FINAL

SUPPLEMENTAL HUMAN HEALTH RISK ASSESSMENT

FOR

REVISED RANGE MAINTENANCE SOLDIER AT THE FORMER WINKLEPECK BURNING GROUNDS

PREPARED FOR

US Army Corps of Engineers®

LOUISVILLE DISTRICT
CONTRACT No. W912QR-04-D-0019
DELIVERY ORDER 008

May 2006

SAIC®

05-243(E)/050506

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

contributed to the preparation of this document and should not
be considered an eligible contractor for its review.

CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Science Applications International Corporation (SAIC) has completed the *Final Supplemental Human Health Risk Assessment for Revised Range Maintenance Soldier at the Former Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio*. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures, and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing Corps policy.

Sharon K Robers

Sharon Robers
Study/Design Team Leader

05/02/06
Date

W. Kevin Jago

Kevin Jago
Independent Technical Review Team Leader

5/2/06
Date

Significant concerns and the explanation of the resolution are as follows:

Internal SAIC Independent Technical Review comments are recorded on a Document Review Record per SAIC quality assurance procedure QAAP 3.1. This Document Review Record is maintained in the project file. Changes to the report addressing the comments have been verified by the Study/Design Team Leader.

As noted above, all concerns resulting from independent technical review of the project have been considered.

Barney W. Cornaby

Principal w/ A-E firm

May 2, 2006
Date

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Louisville District
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Prepared by

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CONTENTS

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TABLES

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ACRONYMS

ALM	Adult Lead Methodology
Army	U. S. Army
BGS	below ground surface
COC	chemical of concern
COPC	chemical of potential concern
cPAH	carcinogenic PAH
CSF	cancer slope factor
DAD	dermally absorbed dose
DCE	dichloroethene
EPA	U. S. Environmental Protection Agency
EPC	exposure point concentration
FFS	Focused Feasibility Study
FWHHRAM	Facility-Wide Human Health Risk Assessor's Manual
GAF	gastrointestinal absorption factor
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
ILCR	incremental lifetime cancer risk
IRIS	Integrated Risk Information System
MDC	maximum detected concentration
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
PAH	polycyclic aromatic hydrocarbon
PEF	particulate emission factor
PRG	preliminary remediation goal
RDA	recommended daily allowance
RDI	recommended daily intake
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RfC	reference concentration
RfD	reference dose
RVAAP	Ravenna Army Ammunition Plant
TEF	toxicity equivalency factor
TNT	trinitrotoluene
UCL_{95}	95% upper confidence limit
VOC	volatile organic compound
WBG	Winklepeck Burning Grounds
WOE	weight-of-evidence

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1.0 INTRODUCTION

This report documents the supplemental human health risk assessment (HHRA) performed for the Winklepeck Burning Grounds (WBG) at the U. S. Army (Army) Joint Munitions Command Ravenna Army Ammunitions Plant (RVAAP), Ravenna, Ohio. This Supplemental HHRA documents the potential health risks to humans resulting from potential exposure to contamination remaining at WBG following remedial actions documented in the Focused Feasibility Study (FFS) and Proposed Plan (USACE 2005a).

Previously, a HHRA was conducted to evaluate and document the potential risks to human health associated with the use of WBG as a Mark 19 Range in support of the FFS. The results of the FFS HHRA were used to: (1) document and evaluate risks to human health, (2) determine the need for remedial action, and (3) identify chemicals of concern (COCs) and chemical-specific remediation levels. The selected remedy for WBG, as developed in the FFS and presented in the Proposed Plan (USACE 2005a), employed risk-based cleanup goals for a Mark 19 Grenade Machinegun Range Maintenance Soldier developed from the HHRA exposure assumptions and results. This Supplemental HHRA evaluates whether new COCs or cleanup goals would be needed if the Range Maintenance Soldier were to be present on the Mark 19 Grenade Machinegun Range for a greater number of days or longer period of time each day than was assumed in the FFS HHRA.

The supplemental receptor was evaluated at the request of the Army and the Ohio Army National Guard (OHARNG) to determine if unacceptable risks existed or if any additional remediation would be required if the duration or frequency of exposure were adjusted for the Range Maintenance Soldier. These adjustments do not reflect a change of the receptor, rather they are hypothetical changes to the potential number of days and number of hours each day that a Range Maintenance Soldier may be on the planned Mark 19 Range. The information presented in this Supplemental HHRA will be used by risk and military mission managers to determine the appropriate administrative controls to employ for range operations or determine if additional remediation might be necessary if the Range Maintenance Soldier was required to be on WBG for longer periods of time than originally assumed in the FFS.

This Supplemental HHRA is organized into six major sections. The data evaluation process used to identify chemicals of potential concern (COPCs) is discussed in Chapter 2. The exposure assessment, which is performed to identify the exposure pathways by which receptors may be exposed to contaminants and calculate potential intakes, is presented in Chapter 3. The toxicity assessment for the COPCs is presented in Chapter 4. The results of the risk characterization are presented in Chapter 5. An assessment of the uncertainties associated with the risk characterization and the conclusions of the Supplemental HHRA are summarized in Chapter 6. Chapter 7 presents the references used in this report.

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2.0 DATA EVALUATION

This chapter provides a description of the data used in this Supplemental HHRA and the COPCs for WBG.

The relevant data at WBG are deep surface soil [defined as soils coming from 0 to 1.2 m (0 to 4 ft) below ground surface (BGS)]. This interval is the assumed maximum depth of exposure for the pertinent human receptor at the WBG (see Chapter 3 for more details on this receptor). Deep surface soil samples included in this Supplemental HHRA are listed in Table 2-1. Soil samples collected in Phase I, Phase II, and Phase III investigations are included in this Supplemental HHRA. Soil samples collected from locations that have been removed or are to be removed per the proposed plan were excluded from the data set.

