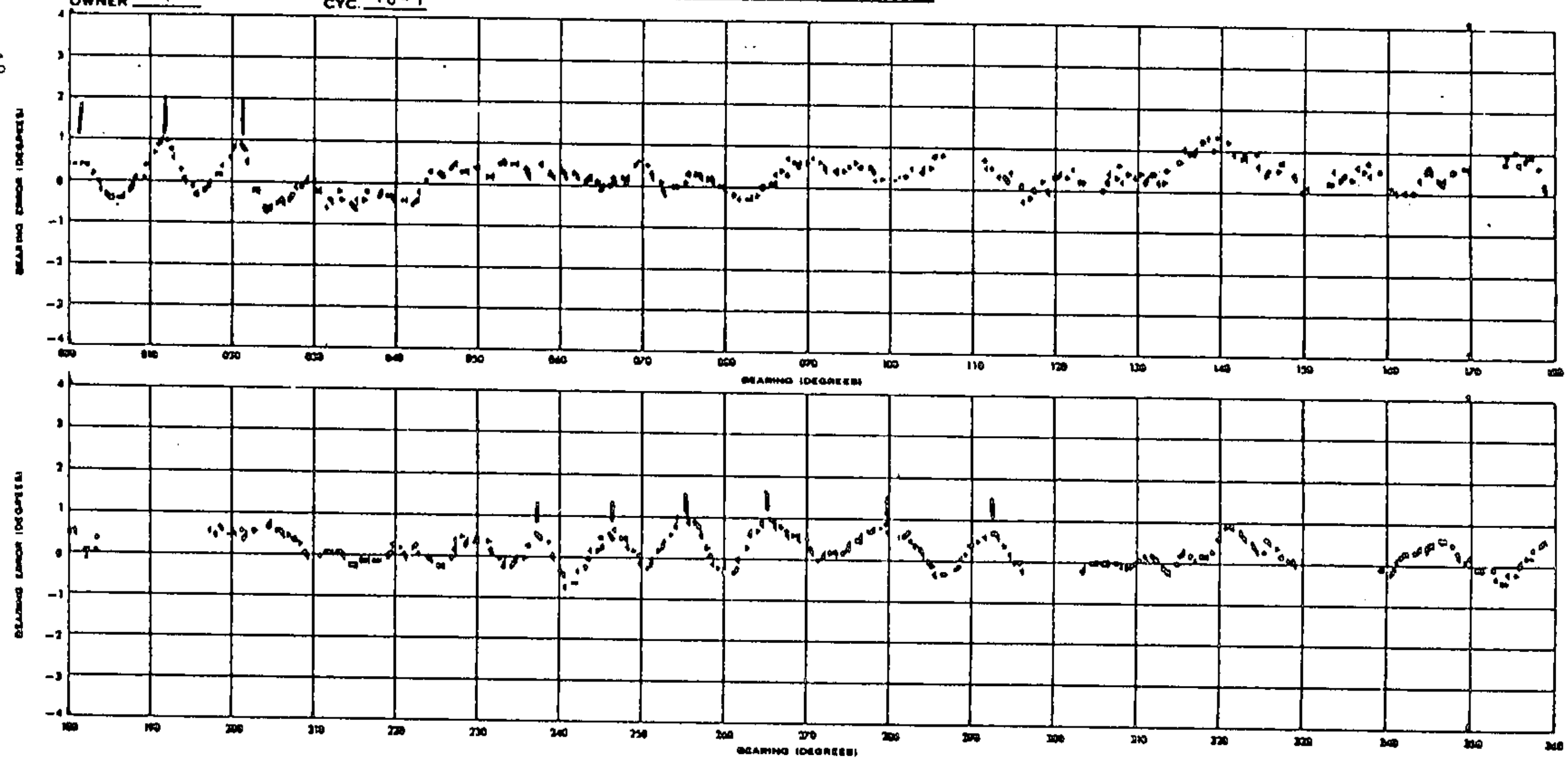
CYC. 76-1

BEARING ERROR REPORT

FACILITY NAME EPHRATA, WA

CLASS H

IDENT. - TYPE EPH VOR



SUMMARY HISTORY BY SECTORS

DATE	FLIGHT NO	AIR-CRAFT	ALTITUDE	START BEARING	DIREC-TION	END BEARING	DISTANCE MAX.	DISTANCE MIN	AVERAGE POL.	AVERAGE AM	AVERAGE FM
12-16-75	614	C92	23100	22.0	CCW	102.5	79	40	1.2		
12-26-75	615	C90	19600	87.5	CCW	256.5	51	33	.5	30	28
12-17-75	616	C90	21400	241.5	CCW	172.9	66	45	.9	29	26
07-05-75	600	090	21300	177.9	CCW	65.0	32	21	.4	26	27
07-29-75	621	C91	33107	265.0	CW	300.0	43	30	.5	28	31

FACILITY CHARACTERISTICS

MEAN ERROR (DEG)	DISPERSION RANGE 68%	DISPERSION RANGE 95%	DISPERSION RANGE 99.7%
+0.2	+0.5	+0.9	+1.2
	-0.2	-0.5	-0.5

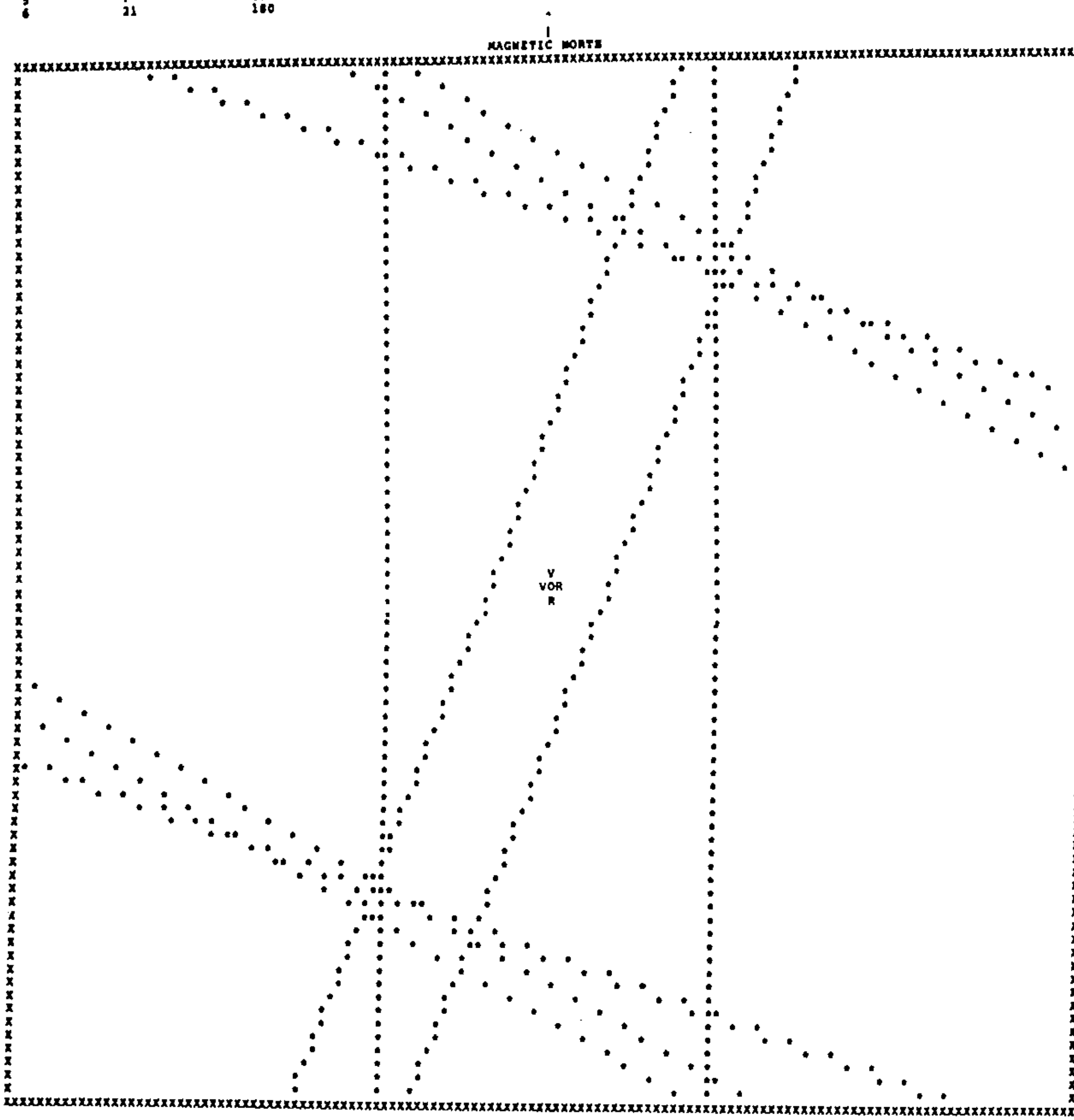
Example 3c(1)

VOR SCALLOPING PROGRAM DEVELOPED BY S.E. Palmer, P.E.
FAA NORTHWEST REGION, SEATTLE, WASHINGTON
CP/M VERSION 1.0, 3-MARCH-83

LOCATION: TWIN FALLS, IDAHO
FREQUENCY: 115.8
ENGINEER: SEP
F/C AIRCRAFT: N-47
DATE: 5/15/80
SCALE OF PLOT: 500 FEET PER INCH

THE NUMBER OF SCALLOPS COUNTED FOR EACH AZIMUTH IS:

DATA	NUMBER OF SCALLOPS	AZIMUTH
1	45	290
2	44	120
3	44	110
4	48	300
5	7	20
6	21	180



THE PLOT SCALE IS 500 FEET PER INCH.
PHOTO REDUCED

A POSSIBLE SOLUTION USING 4 INTERSECTING LINES IS 2126 FEET FROM THE VOR ON THE 28 OR 208 DEGREE RADIAL.

THE ABOVE SOLUTION(S) MAY NOT BE VALID AND SHOULD BE VERIFIED BY GRAPHICAL ANALYSIS, ESPECIALLY IF MORE THAN 4 BEARINGS ARE PLOTTED.

THE LOCATION OF THE SCALLOPING SOURCE IS AT THE COMMON INTERSECTIONS OF THE LINES OF ASTERISKS. TWO POSSIBLE SOULTIONS ARE FOUND, ONE CORRECT AND THE OTHER INCORRECT. THE TWO SOLUTIONS ARE LOCATED ON RECIPROCAL VOR BEARINGS, THE SAME DISTANCE FROM THE VOR. THE CORRECT SOLUTION MUST BE DETERMINED BY INSPECTION OF THE FACILITY.

THE ABOVE PLOT SHOULD HAVE A CONTINUOUS ROW OF X'S IN THE VERTICAL COLUMNS ON EACH SIDE OF THE PAPER. IF NOT AN ERROR IN THE PLOT HAS OCCURED.

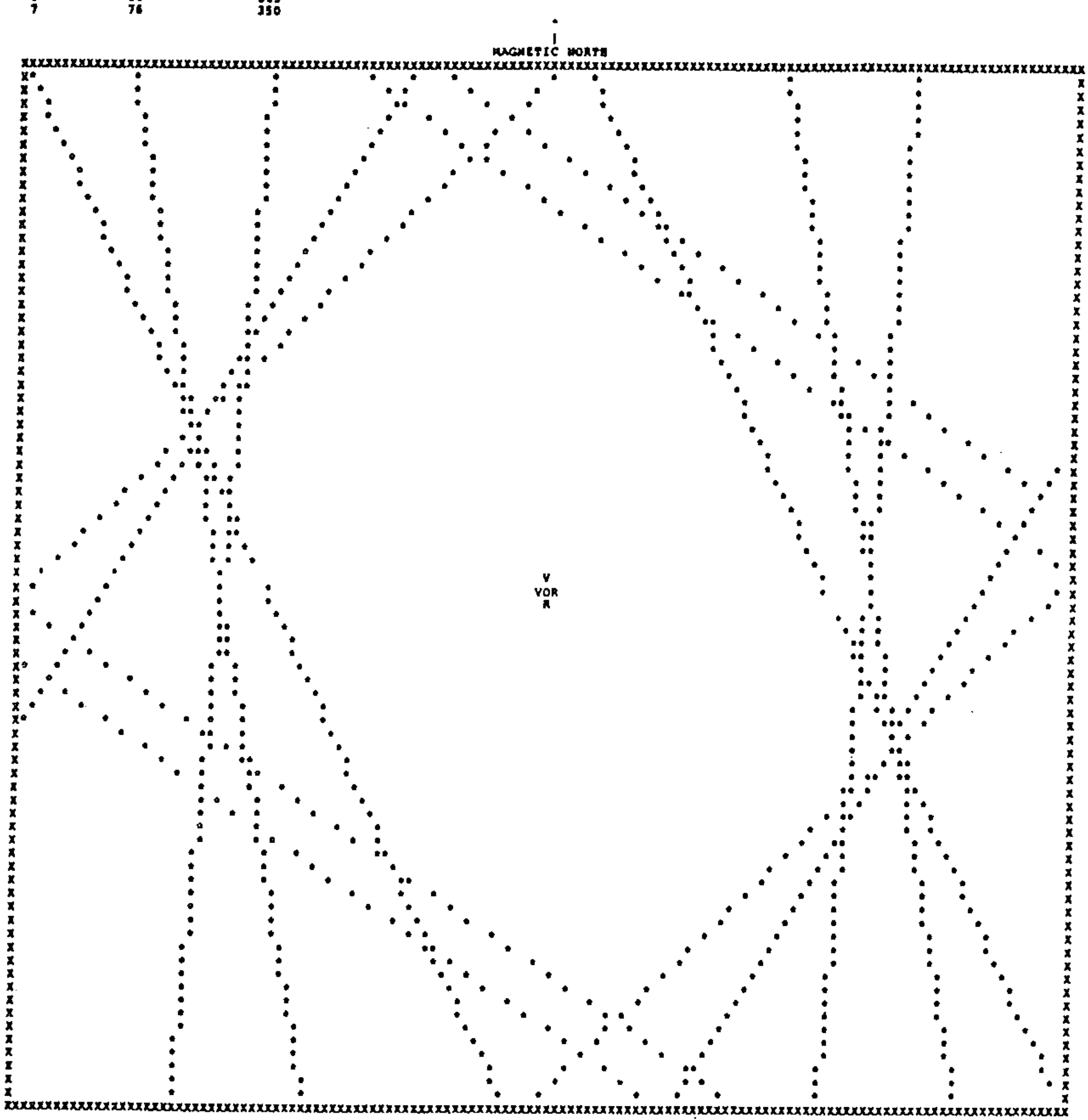
TO MAKE THE LINES OF ASTERISKS MORE VISIBLE, USE A FELT TIP MARKER. AT ANGLES NEAR 90 OR 270 DEGREES ONLY A FEW ASTERISKS PER INCH ARE PRINTED.

VOR SCALLOPING PROGRAM DEVELOPED BY E.E. Palmer, P.E.
FAA NORTHWEST REGION, SEATTLE, WASHINGTON
CP/M VERSION 1.0, 3-MARCH-83

LOCATION: PORT ANGELES, WASHINGTON
FREQUENCY: 108.4
ENGINEER: EEP
F/C AIRCRAFT: N-61
DATE: 5-15-80
SCALE OF PLOT: 1000 FEET PER INCH

THE NUMBER OF SCALLOPS COUNTED FOR EACH AZIMUTH IS:

DATA	NUMBER OF SCALLOPS	AZIMUTH
1	90	210
2	75	125
3	60	155
4	76	5
5	86	305
6	86	225
7	76	350



THE PLOT SCALE IS 1000 FEET PER INCH.

A POSSIBLE SOLUTION USING 4 INTERSECTING LINES IS 4807 FEET FROM THE VOR ON THE 115 OR 295 DEGREE RADIAL.
PHOTO REDUCED

THE ABOVE SOLUTION(S) MAY NOT BE VALID AND SHOULD BE VERIFIED BY GRAPHICAL ANALYSIS, ESPECIALLY IF MORE THAN 4 BEARINGS ARE PLOTTED.

THE LOCATION OF THE SCALLOPING SOURCE IS AT THE COMMON INTERSECTIONS OF THE LINES OF ASTERISKS. TWO POSSIBLE SOULTIONS ARE FOUND, ONE CORRECT AND THE OTHER INCORRECT. THE TWO SOLUTIONS ARE LOCATED ON RECIPROCAL VOR BEARINGS, THE SAME DISTANCE FROM THE VOR. THE CORRECT SOLUTION MUST BE DETERMINED BY INSPECTION OF THE FACILITY.

THE ABOVE PLOT SHOULD HAVE A CONTINUOUS ROW OF X'S IN THE VERTICAL COLUMNS ON EACH SIDE OF THE PAPER. IF NOT AN ERROR IN THE PLOT HAS OCCURED.

TO MAKE THE LINES OF ASTERISKS MORE VISIBLE, USE A FELT TIP MARKER. AT ANGLES NEAR 90 OR 270 DEGREES ONLY A FEW ASTERISKS PER INCH ARE PRINTED.

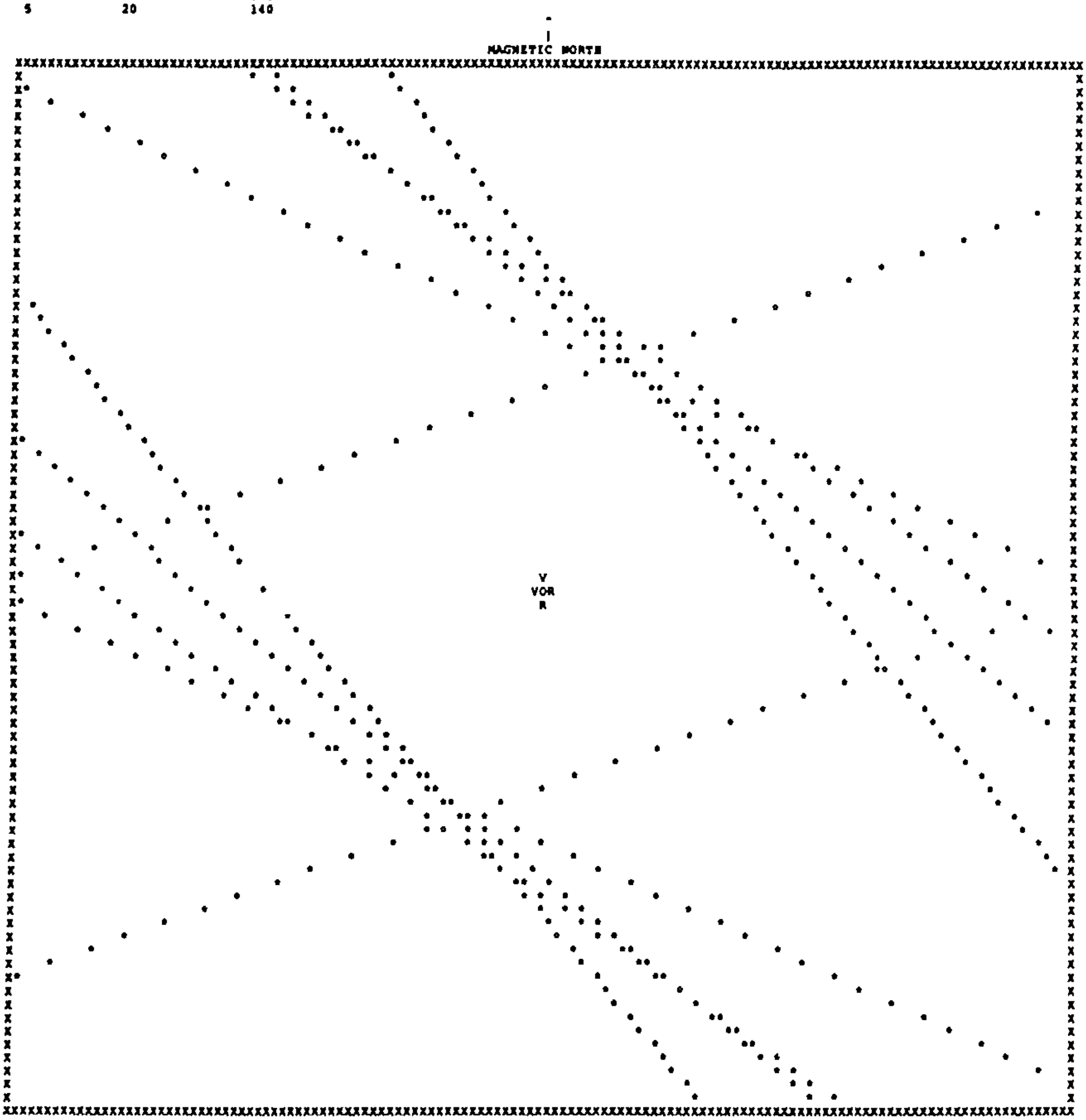
Example 3e(3)

VOR SCALLOPING PROGRAM DEVELOPED BY E.E. Palmer, P.E.
FAA NORTHWEST REGION, SEATTLE, WASHINGTON
CP/M VERSION 1.0, 3-MARCH-83

LOCATION: BAYVIEW, WASHINGTON
FREQUENCY: 108.2
ENGINEER: EEP
F/C AIRCRAFT: N-47
DATE: 5/15/80
SCALE OF PLOT: 400 FEET PER INCH

THE NUMBER OF SCALLOPS COUNTED FOR EACH AZIMUTH IS:

DATA	NUMBER OF SCALLOPS	AZIMUTH
1	18	70
2	22	115
3	21	130
4	24	305
5	20	140



THE PLOT SCALE IS 400 FEET PER INCH.

A POSSIBLE SOLUTION USING 4 INTERSECTING LINES IS 1164 FEET FROM THE VOR ON THE 17 OR 197 DEGREE RADIAL.

PHOTO REDUCED

THE ABOVE SOLUTION(S) MAY NOT BE VALID AND SHOULD BE VERIFIED BY GRAPHICAL ANALYSIS, ESPECIALLY IF MORE THAN 4 BEARINGS ARE PLOTTED.

THE LOCATION OF THE SCALLOPING SOURCE IS AT THE COMMON INTERSECTIONS OF THE LINES OF ASTERISKS. TWO POSSIBLE SOULTIONS ARE FOUND, ONE CORRECT AND THE OTHER INCORRECT. THE TWO SOLUTIONS ARE LOCATED ON RECIPROCAL VOR BEARINGS, THE SAME DISTANCE FROM THE VOR. THE CORRECT SOLUTION MUST BE DETERMINED BY INSPECTION OF THE FACILITY.

THE ABOVE PLOT SHOULD HAVE A CONTINUOUS ROW OF X'S IN THE VERTICAL COLUMNS ON EACH SIDE OF THE PAPER. IF NOT AN ERROR IN THE PLOT HAS OCCURED.

TO MAKE THE LINES OF ASTERISKS MORE VISIBLE, USE A FELT TIP MARKER. AT ANGLES NEAR 90 OR 270 DEGREES ONLY A FEW ASTERISKS PER INCH ARE PRINTED.

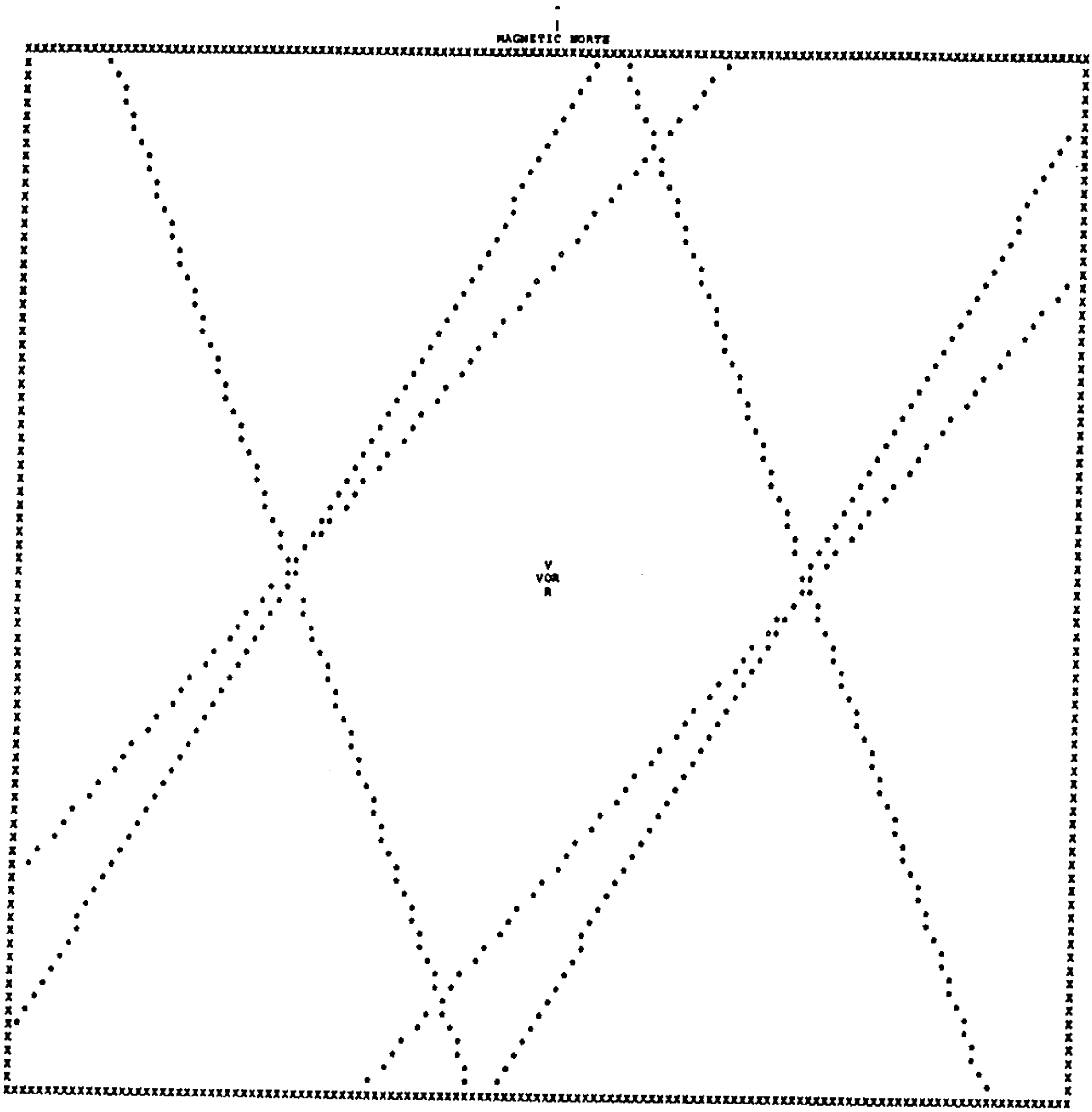
Example 3e(4)

VOR SCALLOPING PROGRAM DEVELOPED BY E.E. Palmer, P.E.
FAA NORTHWEST REGION, SEATTLE, WASHINGTON
CP/M VERSION 1.0, 3-MARCH-83

LOCATION: SALMON, IDAHO
FREQUENCY: 113.8
ENGINEER: EEP
F/C AIRCRAFT: SAFI
DATE: 5/15/80
SCALE OF PLOT: 10 FEET PER INCH

THE NUMBER OF SCALLOPS COUNTED FOR EACH AZIMUTH IS:

DATA	NUMBER OF SCALLOPS	AZIMUTH
1	.5	40
2	.55	210
3	.6	160



THE PLOT SCALE IS ~~10~~ FEET PER INCH.
PHOTO REDUCED

A POSSIBLE SOLUTION USING 3 INTERSECTING LINES IS 31 FEET FROM THE VOR ON THE 93 OR 273 DEGREE RADIAL.

THE ABOVE SOLUTION(S) MAY NOT BE VALID AND SHOULD BE VERIFIED BY GRAPHICAL ANALYSIS, ESPECIALLY IF MORE THAN 4 BEARINGS ARE PLOTTED.

THE LOCATION OF THE SCALLOPING SOURCE IS AT THE COMMON INTERSECTIONS OF THE LINES OF ASTERISKS. TWO POSSIBLE SOULTIONS ARE FOUND, ONE CORRECT AND THE OTHER INCORRECT. THE TWO SOLUTIONS ARE LOCATED ON RECIPROCAL VOR BEARINGS, THE SAME DISTANCE FROM THE VOR. THE CORRECT SOLUTION MUST BE DETERMINED BY INSPECTION OF THE FACILITY.

THE ABOVE PLOT SHOULD HAVE A CONTINUOUS ROW OF X'S IN THE VERTICAL COLUMNS ON EACH SIDE OF THE PAPER. IF NOT AN ERROR IN THE PLOT HAS OCCURED.

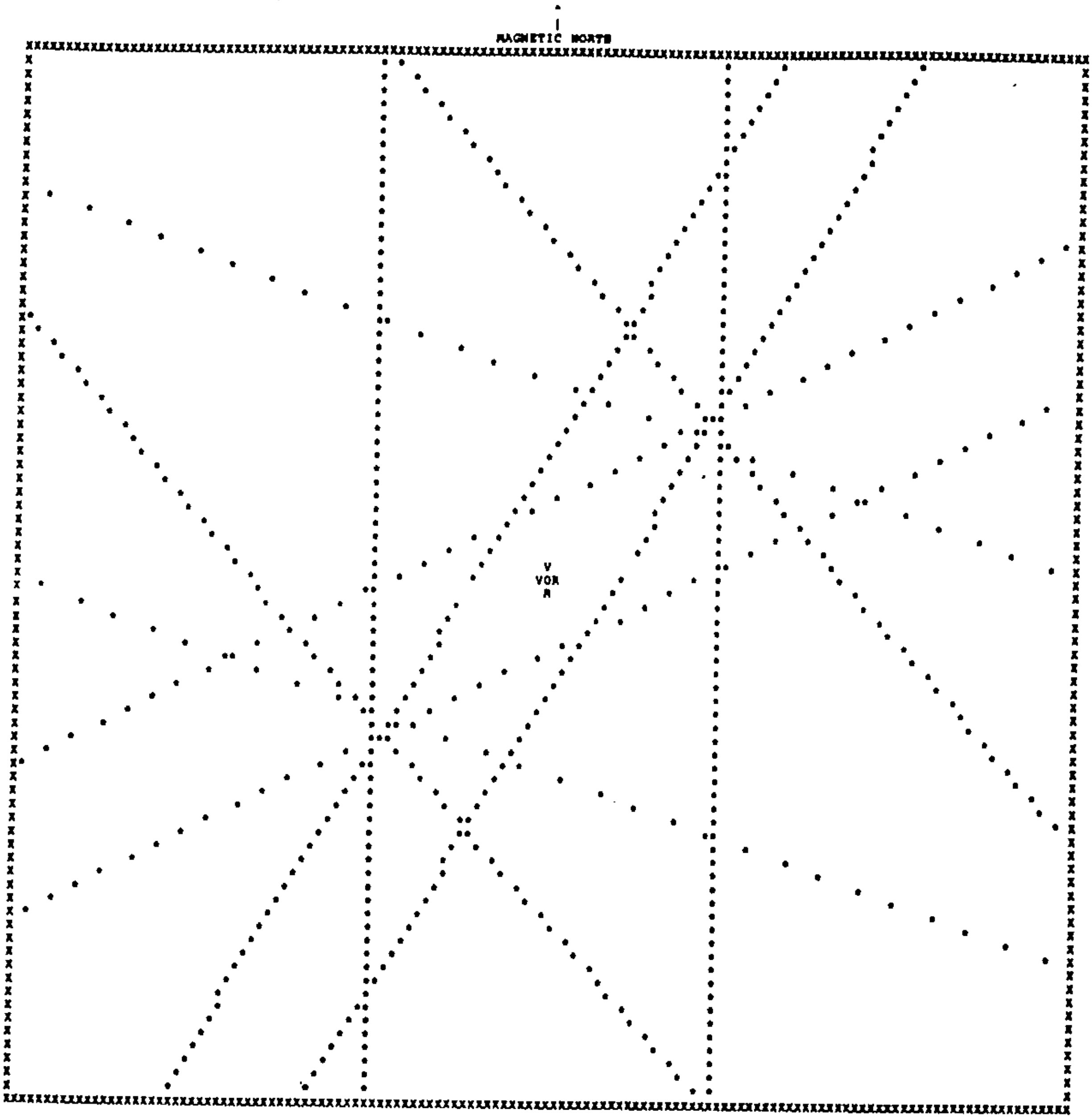
TO MAKE THE LINES OF ASTERISKS MORE VISIBLE, USE A FELT TIP MARKER. AT ANGLES NEAR 90 OR 270 DEGREES ONLY A FEW ASTERISKS PER INCH ARE PRINTED.

VOR SCALLOPING PROGRAM DEVELOPED BY E.E. Palmer, P.E.
FAA NORTHWEST REGION, SEATTLE, WASHINGTON
CP/M VERSION 1.0, 3-MARCH-83

LOCATION: BURLEY, IDAHO
FREQUENCY: 112.6
ENGINEER: EP
F/C AIRCRAFT: SAFI
DATE: 3-MAR-83
SCALE OF PLOT: 20 FEET PER INCH

THE NUMBER OF SCALLOPS COUNTED FOR EACH AZIMUTH IS:

DATA	NUMBER OF SCALLOPS	AZIMUTH
1	.3	30
2	.333	63
3	.91	110
4	1.1	139
5	.83	180



THE PLOT SCALE IS ~~20~~ FEET PER INCH. PHOTO REDUCED

A POSSIBLE SOLUTION USING 4 INTERSECTING LINES IS 56 FEET FROM THE VOR ON THE 45 OR 225 DEGREE RADIAL.

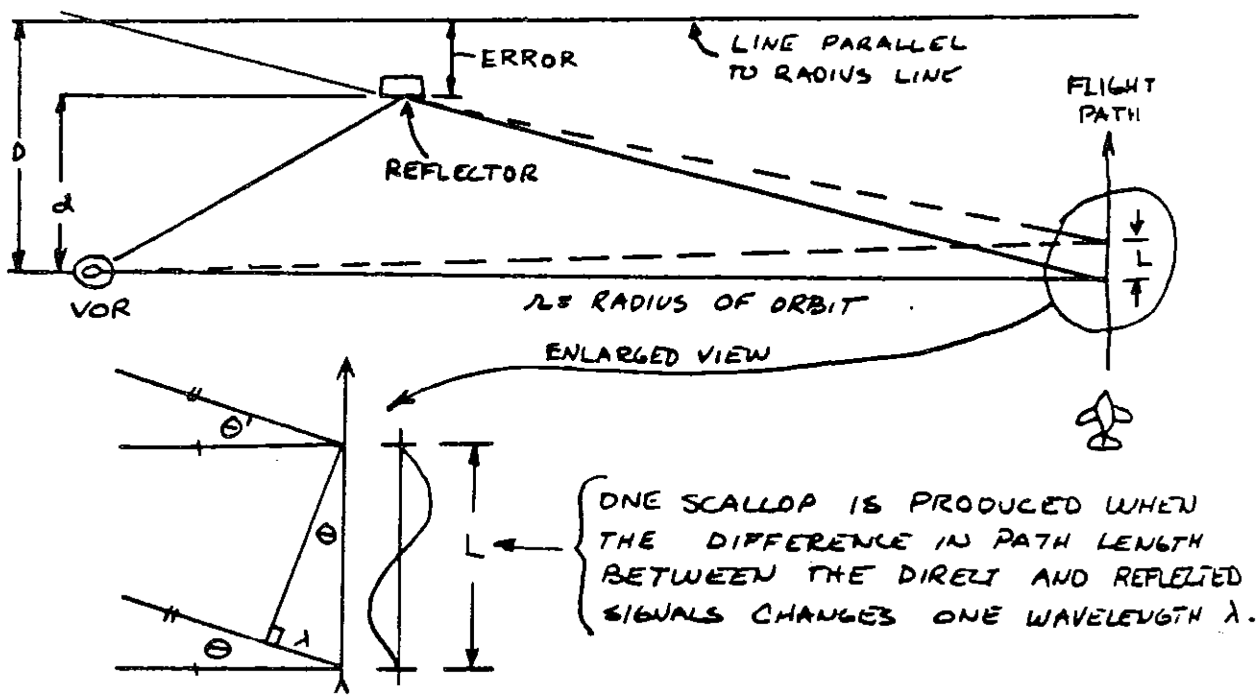
THE ABOVE SOLUTION(S) MAY NOT BE VALID AND SHOULD BE VERIFIED BY GRAPHICAL ANALYSIS, ESPECIALLY IF MORE THAN 4 BEARINGS ARE PLOTTED.

THE LOCATION OF THE SCALLOPING SOURCE IS AT THE COMMON INTERSECTIONS OF THE LINES OF ASTERISKS. TWO POSSIBLE SOULTIONS ARE FOUND, ONE CORRECT AND THE OTHER INCORRECT. THE TWO SOLUTIONS ARE LOCATED ON RECIPROCAL VOR BEARINGS, THE SAME DISTANCE FROM THE VOR. THE CORRECT SOLUTION MUST BE DETERMINED BY INSPECTION OF THE FACILITY.

THE ABOVE PLOT SHOULD HAVE A CONTINUOUS ROW OF X'S IN THE VERTICAL COLUMNS ON EACH SIDE OF THE PAPER. IF NOT AN ERROR IN THE PLOT HAS OCCURED.

TO MAKE THE LINES OF ASTERISKS MORE VISIBLE, USE A FELT TIP MARKER. AT ANGLES NEAR 90 OR 270 DEGREES ONLY ~~A FEW~~ ASTERISKS PER INCH ARE PRINTED.

THE FOLLOWING DERIVATION IS FOR THE DISTANCE "D" FROM THE VOR TO A LINE PARALLEL TO THE RADIUS WHICH PASSES THROUGH THE SCALLOPING SOURCE. (SEE BELOW) THE DISTANCES ARE DRAWN OUT OF PROPORTION WHICH EXAGGERATES THE APPARENT ERROR.



FROM THE ABOVE IT CAN BE SEEN THAT:

1. $\theta = \theta'$ 2. $\sin\theta = \frac{\lambda}{L}$ 3. $\sin\theta = \tan\theta = \frac{D}{r}$ (FOR SMALL ANGLES)

WHERE $D << r$ AND:

L = LENGTH OF ONE SCALLOP IN FEET
λ = WAVELENGTH IN FEET
r = ORBITAL RADIUS DISTANCE IN FEET
θ = ANGLE BETWEEN THE DIRECT AND REFLECTED SIGNALS IN DEGREES
D = APPROXIMATE DISTANCE FROM THE RADIUS LINE TO THE REFLECTOR

PREPARED BY	CHECKED BY	DATE
Earl Palmer		10-18-77
SUBJECT: CALCULATION OF VOR SCALLOPING SOURCES		FILE NO. 6790-1
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SOLVING EQUATION 3. FOR D

4. $D = r \sin\theta' = r \sin\theta$, $\sin\theta = \frac{\lambda}{L}$, THEN $\boxed{D = \frac{r\lambda}{L}}$

AS FLIGHT CHECK ORBIT RECORDINGS ARE CALIBRATED IN DEGREES, NOT FEET, IT IS MORE CONVENIENT TO COUNT THE NUMBER OF SCALLOPS PER DEGREE. THE FLIGHT CHECK RECORDER BEARING INCREMENTS EVERY 10 DEGREE, IT IS CONVENIENT TO COUNT THE NUMBER OF SCALLOPS IN 10 DEGREE SEGMENTS.