Table 2-1. Deep Surface Soil Samples Used for WBG Supplemental HHRA

Station	Sample ID	Depth	Station	Sample ID	Depth	Station	Sample ID	Depth
Phase I (June - July 1996)			*Phase II (April - May 1998)*			*Phase III (August - November 2000)*		
WBGss-001	WBGSS-001-0456-SO	0 - 2	WBGso-005	WB0765	2 - 4	Burn Pad 37,38	WB1001	0 - 1
WBGss-002	WBGSS-002-0457-SO	0 - 2	WBGso-006	WB0764	2 - 4	Burn Pad 37,38	WB1002	0 - 1
WBGss-003	WBGSS-003-0458-SO	0 - 2	WBGso-035	WB0763	2 - 4	Burn Pad 37,38	WB1003	0 - 1
WBGss-004	WBGSS-004-0459-SO	0 - 0.7	WBGso-037	WB0761	2 - 4	Burn Pad 37,38	WB1004	0 - 1
WBGss-004	WBGSS-004-0672-SO	0 - 0.6	WBGso-054	WB0753	2 - 4	Burn Pad 37,38	WB1005	0 - 1
WBGss-005	WBGSS-005-0460-SO	0 - 2	WBGso-055	WB0754	2 - 4	Burn Pad 37,38	WB1006	0 - 1
WBGss-006	WBGSS-006-0461-SO	0 - 2	WBGso-057	WB0756	2 - 4	Burn Pad 37,38	WB1007	0 - 1
WBGss-007	WBGSS-007-0462-SO	0 - 2	WBGso-059	WB0760	2 - 4	Burn Pad 37,38	WB1008	0 - 1
WBGss-008	WBGSS-008-0463-SO	0 - 2	WBGso-062	WB0758	2 - 4	Burn Pad 37,38	WB1009	0 - 1
WBGss-009	WBGSS-009-0464-SO	0 - 2	WBGso-069	WB0750	2 - 4	Burn Pad 66,67	WB2010	0 - 1
WBGss-010	WBGSS-010-0465-SO	0 - 2	WBGso-070	WB0748	2 - 4	Burn Pad 66,67	WB2011	0 - 1
WBGss-011	WBGSS-011-0466-SO	0 - 2	WBGso-073	WB0752	2 - 4	Burn Pad 66,67	WB2012	0 - 1
WBGss-012	WBGSS-012-0467-SO	0 - 2	WBGso-107	WB0766	2 - 4	Burn Pad 66,67	WB2013	0 - 1
WBGss-013	WBGSS-013-0468-SO	0 - 2	WBGso-142	WB0772	2 - 4	Burn Pad 66,67	WB2014	0 - 1
WBGss-014	WBGSS-014-0469-SO	0 - 1.5	WBGso-168	WB0773	2 - 4	Burn Pad 66,67	WB2015	0 - 1
WBGss-015	WBGSS-015-0470-SO	0 - 2	WBGso-178	WB0928	2 - 4	Burn Pad 66,67	WB2016	0 - 1
WBGss-016	WBGSS-016-0471-SO	0 - 2	WBGso-185	WB0762	2 - 4	Burn Pad 66,67	WB2017	0 - 1
WBGss-017	WBGSS-017-0472-SO	0 - 2	WBGso-186	WB0770	2 - 4	Burn Pad 66,67	WB2018	0 - 1
WBGss-018	WBGSS-018-0473-SO	0 - 1.5	WBGso-187	WB0940	2 - 4	Burn Pad 58,59	WB3019	0 - 1
WBGss-019	WBGSS-019-0474-SO	0 - 1.5	WBGso-188	WB0918	2 - 4	Burn Pad 58,59	WB3020	0 - 1
WBGss-020	WBGSS-020-0477-SO	0 - 2	WBGso-189	WB0919	2 - 4	Burn Pad 58,59	WB3021	0 - 1
WBGss-021	WBGSS-021-0478-SO	0 - 2	WBGso-190	WB0920	2 - 4	Burn Pad 58,59	WB3022	0 - 1
WBGss-022	WBGSS-022-0479-SO	0 - 2	WBGso-191	WB0921	2 - 4	Burn Pad 58,59	WB3023	0 - 1
WBGss-023	WBGSS-023-0480-SO	0 - 2	WBGso-192	WB0922	2 - 4	Burn Pad 58,59	WB3024	0 - 1
WBGss-024	WBGSS-024-0481-SO	0 - 2	WBGso-196	WB0943	2 - 4	Burn Pad 58,59	WB3025	0 - 1
WBGss-025	WBGSS-025-0482-SO	0 - 0.5	WBGss-100	WB0689	0 - 1	Burn Pad 58,59	WB3026	0 - 1
WBGss-026	WBGSS-026-0483-SO	0 - 1.3	WBGss-101	WB0690	0 - 1	Burn Pad 58,59	WB3027	0 - 1
WBGss-027	WBGSS-027-0484-SO	0 - 0.5	WBGss-102	WB0691	0 - 1	WBG-197	WBG4000	0 - 1
WBGss-028	WBGSS-028-0485-SO	0 - 2	WBGss-103	WB0692	0 - 1	WBG-198	WBG4003	0 - 1
WBGss-029	WBGSS-029-0486-SO	0 - 2	WBGss-104	WB0693	0 - 1	WBG-199	WBG4006	0 - 1
WBGss-030	WBGSS-030-0487-SO	0 - 1.5	WBGss-106	WB0695	0 - 1	WBG-199	WBG4007	2 - 4
WBGss-030	WBGSS-030-0673-SO	0 - 1.5	WBGss-107	WB0696	0 - 1	WBG-200	WBG4009	0 - 1
WBGss-031	WBGSS-031-0488-SO	0 - 2	WBGss-108	WB0697	0 - 1	WBG-201	WBG4012	0 - 1
WBGss-032	WBGSS-032-0489-SO	0 - 0.5	WBGss-109	WB0698	0 - 1	WBG-202	WBG4015	0 - 1
WBGss-033	WBGSS-033-0490-SO	0 - 2	WBGss-110	WB0699	0 - 1	WBG-203	WBG4018	0 - 1
WBGss-034	WBGSS-034-0491-SO	0 - 2	WBGss-111	WB0700	0 - 1	WBG-203	WBG4019	2 - 4

Table 2-1. Deep Surface Soil Samples Used for WBG Supplemental HHRA (continued)