THEN: L IN DEGREES $= \frac{10}{n}$, WHERE n = NUMBER OF SCALLOPS

THE LENGTH OF ONE SCALLOP IN FEET CAN BE FOUND FROM THE FOLLOWING RELATIONSHIP:

$$\frac{L_{FEET}}{2\pi r} = \frac{L_{DEGREES}}{360} \quad \text{OR} \quad L_{FT} = L_{DEG.} \times \frac{2\pi r}{360}$$

(CIRCUMFERENCE)

$$L_{FT} = \frac{10}{n} \times \frac{2\pi r}{360} = \frac{\pi r}{18n}$$

FROM EQUATION 4, $D = \frac{r\lambda}{L}$, THEN $D = r\lambda \times \frac{18n}{\pi r} = \boxed{\frac{18n\lambda}{\pi} = D}$ EQ. 5

NOTE THAT THE RADIUS OF ORBIT IS NOT IN EQUATION 5.

IF THE VOR FREQUENCY IS ASSUMED TO BE 115 MHz,

THE EQUATION CAN BE FURTHER SIMPLIFIED TO:

$$\boxed{D = 49n}$$

PREPARED BY Earl Palmer	CHECKED BY	DATE 10-18-77
SUBJECT CALCULATION OF VOR SCALLOPING SOURCES		FILE NO. 6970-1
		SHEET 2 OF 2 SHEETS

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```
100 CL$=CHR$(12):PRINT CL$
110 PRINT
120 DEFINT J,K,N,X,Y,Z
130 PRINT TAB(20)"VOR SCALLOPING PROGRAM"
140 PRINT
150 PRINT"IS WIDE 132 COLUMN PAPER INSTALLED IN THE PRINTER? (Y/N)  <Y>"
160 X$=INPUT$(1)
170 IF (X$<>"N" AND X$<>"n") THEN GOTO 200
180 PRINT:PRINT"SORRY, YOU MUST RECONFIGURE YOUR PRINTER!!!!!!!!"
190 GOTO 150
200 PRINT CL$
210 PRINT "VOR SCALLOPING PROGRAM"
220 PRINT:PRINT"Developed by E.E. Palmer, P.E., FAA"
230 PRINT:PRINT"Northwest Region, Seattle, WA., 3/30/80; Revised 3/3/83"
240 PRINT
250 DEFINT Q
260 DIM Q(40),S(15),A(15)
270 LINE INPUT"LOCATION ";LO$:PRINT
280 LINE INPUT"DATE ";D$:PRINT
290 LINE INPUT"ENGINEER ";EN$:PRINT
300 LINE INPUT"FLIGHT CHECK AIRCRAFT ";AC$:PRINT
310 INPUT"FACILITY FREQUENCY IN MHZ";F:PRINT
320 PRINT CL$
330 INPUT"NUMBER OF BEARINGS TO BE PLOTTED ";X%:PRINT
340 IF X%<3 THEN PRINT "THREE OR MORE ARE REQUIRED":GOTO 320
350 PRINT"TYPE IN THE NUMBER OF SCALLOPS COUNTED, THEN A COMMA FOLLOWED BY"
360 PRINT"THE AZIMUTH (OR AVERAGE AZIMUTH) WHERE THE SCALLOPS WERE COUNTED."
370 PRINT"DO NOT USE AZIMUTHS BETWEEN 85 AND 95, OR BETWEEN 265 AND 275 DEGREES.
380 FOR N%=1 TO X%
390 PRINT
400 INPUT"NUMBER OF SCALLOPS IN 10 DEG., AZIMUTH ";S(N%),A(N%)
410 IF A(N%)>=85 AND A(N%)<= 95 THEN PRINT A(N%);" IS BETWEEN 85 AND 95 DEGREES!"
    :GOTO 400
420 IF A(N%)>=265 AND A(N%)<=275 THEN PRINT A(N%);" IS BETWEEN 265 AND 275 DEGRE
ES!":GOTO 400
430 NEXT N%
440 LT=0:BT=20:PT=20
450 FOR N%=1 TO X% : REM ESTIMATE PLOT SCALE
460 LT=LT+S(N%)
470 NEXT N%
480 LT=(LT/X%)*(2000/F)
490 IF LT<10 THEN C=10 : GOTO 580
500 IF LT<25 THEN C=25 : GOTO 580
510 IF LT<50 THEN C=50 : GOTO 580
520 IF LT<100 THEN C=100 : GOTO 580
530 IF LT<200 THEN C=200 : GOTO 580
540 IF LT<400 THEN C=400 : GOTO 580
550 IF LT<1000 THEN C=1000 : GOTO 580
560 IF LT<2000 THEN C=2000 : GOTO 580
570 IF LT>=2000 THEN C=4000
580 PRINT "THE SCALE OF THE PLOT WILL BE";C;"FEET PER INCH. "
590 PRINT "IS THIS SATISFACTORY?   Y OR N ?"
600 INPUT SC$
610 IF SC$="Y" OR SC$="y" THEN 630
620 INPUT "WHAT IS THE DESIRED SCALE IN FEET PER INCH";C
630 PRINT "SET THE PRINTER TO THE TOP OF PAGE: PRESS ANY KEY TO START";:INPUT X$
640 PRINT CL$ : PRINT "STANDBY, THE SCALLOP PLOT IS IN PROCESS"
650 LPRINT:LPRINT CHR$(27)+CHR$(31)+CHR$(13)
```

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```
660 REM THE ABOVE LINE CONFIGURES THE DIABLO 630 PRINTER FOR 10CPI PRINTING
670 REM AND 6INE PER INCH VERTICAL SPACING.  CHANGE FOR OTHER PRINTERS
680 LPRINT "VOR SCALLOPING PROGRAM DEVELOPED BY E.E. Palmer, P.E."
690 LPRINT "FAA NORTHWEST REGION, SEATTLE, WASHINGTON"
700 LPRINT "CP/M VERSION 1.0, 3-MARCH-83"
710 LPRINT :LPRINT "LOCATION: ";TAB(16);LO$
720 LPRINT "FREQUENCY:";TAB(15);F;"MHZ"
730 LPRINT "ENGINEER: ";TAB(16);EN$
740 LPRINT "F/C AIRCRAFT: ";TAB(16);AC$
750 LPRINT "DATE: ";TAB(16);D$
760 LPRINT "SCALE OF PLOT:";INT(C);" FEET PER INCH":LPRINT
770 LPRINT "THE NUMBER OF SCALLOPS COUNTED FOR EACH AZIMUTH IS:"
780 LPRINT "DATA  NUMBER OF SCALLOPS  AZIMUTH"
790 LPRINT "====  ================  ======="
800 FOR N%=1 TO X%
810 LPRINT N%;TAB(13);S(N%);TAB(29);A(N%)
820 NEXT N%
830 LPRINT TAB(66);"^"
840 LPRINT TAB(66);"|"
850 LPRINT TAB(59);"MAGNETIC NORTH"
860 FOR Y%=1 TO 130
870 LPRINT "X";
880 NEXT Y%
890 LPRINT "X"
900 FOR L=2 TO 78:REM L = LINE NUMBER
910 FOR N%=1 TO X%
920 TA=66+(SIN(A(N%)*3.142/180)/COS(A(N%)*3.142/180))*(40-L)*(10/6)
930 TB=563801*S(N%)/(F*C*COS(A(N%)*3.142/180))
940 W=TA+TB+.5 :REM W=TAB VALUE FORM 2 TO 132
950 W=INT(W)
960 IF (W<2 OR W>129) THEN 980
970 M=M+1:Q(M)=W:REM M = NUMBER OF TAB VALUES PER LINE
980 W=TA-TB+.5
990 W=INT(W)
1000 IF (W<2 OR W>129) THEN 1020
1010 M=M+1:Q(M)=W:REM ARRAY OF TAB VALUES TO BE PLOTTED
1020 NEXT N%
1030 FOR K%=1 TO M-1:REM START OF TAB VALUE SORT
1040 FOR J%=1 TO M-K%
1050 IF Q(J%)<Q(J%+1) THEN 1070
1060 V=Q(J%):Q(J%)=Q(J%+1):Q(J%+1)=V
1070 NEXT J%
1080 NEXT K%
1090 IF X%=<3 THEN 1190
1100 REM START OF BEST INTERSECTION CALCULATION FOR 4 LINES.
1110 FOR K% = 1 TO M-3
1120 KS=Q(K%+3)-Q(K%)
1130 IF KS>20 THEN 1180
1140 IF KS>BT THEN 1180
1150 BT=KS:REM BT=BEST TAB WIDTH VALUE
1160 BL=L:REM BL=BEST LINE VALUE
1170 BV=(Q(K%+3)+Q(K%+2)+Q(K%+1)+Q(K%))/4:REM BV=BEST AVERAGE TAB VALUE
1180 NEXT K%
1190 IF X%=>4 THEN 1290
1200 REM START OF BEST INTERSECTION CALCULATION FOR 3 LINES.
1210 FOR K%=1 TO M-2
1220 KS=Q(K%+2)-Q(K%)
1230 IF KS>20 THEN 1280
```

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```
1240 IF KS>PT THEN 1280
1250 PT=KS
1260 PL=L
1270 PV=(Q(K%+2)+Q(K%+1)+Q(K%))/3
1280 NEXT K%
1290 E=0:REM SORT TO DISCARD EQUAL TAB VALUES
1300 FOR B%=1 TO M-1
1310 IF Q(B%)=Q(B%+1) THEN 1330
1320 E=E+1:Q(E)=Q(B%):M=E
1330 NEXT B%
1340 IF Q(B%)=0 THEN 1360
1350 E=E+1:Q(E)=Q(B%)
1360 M=E
1370 LPRINT "X";:REM PUTS X ON LEFT BOUNDARY OF PLOT
1380 IF L=39 THEN 1460
1390 IF L=40 THEN 1560
1400 IF L=41 THEN 1660
1410 FOR R=1 TO M
1420 IF Q(R)<2 THEN GOTO 1440
1430 LPRINT TAB(Q(R));"*";
1440 NEXT R
1450 GOTO 1750
1460 FOR R=1 TO M/2
1470 IF Q(R)=66 THEN GOTO 1500
1480 LPRINT TAB(Q(R));"*";
1490 NEXT R
1500 LPRINT TAB(66);"V";
1510 FOR R=M/2+1 TO M
1520 IF Q(R)=66 THEN GOTO 1540
1530 LPRINT TAB(Q(R));"*";
1540 NEXT R
1550 GOTO 1750
1560 FOR R=1 TO M/2
1570 IF (Q(R)=65 OR Q(R)=66 OR Q(R)=67) THEN GOTO 1600
1580 LPRINT TAB(Q(R));"*";
1590 NEXT R
1600 LPRINT TAB(65);"VOR";
1610 FOR R=M/2+1 TO M
1620 IF (Q(R)=65 OR Q(R)=66 OR Q(R)=67) THEN GOTO 1640
1630 LPRINT TAB(Q(R));"*";
1640 NEXT R
1650 GOTO 1750
1660 FOR R=1 TO M/2
1670 IF Q(R)=66 THEN GOTO 1700
1680 LPRINT TAB(Q(R));"*";
1690 NEXT R
1700 LPRINT TAB(66);"R";
1710 FOR R=M/2+1 TO M
1720 IF Q(R)=66 THEN GOTO 1740
1730 LPRINT TAB(Q(R));"*";
1740 NEXT R
1750 LPRINT TAB(131);"X"
1760 FOR R=1 TO M
1770 Q(R)=0
1780 NEXT R
1790 M=0
1800 NEXT L
1810 FOR Z%=1 TO 131
```

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```
1820 LPRINT "X";
1830 NEXT Z%
1840 LPRINT : LPRINT
1850 LPRINT TAB(54)"THE PLOT SCALE IS";C;"FEET PER INCH."
1860 LPRINT
1870 IF X%=<3 THEN 1950
1880 IF BT>10 THEN 2090
1890 BL=(40-BL)/6 : BV=(BV-66)/10 : BA=ATN(BV/BL)*180/3.14159 + .5
1900 BR=BV*C/SIN(BA*3.14159/180)+.5 : BR=ABS(INT(BR)) : BA=INT(BA)
1910 IF BA < 0 THEN BA=BA+180
1920 BB=BA+180
1930 LPRINT "A POSSIBLE SOLUTION USING 4 INTERSECTING LINES ";
1940 LPRINT "IS";BR;"FEET FROM THE VOR ON THE";BA;"OR";BB;"DEGREE RADIAL."
1950 IF X%=>4 THEN 2040
1960 IF PT > 10 THEN 2090
1970 PL=(40-PL)/6 : PV=(PV-66)/10 : PA=ATN(PV/PL)*180/3.14159 + .5
1980 PR=PV*C/SIN(PA*3.14159/180)+.5 : PR = ABS(INT(PR)) : PA = INT (PA)
1990 IF PA < 0 THEN PA=PA + 180
2000 PB=PA+180
2010 LPRINT
2020 LPRINT "A POSSIBLE SOLUTION USING 3 INTERSECTING LINES ";
2030 LPRINT "IS";PR;"FEET FROM THE VOR ON THE";PA;"OR";PB;"DEGREE RADIAL."
2040 LPRINT
2050 LPRINT "THE ABOVE SOLUTION(S) MAY NOT BE VALID AND SHOULD BE VERIFIED ";
2060 LPRINT "BY GRAPHICAL ANALYSIS, ESPECIALLY IF MORE THAN 4 BEARINGS ARE ";
2070 LPRINT "PLOTTED."
2080 LPRINT
2090 LPRINT "THE LOCATION OF THE SCALLOPING SOURCE IS AT THE COMMON ";
2100 LPRINT "INTERSECTIONS OF THE LINES OF ASTERISKS.  TWO POSSIBLE "
2110 LPRINT "SOULTIONS ARE FOUND, ONE CORRECT AND THE OTHER INCORRECT.  ";
2120 LPRINT "THE TWO SOLUTIONS ARE LOCATED ON RECIPROCAL VOR BEARINGS, "
2130 LPRINT "THE SAME DISTANCE FROM THE VOR.  THE CORRECT SOLUTION MUST BE ";
2140 LPRINT "DETERMINED BY INSPECTION OF THE FACILITY. "
2150 LPRINT
2160 LPRINT "THE ABOVE PLOT SHOULD HAVE A CONTINUOUS ROW OF X'S IN THE ";
2170 LPRINT "VERTICAL COLUMNS ON EACH SIDE OF THE PAPER.  IF NOT "
2180 LPRINT "AN ERROR IN THE PLOT HAS OCCURED."
2190 LPRINT
2200 LPRINT "TO MAKE THE LINES OF ASTERISKS MORE VISIBLE, USE A FELT ";
2210 LPRINT "TIP MARKER.  AT ANGLES NEAR 90 OR 270 DEGREES ONLY A FEW "
2220 LPRINT "ASTERISKS PER INCH ARE PRINTED. "
2230 LPRINT CHR$(12)
2240 BT=20:PT=20
2250 LPRINT :LPRINT
2260 PRINT"DO YOU WANT TO CHANGE SCALE AND MAKE ANOTHER PLOT? (Y OR N)  <YES>"
2270 SC$=INPUT$(1)
2280 IF SC$="N" THEN 2310
2290 INPUT"SCALE IN FEET PER INCH= ";C
2300 GOTO 640
2310 PRINT"DO YOU WANT TO CHANGE ANY OF THE SCALLOP DATA?  (Y/N)  <YES>"
2320 DS$=INPUT$(1)
2330 IF DS$="N" THEN 2350
2340 GOTO 320
2350 PRINT"DO YOU WANT TO PLOT ANOTHER FACILITY?  (Y/N)  <YES>"
2360 AF$=INPUT$(1)
2370 IF AF$="N"THEN 2400
2380 GOTO 270
2390 PRINT CL$
```

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```
2400 PRINT"THIS ENDS THE SCALLOPING ANALYSIS PROGRAM.  HOPE YOU FIND THE SOURCE.
2410 END
```

APPENDIX 5. DESCRIPTION OF SITE DRAWINGS

1. Vicinity Sketch. The following detailed information should be included in this site drawing: (1) location of the facility with respect to any nearby town or airport, if possible, (2) all roads, utility (railroad, power, telephone) lines within the immediate site area, (3) section, county, township or other boundary lines in the vicinity. It should be drawn to include as much area as practicable, and may include general topography. The vicinity sketch is usually combined with the site plan or plot layout.

2. The Site Plan Sketch. This site drawing should show the property ties (easements, rights of way, etc.), natural features, and other important details of the site such as trees, fences, drainage, existing buildings, utility lines, and obstructions within the adjacent terrain (out to 2000 feet, if necessary) of the antenna position. An additional topography map of the site showing more detail than those provided by the geological survey may be required for evaluating sites shown to be especially troublesome. This expansion of the Site Plan is referred to as a "Data of Reflecting Surfaces" and usually is limited to a radius of one mile; particular care should be taken to show the location and orientation of all objects with precision. Correlation with aberrations found on the flight readings will then be possible, and corrective action required will be more easily determined. Plans and profiles of access roads, if applicable, should be included also as supplementary sketches or details.

3. The Plot Layout Plan.

a. The plan should show the layout of the building, the access road, and the location of field detectors, communications antenna, utility terminal pole, other poles, lines of power and control cables, location and log of borings, location of all stakes, marks, and reference points which have been set, and other important details.

b. On the same drawing sheet with the Plot Layout Plan, location data should be noted as follows:

(1) Latitude/Longitude: In degrees, minutes, and seconds, obtained by solar or stellar observations or by referral to a true and correctly known position. The coordinates established for the location should be determined to the best accuracy feasible, but must be at least accurate to the nearest fifteen seconds. This minimum value of accuracy was selected since it is not practical to provide greater accuracy in the majority of instances. (The coordinates for all facilities in the United States will be determined to an accuracy of ±40 feet by the United States Geological Survey.)

(2) Elevation: Nearest 50 feet.

(3) Location: State, Township, Section, County, City, etc.

(4) Power Company: Address and power characteristics.

(5) Telephone Company: Address and type of services available.

(6) Area Type: (desert, farm, etc.).

4. Horizon Profile shall be prepared for each facility. This is to be accomplished by setting up the transit or theodolite at the correct antenna height and location proposed for that particular facility. (A truck roof and/or temporary platform should be used when setting the instrument at 16 feet.) If it has not yet been determined which antenna height is to be used (4 feet or 16 feet), then two profiles should be made. If, however, the horizon profile for an antenna height of 4 feet does not show any object above 0.5° then the profile using the 16 feet does not have to be made. It is very important to ensure that the accuracy of the vertical angle is at least $\pm 0.1^{\circ}$. Plotting this information each 10 degrees throughout the 360 degrees is to be considered nominal; however, where significant changes occur above zero elevation, it is desirable that more frequent readings be taken. The "line of sight" elevation angles thus obtained shall then be used to prepare "Line of Sight Coverage Polar Plots" for aircraft at various altitudes by utilizing figures 6-11 and 6-12. These coverage polar plots are usually prepared for an aircraft altitude of 1500 feet. Identification of the site, elevation, simulated antenna height, and altitude for which the computations were made should be included on the "Coverage Plot."

APPENDIX 6. PANORAMIC MOSAIC PHOTOGRAPHS OF VOR SITES

This appendix provides panoramic mosaic photographs of several VOR sites. These mosaics show the visual horizon profile for each site, with a grid on the photograph to indicate the angular height of obstructions in the field of view. In addition to the visual horizon photos, the Semi-Automated Flight Inspection Bearing Error Reports (SAFI BERs) for each site have been stripped in to show how bearing errors correlate with observed obstructions.

In figure 1, the horizon and BER for the Florence, SC VOR is shown. The scalloping that peaks at an azimuth of 48 degrees appears to arise from the monitor support south of the VOR antenna, in the middle of the extended counterpoise. Another potential source of interference is the line of trees north and east of the antenna, particularly the tall cluster at about 28 degrees azimuth. However, the BER does not have sufficient resolution to verify that these trees are a source of scalloping.

Figure 2 shows the horizon profile and BER for the Toccoa, GA VOR. This is representative of mountaintop VOR installations, and suggests some of the problems with this type of site. Note the twin hilltops at the 325-degree azimuth. This feature of the terrain is intrusive to the VOR field and yet, is too large to be removed or significantly altered. The BER does not have sufficient resolution to identify what impact these hilltops have on the VOR signal.

Figure 3 is the horizon profile seen from the St. Thomas, VI VOR. This is another mountaintop site, although with an unusually clear field of view except for the mountaintops to the east-southeast (95° to 100° azimuth). Some of the blank segments of the BER are suggestive of interference from this ridge, but the actual flight recordings would be required to determine the precise effect of these mountaintops.

Figure 4 is the panoramic view from the Atlanta, GA Doppler VOR, as well as a SAFI BER for that station. This horizon is very clear, the only obstructions being the airport control tower at 46 degrees azimuth, a water tower at 217 degrees azimuth, and a tall tree at 245 degrees azimuth. The BER has too much smoothing to permit identification of the scalloping that may arise from these obstructions.

See appendix 4 for a description of the use of flight recordings in determining the specific location of scalloping sources.

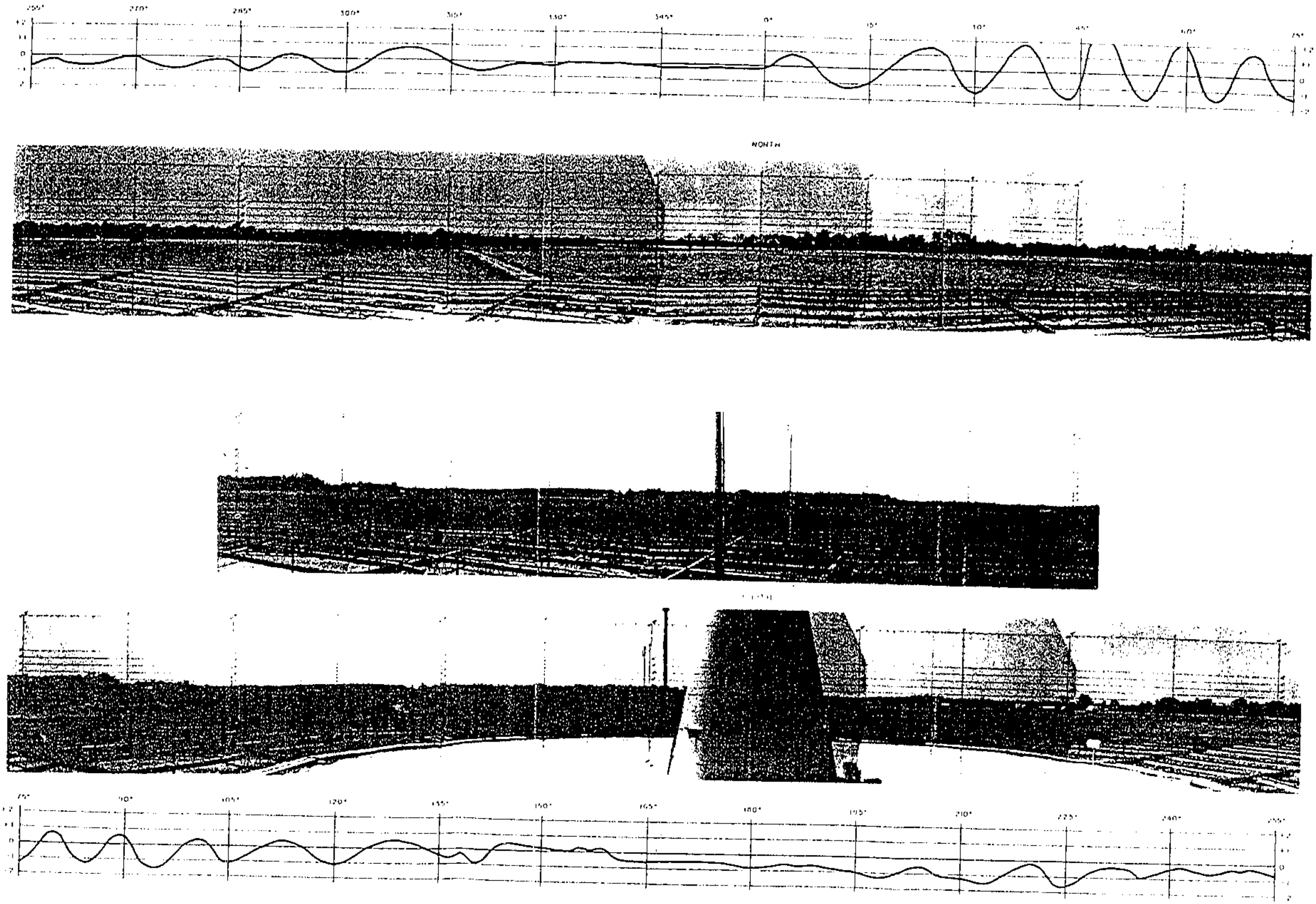


FIGURE 1. FLORENCE, S.C. VOR Page 3 (and 4)

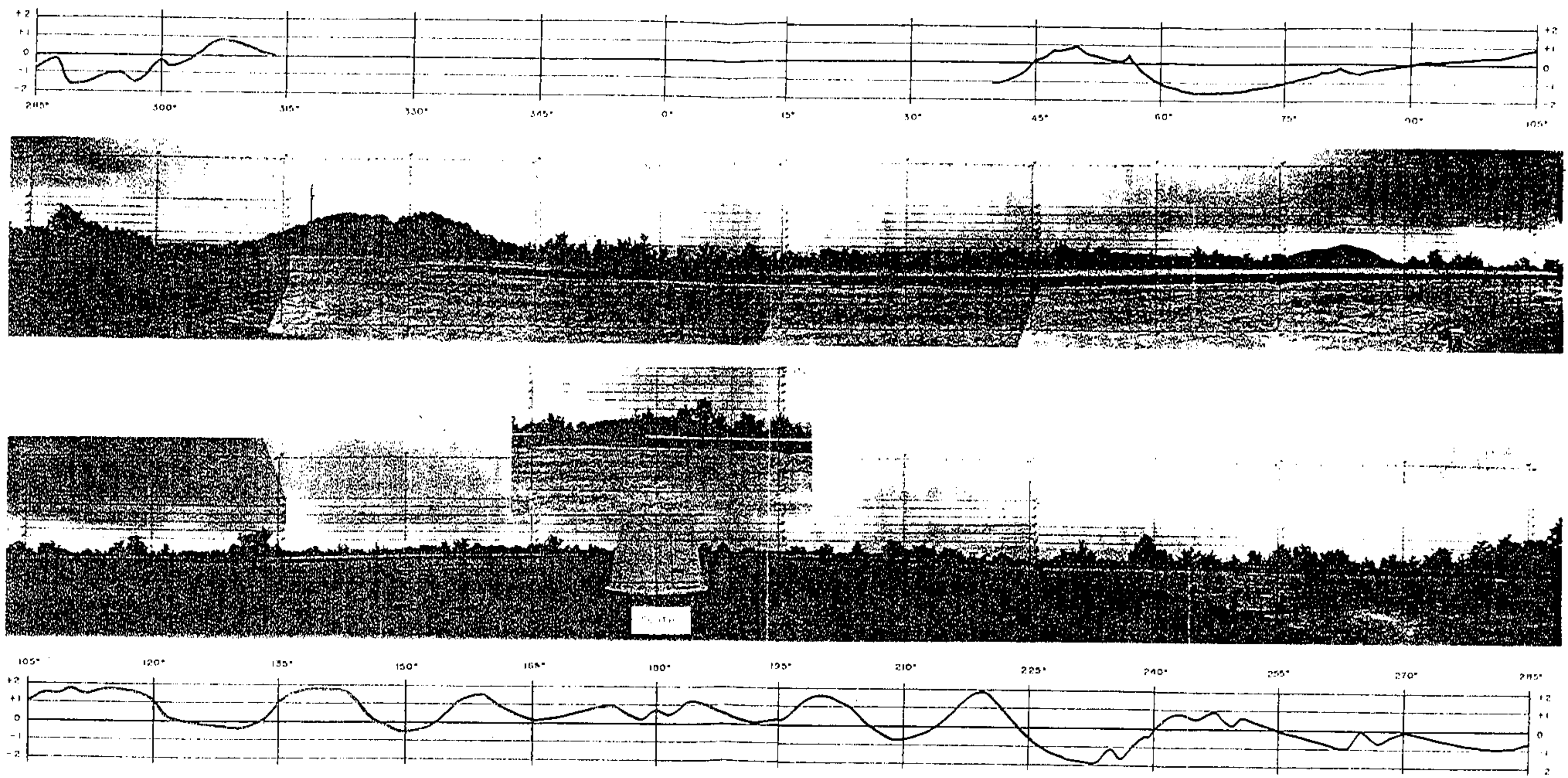


FIGURE 2. TOCCOA, GA. VOR

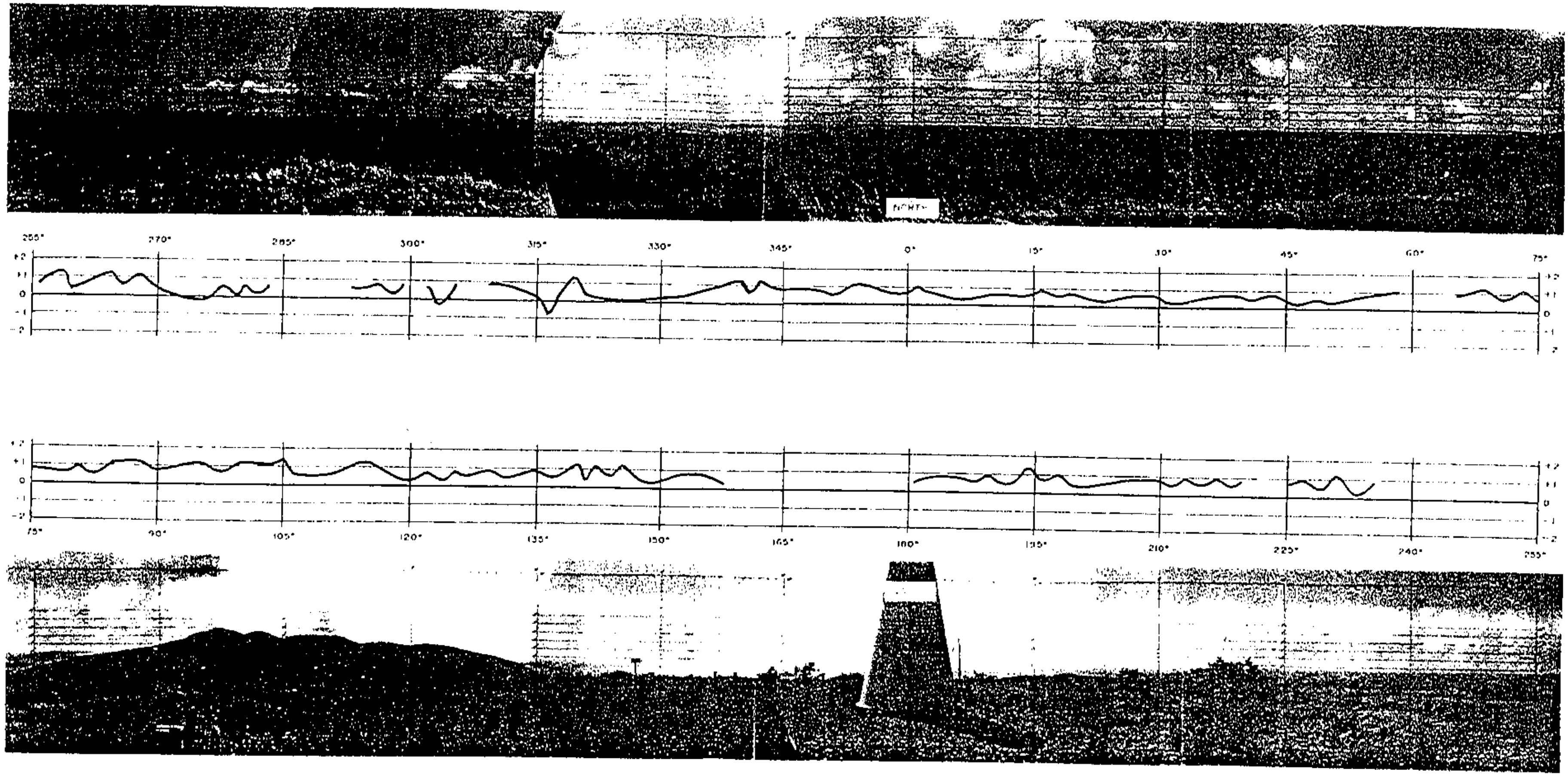


FIGURE 3. ST. THOMAS, V.I. VOR

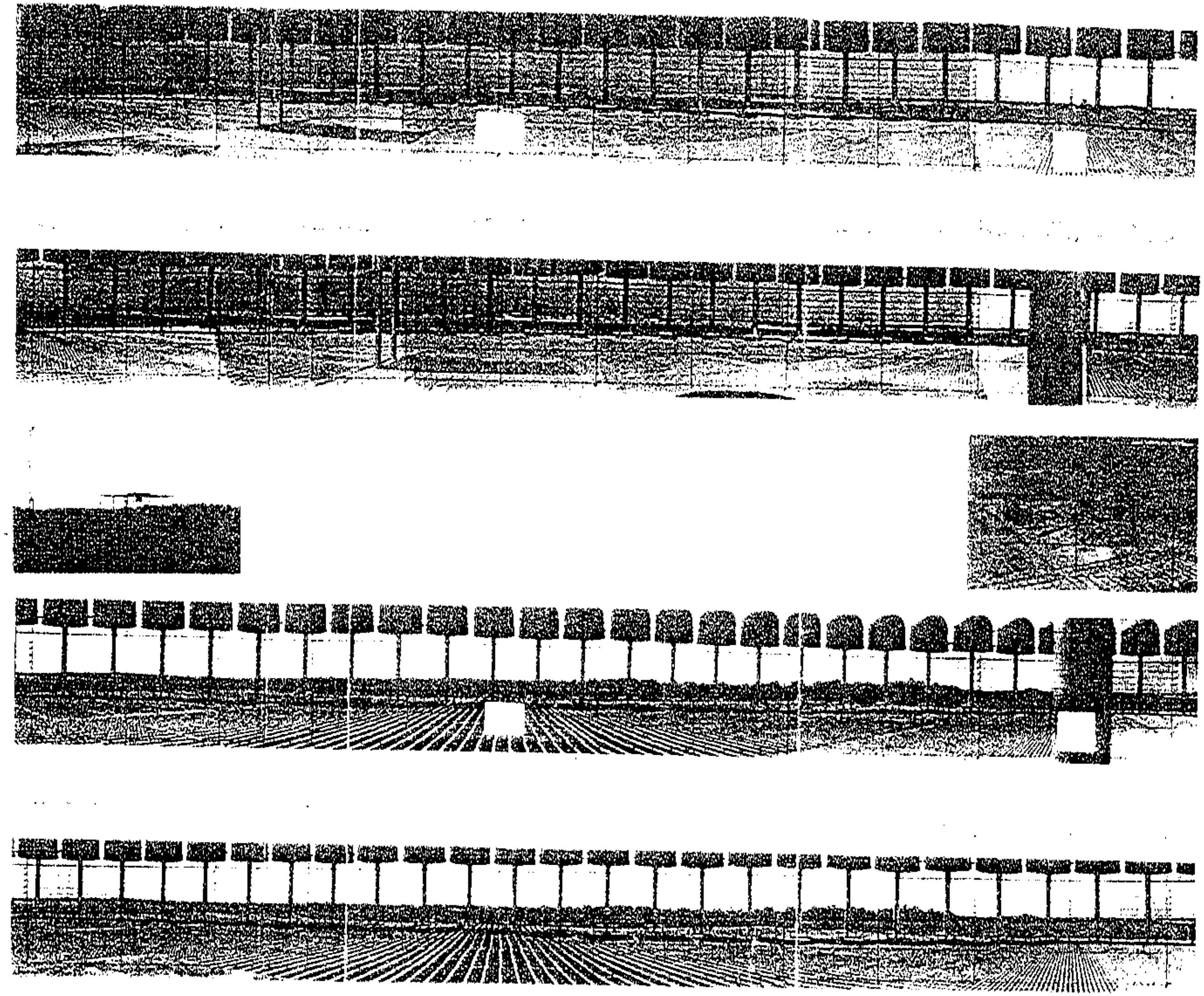


FIGURE 4. ATLANTA, GA. DVOR

APPENDIX 7. TYPICAL VOR SITES

Section 1. General

1. INTRODUCTION. Presented in this appendix are the measured performances and plan views of a series of typical VOR sites of varying complexity accumulated by the FAA over the years. Included are a number of mountaintop facilities. Data were selected on the basis of what was deemed most useful to the siting engineer.

Section 2. Alma, Georgia

COMMENTS: This is a good site inasmuch as the terrain is flat and the trees and reflecting objects have been cleared to a radius of approximately 2000 feet. A study of the course scalloping from the recordings of the 20-mile-radius calibration showed that most of the scalloping is nonsinusoidal, a characteristic of scalloping caused by trees.

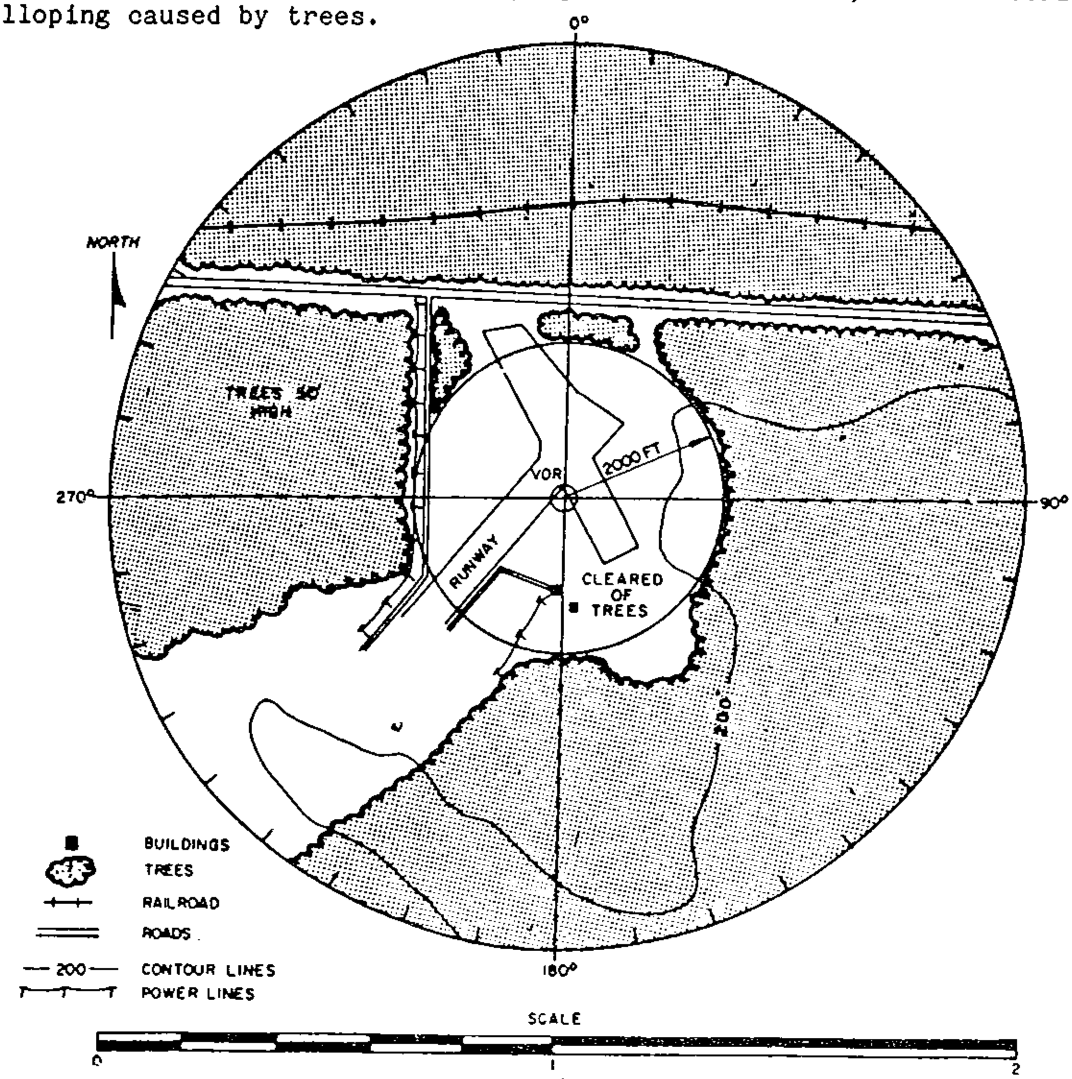
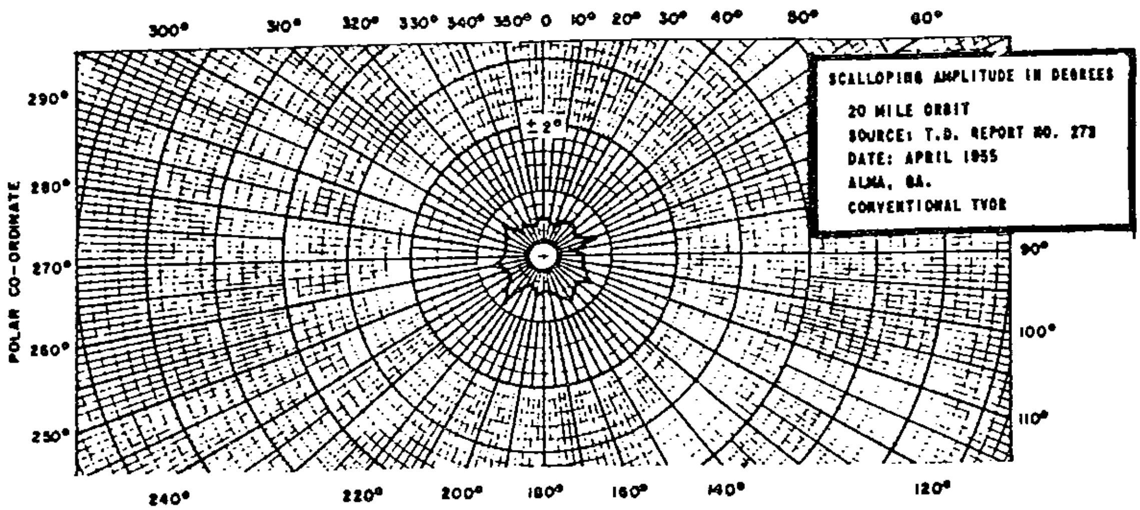


FIGURE 1. VICINITY SKETCH (1-Mile Radius) ALMA, GEORGIA

Section 2. Alma, Georgia (continued)



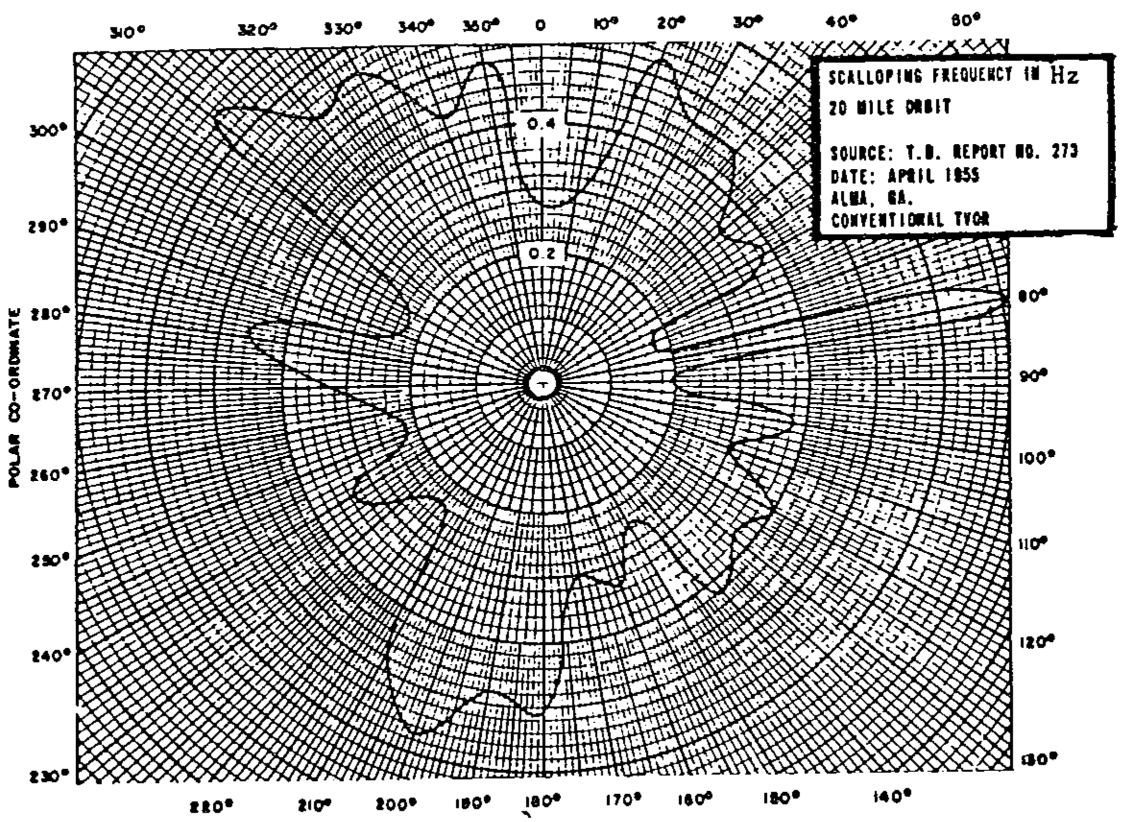


FIGURE 2. SCALLOPING AMPITUDE AND FREQUENCY

Section 3. Atlantic City, New Jersey (FAA Technical Center)