Station	Sample ID	Depth	Station	Sample ID	Depth	Station	Sample ID	Depth
Phase I (June - July 1996)			*Phase II (April - May 1998)*			*Phase III (August - November 2000)*		
WBGss-035	WBGSS-035-0492-SO	0 - 2	WBGss-112	WB0701	0 - 1	WBG-204	WBG4023	0 - 1
WBGss-036	WBGSS-036-0493-SO	0 - 2	WBGss-113	WB0702	0 - 1	WBG-205	WBG4026	0 - 1
WBGss-037	WBGSS-037-0494-SO	0 - 2	WBGss-114	WB0703	0 - 1	WBG-205	WBG4027	2 - 4
WBGss-038	WBGSS-038-0495-SO	0 - 2	WBGss-115	WB0704	0 - 1	WBG-206	WBG4029	0 - 1
WBGss-039	WBGSS-039-0496-SO	0 - 2	WBGss-116	WB0705	0 - 1	WBG-207	WBG4032	0 - 1
WBGss-040	WBGSS-040-0497-SO	0 - 2	WBGss-117	WB0706	0 - 1	WBG-208	WBG4035	0 - 1
WBGss-041	WBGSS-041-0499-SO	0 - 0.5	WBGss-118	WB0707	0 - 1	WBG-209	WBG4038	0 - 1
WBGss-042	WBGSS-042-0500-SO	0 - 2	WBGss-119	WB0708	0 - 1	WBG-210	WBG4041	0 - 1
WBGss-043	WBGSS-043-0501-SO	0 - 2	WBGss-120	WB0709	0 - 1	WBG-210	WBG4042	2 - 4
WBGss-044	WBGSS-044-0502-SO	0 - 2	WBGss-121	WB0710	0 - 1	WBG-211	WBG4046	0 - 1
WBGss-045	WBGSS-045-0503-SO	0 - 1	WBGss-122	WB0711	0 - 1	WBG-212	WBG4049	0 - 1
WBGss-046	WBGSS-046-0504-SO	0 - 2	WBGss-123	WB0712	0 - 1	WBG-213	WBG4052	0 - 1
WBGss-047	WBGSS-047-0505-SO	0 - 2	WBGss-124	WB0713	0 - 1	WBG-214	WBG4055	0 - 1
WBGss-048	WBGSS-048-0506-SO	0 - 2	WBGss-125	WB0714	0 - 1	WBG-215	WBG4058	0 - 1
WBGss-049	WBGSS-049-0507-SO	0 - 2	WBGss-126	WB0715	0 - 1	WBG-216	WBG4061	0 - 1
WBGss-050	WBGSS-050-0508-SO	0 - 1	WBGss-127	WB0716	0 - 1	WBG-218	WBG4067	0 - 1
WBGss-051	WBGSS-051-0509-SO	0 - 2	WBGss-128	WB0717	0 - 1	WBG-218	WBG4068	2 - 4
WBGss-052	WBGSS-052-0512-SO	0 - 2	WBGss-129	WB0718	0 - 1	WBG-219	WBG4070	0 - 1
WBGss-053	WBGSS-053-0513-SO	0 - 2	WBGss-130	WB0719	0 - 1	WBG-219	WBG4071	2 - 4
WBGss-054	WBGSS-054-0514-SO	0 - 0.5	WBGss-131	WB0720	0 - 1	WBG-220	WBG4073	0 - 1
WBGss-055	WBGSS-055-0515-SO	0 - 2	WBGss-132	WB0721	0 - 1	WBG-220	WBG4074	2 - 4
WBGss-056	WBGSS-056-0516-SO	0 - 2	WBGss-133	WB0722	0 - 1	WBG-221	WBG4076	0 - 1
WBGss-057	WBGSS-057-0517-SO	0 - 2	WBGss-134	WB0723	0 - 1	WBG-222	WBG4079	0 - 1
WBGss-057	WBGSS-057-0674-SO	2 - 2	WBGss-135	WB0724	0 - 1	WBG-222	WBG4080	2 - 4
WBGss-058	WBGSS-058-0520-SO	0 - 1.4	WBGss-136	WB0725	0 - 1	WBG-223	WBG4082	0 - 1
WBGss-059	WBGSS-059-0521-SO	0 - 1	WBGss-137	WB0726	0 - 1	WBG-223	WBG4083	2 - 4
WBGss-060	WBGSS-060-0522-SO	0 - 2	WBGss-138	WB0727	0 - 1	WBG-224	WBG4085	0 - 1
WBGss-061	WBGSS-061-0523-SO	0 - 2	WBGss-139	WB0728	0 - 1	WBG-225	WBG4088	0 - 1
WBGss-062	WBGSS-062-0524-SO	0 - 2	WBGss-140	WB0729	0 - 1	WBG-226	WBG4091	0 - 1
WBGss-063	WBGSS-063-0525-SO	0 - 2	WBGss-141	WB0730	0 - 1	WBG-227	WBG4094	0 - 1
WBGss-064	WBGSS-064-0526-SO	0 - 2	WBGss-142	WB0731	0 - 1	WBG-227	WBG4095	2 - 4
WBGss-065	WBGSS-065-0527-SO	0 - 2	WBGss-143	WB0732	0 - 1	WBG-229	WBG4102	0 - 1
WBGss-066	WBGSS-066-0528-SO	0 - 2	WBGss-144	WB0733	0 - 1	WBG-229	WBG4103	2 - 4
WBGss-067	WBGSS-067-0529-SO	0 - 2	WBGss-145	WB0734	0 - 1	WBG-230	WBG4105	0 - 1
WBGss-068	WBGSS-068-0532-SO	0 - 2	WBGss-146	WB0735	0 - 1	WBG-231	WBG4108	0 - 1
WBGss-069	WBGSS-069-0533-SO	0 - 2	WBGss-147	WB0736	0 - 1	WBG-231	WBG4109	2 - 4
WBGss-072	WBGSS-072-0536-SO	0 - 2	WBGss-148	WB0737	0 - 1	WBG-232	WBG4111	0 - 1
WBGss-073	WBGSS-073-0537-SO	0 - 2	WBGss-149	WB0738	0 - 1	WBG-232	WBG4112	2 - 4
WBGss-074	WBGSS-074-0538-SO	0 - 0.5	WBGss-150	WB0739	0 - 1	WBG-233	WBG4116	0 - 1
WBGss-075	WBGSS-075-0539-SO	0 - 2	WBGss-153	WB0742	0 - 0	WBG-234	WBG4119	0 - 1
WBGss-076	WBGSS-076-0541-SO	0 - 2	WBGss-154	WB0743	0 - 0	WBG-235	WBG4122	0 - 1
WBGss-077	WBGSS-077-0542-SO	0 - 0.8	WBGss-168	WB0768	0 - 1	WBG-236	WBG4125	0 - 1
WBGss-097	WBGSS-097-0564-SO	0 - 2	WBGss-169	WB0884	0 - 1	WBG-237	WBG4128	0 - 1
WBGss-098	WBGSS-098-0565-SO	0 - 2	WBGss-170	WB0881	0 - 1	WBG-237	WBG4129	2 - 4
			WBGss-171	WB0882	0 - 1	WBG-238	WBG4133	0 - 1
			WBGss-172	WB0883	0 - 1	WBG-239	WBG4136	0 - 1
			WBGss-173	WB0885	0 - 1	WBG-240	WBG4139	0 - 1
			WBGss-174	WB0886	0 - 1	WBG-240	WBG4140	2 - 4
			WBGss-175	WB0887	0 - 1	WBG-241	WBG4142	0 - 1
			WBGss-176	WB0888	0 - 1	WBG-242	WBG4145	0 - 1
			WBGss-177	WB0889	0 - 1	WBG-242	WBG4146	2 - 4
			WBGss-178	WB0890	0 - 1	WBG-243	WBG4151	2 - 4
			WBGss-179	WB0891	0 - 1	WBG-245	WBG4156	0 - 1
			WBGss-187	WB0912	0 - 1	WBG-246	WBG4159	0 - 1