COMMENT: Tests were conducted at the experimental VOR to determine the effects of isolated forest areas. The data obtained during these tests are also shown in Figure 3.5.

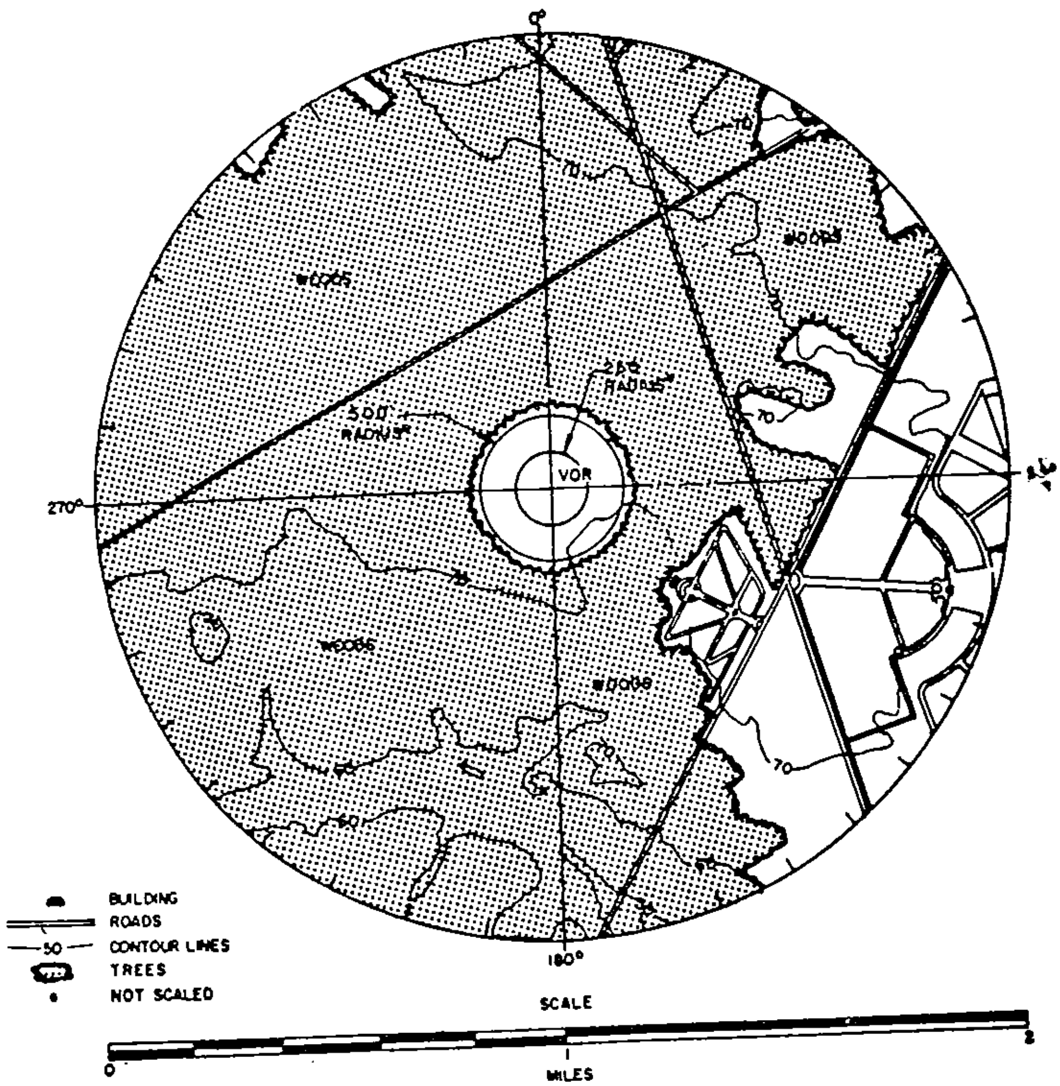
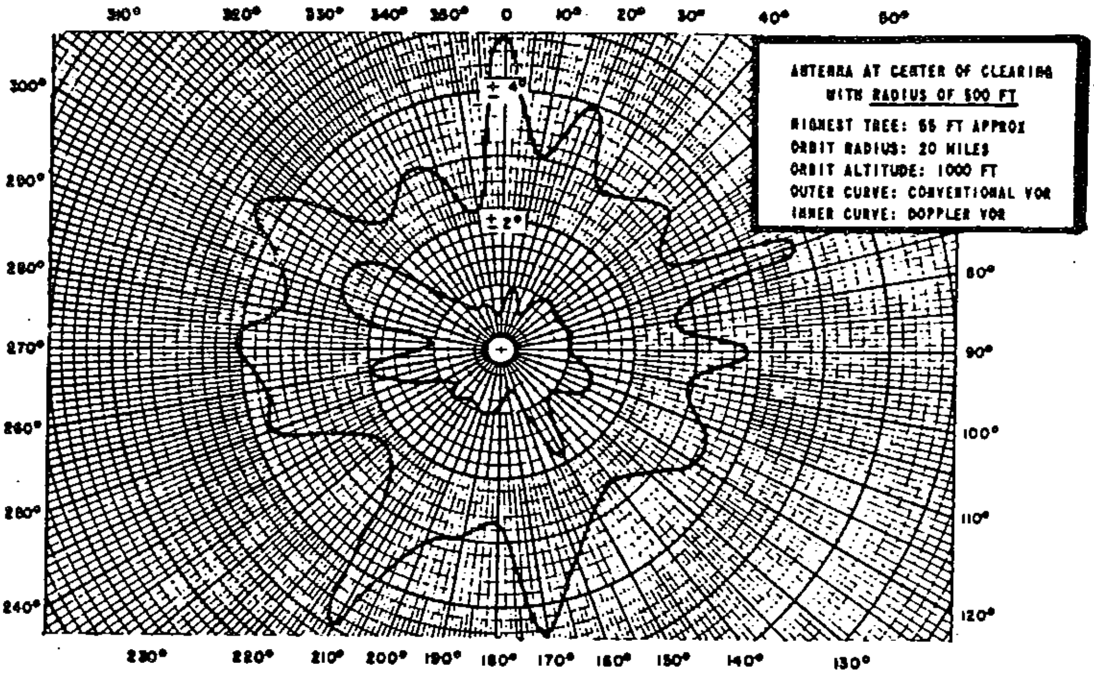


FIGURE 3. VICINITY SKETCH (1-MILE RADIUS) ATLANTIC CITY, NEW JERSEY EXPERIMENTAL VOR

Section 3. Atlantic City, New Jersey (FAA Technical Center) (continued)



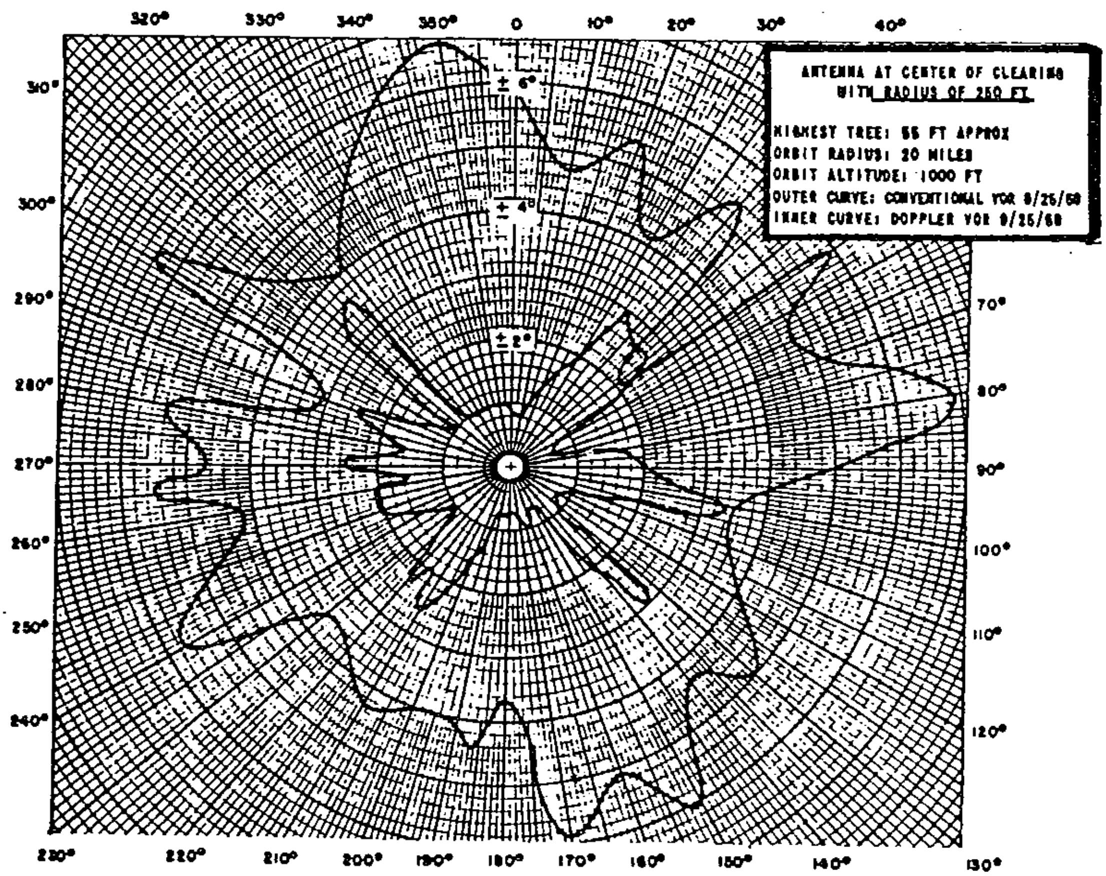


FIGURE 4. SCALLOPING AMPLITUDE

Section 4. Augusta, Maine

COMMENT: This airport site serves as an en route as well as a terminal navigational aid facility.

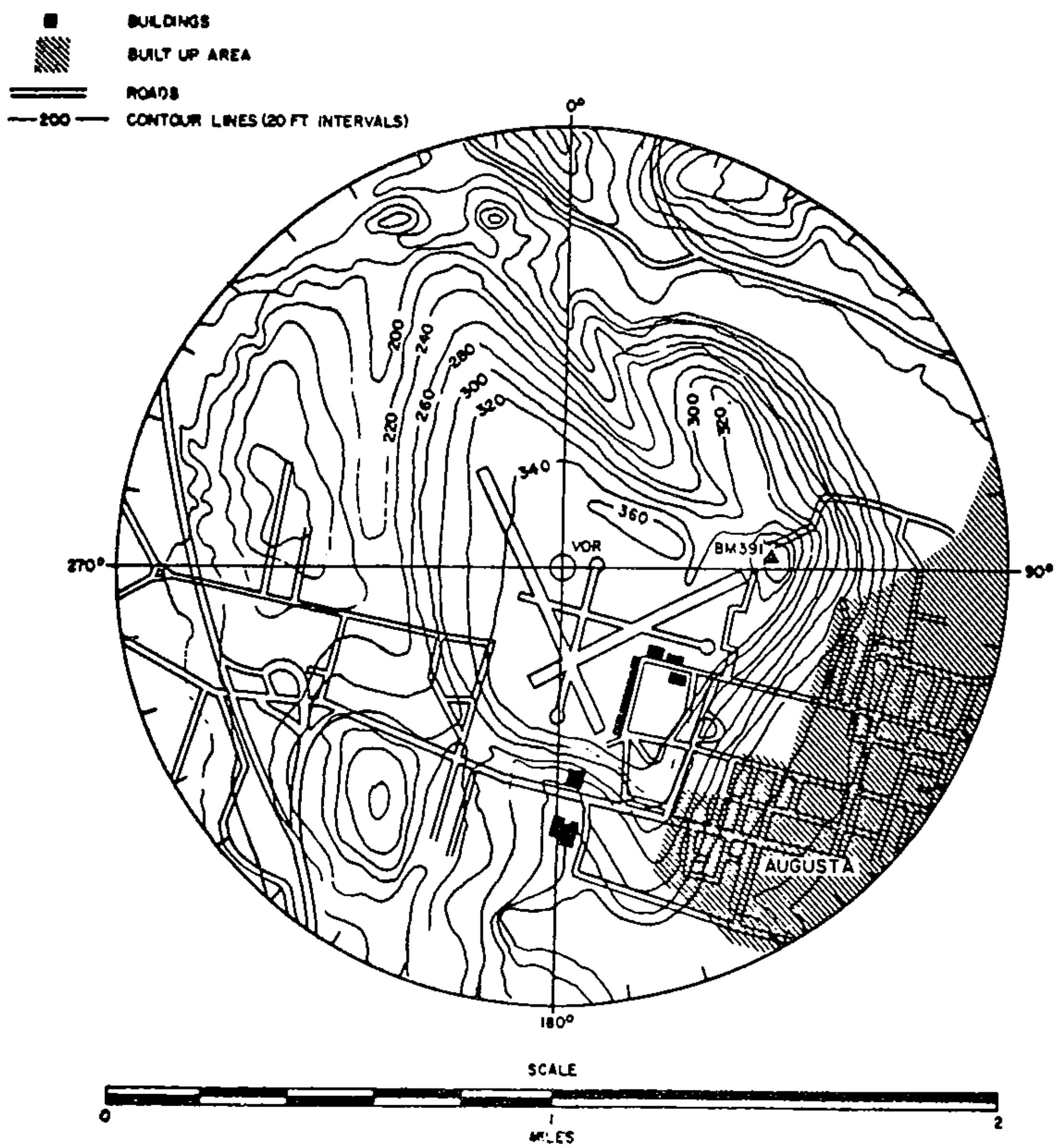
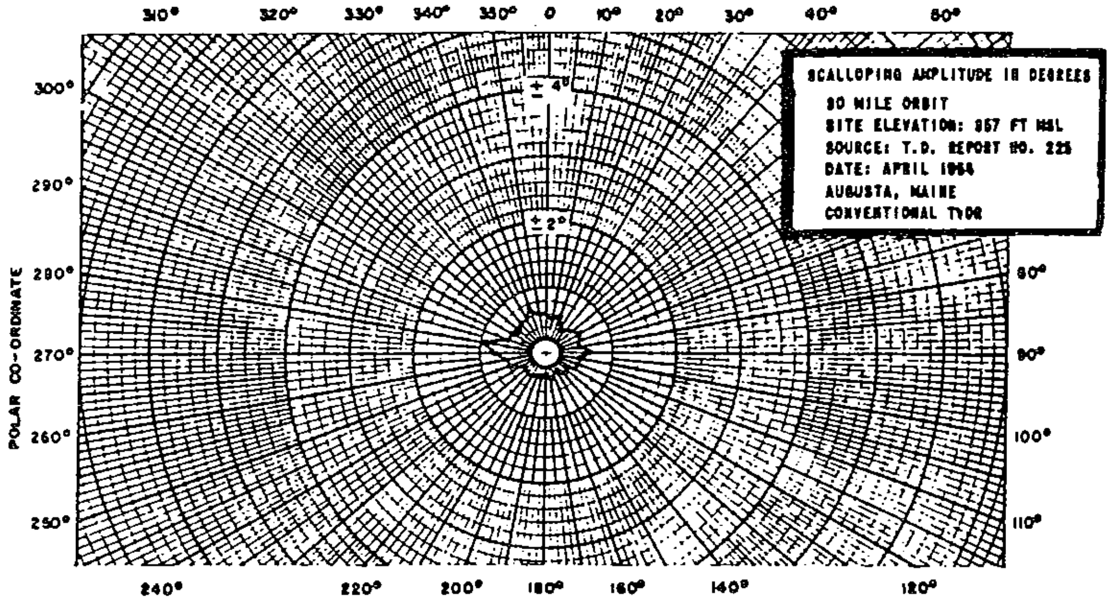


FIGURE 5. VICINITY SKETCH (1-MILE RADIUS) AUGUSTA, MAINE (VORTAC)

Section 4. Augusta, Maine (continued)



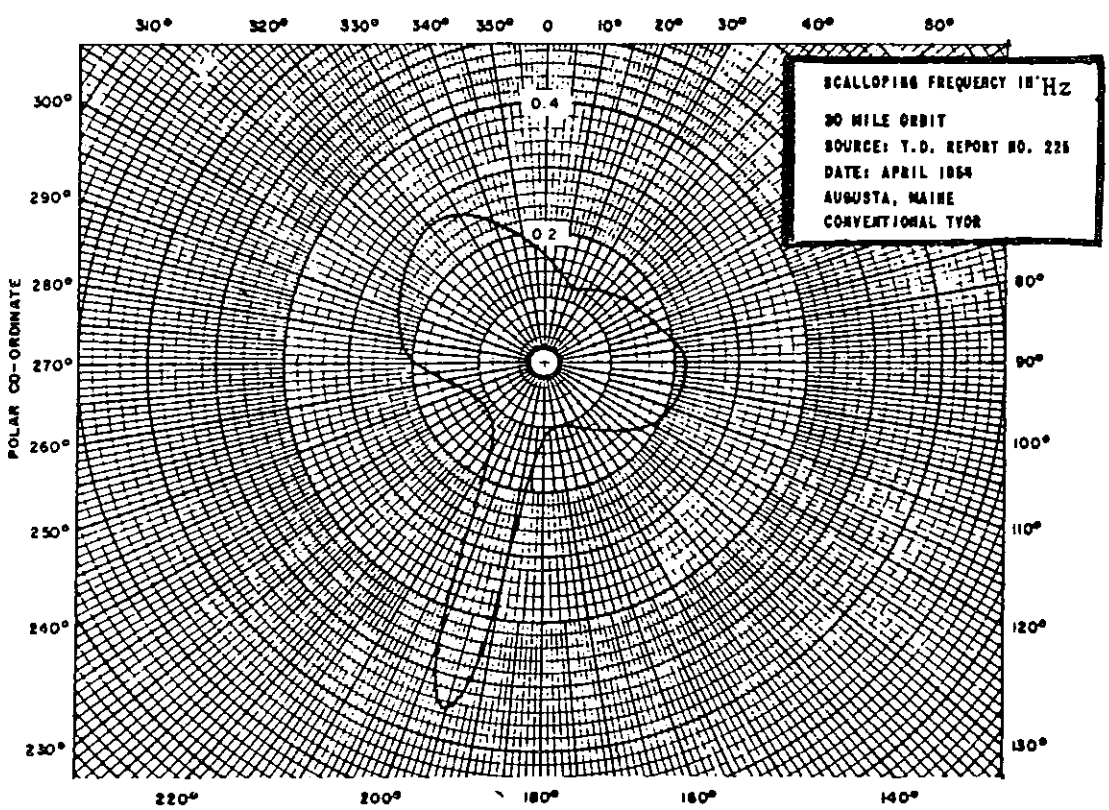


FIGURE 6. SCALLOPING AMPLITUDE AND FREQUENCY

Section 5. Biscayne Bay, Florida

COMMENTS: Experience has shown that ships and large aquatic structures within 2500 feet and aircraft within a mile of the facility are capable of causing significant VOR scalloping or errors. Beyond the one-mile radius mapped, tower extending 1000 feet or more above the VOR site may account for the measured scalloping and roughness.

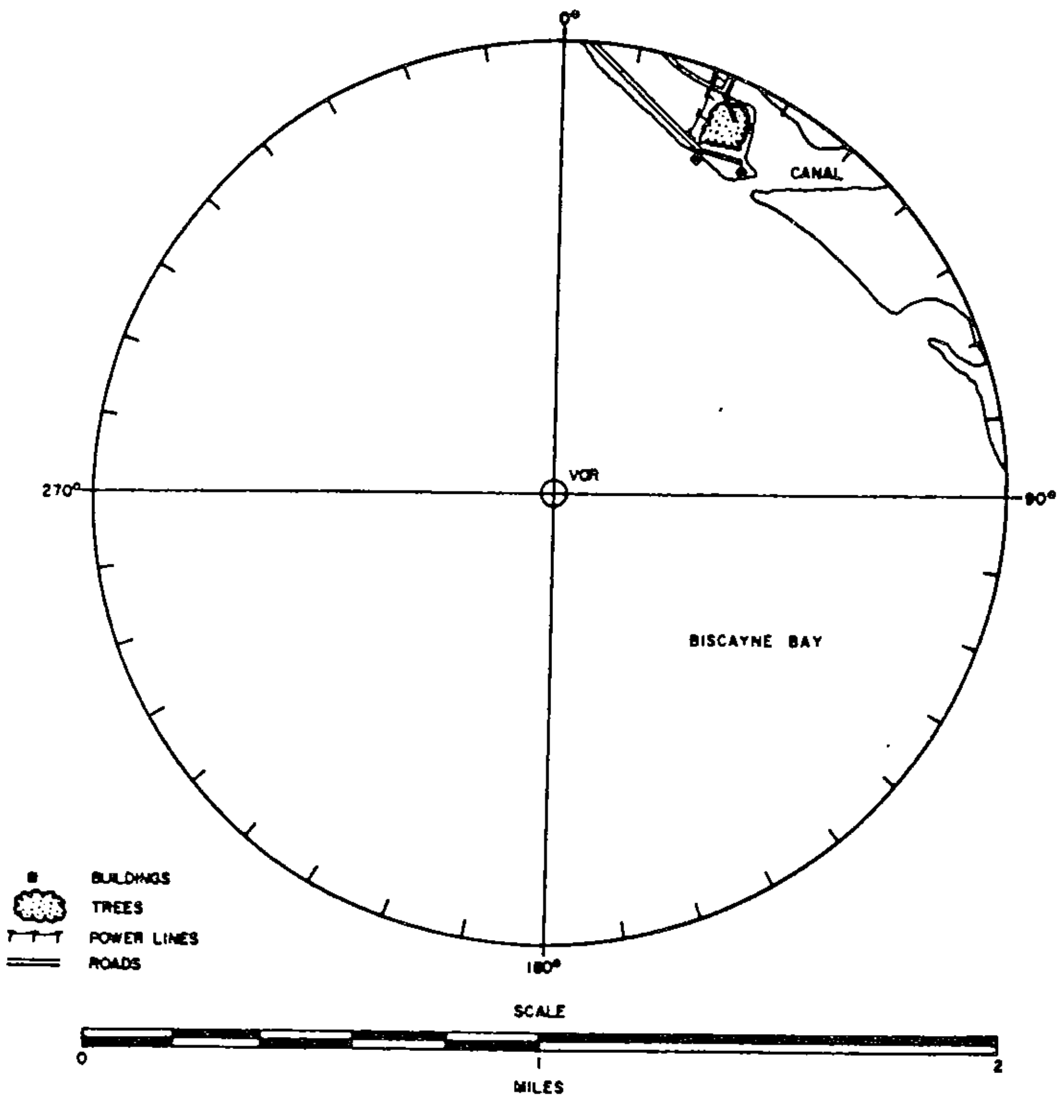


FIGURE 7. VICINITY SKETCH (1-MILE RADIUS) BISCAYNE BAY, FLORIDA VOR

Section 5. Biscayne Bay, Florida (continued)

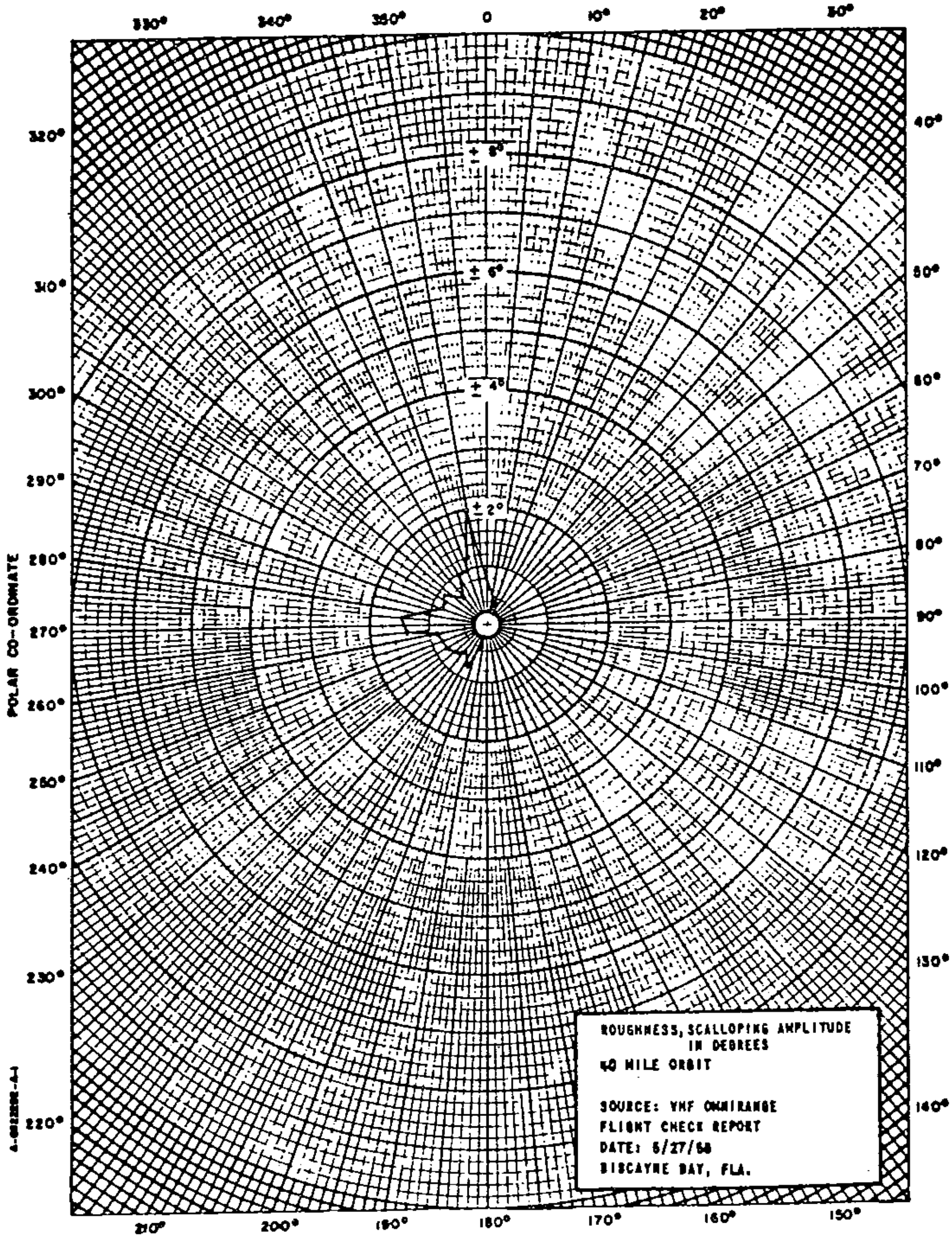


FIGURE 8. ROUGHNESS AND SCALLOPING

Section 6. Boulder City, Nevada

COMMENT: This is an example of a satisfactory "Conventional" VOR in very difficult terrain. Successful operation was achieved by use of a very large counterpoise (200-foot diameter). For additional information see VORTAC Facility Plot Plan.

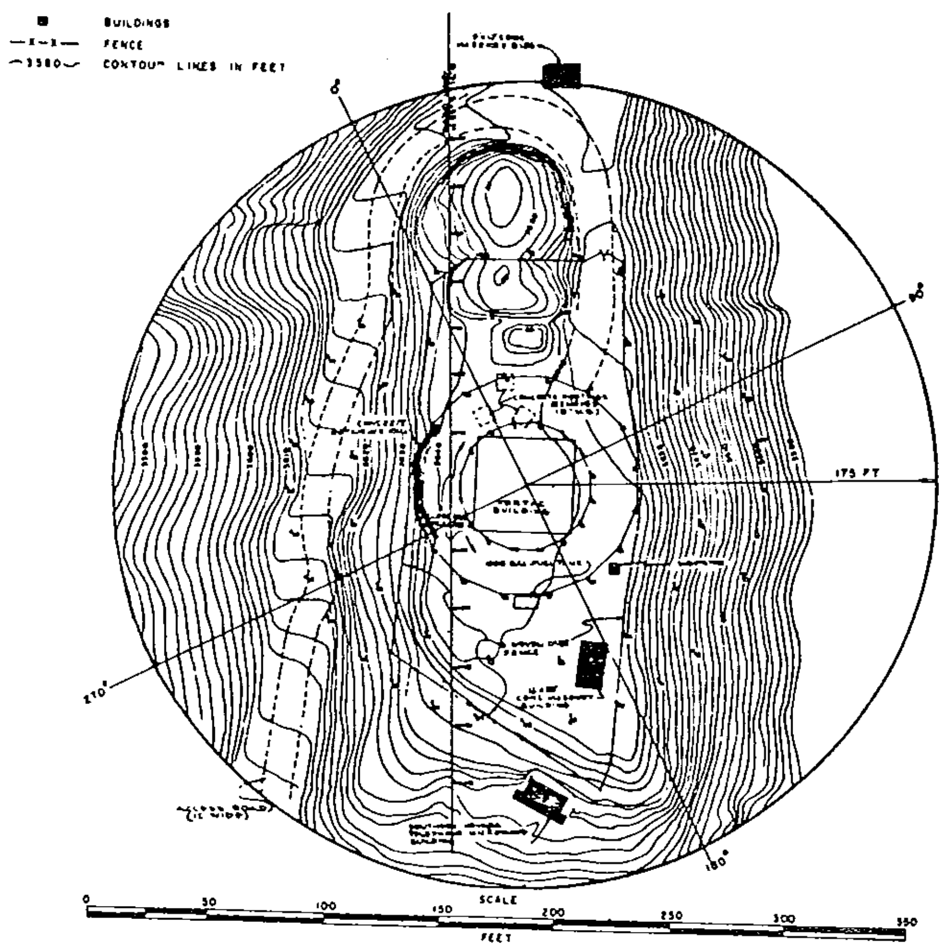


FIGURE 9. VICINITY SKETCH (175-FOOT RADIUS) BOULDER CITY, NEVADA VORTAC

Section 6. Boulder City, Nevada (continued)

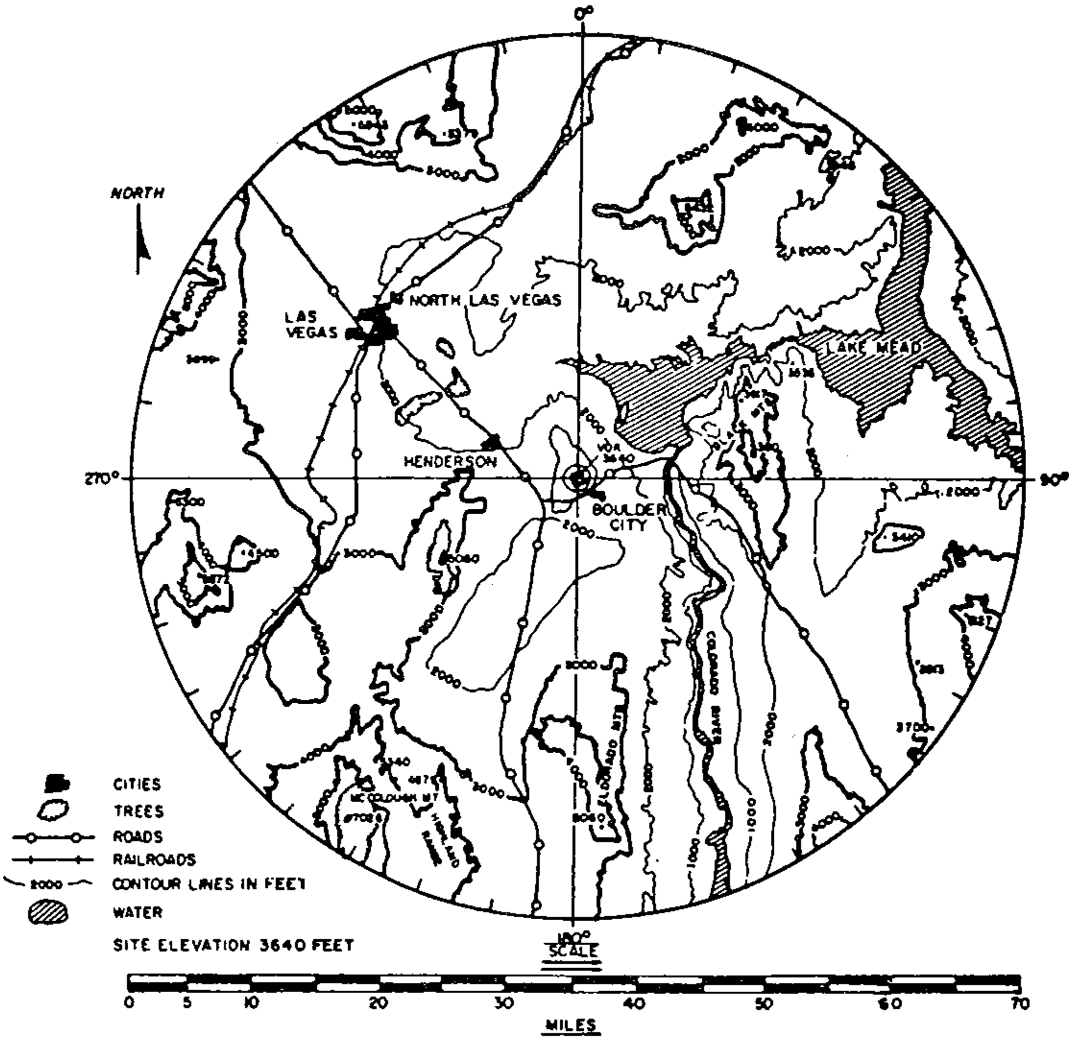


FIGURE 10. VICINITY SKETCH (35-Mile Radius) BOULDER CITY, NEVADA VORTAC

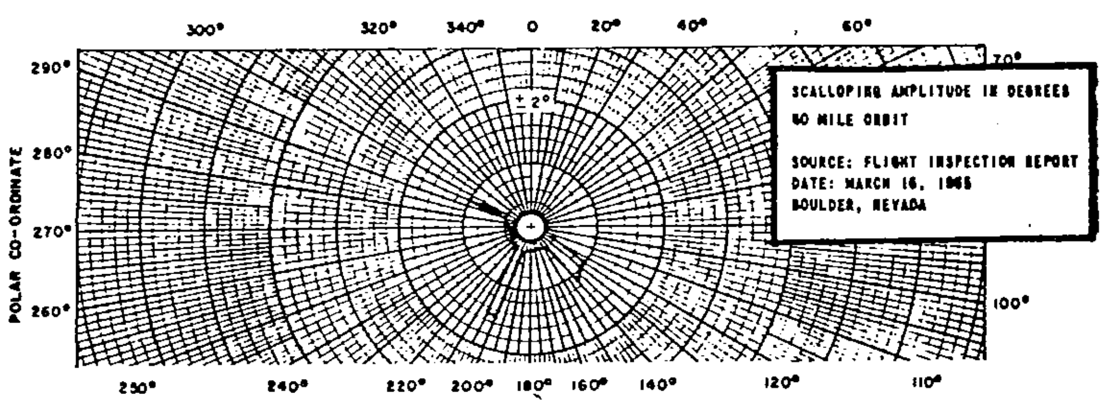


FIGURE 11. SCALLOPING AMPLITUDE

Section 7. Chattanooga, Tennessee

COMMENTS: This is a satisfactory site located in very rugged terrain. The site for the VOR antennas was prepared with very little earth-moving. The station is sited on a knob approximately as high as or higher than the nearby mountainous terrain.

The large scalloping at 16 degrees azimuth is believed to be caused by energy reflected off an inclined plane formed by the ridge running northeast, which redirects the signal to the 16-degree azimuth. It is also quite possible that reflected energy from below the site causes nulls in the vertical plane field intensity pattern at 16 degrees azimuth resulting in the course roughness and scalloping.

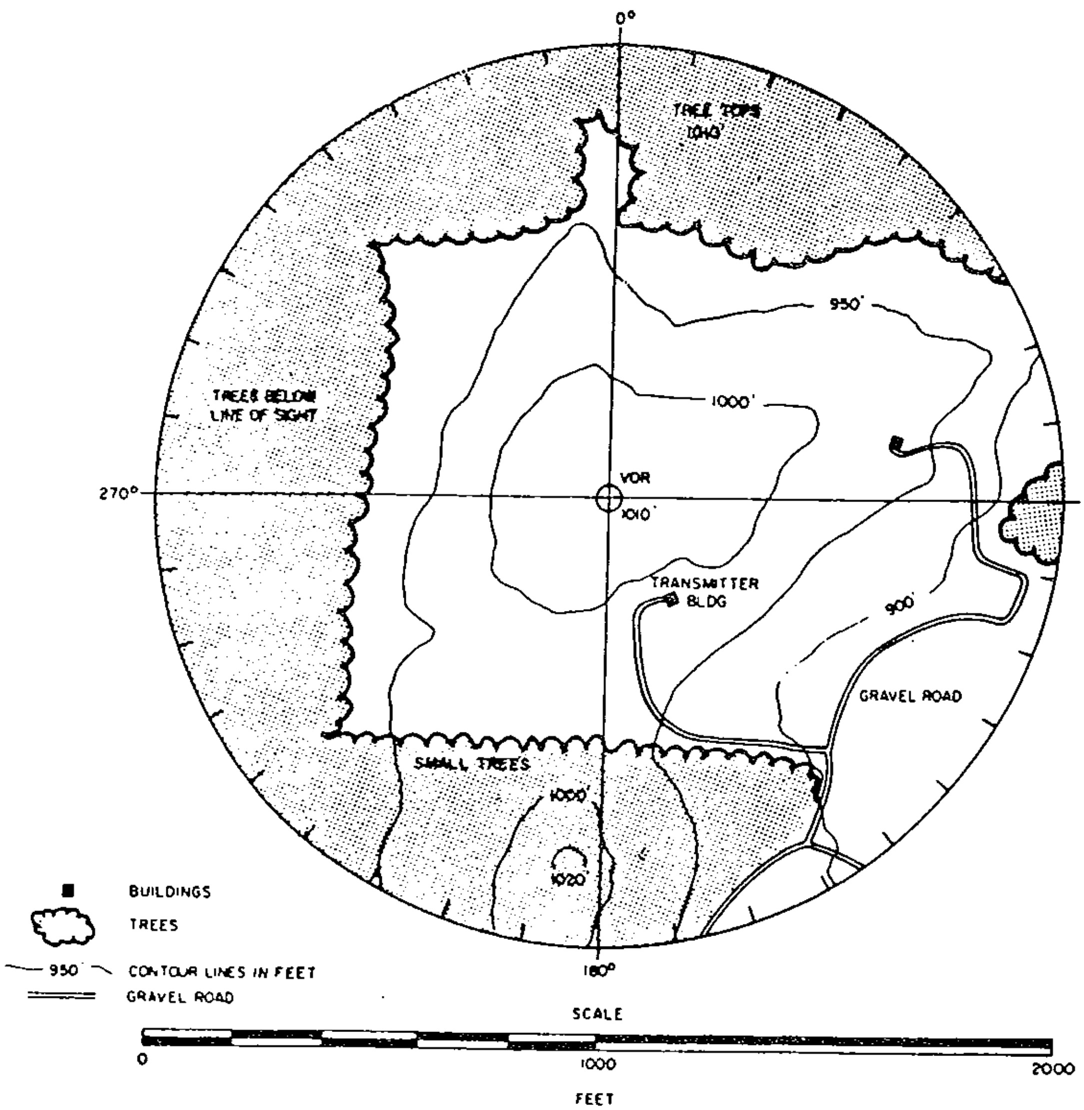


FIGURE 12. VICINITY SKETCH (1000-FOOT RADIUS) CHATTANOOGA, TENNESSEE (VORTAC)

Section 7. Chattanooga, Tennessee (continued)

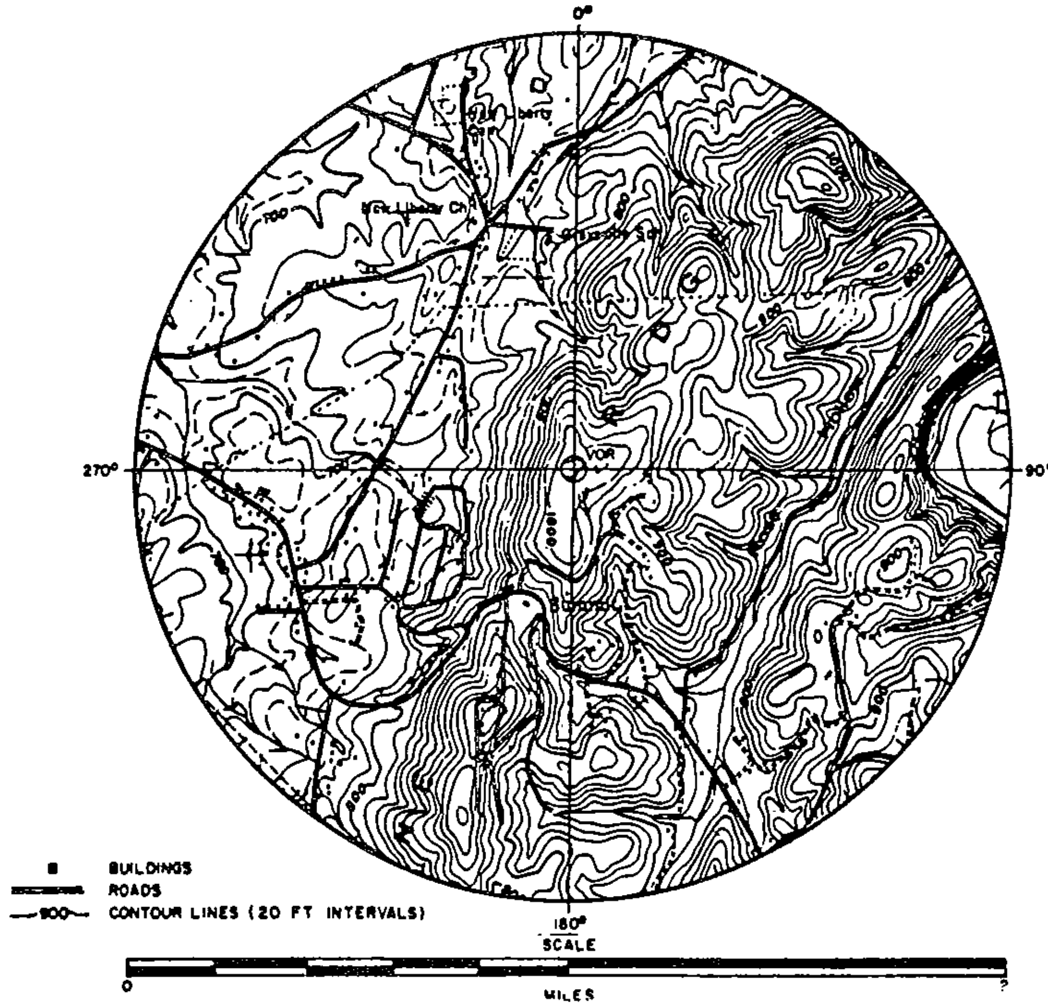


FIGURE 13. VICINITY SKETCH (1-Mile Radius) CHATTANOOGA, TENNESSEE (VORTAC)

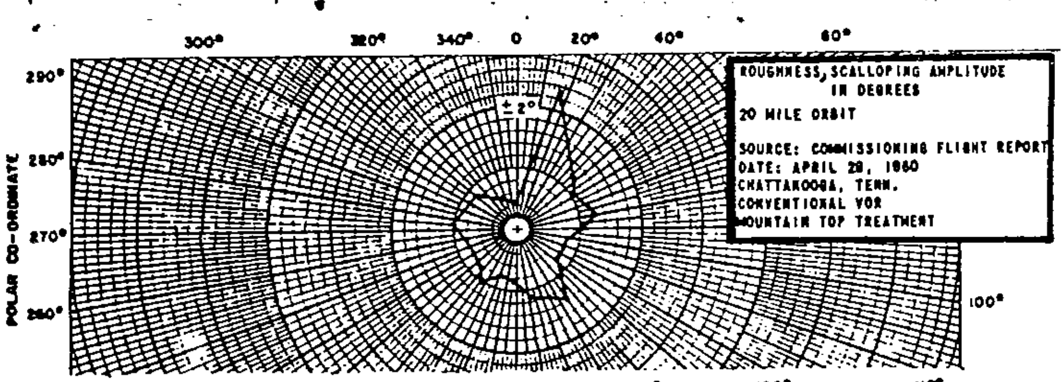


FIGURE 14. ROUGHNESS AND SCALLOPING

Section 8. Columbia, South Carolina

COMMENT: This is an example of an unsatisfactory VOR site test. Excessive bearing errors and severe scalloping on many radials (not shown) were the principal deficiencies. The surrounding forests and the irregular nearby terrain contours were the specific conditions necessitating selection of an alternate site for the VOR.

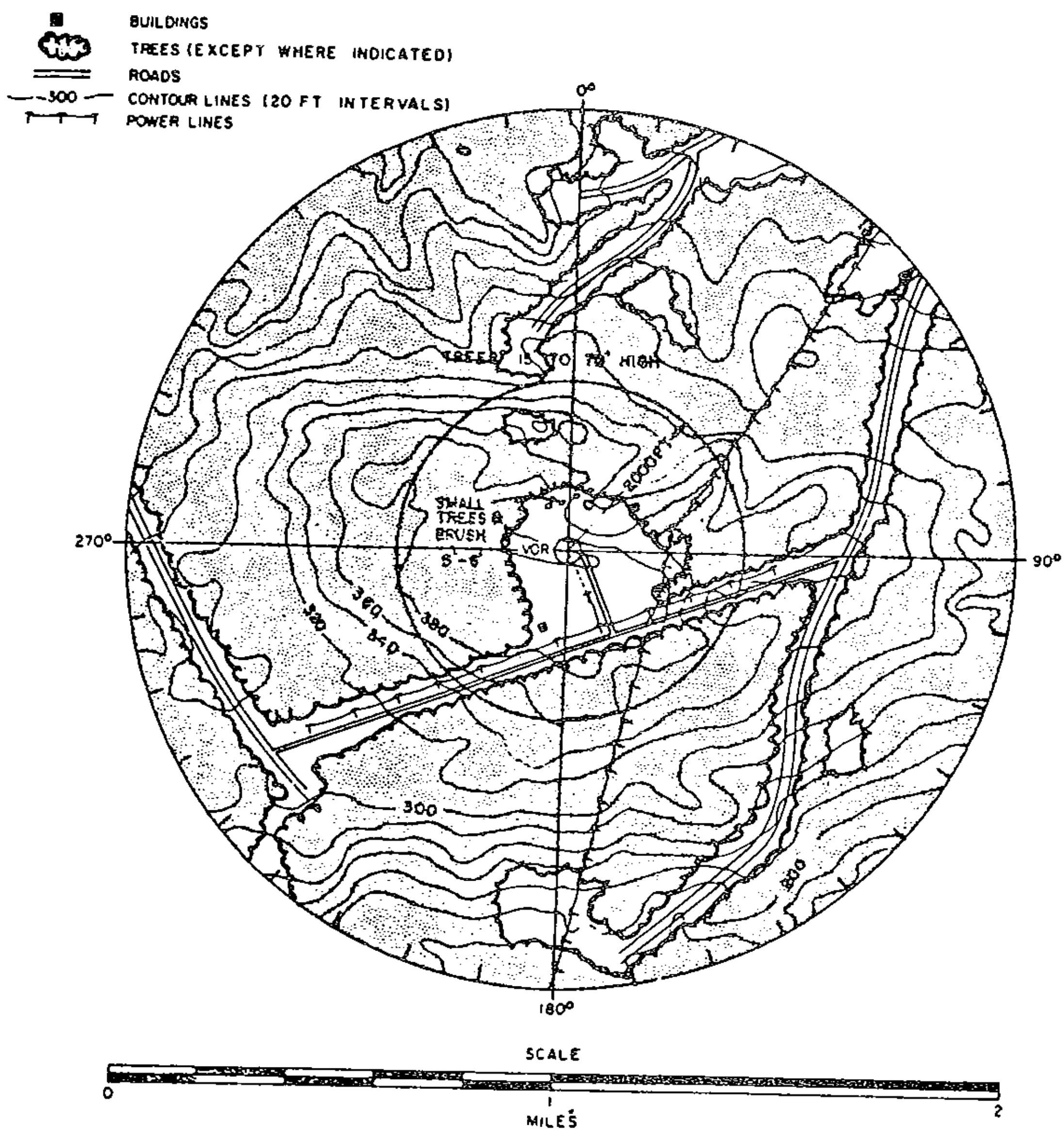
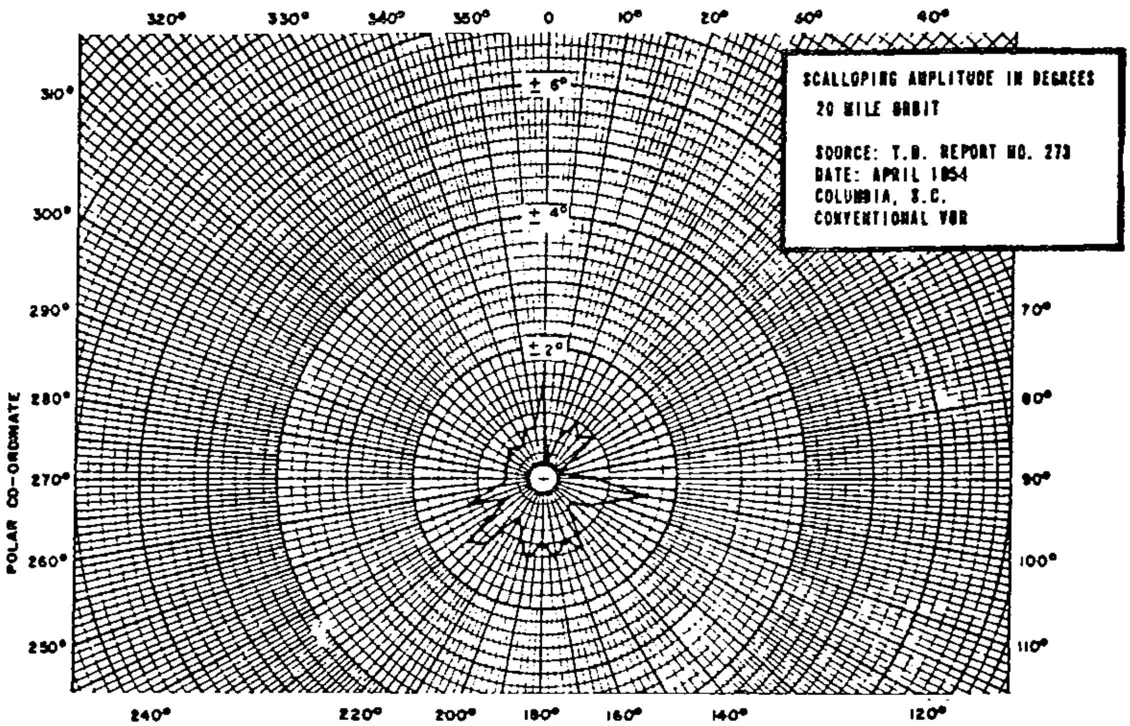


FIGURE 15. VICINITY SKETCH (1-MILE RADIUS) COLUMBIA, SOUTH CAROLINA (TEST SITE FACILITY)

Section 8. Columbia, South Carolina (continued)



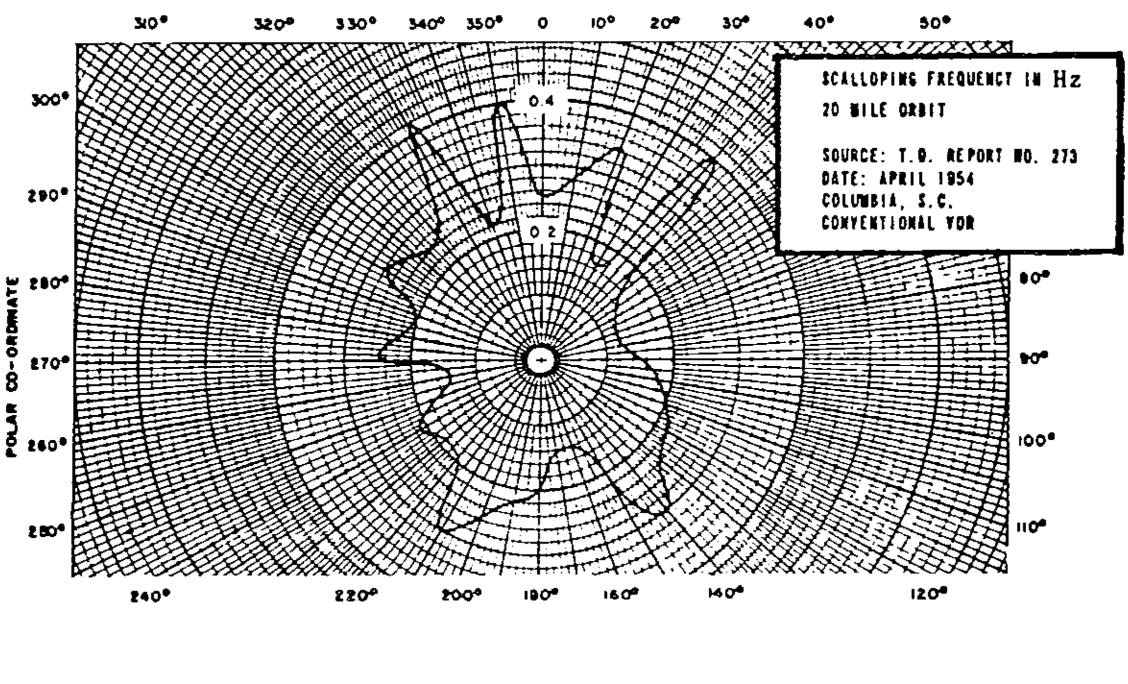


FIGURE 16. SCALLOPING AMPLITUDE AND FREQUENCY

Section 9. Dayton, Ohio

COMMENT: This site is unacceptable as a VOR facility because of scalloping and bending on many radials due to trees. The maximum course scalloping was caused by the wooded section shown on the map approximately 1000 feet south of the VOR. Considerable course scalloping was also caused by the small woods northwest of the VOR.

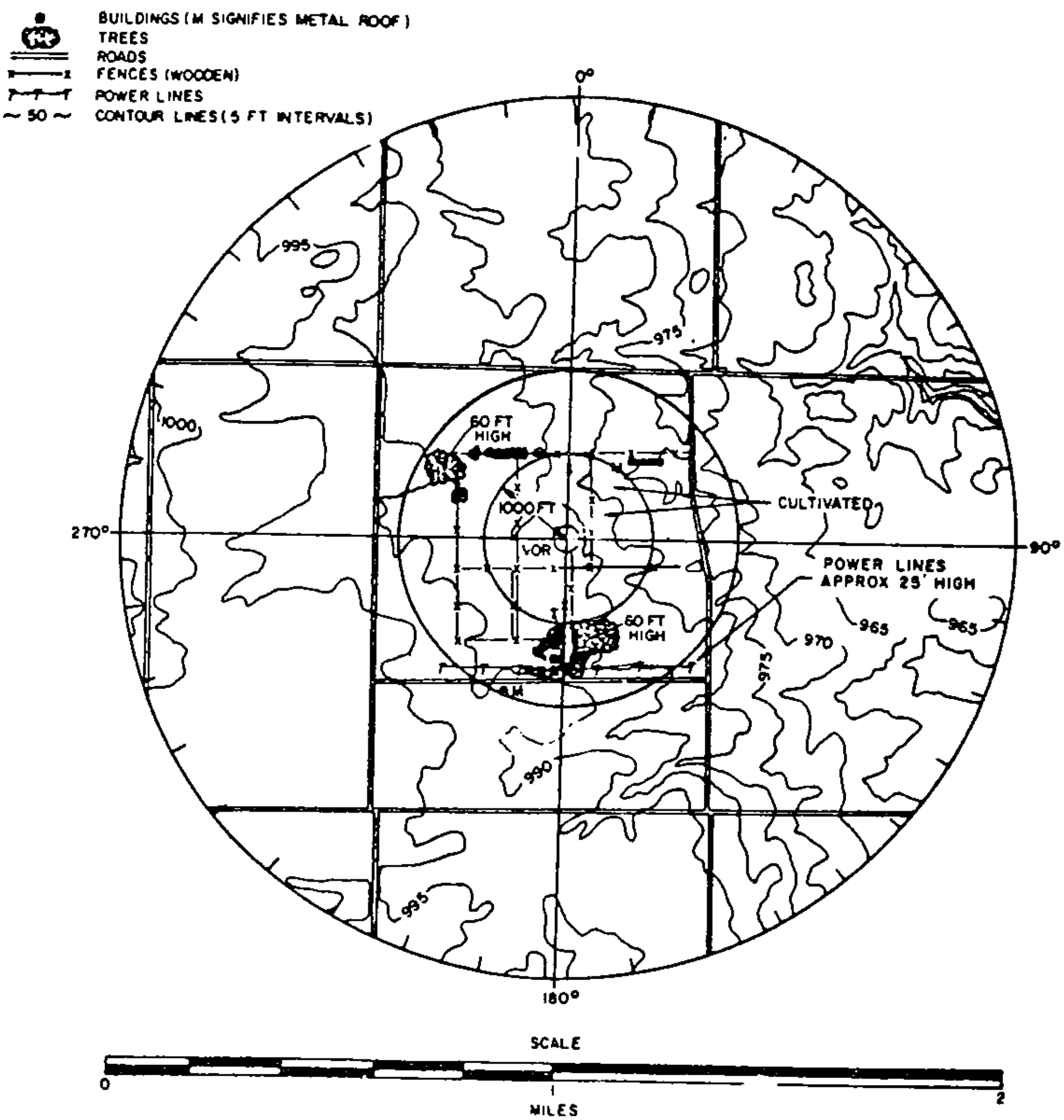


FIGURE 17. VICINITY SKETCH (1-MILE RADIUS) DAYTON, OHIO

Section 9. Dayton, Ohio (continued)

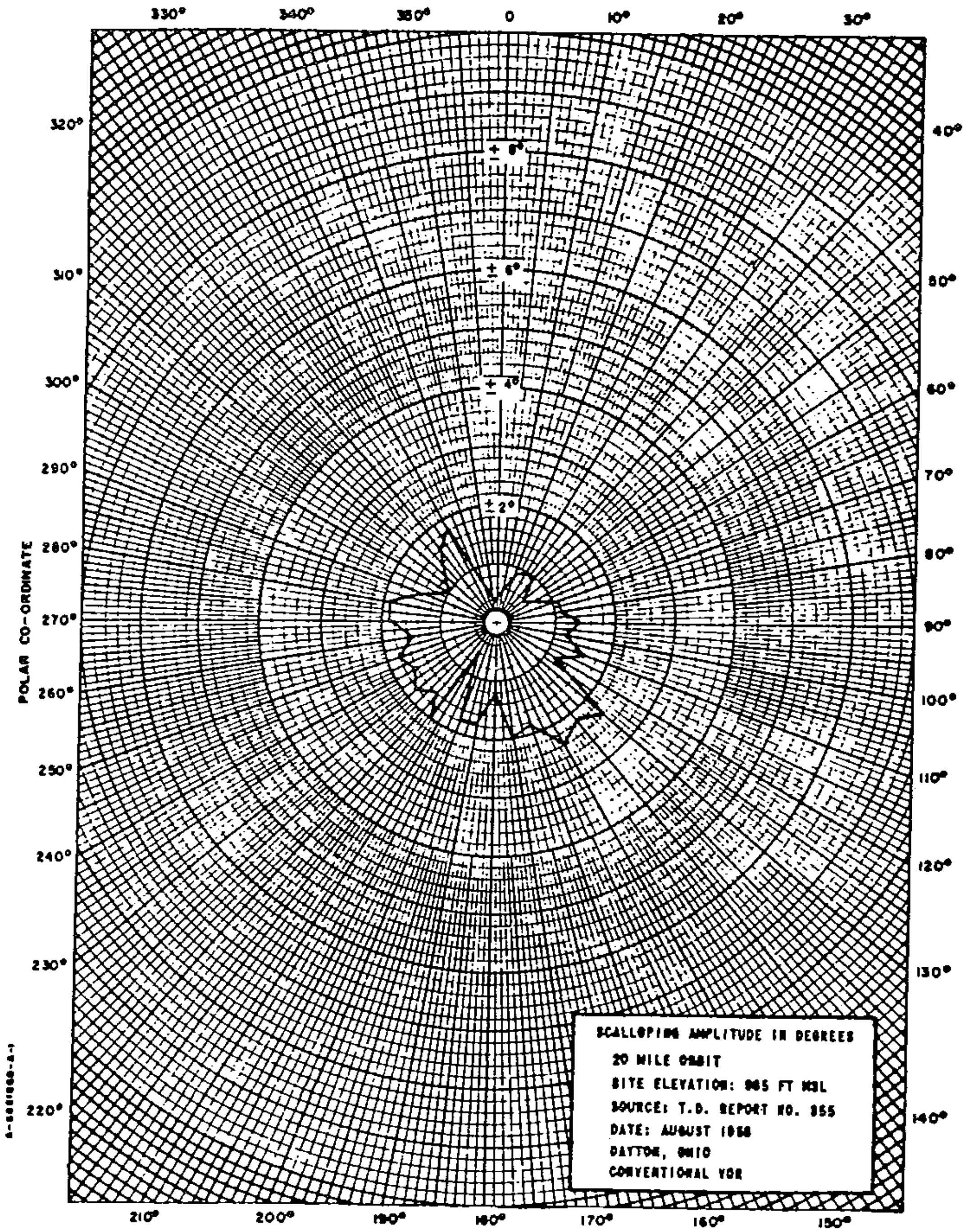


FIGURE 18. SCALLOPING AMPLITUDE

Section 10. Elizabeth City, North Carolina

COMMENTS: The Elizabeth City, North Carolina VOR is located on flat terrain which is free of obstructions for a minimum radius of 1500 feet. A dense wooded area having trees 90 feet high is located approximately 2250 feet from the VOR at an azimuth of 240 degrees. Power lines 20 to 40 feet high enclose three sides of the site at distances of 1500 feet or more.

Woods produce nonsinusoidal course scalloping (course roughness) making it difficult to analyze the scalloping by measuring frequency. Since woods cause scalloping in their approximate direction, the scalloping in the sector from 180 to 250 degrees is no doubt caused by the 60- to 90-foot trees.

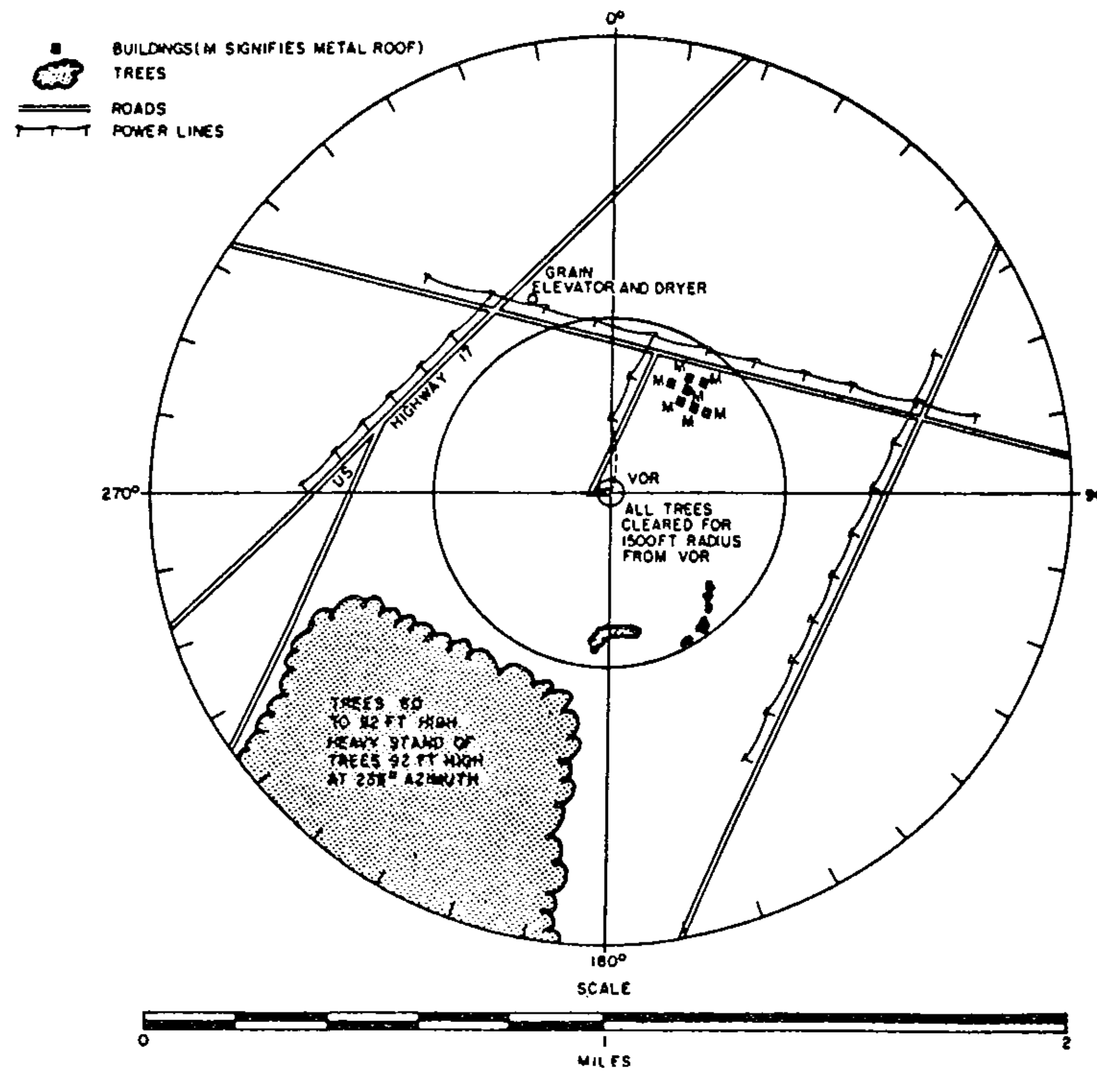
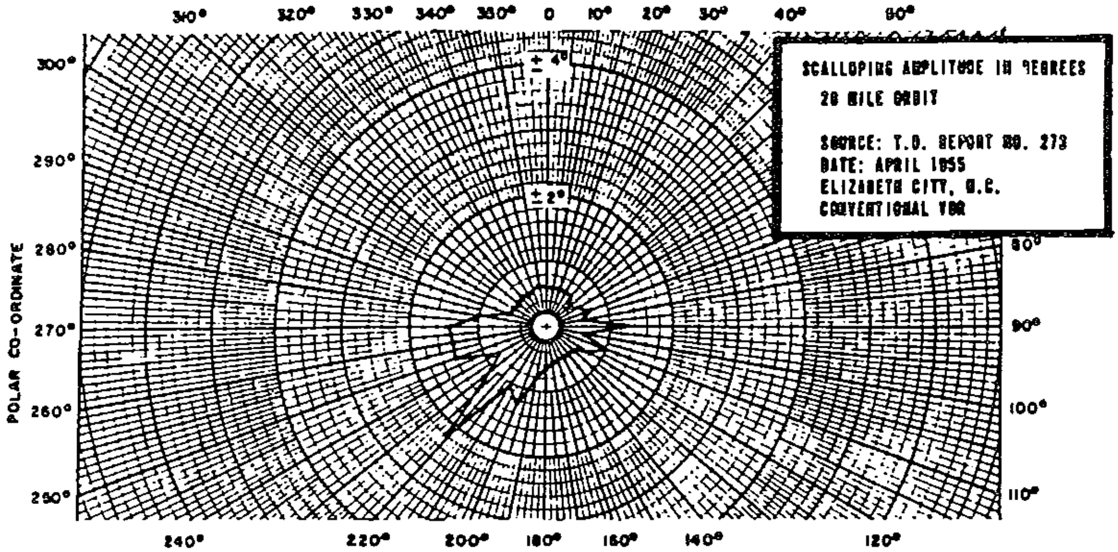


FIGURE 19. VICINITY SKETCH (1-MILE RADIUS) ELIZABETH CITY, NORTH CAROLINA VOR

Section 10. Elizabeth City, North Carolina (continued)



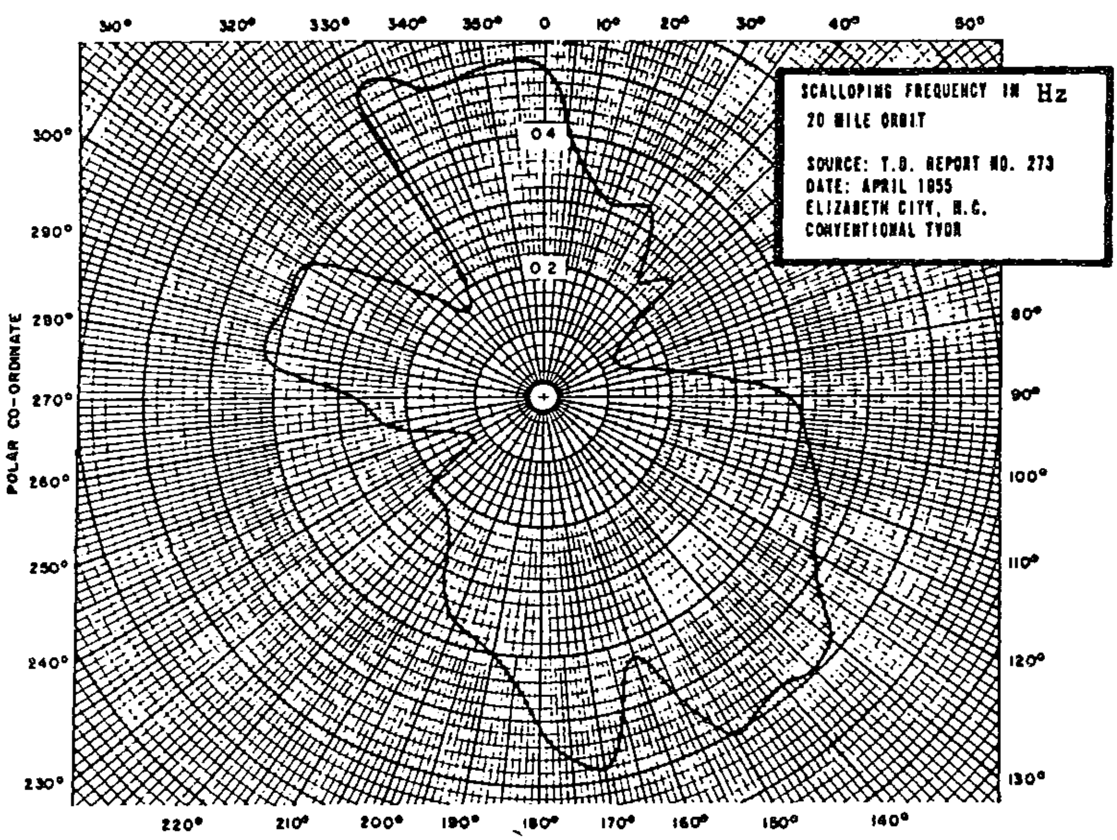


FIGURE 10. SCALLOPING AMPLITUDE AND FREQUENCY

Section 11. Florence, South Carolina

COMMENTS: When operating as a conventional VOR, the power line and trees cause marginal performance. As a Doppler VOR, considerable improvement is realized.

A comparison of orbital and radial scalloping measured on the 248 degrees azimuth at 20 miles distance is very instructive. The conventional VOR produced ±1.2-degrees scalloping on the orbital flight and ±2.5 degrees on the radial flight test. The higher value is a result of the much lower scalloping frequency normally evidenced on all radial flights and the attendant reduced effectiveness of the course deviation indicator filter.

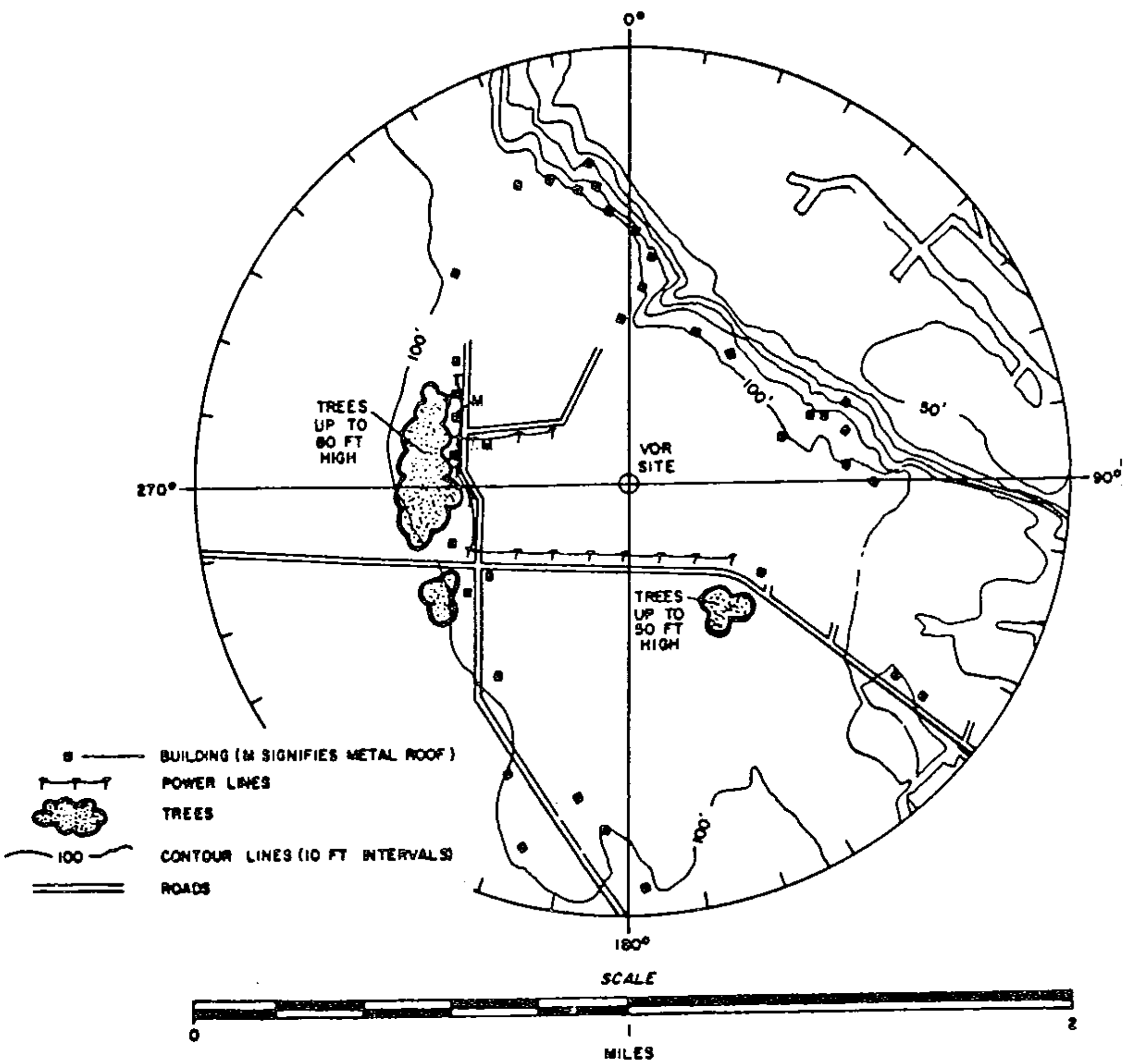


FIGURE 21. VICINITY SKETCH (1-MILE RADIUS) FLORENCE, SOUTH CAROLINA VOR

Section 11. Florence, South Carolina (continued)

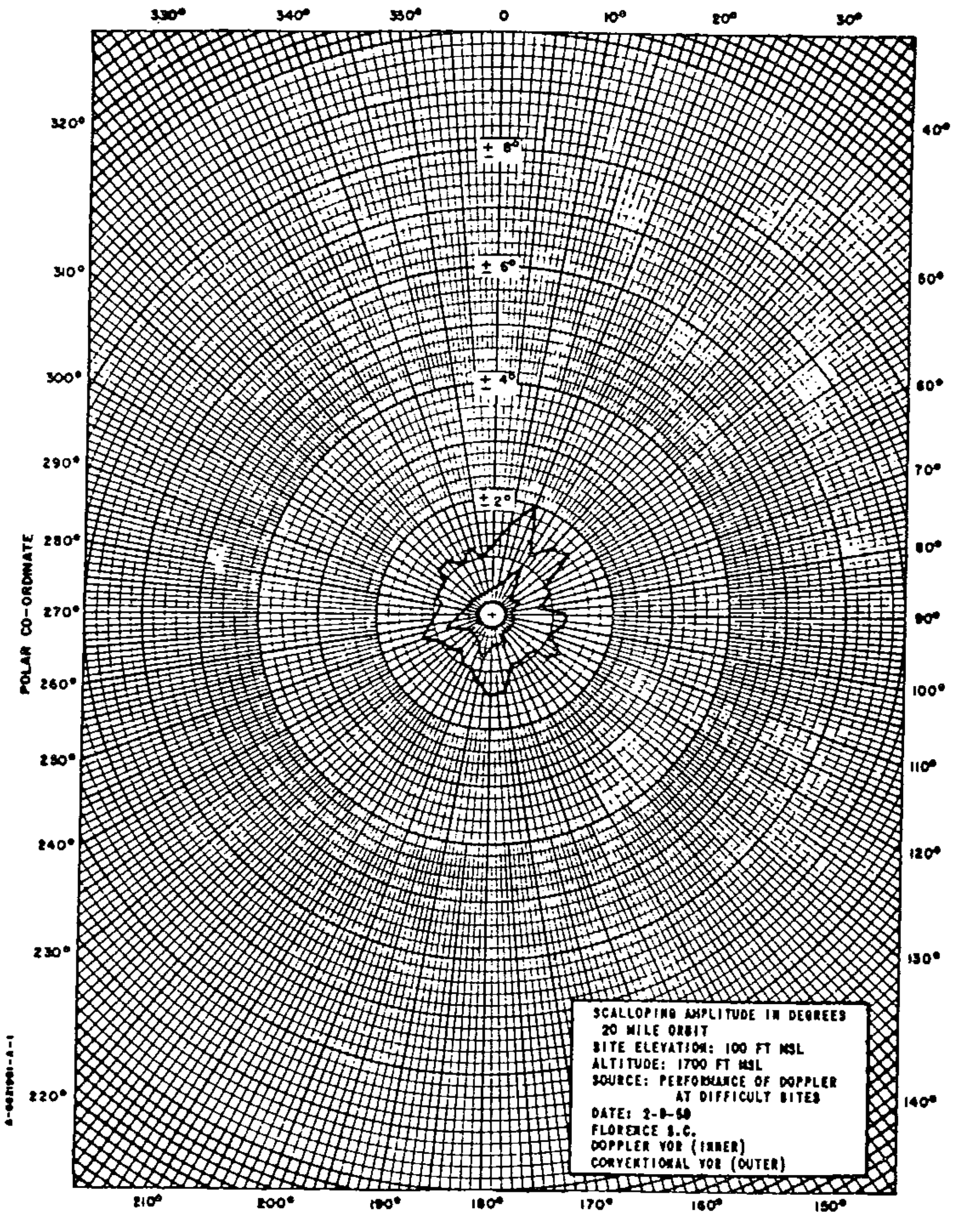
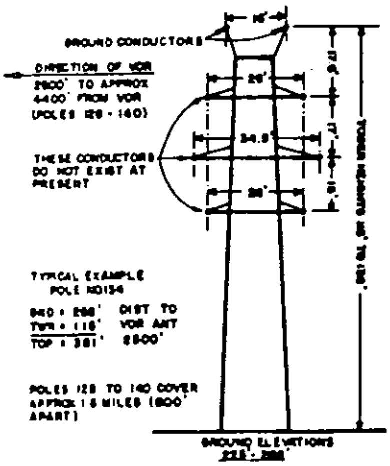


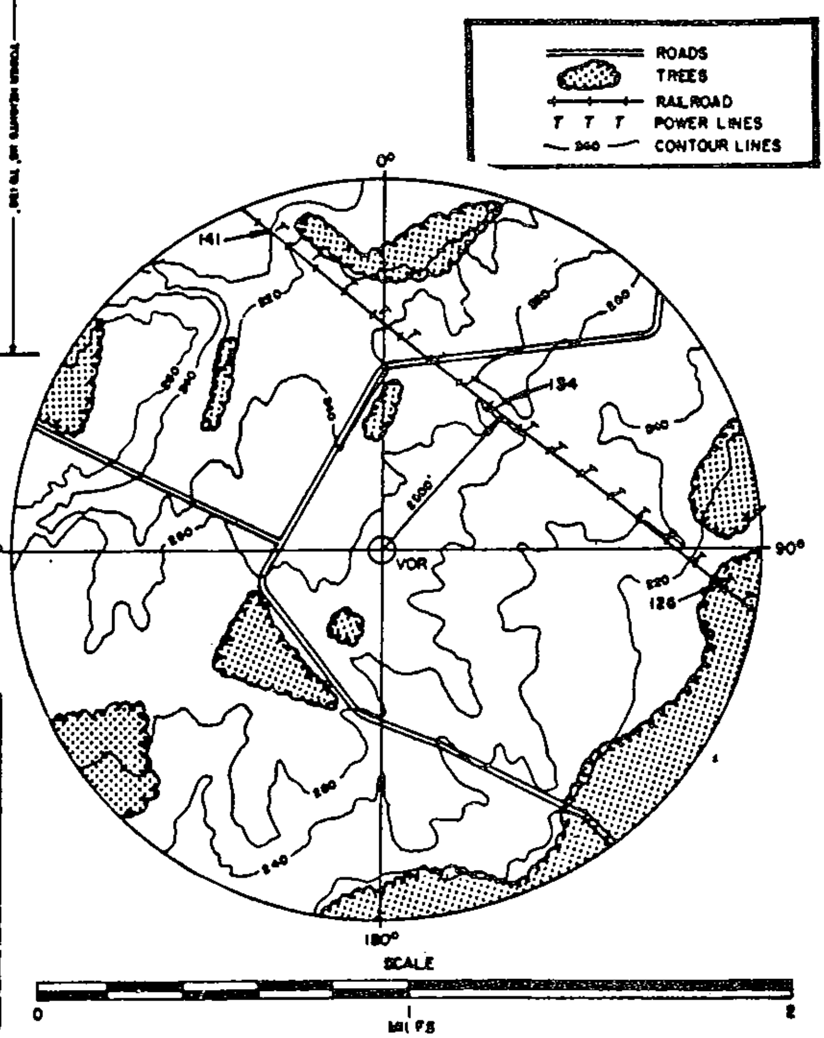
FIGURE 22. SCALLOPING AMPLITUDE

Section 12. Herndon, Virginia

COMMENTS: The towers of the power line 2500 feet northeast of the facility probably cause the 40-degrees azimuth scalloping lobe and the trees 1000 feet southwest of the VOR cause the scalloping in the sector from 200 to 240 degrees azimuth.

The reflections from the northeast power line probably cause the scalloping near 180 degrees azimuth and near 270 degrees azimuth. Fortunately, the wave angle of incidence to the power line that causes maximum scalloping, infringes on the part of the line that is located at a considerable distance (approximately 400 feet) from the VOR.





POLE NO	HT. OF TOP OF POLE ABOVE GROUND	HT. OF BOTTOM OF POWER LINE ABOVE GROUND
126	130	80
127	130	79
128	130	84
129	130	67
130	130	77
131	130	76
132	115	84
133	130	79
134	115	84
135	115	86
136	116	86
137	130	79
138	136	86
139	136	76
140	130	79
141	130	79

FIGURE 23. VICINITY SKETCH (1-MILE RADIUS) HERNDON, VIRGINIA VOR

Section 12. Herndon, Virginia (continued)

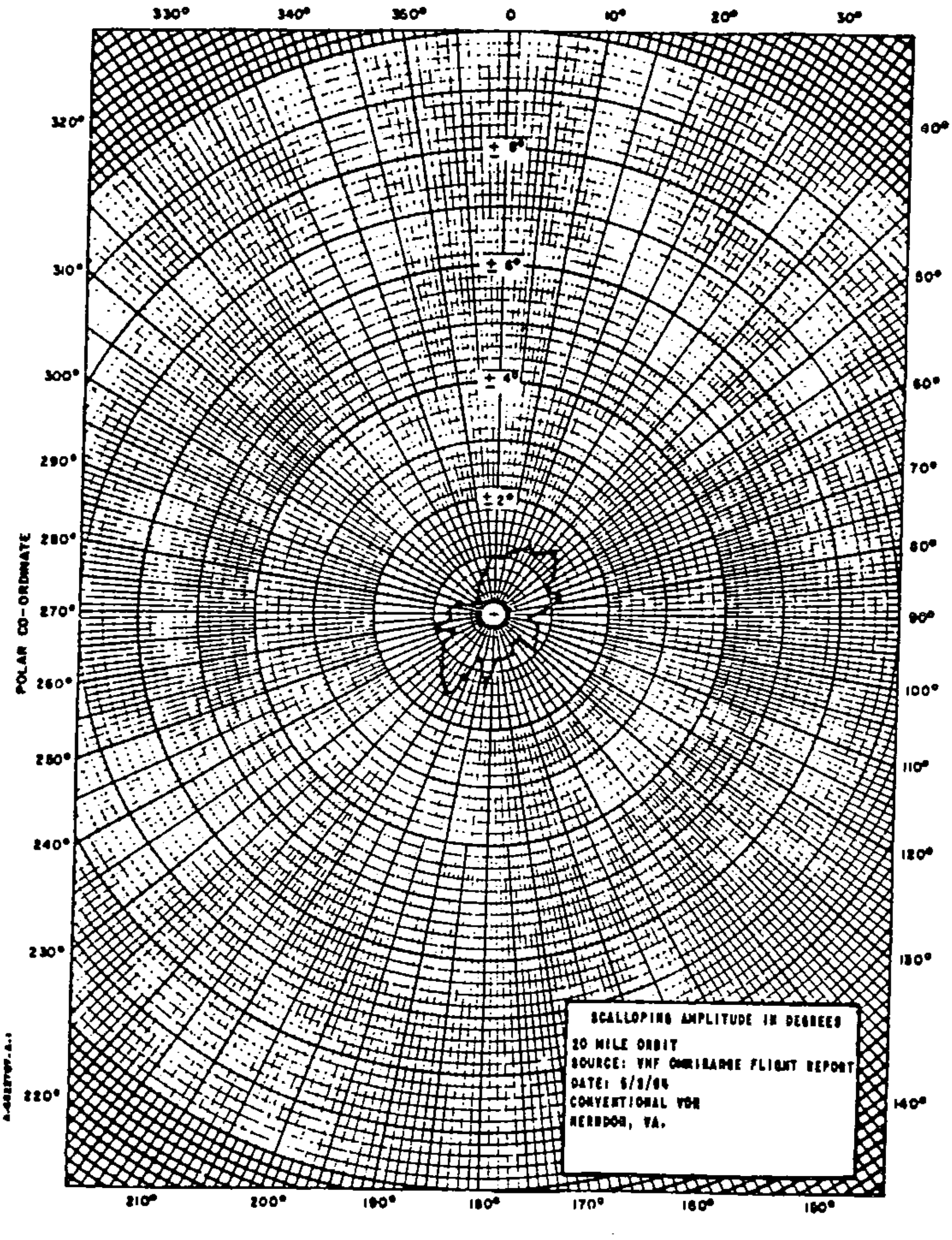


FIGURE 24. SCALLOPING AMPLITUDE

Section 13. Jackson, Michigan

COMMENTS: This information was obtained during the site testing prior to commissioning of the Jackson, Michigan VOR, which is an urban site with power and telephone lines on three sides. The most likely offending reflector, because of proximity and the number of conductors, is a 31-wire line generally running east and west. Its poles are 35 feet high with the part nearest to the VOR being about an 1800-foot distance where the vertical angle is 2.1 degrees. The closest line is a 3-wire line, 35 feet high, located at an azimuth of 180 degrees. It is about a 1600-foot distance, making a vertical angle of 0.9 degree. There are trees in all directions with some as close as 1800 feet with a vertical angle of 2.1 degrees. In addition, there are many hangars, buildings, and industrial plants located within a 1-mile radius.