Table 2-1. Deep Surface Soil Samples Used for WBG Supplemental HHRA (continued)

Station	Sample ID	Depth	Station	Sample ID	Depth	Station	Sample ID	Depth
Phase I (June - July 1996)			*Phase II (April - May 1998)*			*Phase III (August - November 2000)*		
			WBGss-188	WB0913	0 - 1	WBG-246	WBG4160	2 - 4
			WBGss-189	WB0914	0 - 1	WBG-247	WBG4162	0 - 1
			WBGss-190	WB0915	0 - 1	WBG-247	WBG4163	2 - 4
			WBGss-191	WB0916	0 - 1	WBG-249	WBG4170	0 - 1
			WBGss-192	WB0917	0 - 1	WBG-250	WBG4173	0 - 1
			WBGss-193	WB0932	0 - 1	WBG-251	WBG4176	0 - 1
			WBGss-194	WB0935	0 - 1	WBG-252	WBG4179	0 - 1
			WBGss-195	WB0936	0 - 1	WBG-252	WBG4180	2 - 4
			WBGss-196	WB0937	0 - 1	WBG-253	WBG4184	0 - 1
						WBG-254	WBG4187	0 - 1
						WBG-254	WBG4188	2 - 4
						WBG-255	WBG4190	0 - 1
						WBG-255	WBG4191	2 - 4
						WBG-256	WBG4193	0 - 1
						WBG-257	WBG4196	0 - 1
						WBG-257	WBG4197	2 - 4
						WBG-258	WBG4201	0 - 1
						WBG-259	WBG4204	0 - 1
						WBG-260	WBG4207	0 - 1
						WBG-261	WBG4210	0 - 1
						WBG-262	WBG4213	0 - 1
						WBG-263	WBG4216	0 - 1
						WBG-264	WBG4219	0 - 1
						WBG-265	WBG4220	0 - 1
						WBG-266	WBG4221	0 - 1
						WBG-267	WBG4222	0 - 1
						WBG-268	WBG4223	0 - 1
						WBG-269	WBG4224	0 - 1
						WBG-270	WBG4225	0 - 1
						WBG-271	WBG4226	0 - 1
						WBG-272	WBG4227	0 - 1
						WBG-273	WBG4228	0 - 1
						WBG-274	WBG4229	0 - 1
						WBG-275	WBG4230	0 - 1
						WBG-276	WBG4231	0 - 1
						WBG-277	WBG4232	0 - 1
						WBG-278	WBG4233	0 - 1
						WBG-279	WBG4234	0 - 1
						WBG-280	WBG4235	0 - 1
						WBG-281	WBG4236	0 - 1
						WBG-282	WBG4237	0 - 1
						WBG-283	WBG4238	0 - 1
						WBG-284	WBG4239	0 - 1
						WBG-285	WBG4240	0 - 1
						WBG-286	WBG4241	0 - 1
						WBG-287	WBG4242	0 - 1
						WBG-288	WBG4243	0 - 1
						WBG-289	WBG4244	0 - 1
						WBG-290	WBG4245	0 - 1
						WBG-291	WBG4246	0 - 1
						WBG-292	WBG4247	0 - 1
						WBG-293	WBG4248	0 - 1
						WBG-296	WBG4315	0 - 1
						WBG-297	WBG4316	0 - 1

Section 2.1 provides a summary of the COPC selection process and the data assumptions used during that process. Section 2.2 presents the assumptions for COPC screening and Section 2.3 presents the results of the COPC screening process. The COPC screening process follows the methodology presented in *RVAAP's Facility-Wide Human Health Risk Assessor's Manual* (FWHHRAM) (USACE 2005b) and used in the FFS HHRA for WBG.

2.1 CHEMICAL OF POTENTIAL CONCERN SCREENING PROCESS

This subsection provides a description of the screening process used to identify COPCs and the data assumptions used in the process. Per the FWHHRAM (USACE 2005b), this data evaluation consists of five steps: (1) a data quality assessment, (2) frequency-of-detection/weight-of-evidence (WOE) screening, (3) screening of essential human nutrients, (4) risk-based screening, and (5) background screening.

1. **Data Quality Assessment** – Analytical results were reported by the laboratory in electronic form and loaded into a WBG database. Site data were extracted from the database so that only one result is used for each station and depth sampled. Quality control data, such as sample splits and duplicates, and laboratory re-analyses and dilutions, were not included in the determination of COPCs for this risk assessment. Field-screening data that are typically used in the evaluation of nature and extent of contamination at WBG are not included in the dataset for the risk assessment. Samples rejected in the validation process are also excluded from the risk assessment. The percentage of rejected data was less than 1%.

2. **Frequency-of-Detection/WOE Screen** – Each chemical for each environmental medium is evaluated to determine its frequency of detection. Chemicals that were never detected are eliminated as COPCs. No chemicals were eliminated due to less than 5% frequency of detection in this Supplemental HHRA.

3. **Essential Nutrients** – Chemicals considered essential nutrients (i.e., calcium, chloride, iodine, iron, magnesium, potassium, phosphorus, and sodium) are an integral part of the human food supply and are often added to foods as supplements. The U. S. Environmental Protection Agency (EPA) recommends that these chemicals not be evaluated as COPCs so long as they are: (1) present at low concentrations (i.e., only slightly elevated above naturally occurring levels) and (2) toxic at very high doses (i.e., much higher than those that could be associated with contact at the site). Recommended daily allowance (RDA) and recommended daily intake (RDI) values are available for seven of these metals. Based on these RDA/RDI values, a receptor ingesting 100 mg of soil per day would receive less than the RDA/RDI of calcium, magnesium, phosphorus, potassium, and sodium, even if the soil consisted of the pure mineral (i.e., soil concentrations > 1,000,000 mg/kg). Receptors ingesting 100 mg of soil per day would require soil concentrations of 1,500 mg/kg of iodine and 100,000 to 180,000 mg/kg of iron to meet their RDA/RDI for these metals. Concentrations of essential nutrients do not exceed these levels at WBG; thus, these constituents are not addressed as COPCs.

4. **Risk-based Screen** – The objective of this evaluation is to identify COPCs that may pose a potentially significant risk to human health. The risk-based screening values are conservative values published by EPA. The maximum detected concentration (MDC) of each chemical in each environmental medium is compared against the appropriate risk-based screening value. Chemicals detected below these concentrations are screened from further consideration. Detected chemicals without risk-based screening values are not eliminated from the COPC list.

   The risk-based screening values are conservative values published by EPA. For deep surface soil, a conservative screen is performed using the most current residential preliminary remediation goals

(PRGs) published by EPA Region 9 (EPA 2004a). To account for the potential effects of multiple chemicals, PRGs based on non-cancer endpoints are divided by 10. These screening values are very conservative [based on a 1E-06 risk level and a hazard quotient (HQ) of 0.1]. Region 9 PRGs can be found on the EPA Region 9 World Wide Web site (http://www.epa.gov/region09/waste/sfund/prg/index.html).

5. **Background Screen** – For each inorganic constituent detected, concentrations in WBG samples are screened against available, naturally occurring background levels. This screening step, which applies only to the inorganics, is used to determine if detected inorganics are site-related or naturally occurring. If the MDC of a constituent exceeds the background value, the constituent is considered site-related. All detected organic compounds are considered to be above background. Inorganic chemicals whose MDCs are below background levels are eliminated from the COPC list.

   Background data for evaluation of soils at RVAAP are published in the Final version of the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 2001). Background values for soil are available for two soil depths: surface (0 to 1 ft BGS) and subsurface (1 to 12 ft BGS). The background data set includes data from 21 sample locations. Because boring locations were changed during sampling based on the lithological requirements for well screen intervals, all depth intervals for soils were not sampled for each boring. Fifteen of the 21 locations were sampled from 0 to 1 ft BGS (locations 001 through 015), 14 of the 21 locations were sampled from 1 to 3 ft BGS (locations 004 through 006, 008, 010, 012, and 014 through 021), and 13 of the 21 locations were sampled in the 3 to 12 ft BGS range (specifically samples collected from 3 to 4 ft BGS at locations 010 and 020, from 4 to 5 ft BGS at location 006, from 5 to 6 ft BGS at location 021, from 6 to 7 ft BGS at location 008, from 7 to 8 ft BGS at locations 005 and 014, from 8 to 9 ft BGS at location 017, from 9 to 9 ft BGS at location 016, from 9 to 10 ft BGS at location 015, from 10 to 11 ft BGS at location 019, and from 11 to 12 ft BGS at locations 004 and 012). Because this Supplemental HHRA evaluates data over the 0 to 4-ft-BGS range, the background screen for soils is performed using background values for either surface soil (0 to 1 ft BGS) or subsurface soil (1 to 12 ft BGS), whichever is lower.

2.2 CHEMICAL OF POTENTIAL CONCERN SCREENING ASSUMPTIONS

The following assumptions, used in the development of COPCs for this Supplemental HHRA, are noted.

- Chemicals not detected in a medium are not considered to be COPCs.
- Physical chemical data (e.g., alkalinity, pH, etc.) are not considered to be COPCs for WBG.
- Alpha-chlordane and gamma-chlordane are evaluated by screening against the EPA Region 9 PRGs for chlordane.
- Endosulfan I, endosulfan II, and endosulfan sulfate are evaluated by comparing WBG data against screening values (i.e., based on EPA Region 9 PRGs) for endosulfan.
- Endrin aldehyde and endrin ketone are evaluated by comparing WBG data against screening values (i.e., based on EPA Region 9 PRGs) for endrin.
- 1,2-Dichloroethene (DCE) is evaluated by comparing WBG data against screening values (i.e., based on EPA Region 9 PRGs) for *cis*-1,2-DCE.

- *cis*-1,3-Dichloropropene and *trans*-1,3-dichloropropene are evaluated by comparing WBG data against screening values (i.e., based on EPA Region 9 PRGs) for 1,3-dichloropropene.

- Total chromium and hexavalent chromium are evaluated by comparing WBG data against screening values (i.e., based on EPA Region 9 PRGs) for hexavalent chromium.

2.3 CHEMICAL OF POTENTIAL CONCERN SCREENING RESULTS

The COPC screening process and results are summarized in Table 2-2. This table includes

- summary statistics, including frequency of detection, range of detected concentrations, arithmetic average concentration, and 95% upper confidence limit (UCL_{95}) on the mean concentration;

- all screening values (background concentrations and PRGs, as appropriate); and

- final COPC status.

The COPCs are classified as quantitative COPCs or qualitative COPCs based on the availability of EPA-approved toxicity information. COPCs are classified as quantitative if EPA-approved toxicity information is available; hence, risks and hazards can be quantified for these COPCs. COPCs are classified as qualitative if no EPA-approved toxicity information is available; risks and hazards cannot be calculated for these COPCs. Note, however, that toxicity profiles are provided in the Final *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant*, *Ravenna*, *Ohio* (USACE 2001) for both quantitative and qualitative COPCs. The results of the COPC selection process for each medium are provided in Table 2-3.