The Jackson site was used for a considerable amount of Doppler VOR testing. The facility was commissioned with a standard 4-loop antenna system and a Doppler-type counterpoise.

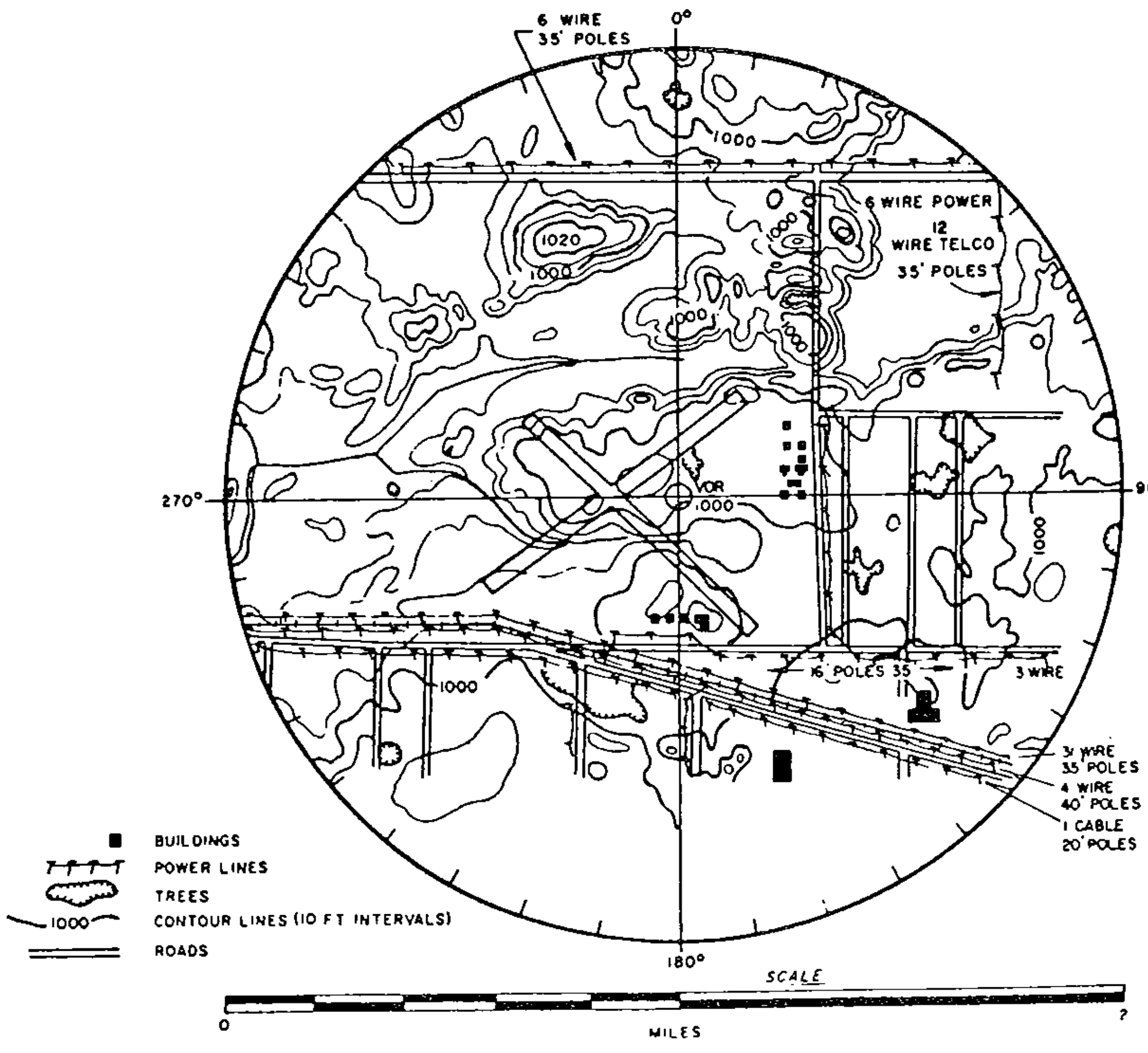


FIGURE 25. VICINITY SKETCH (1-MILE RADIUS) JACKSON, MICHIGAN VOR

Section 13. Jackson, Michigan (continued)

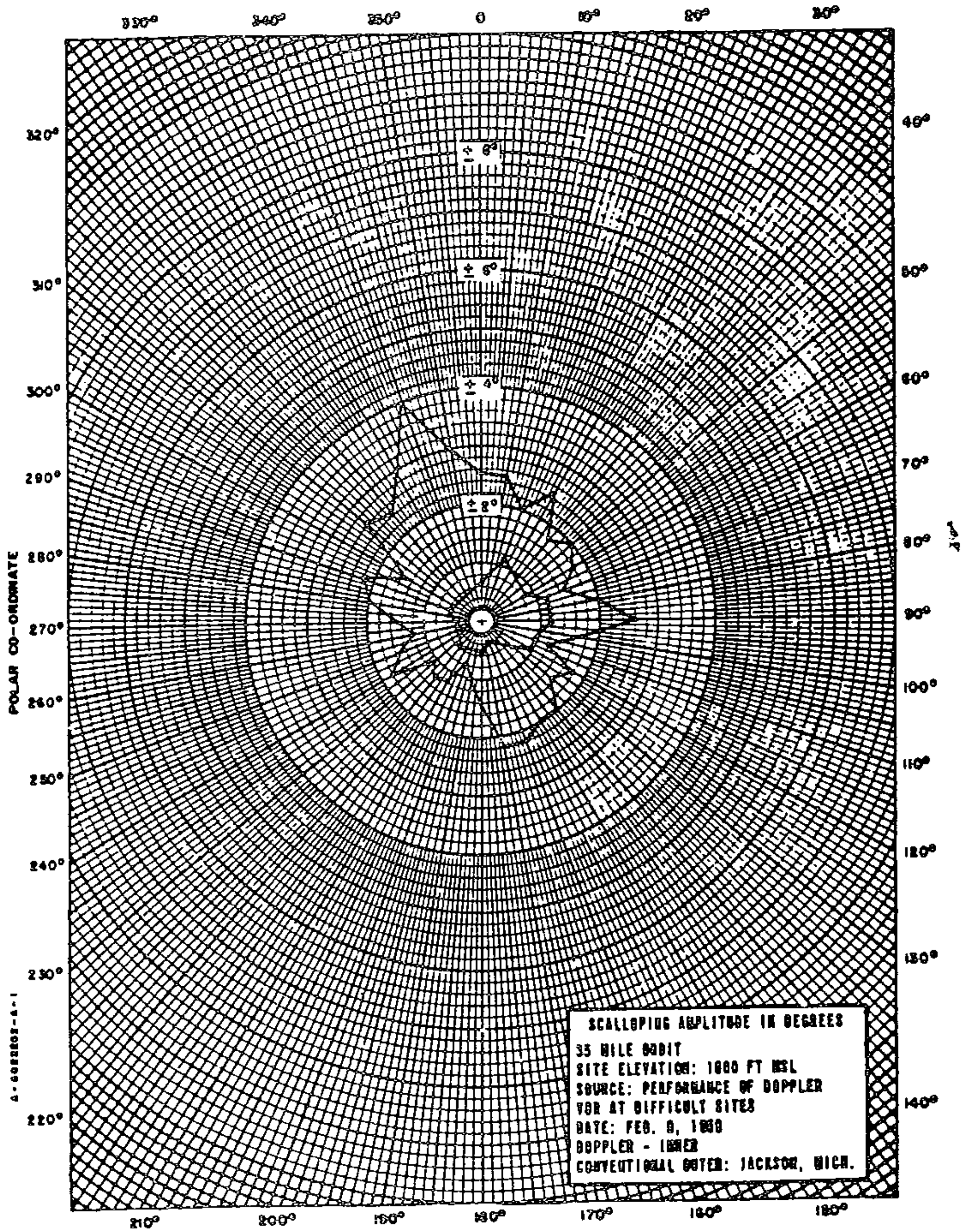


FIGURE 26. SCALLOPING AMPLITUDE

Section 14. Kansas City, Missouri

COMMENTS: The large scalloping in the azimuthal region of 140 degrees is caused by large buildings on high ground and a bridge, all in the city area. The proximity of the PAR to the DVOR is probably the cause of some scalloping in the 30- to 60-degrees sector; however, the buildings and towers in this sector probably cause most of the error. The grain elevator, buildings, and tank farm structures in the 260- to 300-degrees sector are undoubtedly responsible for most of the large scalloping at 255- and 308-degrees azimuth areas. The metal hangars in the 320- to 360-degrees sector probably account for some of the scalloping to the west and northwest.

Probably the main factor responsible for this being a poor site is its location on terrain below the elevation of the surrounding countryside. This also accounts for the poor coverage, undoubtedly due to shadowing.

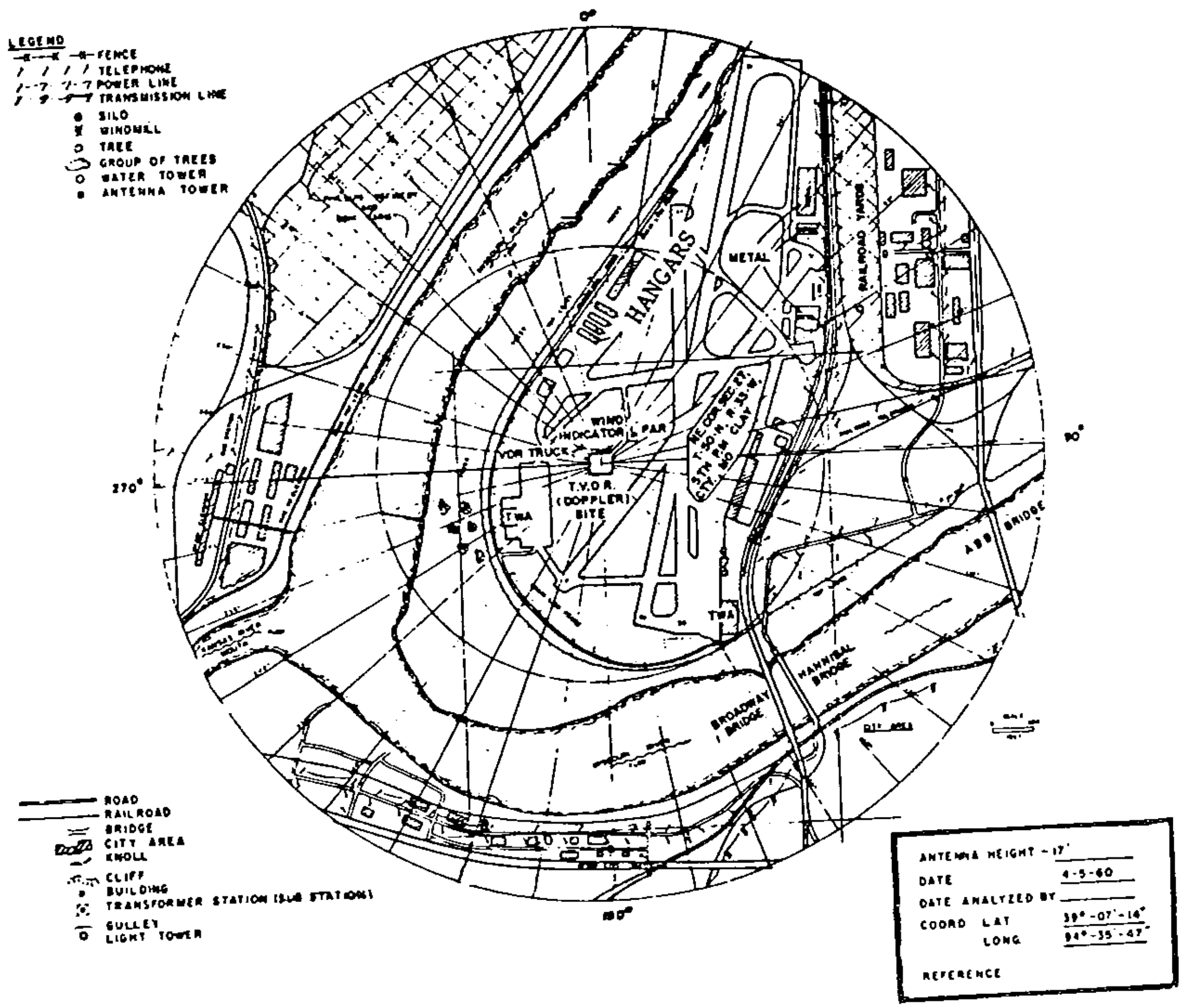


FIGURE 27. VICINITY SKETCH (1-MILE RADIUS) RIVERSIDE, MISSOURI TVOR

Section 14. Kansas City, Missouri (continued)

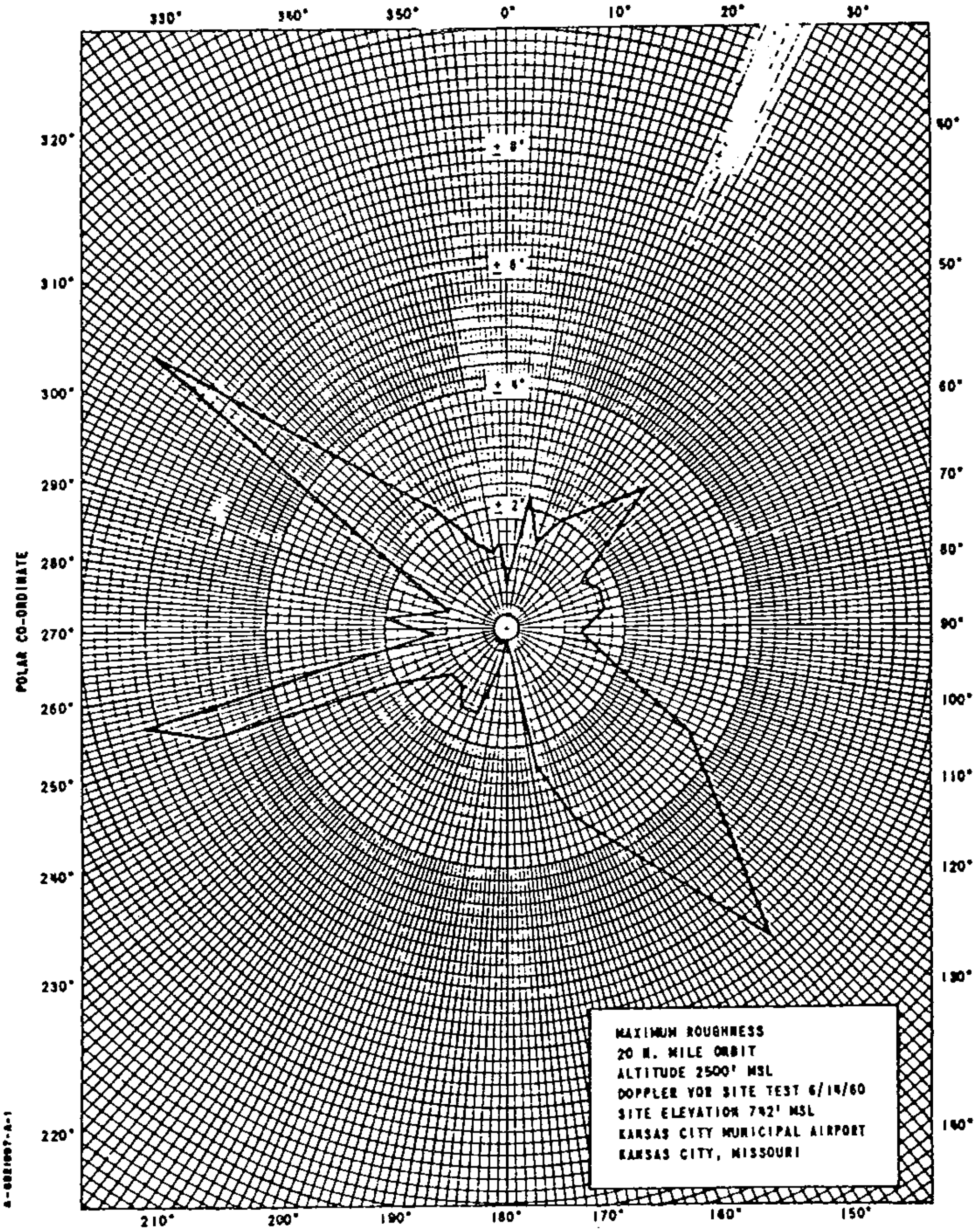


FIGURE 28. ROUGHNESS AMPLITUDE

Section 15. Lake Tahoe, California

COMMENT: This is a good example of a unique mountain top site.

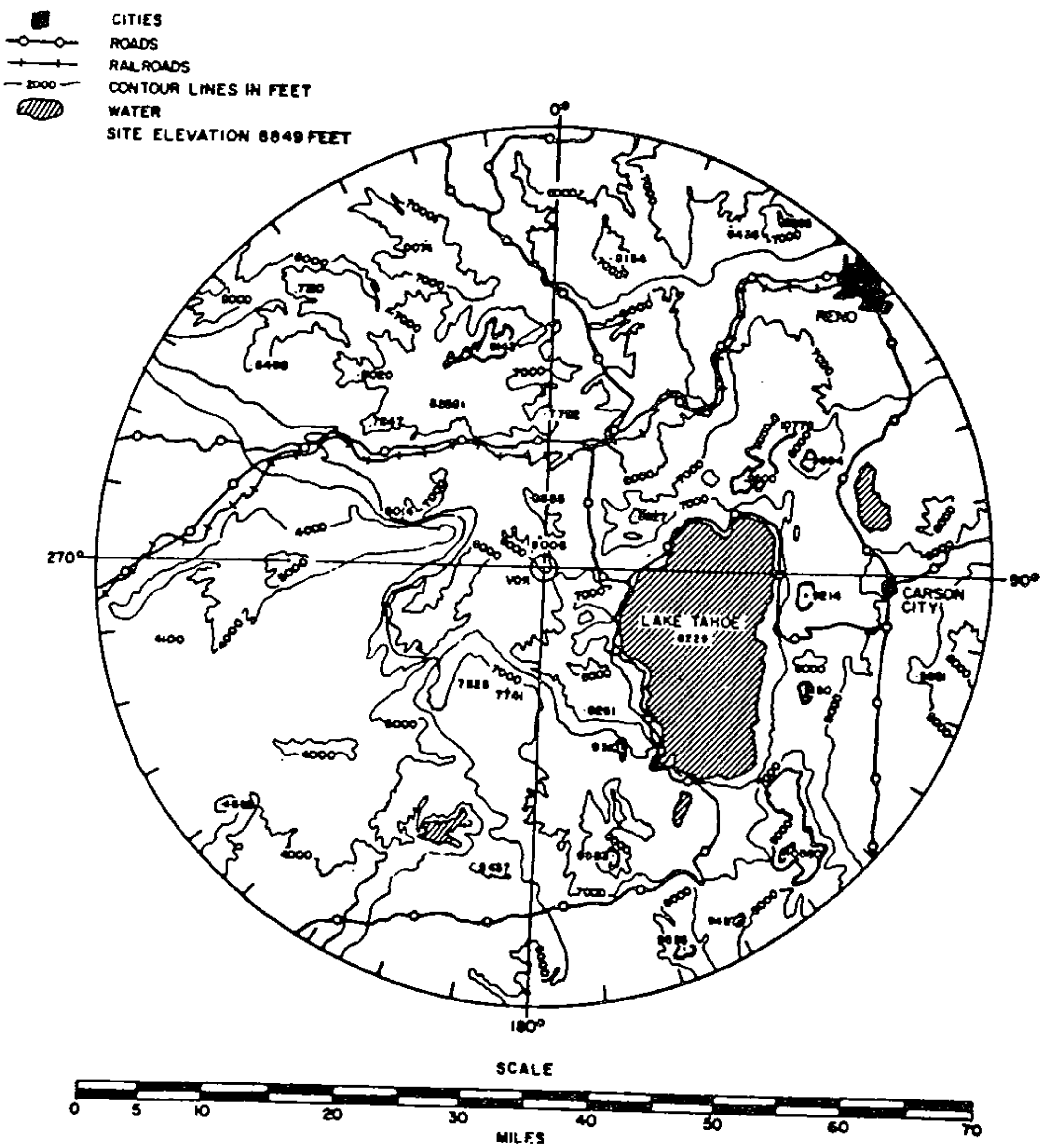


FIGURE 29. VICINITY SKETCH (35-MILE RADIUS) LAKE TAHOE, CALIFORNIA VOR

Section 15. Lake Tahoe, California (continued)

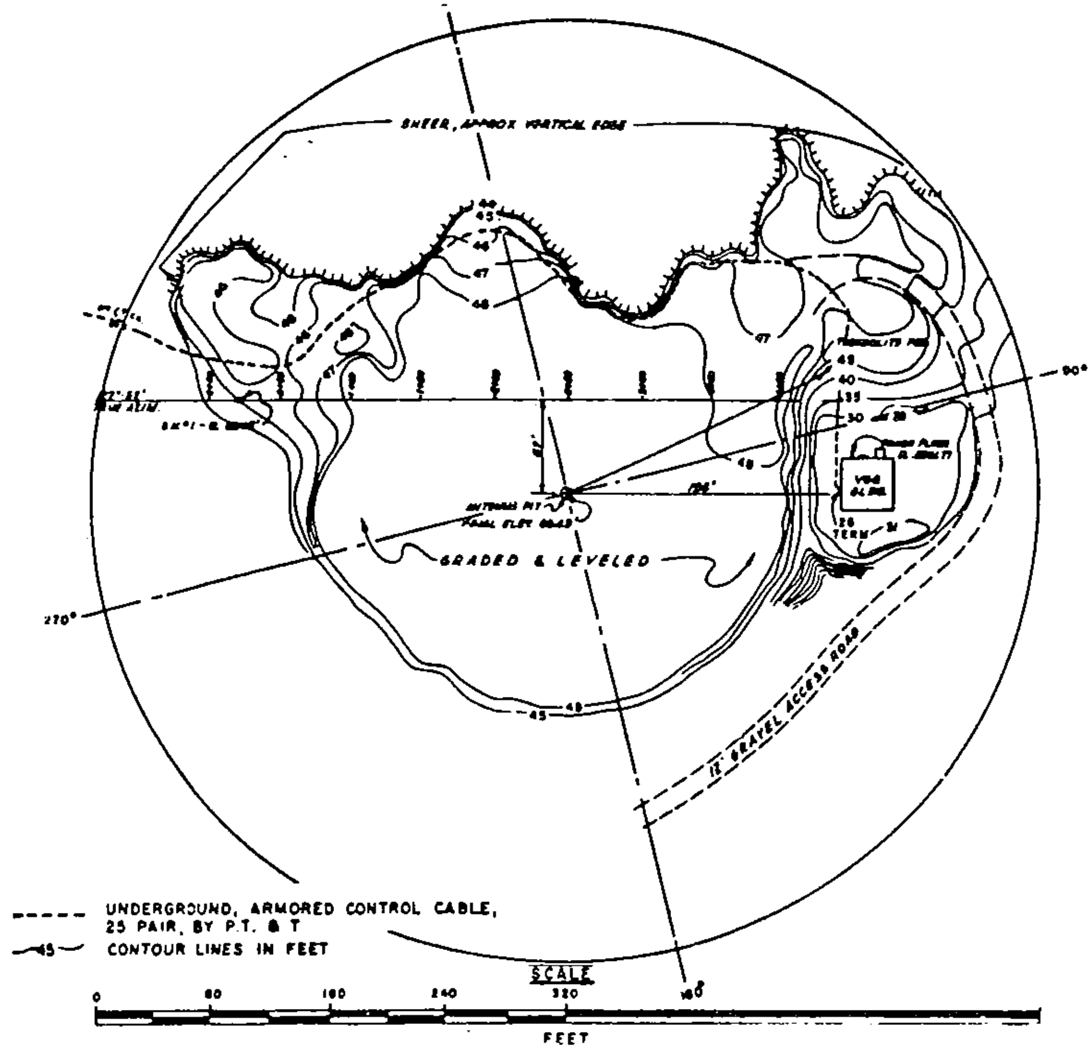


FIGURE 30. VICINITY SKETCH (320-FOOT RADIUS) LAKE TAHOE, CALIFORNIA VOR

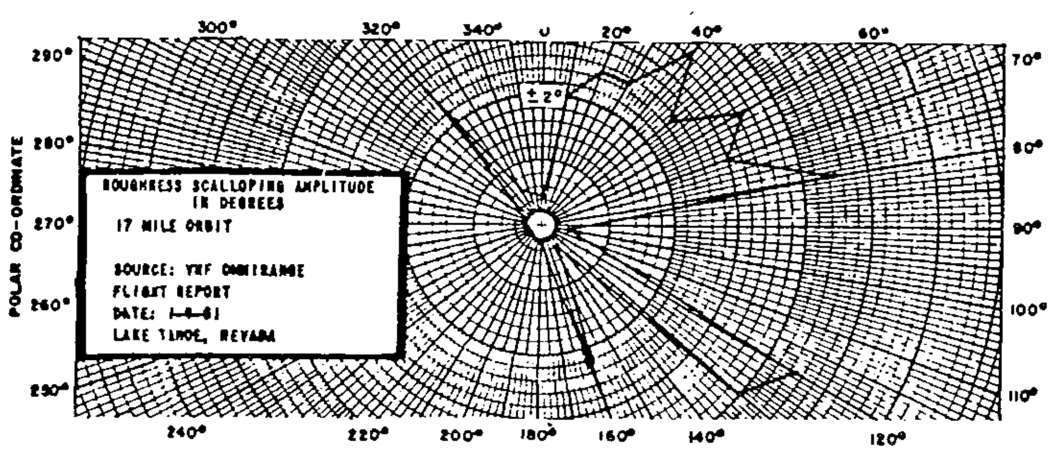


FIGURE 31. SCALLOPING AND ROUGHNESS AMPLITUDE

Section 16. Malad City, Idaho

COMMENT: The 7-mile orbit scalloping amplitude plots show that very satisfactory VOR performance can be obtained in mountainous terrain by careful selection and preparation. Both curves represent results obtained with ground-mounted, 5-loop antennas. The solid line curve was obtained after the site was leveled. A later installation using the FAA 4-loop antenna resulted in a further improvement of VOR performance.

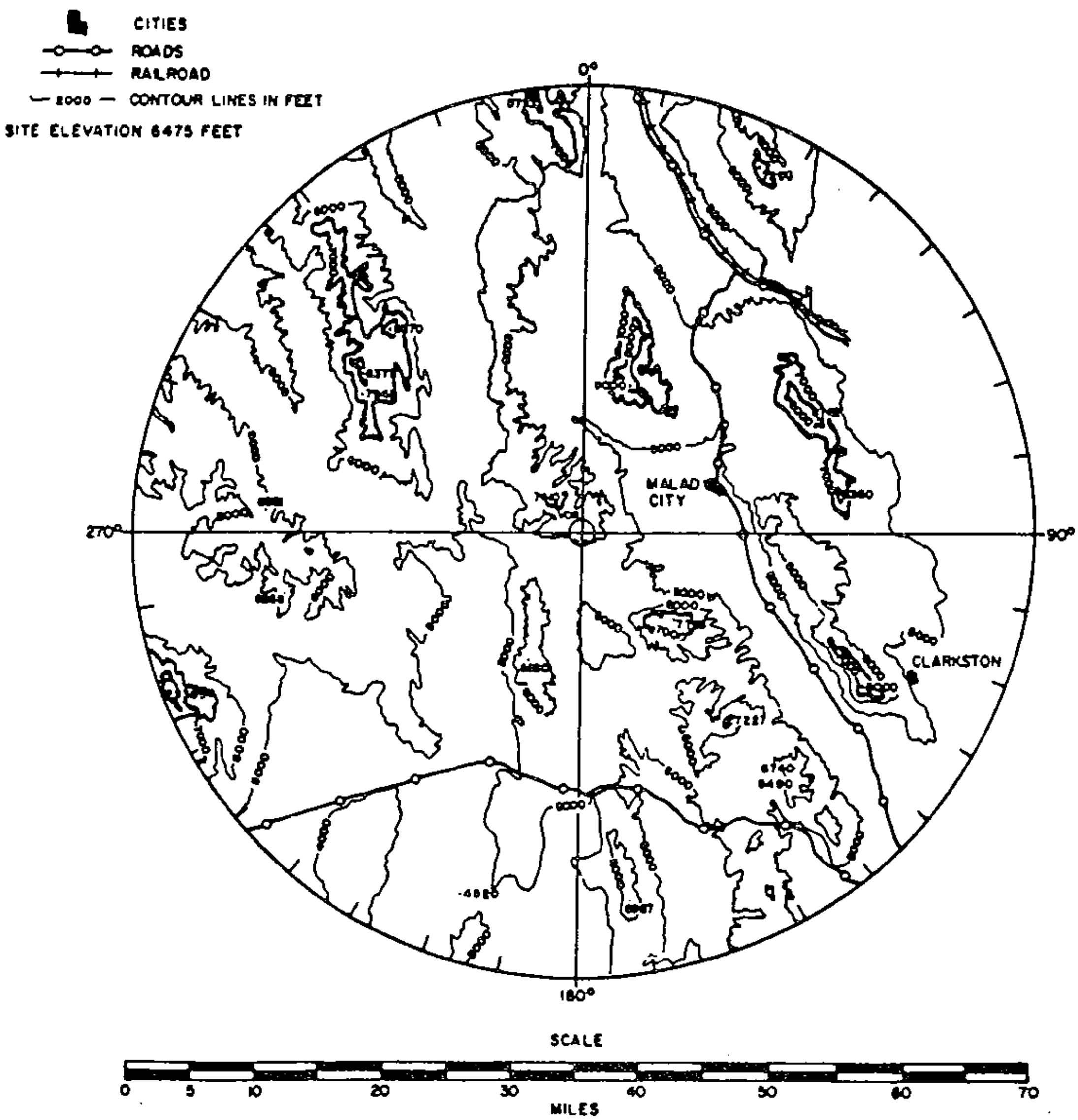


FIGURE 32. VICINITY SKETCH (35-MILE RADIUS) MALAD CITY, IDAHO VOR

Section 16. Malad City, Idaho

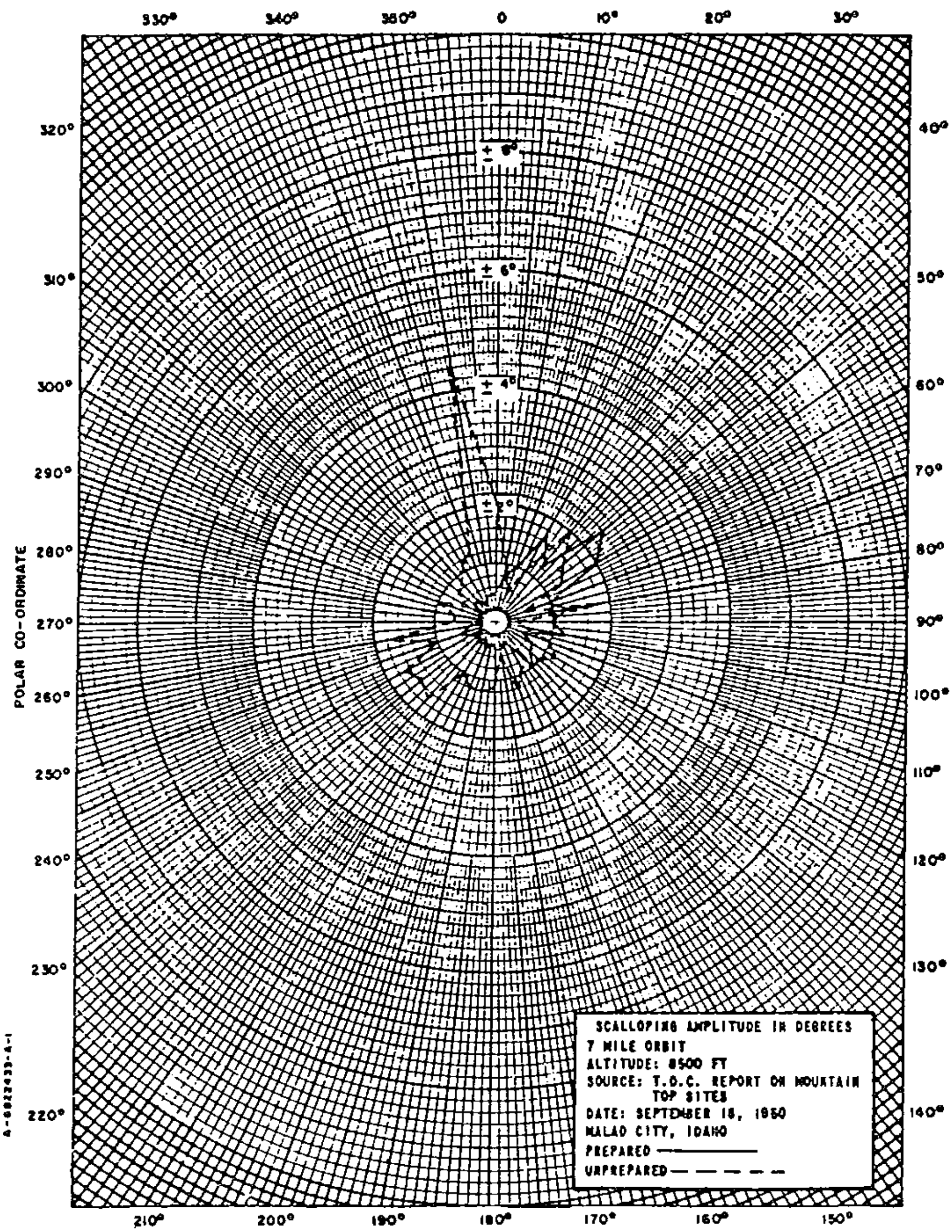


FIGURE 33. SCALLOPING AMPLITUDE

Section 17. Oklahoma City, Oklahoma

COMMENT: The scalloping amplitude curve maxima at 60 and 280 degrees azimuth are believed to be caused by reflections from hangar No. 50 and from the administration building, respectively.

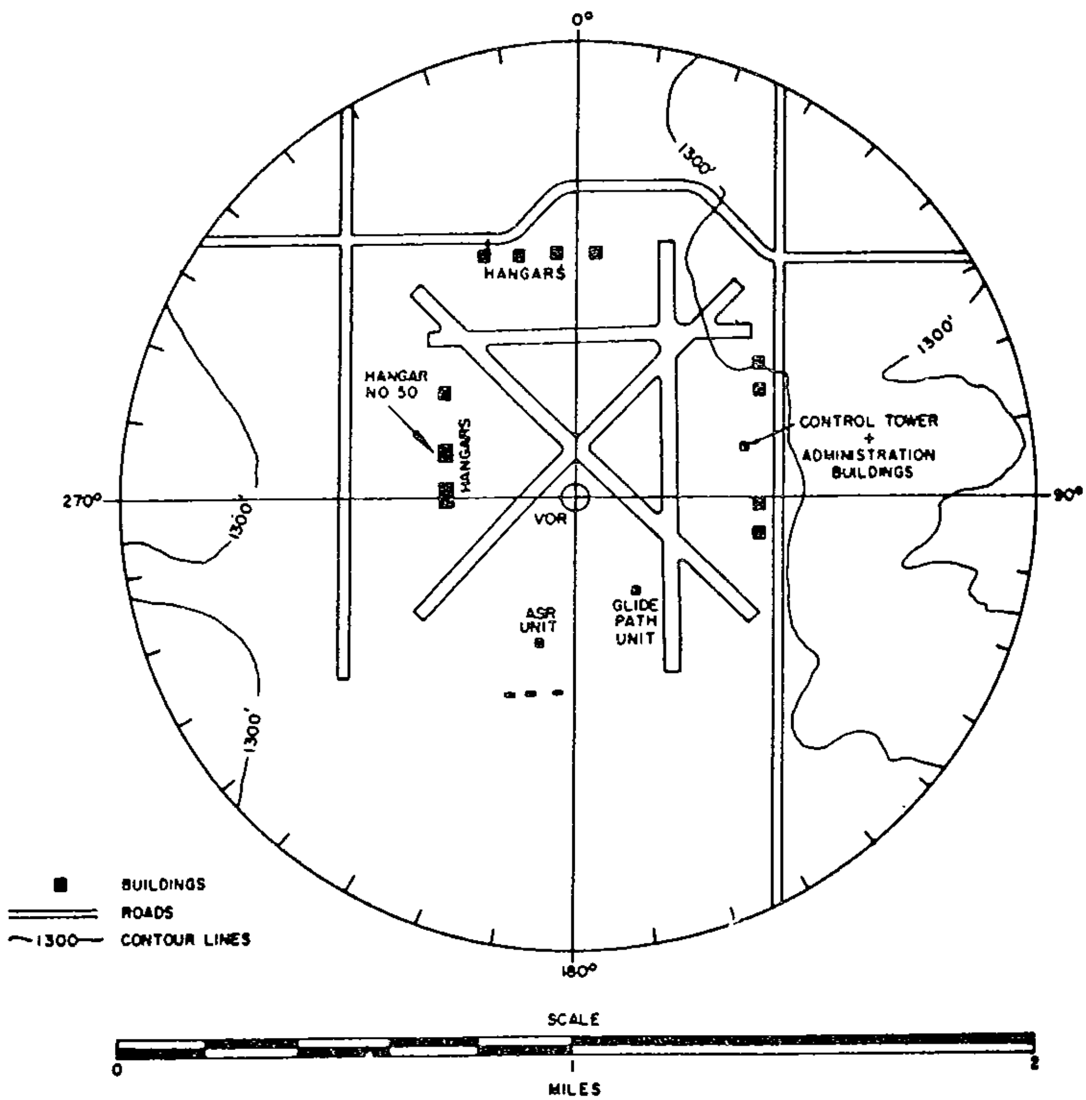
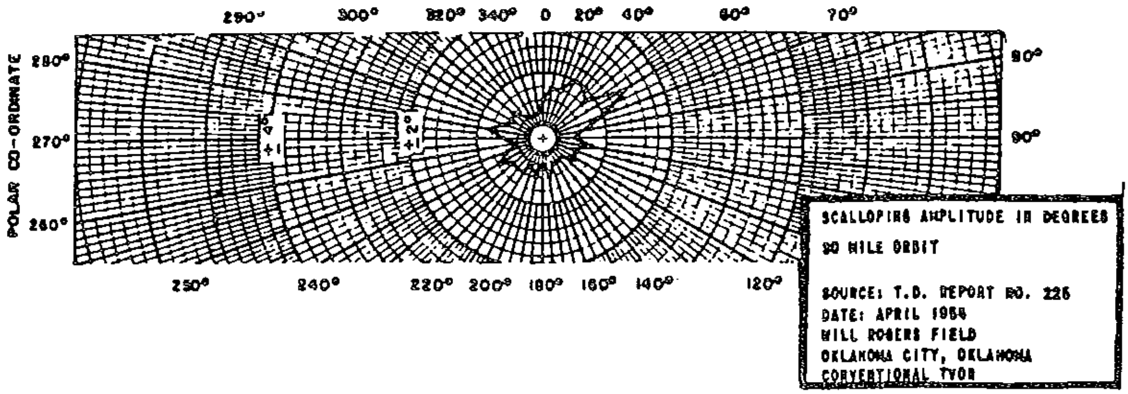


FIGURE 34. VICINITY SKETCH (1-MILE RADIUS) OKLAHOMA CITY, OKLAHOMA VOR)

Section 17. Oklahoma City, Oklahoma (continued)



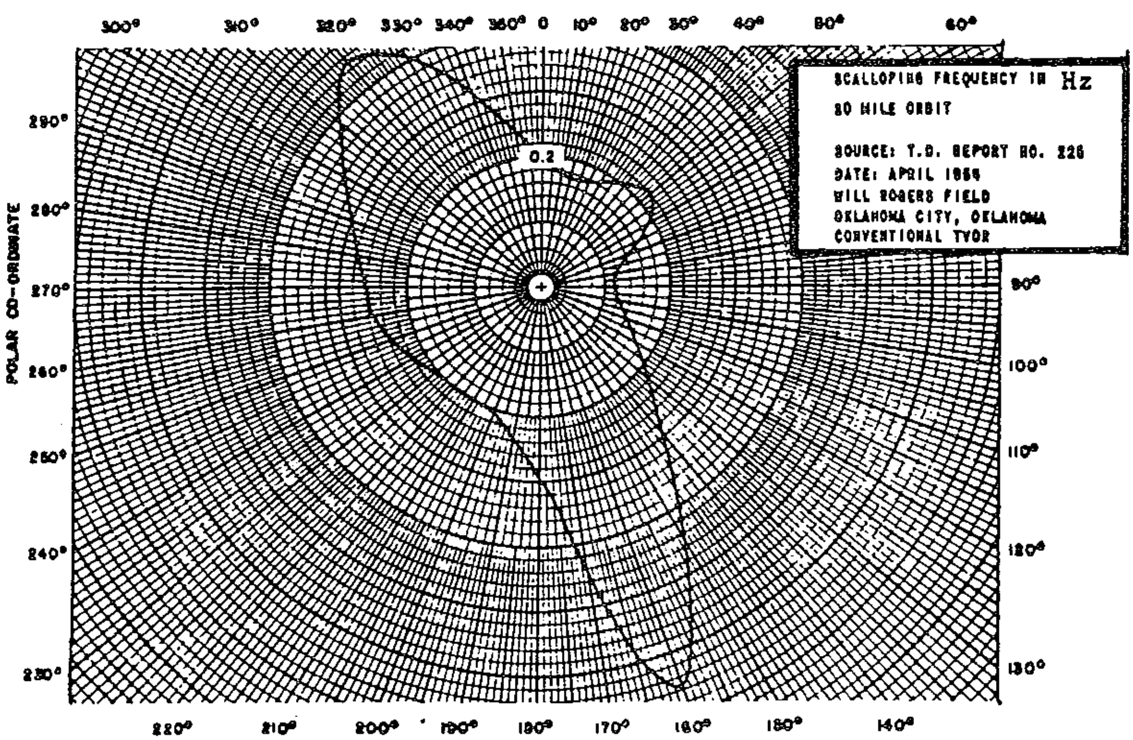


FIGURE 35. SCALLOPING AMPLITUDE AND FREQUENCY

Section 18. Roanoke, Virginia

COMMENT: This a poor site since the ground only 200 feet from the antenna is approximately 15 feet higher than the terrain supporting the antenna. Serious scalloping would be expected on each side of this mound and limited coverage (propagation) in the sector of the higher-than-antenna-site terrain. On a 20-mile circle, the scalloping frequency due to the mound would be so low (0.04 cps) that the scalloping would appear only as a bearing error. This could be measured by obtaining a station bearing error curve with the aircraft at a 20-mile radius.

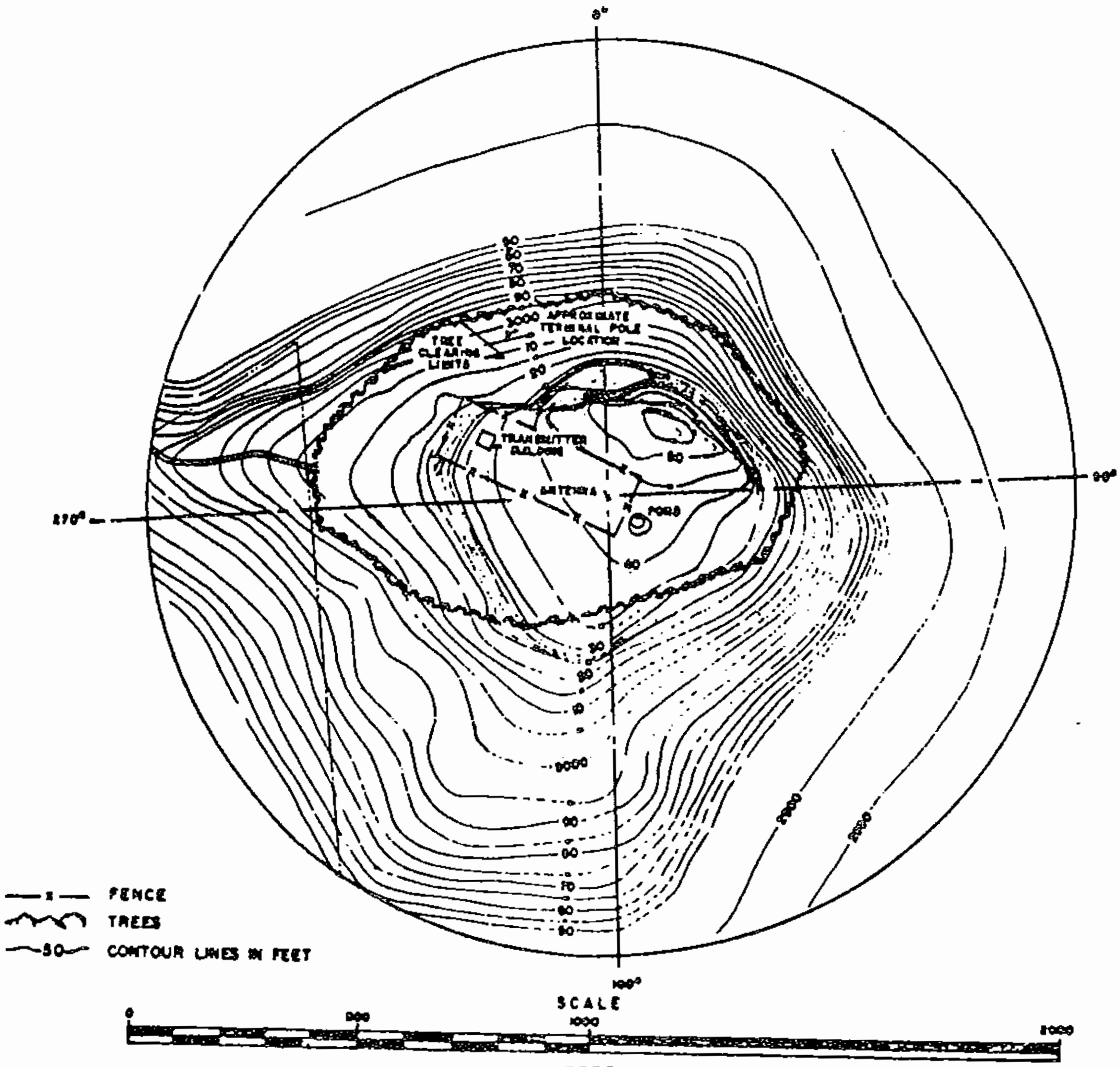


FIGURE 36. VICINITY SKETCH (1000 FOOT RADIUS) ROANOKE, VIRGINIA VOR

Section 18. Roanoke, Virginia (continued)

6820.
Appendix 7

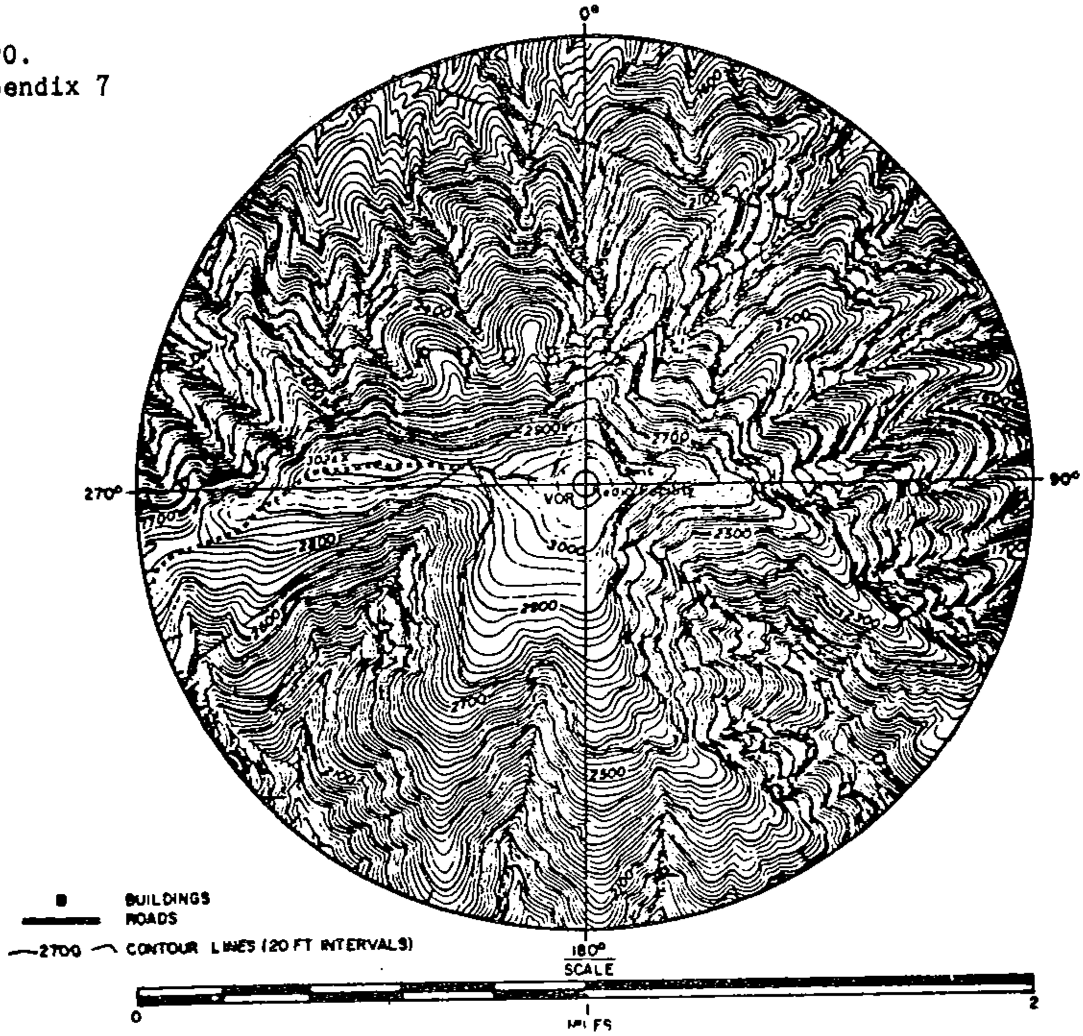


FIGURE 37. VICINITY SKETCH (1-MILE RADIUS) ROANOKE, VIRGINIA VOR

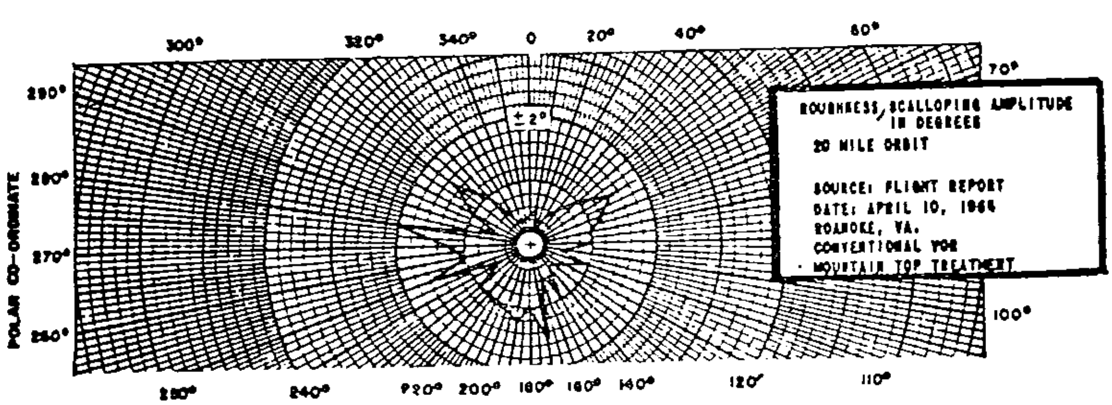


FIGURE 38. SCALLOPING AND ROUGHNESS AMPLITUDE

Section 19. Sisters Island, Alaska

COMMENT: The electrical height of the antennas above the sea is approximately 2100 degrees causing deep vertical plane nulls at intervals of 5 degrees. The surrounding terrain, strongly illuminated by the first signal maximum, reflected energy into the null areas causing course roughness and scalloping.

This is an excellent example of the benefits of the DVOR over the conventional VOR in reducing the effects of deep nulls caused by sea water reflection.

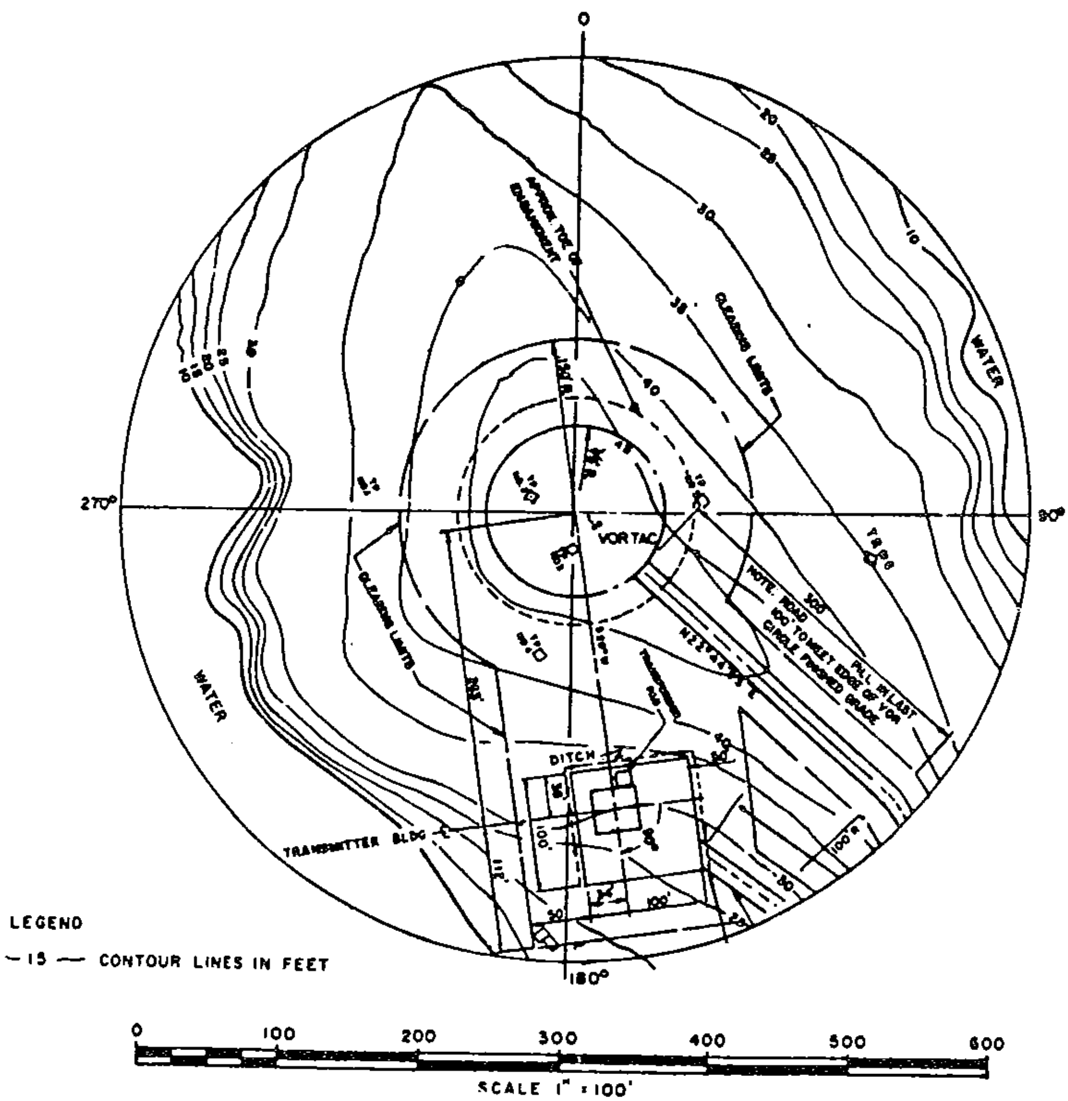


FIGURE 39. VICINITY SKETCH (300-FOOT RADIUS) SISTERS ISLAND, ALASKA VOR

Section 19. Sisters Island, Alaska (continued)

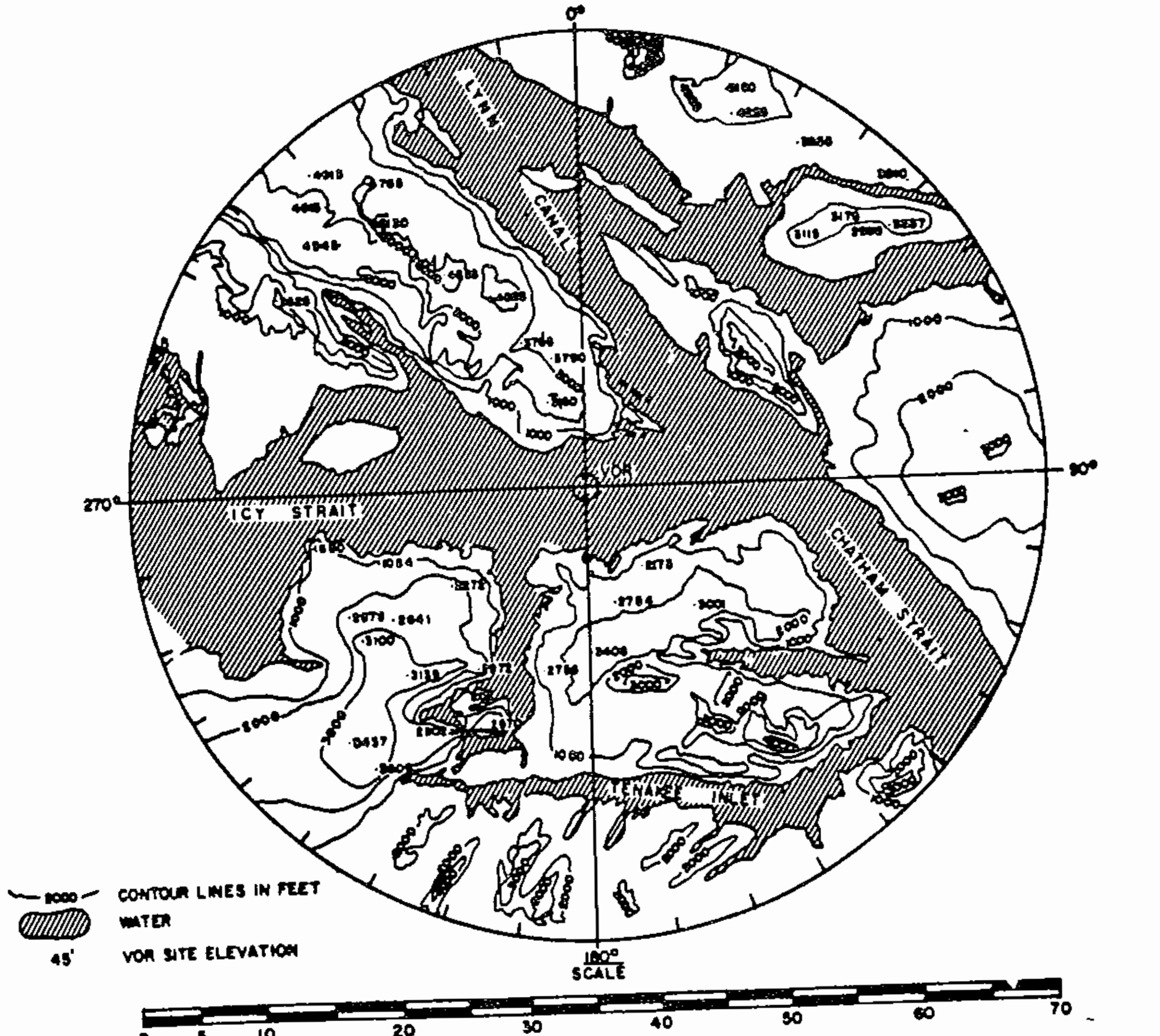


FIGURE 40. VICINITY SKETCH (35-MILE RADIUS) SISTERS ISLAND, ALASKA VOR

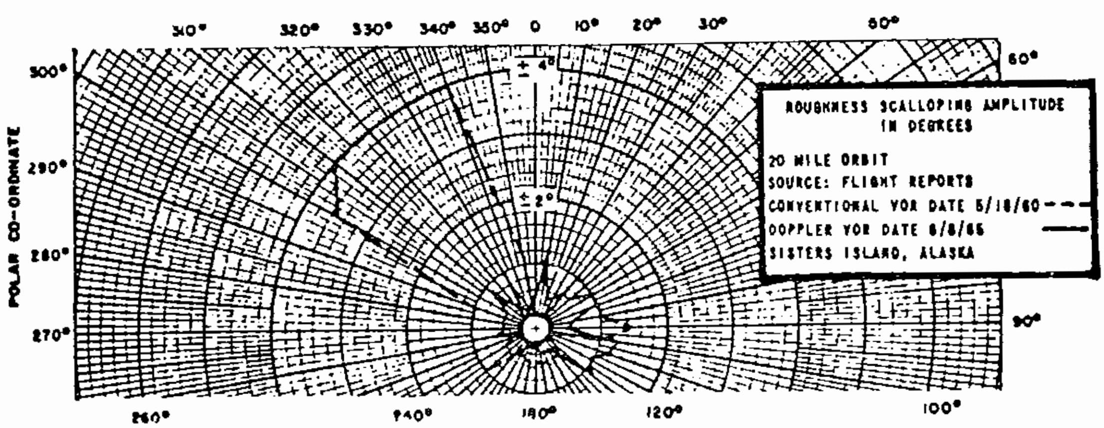


FIGURE 41. SCALLOPING AND ROUGHNESS AMPLITUDE

Section 20. TDC Indianapolis, Indiana

COMMENT: The terrain is flat for miles in all directions from the station. The conventional VOR scalloping in the vicinity of 50 and 230 degrees azimuth is caused by the hangar's north face and west face, respectively; the two towers cause scalloping in the 240 to 260 degrees azimuth sector and the 300 to 320 degrees azimuth sector.

The two vertical towers cause the DVOR scalloping in the vicinity of the 250 and 270 degrees azimuths.

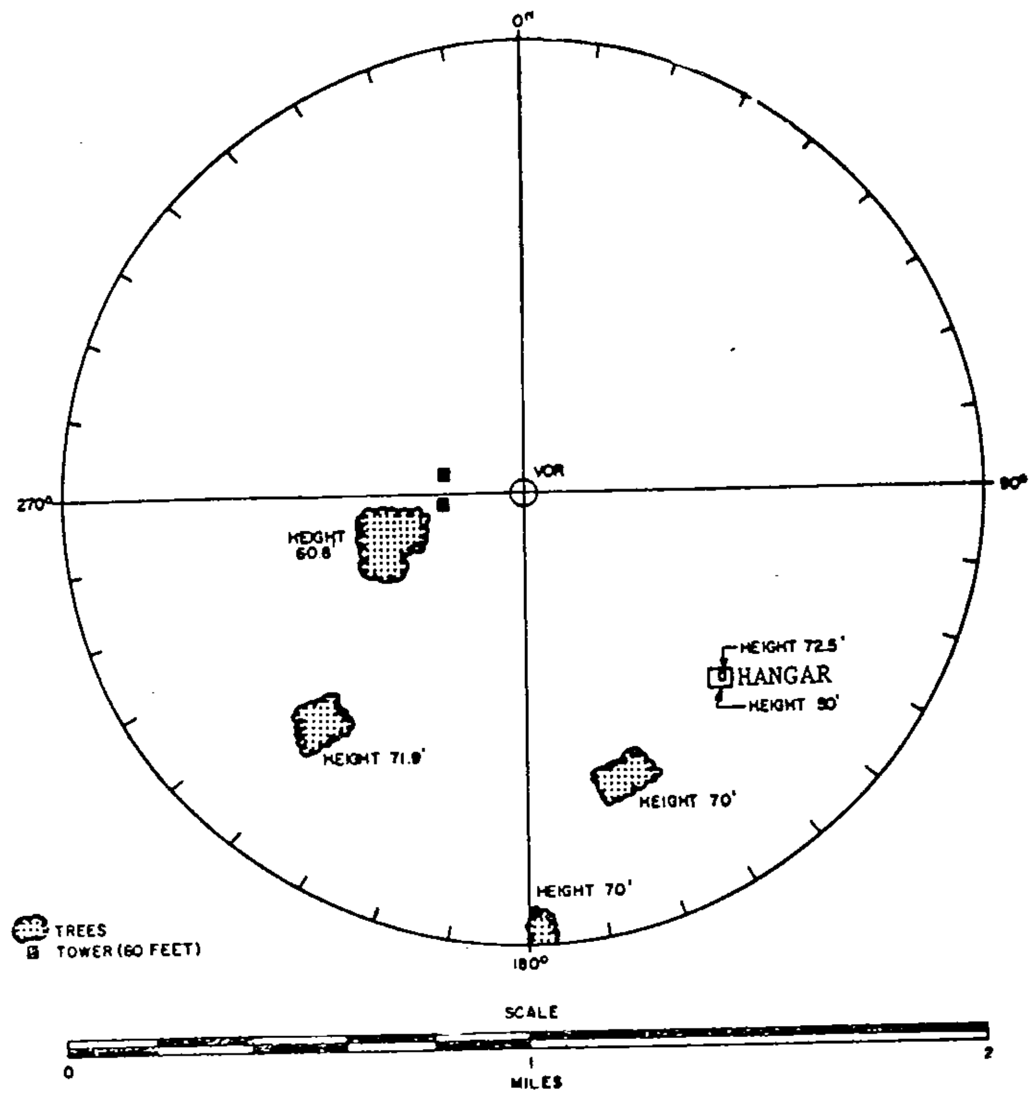
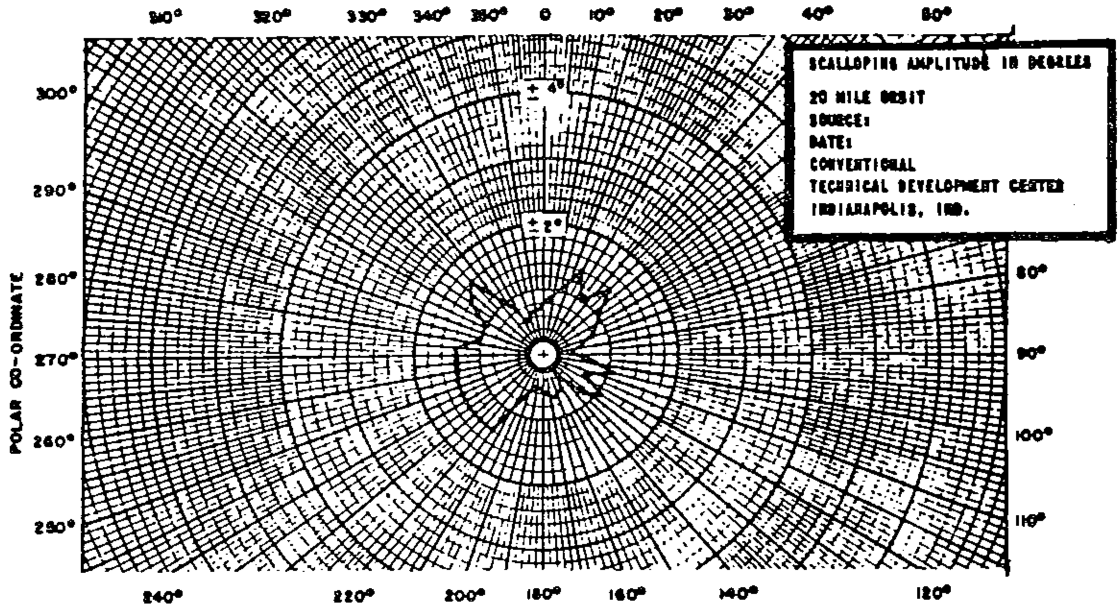


FIGURE 42. VICINITY SKETCH (1-MILE RADIUS) TDC INDIANAPOLIS, INDIANA EXPERIMENTAL VOR

Section 20. TDC Indianapolis, Indiana (continued)



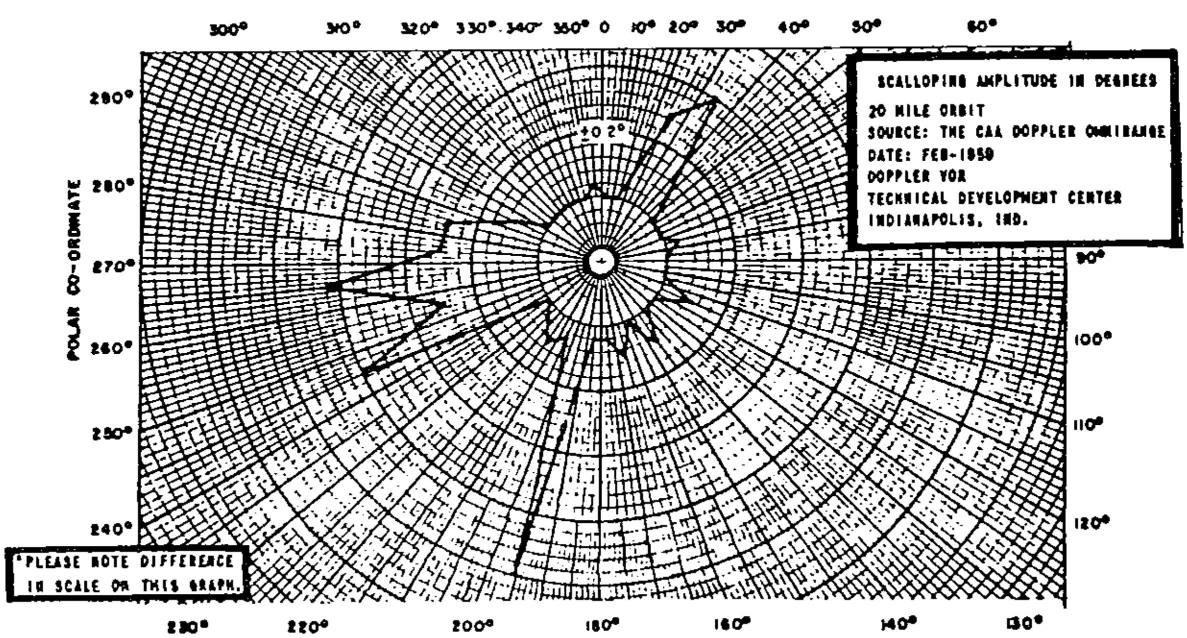


FIGURE 43. SCALLOPING AMPLITUDE

Section 20. TDC Indianapolis, Indiana (continued)

COMMENT: Tests were conducted to determine the performance of a VOR located at various distances from a single tree. The tests were conducted with the horizontal limbs of the tree removed. As the distance between the VOR and the tree is increased, you will note that the scalloping amplitude decreases. The scalloping frequency, however, increases as the distance between the VOR and tree increases. The information obtained during these tests was summarized in Figure 3-5.

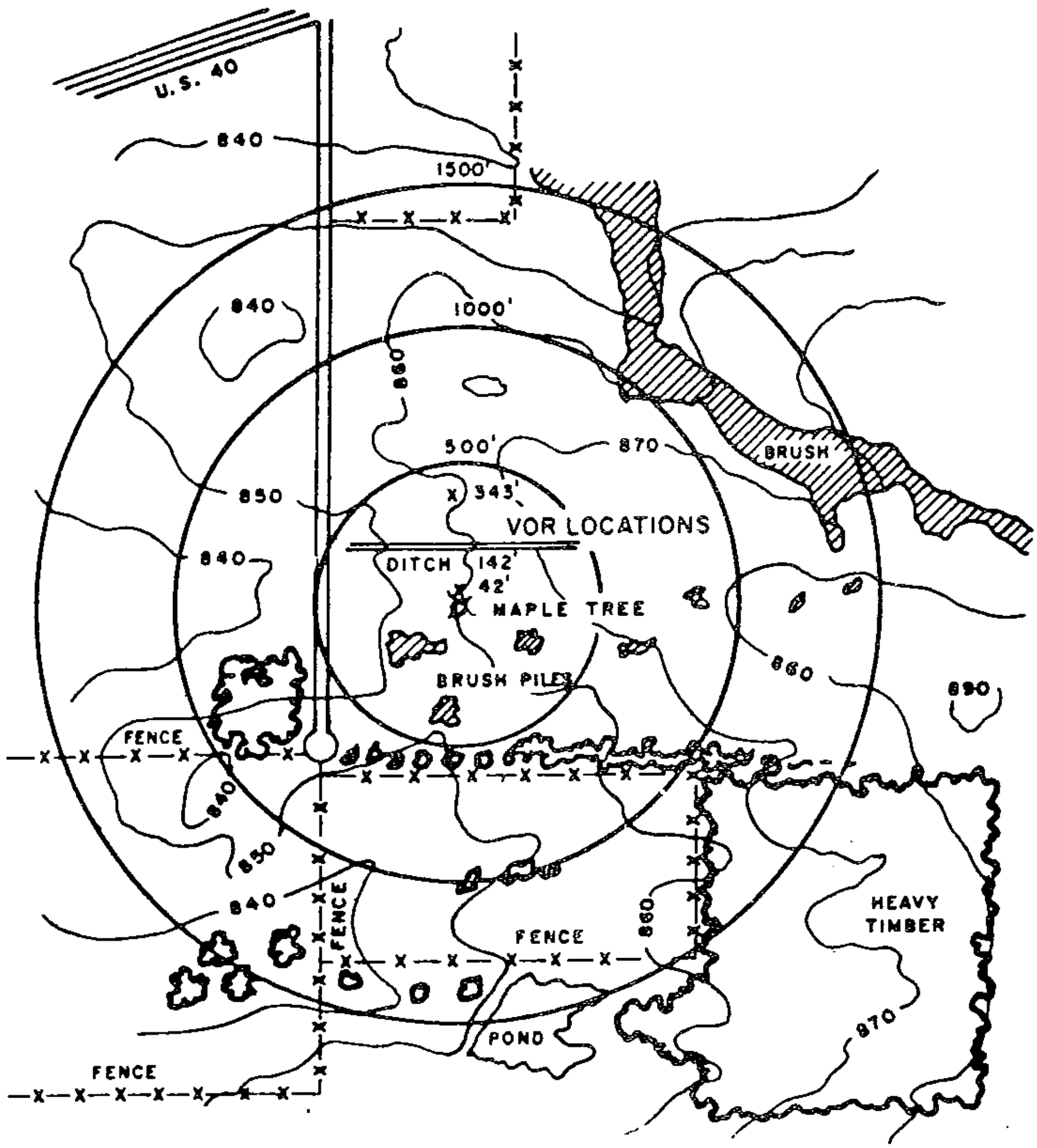


FIGURE 44. VICINITY SKETCH (1500-FOOT RADIUS) TDC INDIANAPOLIS, INDIANA SITE TEST AREA

Section 20. TDC Indianapolis, Indiana (continued)

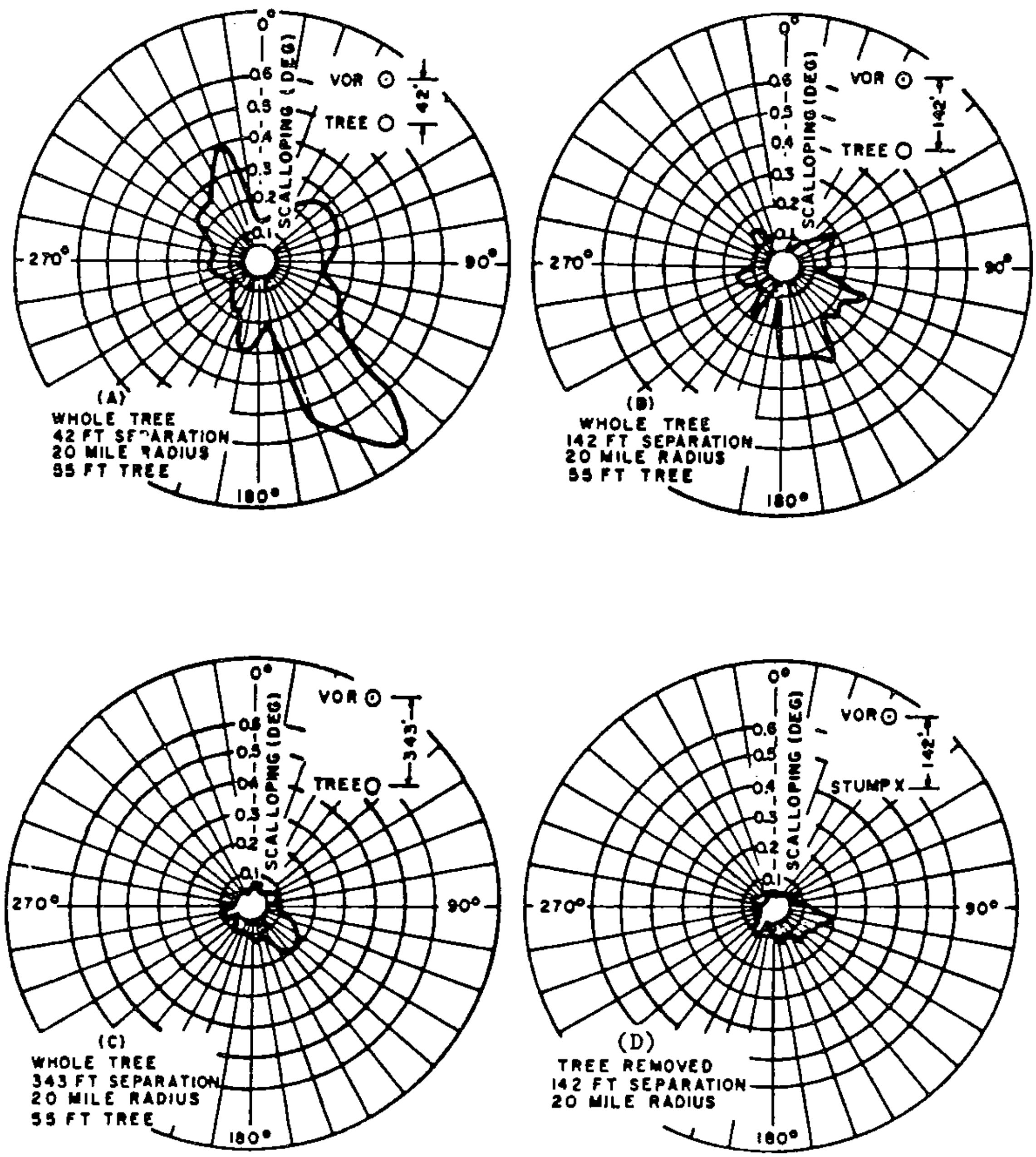


FIGURE 45. SCALLOPING AMPLITUDE

Section 21. Traverse City, Michigan

COMMENT: The site is generally flat with rising land four to six miles distant. Maximum scalloping in the 190 to 210 degrees sector is believed to be due to reflections from the control tower/airport terminal structure.

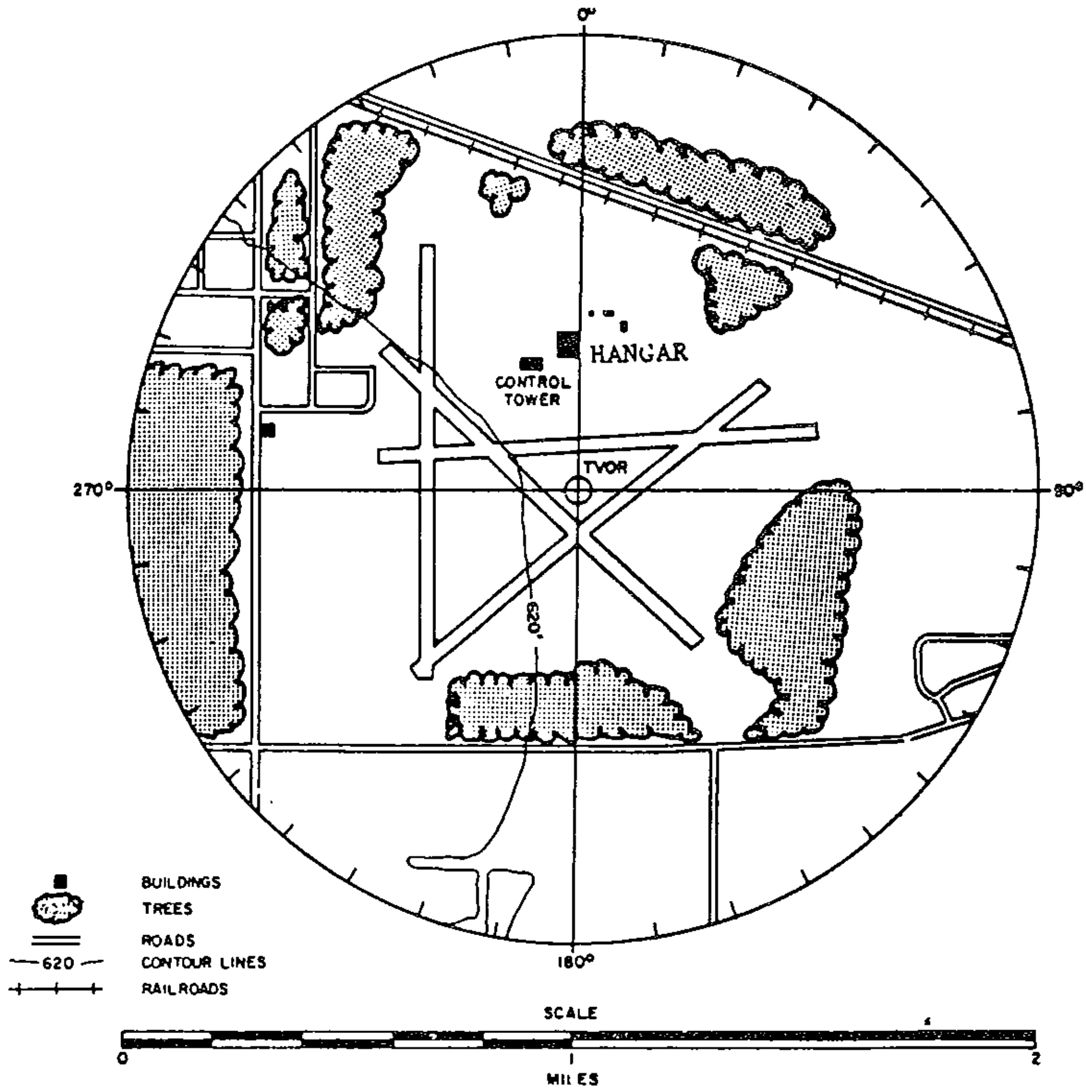
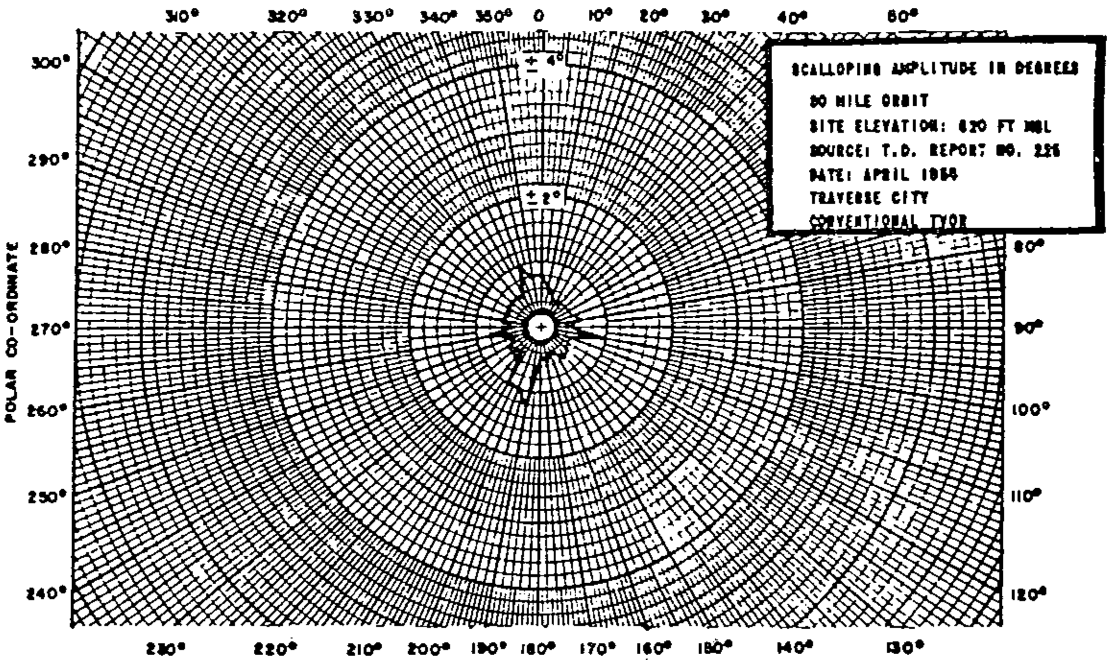


FIGURE 46. VICINITY SKETCH (1-MILE RADIUS) TRAVERSE CITY, MICHIGAN VOR

Section 21. Traverse City, Michigan (continued)



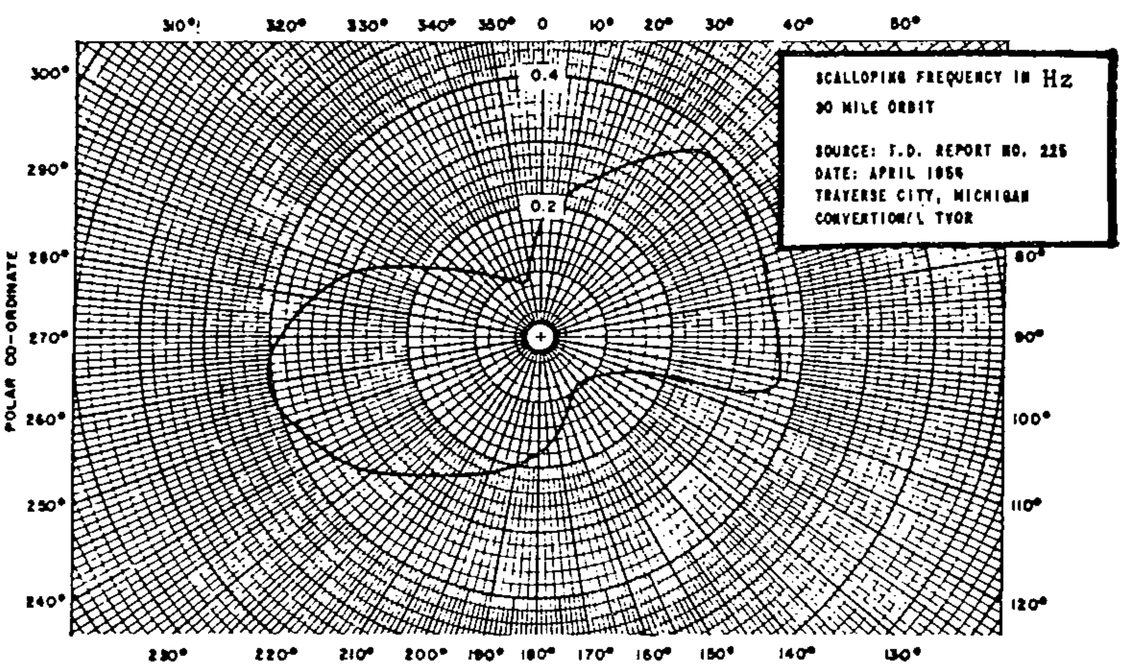


FIGURE 47. SCALLOPING AMPLITUDE AND FREQUENCY

Section 22. Ukiah, California

COMMENT: Performance of this mountain top VOR is very satisfactory. The scalloping graphs indicate the large improvement due to the mountain top VOR configuration when compared to an elevated counterpoise (conventional) installation).

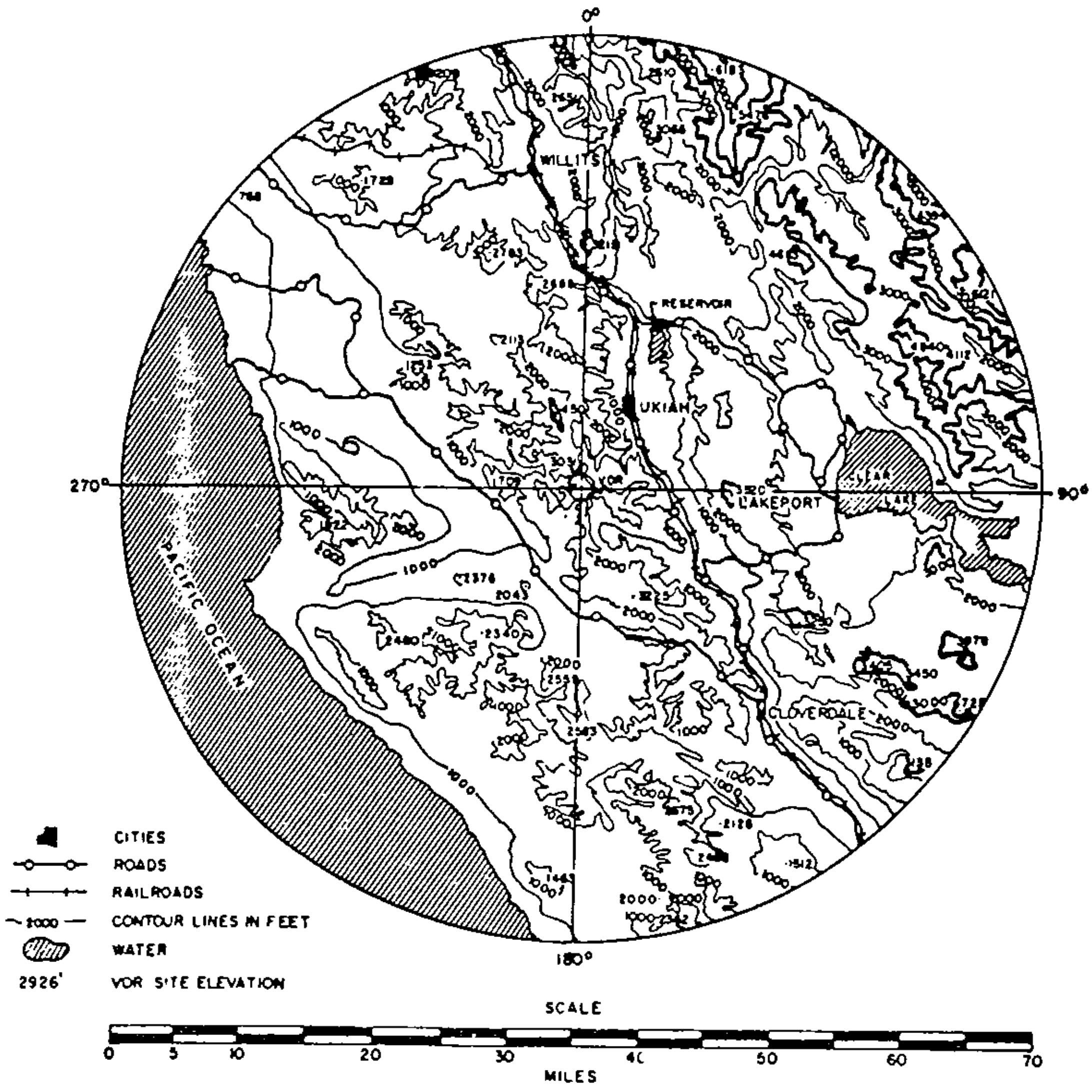


FIGURE 48. VICINITY SKETCH (35-MILE RADIUS) UKIAH, CALIFORNIA VOR

Section 22. Ukiah, California (continued)

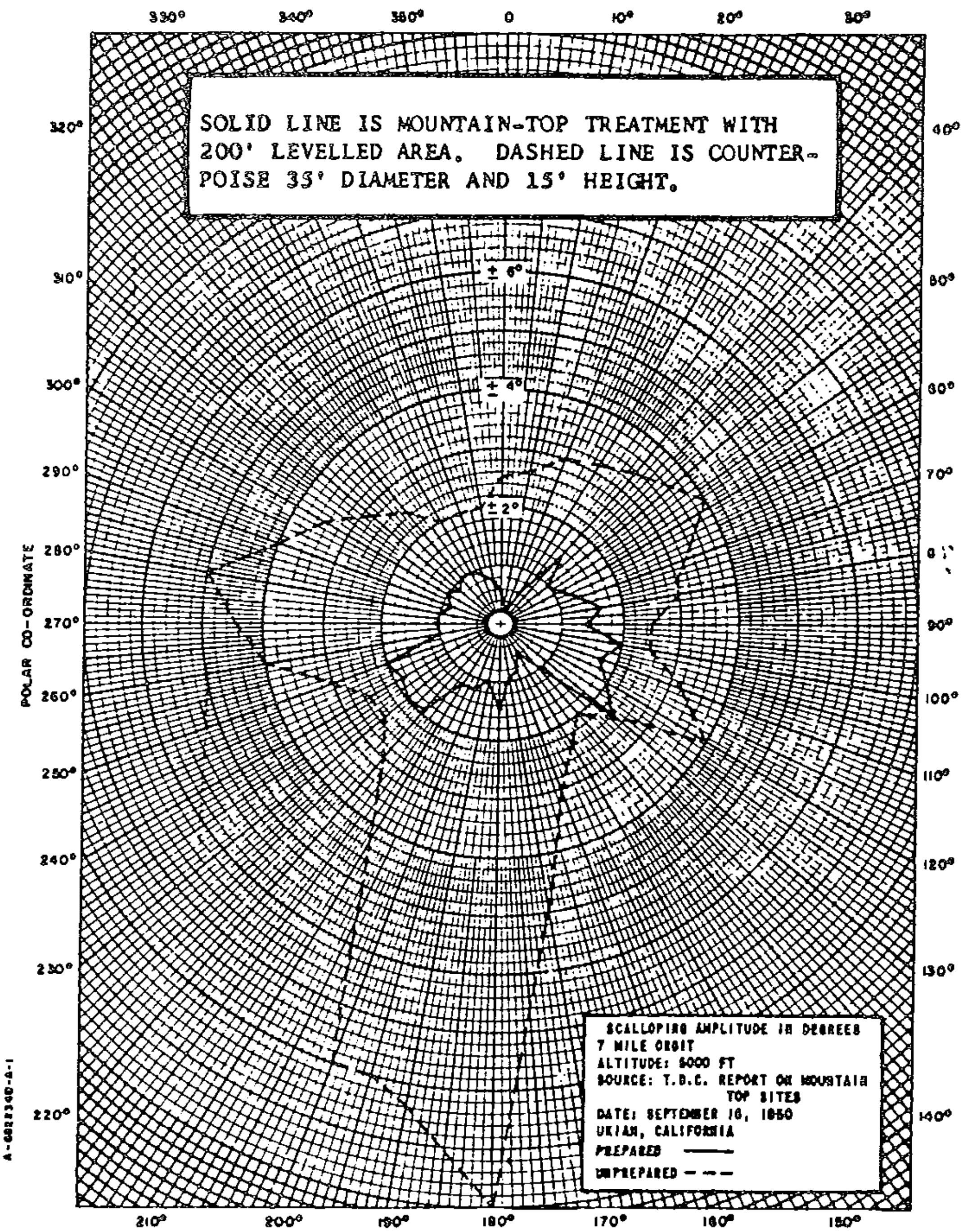


FIGURE 49. SCALLOPING AMPLITUDE

Section 23. Washington, DC

COMMENT: Indicator circuitry filters out the higher frequency scalloping signal thereby minimizing the importance of certain scalloping. The signals that caused the 1.28-Hz scalloping frequency at 310 degrees azimuth and the 0.51 Hz at 170 degrees azimuth are capable of causing course deviation indicator errors of ±6.7 degrees and ±3.7 degrees, respectively, for special cases of flying. Development of the airport and surrounding area has caused continued deterioration of VOR performance and has led to the need for conversion to Doppler.