Table 2-2. Summary of COPC Screening for Winklepeck Burning Grounds Soil

Chemical	CAS Number	Units	Frequency of Detection	Minimum Detect	Maximum Detect	Average Result	UCL_{95} of Mean	EPC	Site Background Criteria[a]	Region 9 Residential PRG	COPC?
Metals											
Aluminum	7429905	mg/kg	313/ 313	1,410	50,100	12,800	13,200	13,200	17,700	7,600	Yes
Antimony	7440360	mg/kg	137/ 244	0.34	236	5.21	7.26	7.26	0.96	3.1	Yes
Arsenic	7440382	mg/kg	314/ 314	0.31	38.4	13	13.4	13.4	15.4	0.39	Yes
Barium	7440393	mg/kg	312/ 313	11.7	10,400	354	446	446	88.4	540	Yes
Beryllium	7440417	mg/kg	150/ 242	0.14	10.9	0.516	0.612	0.612	0.88	15	No
Cadmium	7440439	mg/kg	214/ 312	0.06	877	7.03	12	12	0	3.7	Yes
Calcium	7440702	mg/kg	236/ 243	126	247,000	9,450	10,900	10,900	15,800	--	No
Chromium	7440473	mg/kg	313/ 313	3.4	189	19.6	20.9	20.9	17.4	22	Yes
Chromium, hexavalent	18540299	mg/kg	17/ 44	2	11.8	2.52	3.27	3.27	--	22	No
Cobalt	7440484	mg/kg	241/ 243	0.92	25.4	8.91	9.25	9.25	10.4	140	No
Copper	7440508	mg/kg	241/ 243	5.8	16,800	195	315	315	17.7	310	Yes
Cyanide	57125	mg/kg	19/ 134	0.064	2.8	0.402	0.451	0.451	0	120	No
Iron	7439896	mg/kg	243/ 243	1,350	163,000	25,200	26,600	26,600	23,100	2,300	No
Lead	7439921	mg/kg	313/ 314	5.6	2,800	139	170	170	19.1	400	Yes
Magnesium	7439954	mg/kg	243/ 243	941	53,700	3,530	4,030	4,030	3,030	--	No
Manganese	7439965	mg/kg	313/ 313	65.4	4,270	622	672	672	1,450	180	Yes
Mercury	7439976	mg/kg	217/ 314	0.013	1.4	0.0738	0.0871	0.0871	0.036	2.3	No
Nickel	7440020	mg/kg	241/ 243	7	133	20.6	22	22	21.1	160	No
Potassium	7440097	mg/kg	243/ 243	223	3,710	1,300	1,360	1,360	927	--	No
Selenium	7782492	mg/kg	209/ 314	0.34	5	0.892	0.954	0.954	1.4	39	No
Silver	7440224	mg/kg	56/ 313	0.2	33.2	1.01	1.28	1.28	0	39	No
Sodium	7440235	mg/kg	108/ 236	18.9	2,320	217	247	247	123	--	No
Thallium	7440280	mg/kg	149/ 244	0.17	3.1	0.473	0.507	0.507	0	0.52	Yes
Vanadium	7440622	mg/kg	243/ 243	4.8	44.8	22	22.6	22.6	31.1	7.8	Yes
Zinc	7440666	mg/kg	311/ 313	28.6	24,900	343	482	482	61.8	2,300	Yes
Organics - Explosives											
1,3,5-Trinitrobenzene	99354	mg/kg	40/ 174	0.027	76	2.03	3.07	3.07	--	180	No
1,3-Dinitrobenzene	99650	mg/kg	10/ 174	0.036	0.26	0.471	0.798	0.26	--	0.61	No
2,4,6-Trinitrotoluene	118967	mg/kg	75/ 174	0.03	3,800	72.4	118	118	--	3.1	Yes
2,4-Dinitrotoluene	121142	mg/kg	30/ 174	0.032	1.5	0.181	0.241	0.241	--	0.72	Yes
2,6-Dinitrotoluene	606202	mg/kg	8/ 174	0.075	0.62	0.865	1.41	0.62	--	0.72	No

Table 2-2. Summary of COPC Screening for Winklepeck Burning Grounds Soil (continued)

Chemical	CAS Number	Units	Frequency of Detection	Minimum Detect	Maximum Detect	Average Result	UCL_{95} of Mean	EPC	Site Background Criteria[a]	Region 9 Residential PRG	COPC?
2-Amino-4,6-dinitrotoluene	35572782	mg/kg	8/ 28	0.099	14	1.07	2.01	2.01	--	--	Yes
2-Nitrotoluene	88722	mg/kg	4/ 174	0.074	4.8	0.478	0.803	0.803	--	0.88	Yes
3-Nitrotoluene	99081	mg/kg	6/ 174	0.086	21	0.425	0.67	0.67	--	73	No
4-Amino-2,6-dinitrotoluene	19406510	mg/kg	9/ 28	0.092	0.93	5.45	10.3	0.93	--	--	Yes
4-Nitrotoluene	99990	mg/kg	7/ 174	0.084	0.19	0.486	0.812	0.19	--	12	No
HMX	2691410	mg/kg	41/ 174	0.1	370	8.29	12.9	12.9	--	310	Yes
Nitrobenzene	98953	mg/kg	8/ 174	0.033	0.36	0.477	0.803	0.36	--	2	No
Nitrocellulose	9004700	mg/kg	9/ 29	2.5	315	22.9	43.9	43.9	--	--	Yes
Nitroglycerin	55630	mg/kg	3/ 98	5.5	12	1.85	2.17	2.17	--	35	No
Nitroguanidine	556887	mg/kg	1/ 29	0.091	0.091	0.124	0.126	0.091	--	610	No
RDX	121824	mg/kg	33/ 174	0.14	2,400	44.4	74.6	74.6	--	4.4	Yes
Tetryl	479458	mg/kg	8/ 174	0.054	0.48	1.24	2.08	0.48	--	61	No
Organics - Pesticide/PCB											
4,4'-DDT	50293	mg/kg	1/ 18	0.13	0.13	0.0168	0.0321	0.0321	--	1.7	No
Dieldrin	60571	mg/kg	2/ 18	0.0024	0.0054	0.0105	0.0204	0.0054	--	0.03	No
Endrin ketone	53494705	mg/kg	1/ 18	0.0043	0.0043	0.0103	0.0203	0.0043	--	1.8	No
Heptachlor epoxide	1024573	mg/kg	2/ 18	0.051	0.081	0.0157	0.0284	0.0284	--	0.053	Yes
PCB-1254	11097691	mg/kg	1/ 18	0.14	0.14	0.0376	0.0511	0.0511	--	0.11	Yes
PCB-1260	11096825	mg/kg	2/ 18	0.17	0.46	0.0586	0.102	0.102	--	0.11	Yes
Organics - Semivolatile											
2-Methylnaphthalene	91576	mg/kg	13/ 58	0.047	17	0.743	1.24	1.24	--	5.6	Yes
Acenaphthene	83329	mg/kg	4/ 58	0.14	0.44	0.463	0.6	0.44	--	370	No
Anthracene	120127	mg/kg	8/ 58	0.054	0.87	0.471	0.609	0.609	--	2,200	No
Benz(*a*)anthracene	56553	mg/kg	12/ 58	0.043	2.6	0.514	0.664	0.664	--	0.62	Yes
Benzo(*a*)pyrene	50328	mg/kg	12/ 58	0.04	2.3	0.516	0.663	0.663	--	0.062	Yes
Benzo(*b*)fluoranthene	205992	mg/kg	13/ 58	0.054	2.8	0.534	0.686	0.686	--	0.62	Yes
Benzo(*g*,*h*,*i*)perylene	191242	mg/kg	9/ 58	0.11	1.1	0.479	0.617	0.617	--	--	Yes
Benzo(*k*)fluoranthene	207089	mg/kg	9/ 58	0.065	1.1	0.477	0.616	0.616	--	6.2	No
Bis(2-ethylhexyl)phthalate	117817	mg/kg	3/ 58	0.034	0.14	0.456	0.594	0.14	--	35	No
Carbazole	86748	mg/kg	5/ 58	0.057	0.41	0.46	0.598	0.41	--	24	No
Chrysene	218019	mg/kg	11/ 58	0.05	2.3	0.524	0.671	0.671	--	62	No
Di-n-butyl phthalate	84742	mg/kg	6/ 58	0.053	26	0.921	1.67	1.67	--	610	No

Table 2-2. Summary of COPC Screening for Winklepeck Burning Grounds Soil (continued)

Chemical	CAS Number	Units	Frequency of Detection	Minimum Detect	Maximum Detect	Average Result	UCL_{95} of Mean	EPC	Site Background Criteria[a]	Region 9 Residential PRG	COPC?
Dibenz(*a*,*h*)anthracene	53703	mg/kg	7/ 58	0.054	0.34	0.449	0.588	0.34	--	0.062	Yes
Dibenzofuran	132649	mg/kg	4/ 58	0.045	0.19	0.455	0.593	0.19	--	15	No
Fluoranthene	206440	mg/kg	17/ 58	0.04	5.3	0.613	0.819	0.819	--	230	No
Fluorene	86737	mg/kg	4/ 58	0.18	0.93	0.475	0.612	0.612	--	270	No
Indeno(1,2,3-*cd*)pyrene	193395	mg/kg	9/ 58	0.13	1.4	0.489	0.628	0.628	--	0.62	Yes
N-Nitrosodiphenylamine	86306	mg/kg	2/ 58	0.66	1.5	0.443	0.572	0.572	--	99	No
Naphthalene	91203	mg/kg	9/ 58	0.041	1.6	0.468	0.611	0.611	--	5.6	No
Phenanthrene	85018	mg/kg	18/ 58	0.052	3.2	0.621	0.806	0.806	--	--	Yes
Pyrene	129000	mg/kg	15/ 58	0.036	4.7	0.6	0.79	0.79	--	230	No
Organics - Volatile											
1,2-Dimethylbenzene	95476	mg/kg	1/ 10	0.02	0.02	0.00435	0.00754	0.00754	--	--	Yes
Acetone	67641	mg/kg	2/ 23	0.0049	0.052	0.00791	0.0115	0.0115	--	1,400	No
Benzene	71432	mg/kg	1/ 27	0.032	0.032	0.004	0.00584	0.00584	--	0.64	No
Chloroform	67663	mg/kg	4/ 27	0.002	0.023	0.00365	0.00492	0.00492	--	0.22	No
Dimethylbenzene	1330207	mg/kg	2/ 27	0.02	0.026	0.00441	0.0062	0.0062	--	27	No
Ethylbenzene	100414	mg/kg	2/ 27	0.021	0.16	0.00941	0.0194	0.0194	--	190	No
Methylene Chloride	75092	mg/kg	2/ 27	0.0066	0.012	0.00532	0.00736	0.00736	--	9.1	No
Styrene	100425	mg/kg	1/ 27	0.036	0.036	0.00415	0.00624	0.00624	--	440	No
Toluene	108883	mg/kg	13/ 27	0.00043	0.19	0.0215	0.0375	0.0375	--	66	No
Trichloroethene	79016	mg/kg	1/ 27	0.0012	0.0012	0.00332	0.00413	0.0012	--	0.053	No

[a]Background value reported as 0 for metals not detected in background samples.
CAS = Chemical Abstracts Service.
COPC = Chemical of potential concern.
DDT = Dichlorodiphenyltrichloroethane.
EPC = Exposure point concentration.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
NA = No background criterion available.
PCB = Polychlorinated biphenyl.
PRG = Preliminary remediation goal, values are Region 9 residential PRGs for cancer risk of 1E-06 or noncancer hazard quotient of 0.1.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
UCL_{95} = 95% upper confidence limit.
-- = Background criteria are not applicable (organics), or the chemical was not analyzed for in the background samples (hexavalent chromium).

Table 2-3. Summary of Human Health COPCs at Winklepeck Burning Grounds[a]

Quantitative COPCs[a]		
Explosives		
2,4,6-Trinitrotoluene	2-Nitrotoluene	HMX
2,4-Dinitrotoluene		RDX
Metals		
Aluminum	Cadmium	Manganese
Antimony	Chromium	Thallium
Arsenic	Copper	Vanadium
Barium	Lead[b]	Zinc
Pesticides/PCBs		
Heptachlor epoxide	PCB-1254	PCB-1260
Semivolatile Organic Compounds		
2-Methylnaphthalene	Benzo(*a*)pyrene	Dibenz(*a*,*h*)anthracene
Benz(*a*)anthracene	Benzo(*b*)fluoranthene	Indeno(1,2,3-*cd*)pyrene
Volatile Organic Compounds		
	1,2-Dimethylbenzene	
Qualitative COPCs[c]		
Explosives		
2-Amino-4,6-dinitrotoluene	4-Amino-2,6-dinitrotoluene	Nitrocellulose
Semivolatile Organic Compounds		
Benzo(*g*,*h*,*i*)perylene	Phenanthrene	

[a]COPCs are classified as quantitative when toxicity values from the U. S. Environmental Protection Agency (EPA) are available to quantify risks and hazards.
[b]Although lead does not have toxicity values from EPA, this COPC is evaluated quantitatively using EPA's adult lead model.
[c]COPCs are classified as qualitative when toxicity values from EPA are not available to quantify risks and hazards.
COPC = Chemical of potential concern.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

3.0 EXPOSURE ASSESSMENT

The objectives of the exposure assessment are to estimate the magnitude, frequency, and duration of potential human exposure to COPCs. The four primary steps of the exposure assessment are listed below.

1. Identify the exposure setting, including the proposed Mark 19 Range, and the human receptors associated with that land use.

2. Identify exposure pathways associated with the Mark 19 Range at WBG.

3. Quantify the Mark 19 Range receptor's potential intake of each COPC.

4. Identify the concentrations of COPCs to which the receptor may be exposed.

The output of the exposure assessment is used in conjunction with the output of the toxicity assessment (Chapter 4) to quantify risks and hazards to receptors in the risk characterization (Chapter 5).

3.1 LAND USE AND POTENTIAL RECEPTORS

OHARNG intends to use WBG as a Mark 19 Grenade Machinegun Range; therefore, a National Guard Range Maintenance Soldier is considered to be the relevant receptor for WBG.

As described in the FFS (SAIC 2004), Range Maintenance Soldiers are expected to spend an average of 4 hrs in the impact areas of the range prior to use each weekend, and 8 hours after each weekend use, during an average of 42 scheduled weekends per year. The Range Maintenance Soldier's activity in the impact area is limited to the existing gravel roads, George Road, and the individual target array band access roads. The Range Maintenance Soldier activities will include target maintenance, range maintenance, and controlled burns to clear the range impact area of woody growth and burn off grasses.