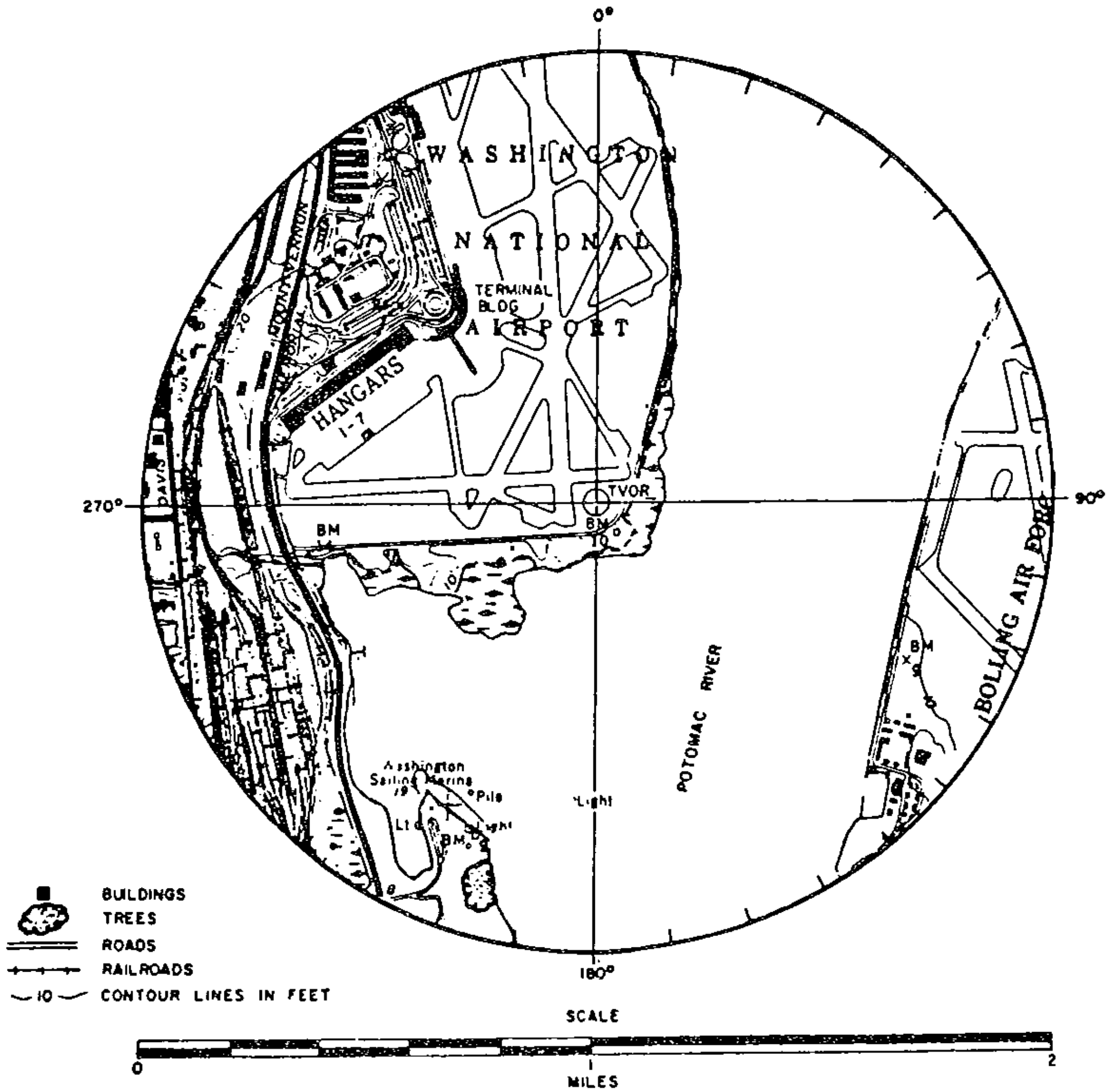
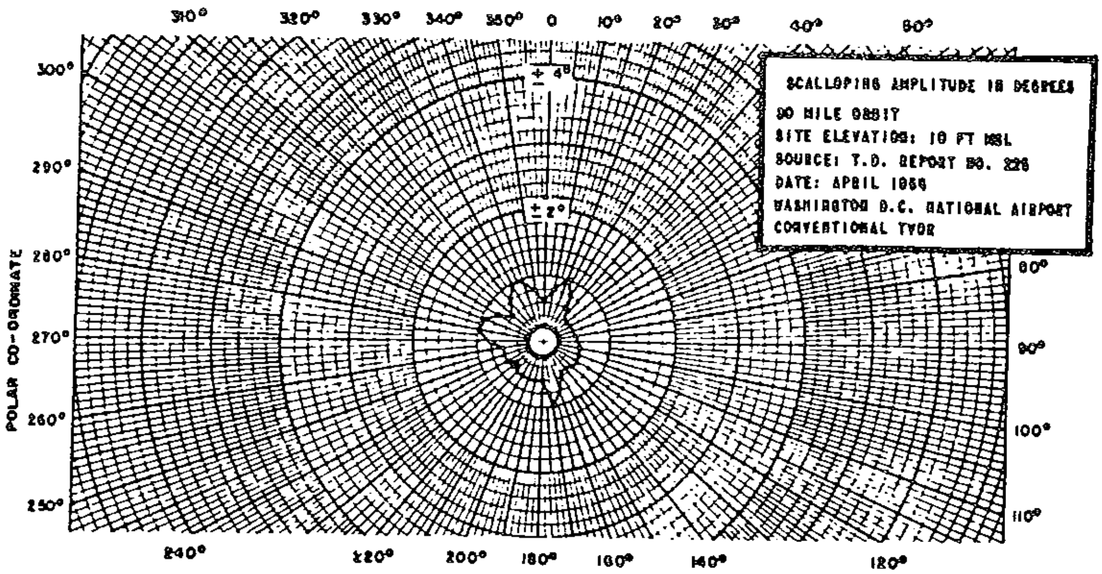


FIGURE 50. VICINITY SKETCH (1-MILE RADIUS) WASHINGTON, DC VOR

Section 23. Washington, DC (continued)



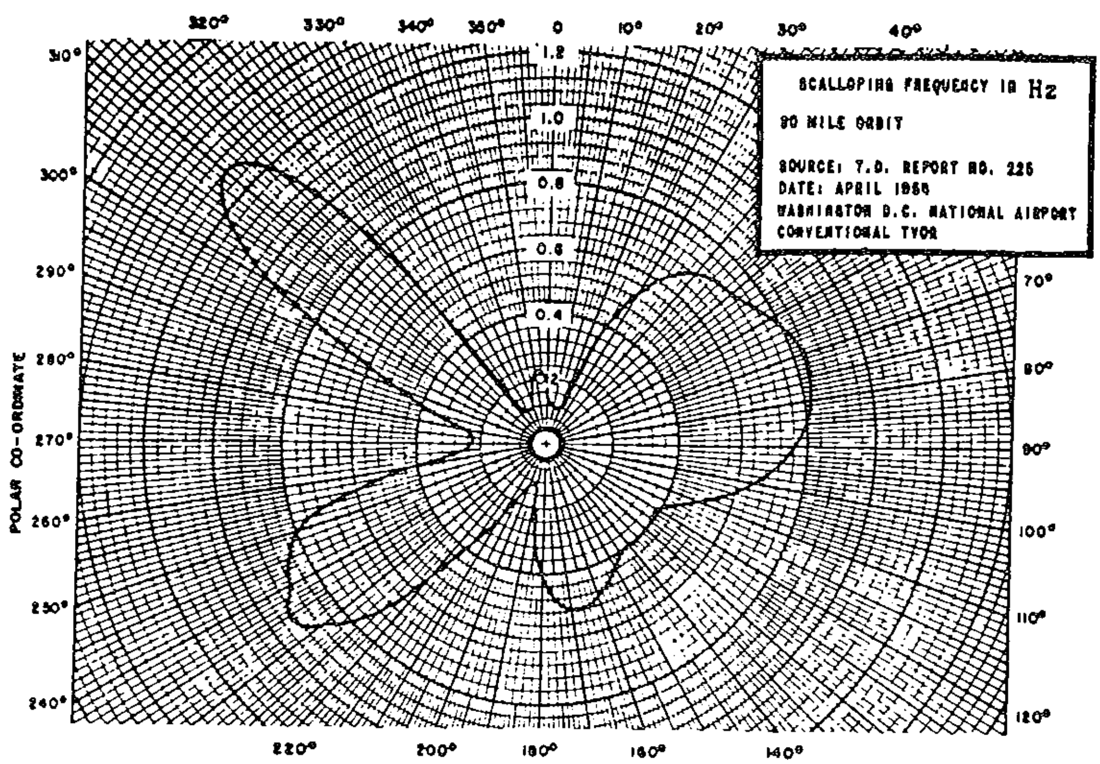


FIGURE 51. SCALLOPING AMPLITUDE AND FREQUENCY

Section 24. Wilmington, North Carolina

COMMENT: This is a good site. It would be an excellent site except for the power line 1100 feet north. The source of course scalloping can often be isolated and attributed to prominent objects in the vicinity of the facility such as power lines, buildings, or towers. A comparison is made between the course scalloping frequency observed and the computed course scalloping frequency of an assumed source of reflections.

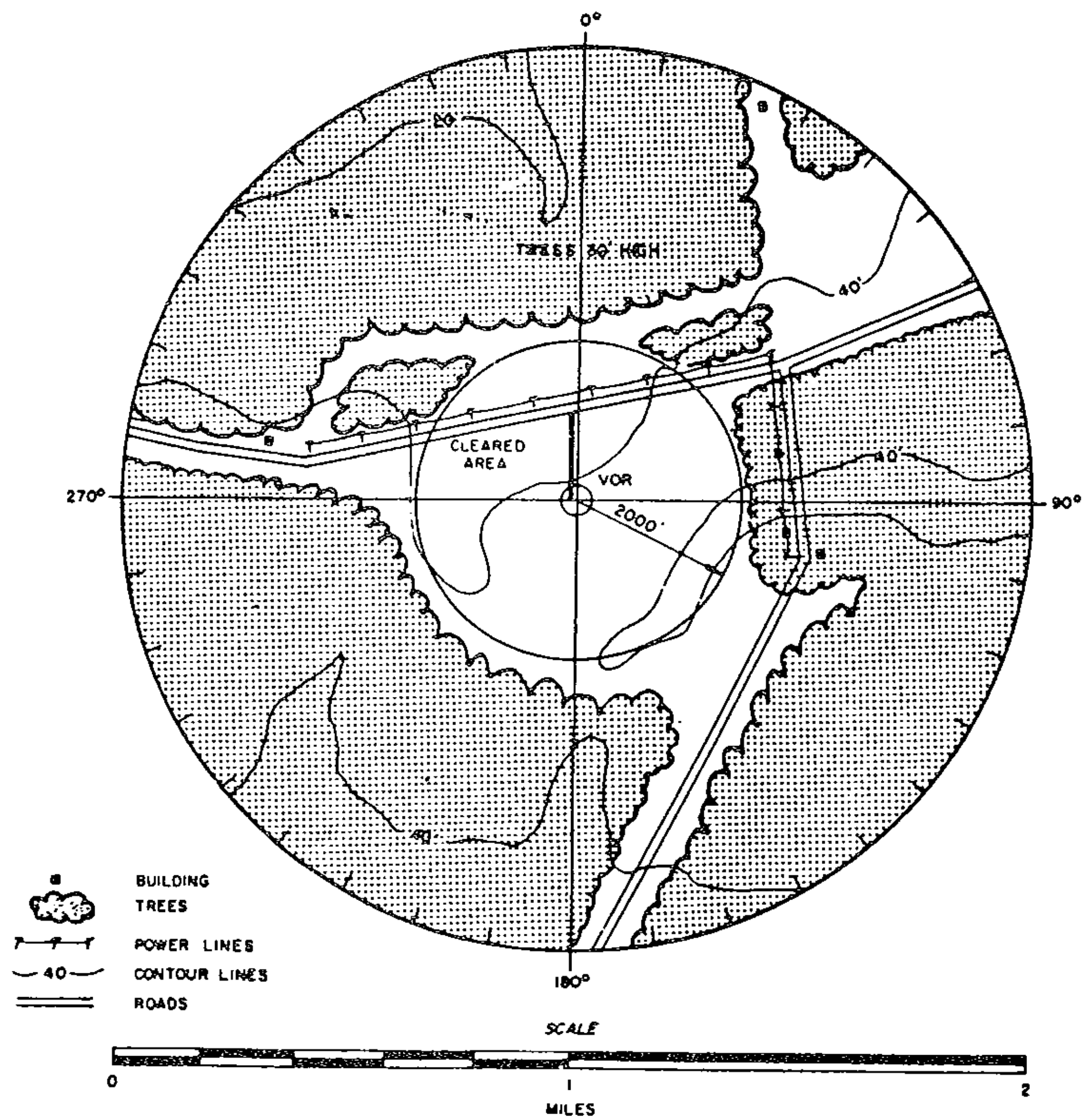
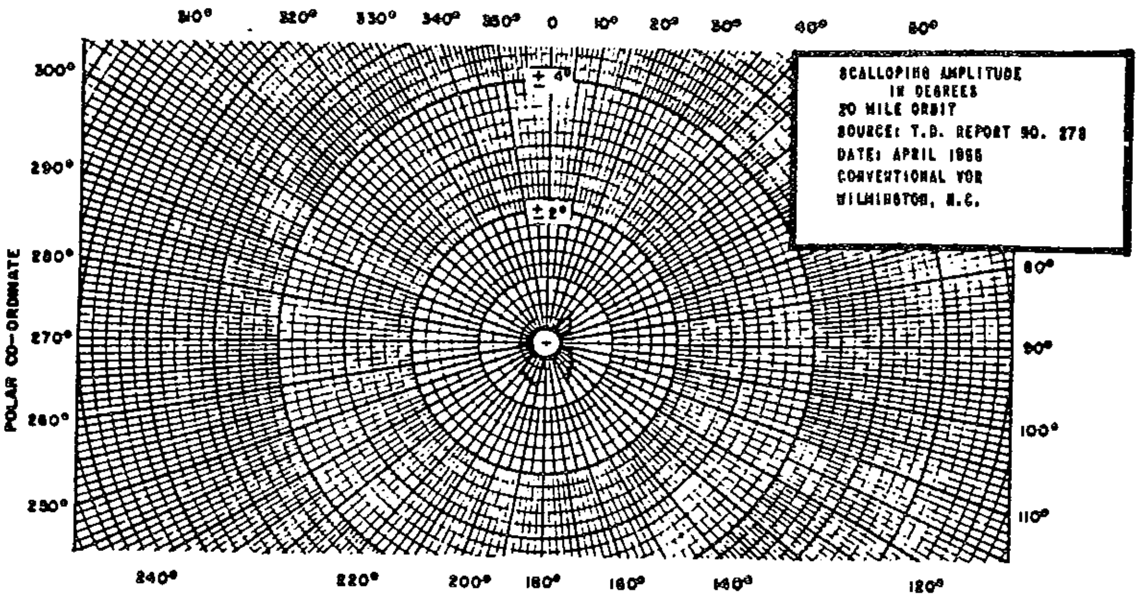


FIGURE 52. VICINITY SKETCH (1-MILE RADIUS) WILMINGTON, NORTH CAROLINA VOR

Section 24. Wilmington, North Carolina (continued)



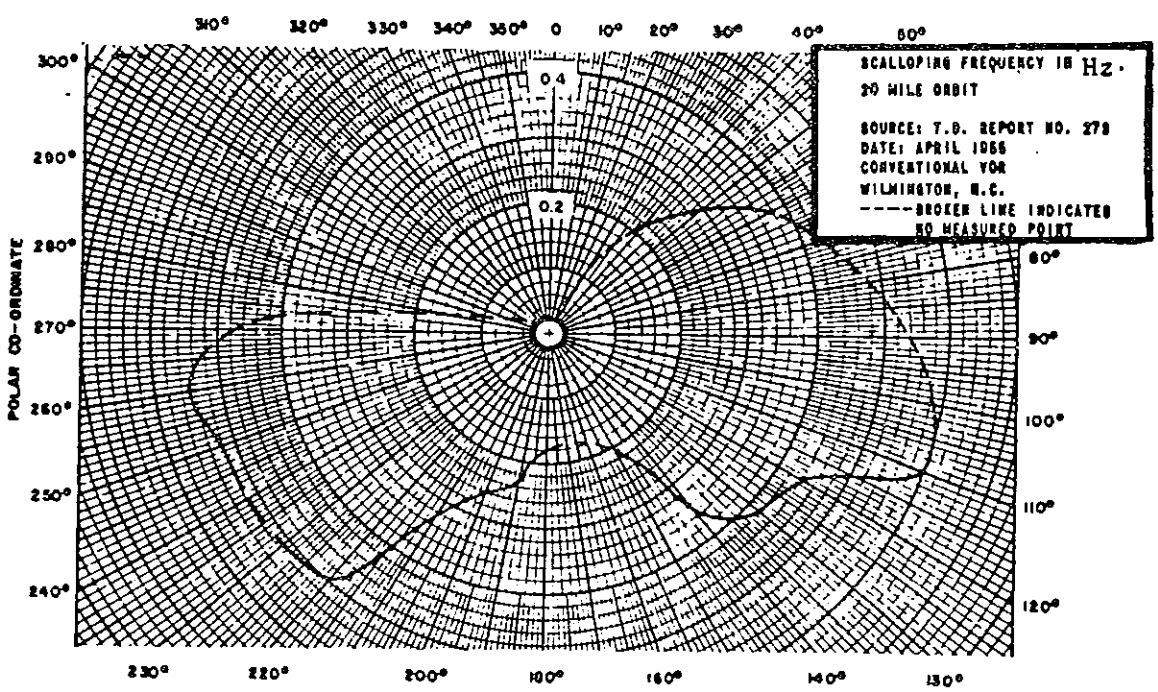


FIGURE 53. SCALLOPING AMPLITUDE AND FREQUENCY

Section 25. Summary of T.D. Report No. 278 (Effect of a Ground Discontinuity of VOR)

1. Introduction and Site Description. In the past, VOR sites have been chosen so that they are located far from large ground discontinuities. Because this practice limits the choice of sites, it was deemed desirable to conduct tests near a large ground discontinuity to determine more precisely its effects on the accuracy of the VOR. This report presents the results of such tests which were conducted near Port Washington, Wisconsin, along the shore of Lake Michigan, where a reasonably straight length of shoreline presented an almost vertical drop of approximately 125 feet from ground-to-water level. The site was relatively flat and devoid of trees and other obstructions for approximately 1000 feet in all directions. Approximately one-third of the site nearest the edge of the lake bank was plowed ground and the remainder was in a natural state. The surface of the lake was calm during the tests.

2. Summary.

a. These tests were conducted on top of a high bluff to determine the effect of an abrupt ground discontinuity on the course accuracy of a VHF omnirange. The results of these tests indicated that satisfactory operation of a VOR located in proximity to a sharp ground discontinuity is attained when the antenna is located 4 feet above the terrain and not less than 63 feet from the ground discontinuity. The tests also showed that the distance from the antenna to the ground discontinuity must be increased to 125 feet for satisfactory operation if the antenna is raised to a height of 14 feet above the terrain (see Table 1).

b. Deep nulls were evident in the vertical plane radiation patterns, and large variations of the course-deviation indicator and the TO-FROM indicator were observed in the nulls when the antenna was placed 13 feet from the discontinuity at a height of 14 feet. These variations were greatly decreased as the antenna was lowered to 4 feet above the terrain and when the distance of 13 feet from the ground discontinuity was maintained. When the antenna was moved away from the ground discontinuity, the nulls of the vertical radiation pattern were filled in and the variations of the course-deviation indicator were further decreased. The surface of the lake was calm during the tests, and flight recordings failed to reveal any irregularities which might be attributed to changes in the surface conditions of the lake.

3. Conclusions.

a. The errors caused by the ground discontinuity were small when:

(1) The VOR antenna was placed 14 feet above ground and 125 feet from the discontinuity, and

(2) The VOR antenna was 4 feet above ground and 63 feet from the discontinuity.

TABLE 1. BEARING ERRORS MEASURED IN THE NULLS*

Distance of Antenna From Ground Discontinuity (Feet)	Null Angle (Degrees)	Antenna Height (Feet)	Maximum Bearing Error in Nulls (± degrees)
13	1.5	14	7.0
13	3.0	14	2.5
13	4.5	14	5.0
13	6.0	14	2.5
13	1.5	4	0.25
13	3.0	4	0.375
13	4.5	4	0.5
13	6.0	4	0.5
125	1.5	14	0.25
125	3.0	14	0.00
63	1.5	4	0.25
63	3.0	4	0.00

* Altitude 1000 feet above ground.

b. The magnitude of the bearing error or scalloping becomes greater as the depth of the nulls in the vertical plane radiation pattern increases.

c. A close correlation was found between calculated and observed location of the lowest null in the vertical plane radiation pattern.

d. The vertical plane radiation patterns show that the effect of the ground discontinuity appears as a multiple-lobe structure superimposed on the normal pattern between elevation angles of approximately 0 to 10 degrees.

e. The depth of the lowest null decreases slowly with an increase in the distance between the VOR antenna and a ground discontinuity.

f. Higher angle nulls produced by the ground discontinuity filled in rapidly as the VOR antenna was moved from the ground discontinuity.

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Appendix J

Cumulative Projects List

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Table J-1. Past, Present, and Reasonably Foreseeable Actions

Project Title	***Project Description***	***Project Status***	***Relevant Cumulative Environmental Factors***
Past Actions			
Grow the Force Initiative	Construction of temporary and permanent facilities and infrastructure at MCB Camp Pendleton to support an increase of approximately 3,000 personnel at MCB Camp Pendleton. The Grow the Force Initiative includes approximately 60 construction projects at MCB Camp Pendleton.	An EA evaluating the potential impacts of 39 projects has been completed and the FONSI signed. The remaining 21 projects have received Categorical Exclusions. Construction is complete.	Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources; Water Resources
Basewide Utilities Infrastructure Improvements (P-1093, P-1094)	Installation and operation of six utility infrastructure improvements throughout MCB Camp Pendleton. The proposed improvements would facilitate the mission of MCB Camp Pendleton by improving water, wastewater, natural gas, electrical and communication systems where they are deteriorating, insufficient, or non-existent. Two of the infrastructure improvements that are proposed within the project vicinity include P-1093 and P-1094. **P-1093 Communication Systems Upgrade.** P-1093 would provide fiber-optic cable and telephone cable connections. This project would provide a redundant communications network to resist single point failures by constructing a minimum of two separate communication line paths to each area on MCB Camp Pendleton. **P-1094 Upgrade and Expand 12 kV Electrical Distribution Systems.** P-1094 would replace the existing 12-kV electrical distribution systems currently fed from the Haybarn substation, and the 4.16 kV subsystems fed from the 12-kV distribution system. The project would construct a total of eight new 12 kV circuits, which would be fed from the new 69-kV substation (P-1048), to provide approximately 60 percent of the electrical power for MCB Camp Pendleton.	An EIS has been completed and the ROD was signed on 23 September 2010. Construction is complete.	Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources; Water Resources
Box Canyon Solar Photovoltaic System	Box Canyon solar photovoltaic system was constructed on top of the Box Canyon land fill at MCB Camp Pendleton. It generates 3 megawatts of solar energy on a daily basis. It went into service in February 2011. To avoid disturbing the earth, the solar panels were attached to frames anchored by massive concrete blocks which are set in beds of gravel on the ground.	An EA has been completed and the FONSI signed. Construction is complete.	Biological Resources; Cultural Resources

Table J-1. Past, Present, and Reasonably Foreseeable Actions

Project Title	***Project Description***	***Project Status***	***Relevant Cumulative Environmental Factors***
Santa Margarita River Railroad Bridge Replacement and Second Track Project	The project included the replacement of the existing single-track railroad bridge downstream from the Stuart Mesa Bridge by North County Transit District. The project included construction of a new two-track bridge, a 0.8-mile (1.3-km) second rail track, and an upgrade and realignment of the existing Fallbrook Junction Passing Track (1.7 miles [2.7 kilometers]) for higher speed. The new bridge would be 755 feet (236 meters) long and consist of a 500-foot (152-meter) main bridge structure spanning the Santa Margarita River and a 255-foot (68.5-meter) approach trestle spanning the tidal marsh to the south. The new double-track segment portion of the project would connect the Stuart Mesa Passing Track with the Fallbrook Junction Passing Track to provide a 4.5-mile (7.2-kilometer) segment of continuous double-track with maximum speeds between 75 and 90 miles per hour (121 and 145 kilometers per hour).	An EA has been completed and the FONSI signed. Construction is complete.	Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources; Water Resources
Basewide Water Infrastructure (P-1044 and P-1045)	This project included construction, operation, and maintenance of infrastructure upgrades, expansions, and improvements on the Basewide water system and replacement of a critical link the Base roadway system. Projects include the Northern Advanced Water Treatment Plan (P-1044) and connection of the Base's northern and southern water system (P-1045).	An EA was prepared for this project and a FONSI was signed on 25 September 2012. Construction is complete.	Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources; Water Resources.
Present Actions			
MCB Camp Pendleton Military Family Housing (PPV-6)	A PPV military family housing development on 77 acres (31 hectares) at the Stuart Mesa agricultural field adjacent to the existing Stuart Mesa Housing to the east. The development includes construction of up to of up to 138 military family housing units, off-street parking spaces for each dwelling unit, one full-size basketball court, one half-size basketball court, three tot lots, one play lot, and a chain link fence surrounding the project site on all sides except on the eastern boundary.	An EA was prepared for this project and a FONSI was signed in September 2009. Construction is complete.	Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources; Water Resources
I-5 North Coast Corridor Project	This project includes construction of one or two High Occupancy Vehicle Managed Lanes in each direction, auxiliary lanes where needed, and possibly one general purpose lane in each direction. The main purpose of the project is to maintain or improve the existing and future traffic operations in the I-5 north coast corridor for the safe and efficient regional movement of people and goods.	An EIR/EIS was prepared and a NOD/ROD was signed. This project is currently under construction.	Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources; Water Resources

Table J-1. Past, Present, and Reasonably Foreseeable Actions

Project Title	*Project Description*	*Project Status*	*Relevant Cumulative Environmental Factors*
Reasonably Foreseeable Projects			
MCTSSA Cantonment Area Expansion	Expansion of the existing MCTSSA cantonment area by approximately 31 acres (13 hectares) to accommodate currently programmed radar antennae (temporary and permanent), vehicle testing track, support facilities, and site improvements needed to support USMC C4I systems capabilities.	An EA has been completed for this project and a FONSI was signed in September 2014. Construction for this project has not started.	Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources; Water Resources.
Seawater Desalinization Plant	The SDCWA began work on a proposed seawater desalination project in 2005 with preparation of a feasibility study of potential site locations within Camp Pendleton. The results from the earlier feasibility study narrowed down possible locations to two specific potential sites adjacent to MCTSSA and adjacent to the SRTTP site.	Project is conceptual. Latest geotech investigation was categorically excluded in 2015.	Access, Utilities, Biological Resources; Cultural Resources; Water Resources.
Santa Margarita River Conjunctive Use Project	The project includes the proposed conjunctive use of surface and groundwater in the lower Santa Margarita River basin. The project would address the water rights permits that were assigned to the Bureau of Reclamation in 1974 (Permits 15000, 8511, and 11357), provide a physical solution to long-standing litigation, reduce dependence on imported water (primarily for the Fallbrook Public Utility District), maintain watershed resources, and improve water supply reliability by managing the yield of the lower Santa Margarita River basin.	An EIS/EIR has been completed for this project and a ROD was signed in January 2017.	Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources
MCB Camp Pendleton Solar Photovoltaic System	The Navy and a private partner would enter into an agreement to allow the private partner to use Navy land to construct, operate, and own the proposed solar photovoltaic system. The partner would sell the generated power to regional customers and/or the Navy. The private partner would be responsible for maintenance, operation, and the eventual decommissioning of the solar PV system. At the end of the agreement, the solar PV system would be decommissioned and the site returned to its pre-project condition. Under the project, up to a 28-megawatt solar photovoltaic system would be constructed and operated at two sites for 37 years. One of the proposed sites is located on the agricultural field east of I-5 and the project site.	An EA has been completed for this project and a FONSI was signed in December 2015. Construction for this project has not started.	Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources

Table J-1. Past, Present, and Reasonably Foreseeable Actions

Project Title	***Project Description***	***Project Status***	***Relevant Cumulative Environmental Factors***
MCB Camp Pendleton Military Family Housing (PPV-7)	Development of up to 132 acres (53 hectares) of former agricultural land to construct, operate, and maintain up to a maximum of 351 military family housing units and supporting infrastructure (e.g., utilities). Paving and site improvements would include paved roads and parking; curbs and gutters; sidewalks; landscaping and irrigation; and, pedestrian and bicycling features. Access to the new housing area would be provided via a new two-lane road that would extend from Cockleburr Canyon Road to Mitchel Boulevard.	An EA has been completed for this project and a FONSI was signed in June 2011. A supplemental EA was completed in June 2015 and a FONSI signed in July 2015. Construction has been completed.	Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources; Water Resources
Joint Logistics Over the Shore, Maritime Prepositioning Force, and Field Exercise Training	The project would increase amphibious training exercises at MCB Camp Pendleton. Amphibious training at Red, Gold, and Green beaches and associated inland training areas, and within and adjacent to the Del Mar Boat Basin, would increase by approximately 25 percent.	An EA has been completed for this action and a FONSI was signed on 28 May 2015.	Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources; Water Resources
Large Scale Exercise Training at MCB Camp Pendleton	The project would increase the frequency and scope of Large Scale Exercise amphibious training at Green Beach and adjacent areas at MCB Camp Pendleton.	This project is currently in the planning process.	Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources; Water Resources
G/ATOR Maintenance and Test Support Facilities	This project includes construction of a G/ATOR Maintenance and Test Support Facility at MCTSSA that includes a G/ATOR building an attached/co-located training resources and visitor's center building, and an Operating Forces Tactical Systems Support Center and Technical Infrastructure and Services Group building.	This project is currently in the planning process.	Air Quality and Greenhouse Gases; Biological Resources; Public Health & Safety; Water Resources
Range and Training Areas Maintenance Activities	The Programmatic EA will programmatically assess future construction, maintenance, sustainment and repair within the ranges, training systems, training areas, and impact areas throughout MCB Camp Pendleton.	An EA is under development. FONSI anticipated in 2018.	Air Quality and Greenhouse Gases; Biological Resources; Cultural Resources; Public Health & Safety; Water Resources

Notes: C4I = Command, Control, Communications, Computers, and Intelligence; EA = environmental assessment; EIR = environmental impact report; EIS = environmental impact statement; FONSI = Finding of No Significant Impact; I-5 = Interstate 5; MCTSSA = Marine Corps Tactical Systems Support Activity; NOD = notice of determination; PPV = Public/Private Venture; USMC = United States Marine Corps.

Appendix K

Operational Constraints

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Stuart Mesa West Training and Conversion, MCB Camp Pendleton
Operational Constraints

All training operations associated with the Stuart Mesa West Training and Conversion project are subject to the restrictions stipulated below. These training restrictions are based on the *Riparian and Estuarine Programmatic Conservation Plan* and associated *Biological Opinion (1-6-95-F-02) Programmatic Activities and Conservation Plans in Riparian and Estuarine/Beach Ecosystems on Marine Corps Base (MCB), Camp Pendleton* (United States Fish and Wildlife Service [USFWS] 1995), MCB Camp Pendleton Range and Training Regulations, MCB Camp Pendleton Environmental Constraints Mapping, and coordination with the USFWS and MCB Camp Pendleton Environmental Security Staff.

Breeding Season Training Constraints

Ground and Vehicle Training Restrictions (Blue Beach Special Management Zone)

1. Military activities shall be kept to a minimum[1] within the Beach area.
2. Vehicle traffic within the management zones shall be kept to a minimum.
3. All activities involving smoke, pyrotechnics, loud noises, blowing sand, and large groupings of personnel (14 or more) shall be kept at least 984 feet (300 meters) away from fenced or posted nesting areas.
4. All other activities shall be kept at least 15 feet (5 meters) away from the posted nesting areas.
5. No native vegetation shall be cut for military training purposes, except exotic plant species when approved by MCB Camp Pendleton Environmental Security.
6. Vehicles and troops accessing the beach at White Beach during the breeding season (1 September – 14 March) shall follow a route along the base of the northerly bluff to maintain the maximum distance from the tern colony.
7. Motorized vehicles shall remain at least 15 feet (5 meters) away from nesting areas with the exception of amphibious vehicles and vehicles using the White Beach access road.
8. Vehicles shall remain on hard packed sand, unless parked, outside posted (signed) areas during the breeding season.
9. Travel speeds shall not to exceed 25 miles per hour (mph).
10. Amphibious tracked vehicles shall traverse the management zones while maintaining both tracks in water at all times.
11. Upon entering the beach from Camp Del Mar, vehicles shall transit in a direct line along a marked corridor bordering the southern edge of the Santa Margarita Management Zone before heading up-coast. During returns, vehicles shall proceed along the same marked corridor.
12. During the breeding season, amphibious tracked vehicles shall not traverse the Santa Margarita Management Zone in excess of a monthly average of 20 traverses per day (one traverse equals one roundtrip to and from Camp Del Mar).

[1] "kept to a minimum" is determined by MCB Camp Pendleton staff in accordance with the *Riparian and Estuarine Programmatic Conservation Plan* and associated Riparian Biological Opinion (1-6-95-F-02) depending on the terrain and situation.

13. To prevent impacts that would require restoration prior to the breeding season, vehicles shall turn 90 degrees from hard pack sand onto the road.
14. The Landing Craft Air Cushion (LCAC) shall not traverse the beach/estuary areas of the management zones.
15. During the breeding season, no digging of fighting positions or bivouacking shall be authorized in the vicinity of nesting areas within the management zones.

Ground and Vehicle Training Restrictions (Former Agricultural Area)

16. Mapped federally listed species shall be avoided within agricultural areas (if present).
17. All vehicles shall avoid the Very High Frequency Omni-directional Range Tactical Aircraft Control (VORTAC) facility Arc.
18. Only foot traffic shall be authorized within Special Use Areas (identified on the constraints maps [Figures 1 and 2]) to avoid noise producing activities within a 500-foot (152-meter) buffer of federally listed species.
19. Engineering training operations outside of National Environmental Policy Act (NEPA) approved landing operation support shall be prohibited within the management zones.
20. At beaches, earth moving activity shall be authorized only for areas of un-vegetated sand as least 984 feet (300 meters) from posted nesting areas unless specifically approved or requested by MCB Camp Pendleton Environmental Security.
21. No non-live fire or noise simulators of any type shall be used on the beach or within former agricultural areas.
22. All activities involving loud noise shall be kept 984 feet (300 meters) from fenced nesting areas.

Air Operations Restrictions (All Areas)

23. No landings shall be permitted within 984 feet (300 meters) of fenced nesting areas.
24. No landings shall be permitted within 500 feet (152 meters) of California gnatcatcher and Ridgway's rail nesting areas.
25. An altitude of 300 feet (91 meters) above ground level (AGL) or higher shall be maintained above nesting areas.
26. An altitude of 200 feet (61 meters) AGL shall be maintained above all structures and facilities (500 feet AGL above the Marine Corps Tactical Systems Support Activity [MCTSSA] cantonment area).
27. A 200-foot landing buffer shall be maintained from all facilities and infrastructure.

Non-Breeding Season Training Constraints

Ground and Vehicle Training Restrictions

1. No native vegetation shall be cut for military training purposes, except exotic plant species when approved be MCB Camp Pendleton Environmental Security.
2. Vehicles shall avoid the dune system at the base of the bluffs, as well as coastal wetlands, as much as possible outside of breeding season.

3. Travel speeds shall not exceed 25 mph.
4. Upon entering the beach from Camp Del Mar vehicles shall transit in a direct line along a marked corridor bordering the southern edge of the Santa Margarita Management Zone before heading up-coast. During returns, vehicles shall proceed along the same marked corridor.
5. To prevent impacts that would require restoration prior to the breeding season, vehicles shall turn 90 degrees from hard pack sand onto the road.
6. Engineering training operations outside of NEPA approved landing operation support shall be prohibited within the management zones.
7. At beaches, earth moving activity shall only be authorized for areas of unvegetated sand at least 984 feet (300 meters) from posted nesting areas unless specifically approved or requested by MCB Camp Pendleton Environmental Security.
8. Military activities shall be kept to a minimum within the Management Zone during the non-breeding season in order to minimize disturbance to wintering snowy plovers.

Air Operations Restrictions (All Areas)

9. An altitude of 200 feet (61 meters) AGL shall be maintained above all structures and facilities.
10. An altitude of 500 feet (152 meters) AGL shall be maintained above the MCTSSA cantonment area.
11. A 200-foot (61-meter) landing buffer shall be maintained from all facilities and infrastructure.

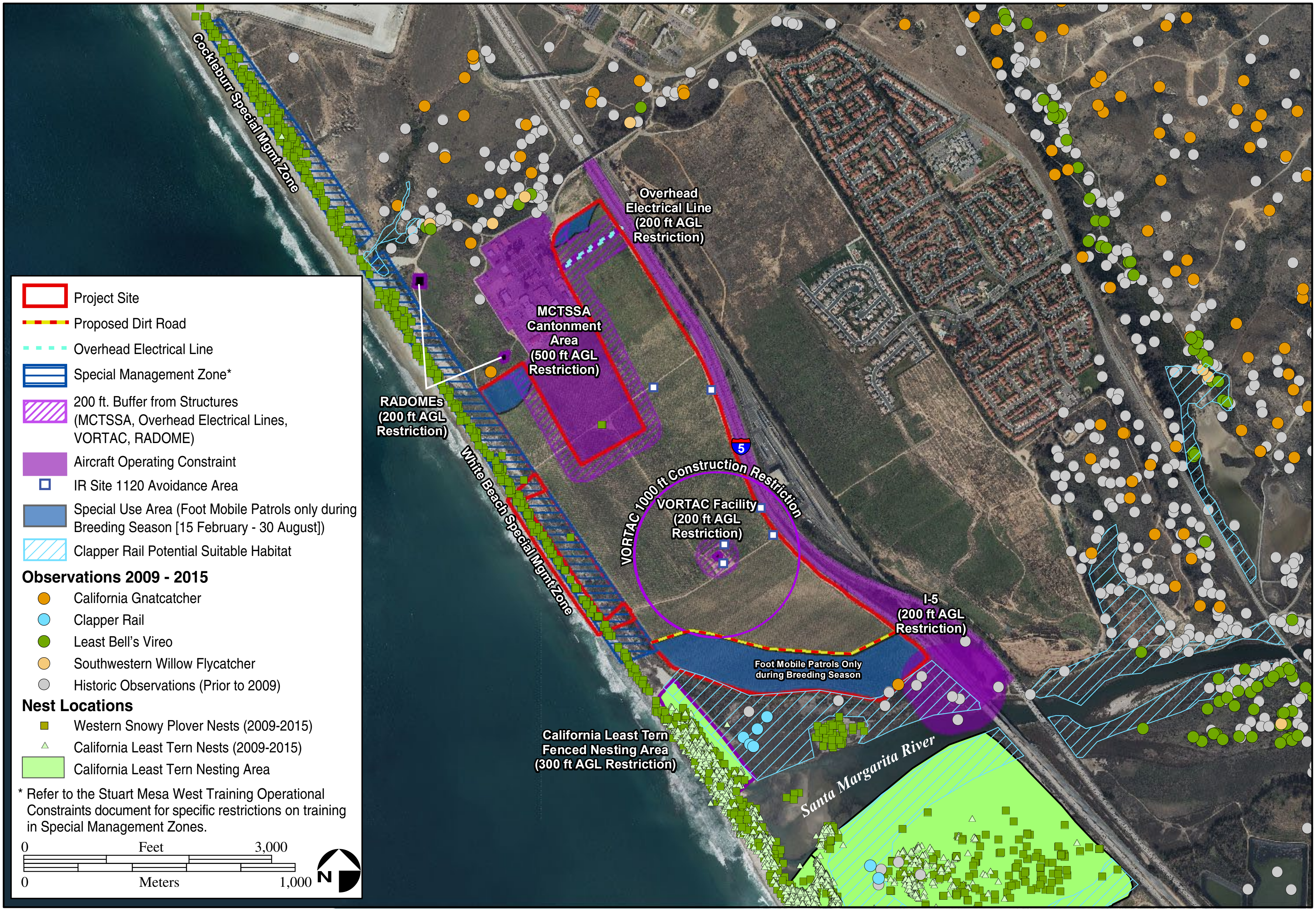

Figure 1. Vehicle and Aircraft Operating Constraints during the Breeding Season (15 February - 30 August)

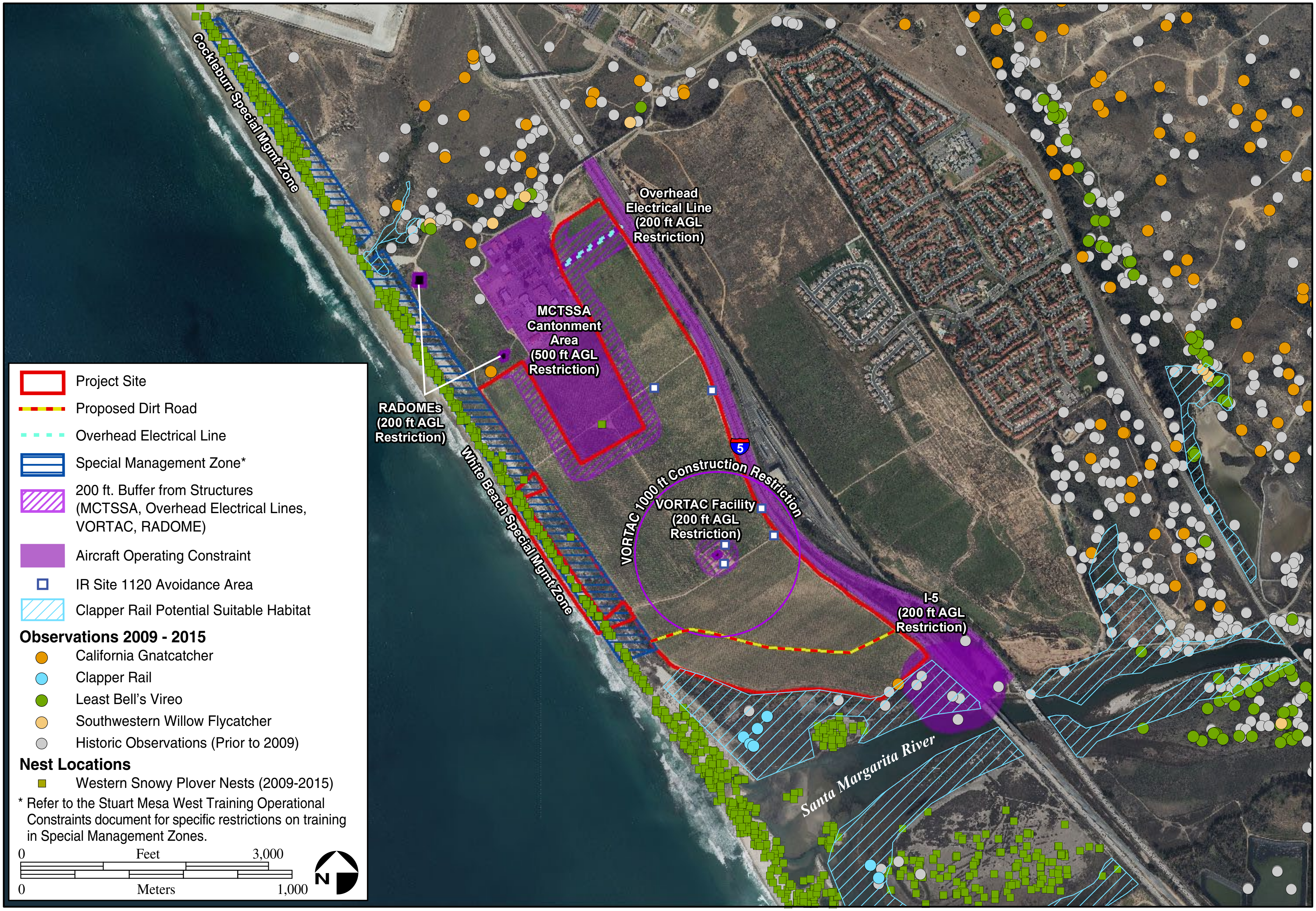

Figure 2. Vehicle and Aircraft Operating Constraints Outside the Breeding Season (31 August - 14 February)

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