A National Guard Range Maintenance Soldier exposure scenario was developed in the FFS HHRA (SAIC 2004) to evaluate risks and to calculate remediation goals for the FFS based on the following assumptions.

- This receptor is responsible for both routine maintenance of the range and targets and annual clearance of practice rounds.

- The soldier performs these duties using a combination of walking over the range, driving over the range in an all-terrain-vehicle-style vehicle, and driving on access roads in a closed vehicle, such as a pickup truck.

- At a minimum, the soldier wears a short-sleeved shirt, long pants, and boots.

- The receptor is present at the range 85 days/year, for 6 hrs/day (i.e., 42 weekends per year, 4 hrs before use and 8 hrs after use, plus 1 day for annual clearance). This equates to 12 hrs over 2 days (4 hrs 1 day before use, plus 8 hrs 1 day after use = 12 hrs) or an average of 6 hrs/day. The Range Maintenance Soldier spends the rest of the workday performing other duties at the Ravenna Training and Logistics Site. This scenario assumes the same soldier (or soldiers) performs these duties all year for a 25-year enlistment.

- The Range Maintenance Soldier is assumed to have an inhalation rate of 27.6 m^3/day. This assumes the receptor spends 75% of their time in light activities and 25% of their time in moderate activities. The inhalation rate is a weighted average that estimated 75% of the time at work is spent doing light activities at an inhalation rate of 1.0 m^3/hr and 25% of the time at work is spent doing moderate activities at an inhalation rate of 1.6 m^3/hr. This results in an estimated point value of 1.15 m^3/hr [0.75(1.0) + 0.25(1.6) = 1.15]. This converts to a daily inhalation rate of 1.15 m^3/hr x 24 hrs/day = 27.6 m^3/day.

- The receptor may spend a given day in a small area of the range, but over the course of the year, the receptor will conduct activities over the entire range.

- This scenario will be protective of users of the range who are present for a much shorter time (i.e., 4 days/year for 12 hrs/day for training). This is based on an individual National Guard Trainee who may train at the range a maximum of 4 days/year with a normal training day of 8 to 12 hrs (i.e., trainees will not bivouac at the range).

For this Supplemental HHRA, a Revised National Guard Range Maintenance Soldier is assumed to work at WBG full time: 12 hrs/day, 330 days/year (i.e., 7 days/week, approximately 47 weeks/year). The Revised National Guard Range Maintenance Soldier is assumed to spend the remaining 35 days/year away from WBG. (e.g., days off). The purpose of this Supplemental HHRA is to ensure remedial activities at WBG are protective even if a National Guard Soldier spends more time at WBG than previously assumed in the FFS. All other exposure parameters (except the exposure time and exposure frequency) for the National Guard Range Maintenance Soldier are the same as those previously used in the FFS and described above.

Potential exposure pathways associated with the Revised National Guard Range Maintenance Soldier are shown in Table 3-1.

Table 3-1. Conceptual Exposure Model for Revised National Guard Range Maintenance Soldier at Winklepeck Burning Grounds

Pathway	National Guard Range Maintenance Soldier
Deep Surface Soils (0 to 4 ft BGS)	
Incidental soil ingestion	l
Dermal contact with soil	l
Inhalation of VOCs and dust	l

BGS = Below ground surface.
VOC = Volatile organic compound.
= Pathway is evaluated in this human health risk assessment.

Exposure parameters used to calculate intake for the Revised National Guard Range Maintenance Soldier in this Supplemental HHRA are listed in Table 3-2. Note, only the exposure time (12 hrs/day) and exposure frequency (330 days/year) differ from the National Guard Range Maintenance Soldier evaluated in the FFS (SAIC 2004).

Table 3-2. Exposure Parameters for Revised National Guard Range Maintenance Soldier

Parameter	Units	Value	Source
Incidental Ingestion			
Soil ingestion rate	kg/day	0.0001	RAGS Part B (EPA 1991)[a]
Exposure time	hrs/day	12	Site-specific per Col. Tadsen[b]
Exposure frequency	days/year	330	Site-specific per Col. Tadsen[b]
Exposure duration	years	25	Assumed enlistment period[a]
Body weight	kg	70	RAGS Part B (EPA 1991)[a]
Carcinogen averaging time	days	25,550	RAGS Part B (EPA 1991)[a]
Noncarcinogen averaging time	days	9,125	RAGS Part B (EPA 1991)[a]
Fraction ingested	unitless	1	Conservative assumption[a]
Conversion factor	days/hr	0.042	
Dermal Contact			
Skin area	M^2/event	0.33	Head, hands, and forearms, *Exposure Factors Handbook* (EPA 1997a)[a]
Adherence factor	mg/cm^2	0.3	Value for construction worker (95th percentile); values from RAGS Part E (EPA 2004b)[a]
Absorption fraction	unitless	Chemical-specific	Chemical-specific absorption fraction values from RAGS Part E (EPA 2004b) or default values from the FWHHRAM (USACE 2005b): SVOCs = 10%; VOCs = 1%; and inorganics = 0.1[a]
Exposure frequency	events/year	330	Site-specific per Col. Tadsen[b]
Exposure duration	years	25	Assumed enlistment period[a]
Body weight	kg	70	RAGS Part B (EPA 1991)[a]
Carcinogen averaging time	days	25,550	RAGS Part B (EPA 1991)[a]
Noncarcinogen averaging time	days	9,125	RAGS Part B (EPA 1991)[a]
Conversion factor	$(kg\text{-}cm^2)/(mg\text{-}m^2)$	0.01	
Inhalation of VOCs and Dust			
Inhalation rate	m^3/day	27.6	Site-specific per Col. Tadsen[c]
Exposure time	hrs/day	12	Site-specific per Col. Tadsen[b]
Exposure frequency	days/year	330	Site-specific per Col. Tadsen[b]
Exposure duration	years	25	Assumed enlistment period[a]
Body weight	kg	70	RAGS Part B (EPA 1991)[a]
Carcinogen averaging time	days	25,550	RAGS Part B (EPA 1991)[a]
Noncarcinogen averaging time	days	9,125	RAGS Part B (EPA 1991)[a]
Particulate emission factor	m^3/kg	9.24E+08	Default value for Cleveland, Ohio, assuming a 0.5-acre source area[d]
Conversion factor	days/hr	0.042	

[a]Value is the same as that cited in the FWHHRAM for National Guard Trainee.
[b]The Range Maintenance Soldier is assumed to spend 12 hrs in the impact area of the range 7 days/week for approximately 47 weeks/year. This is estimated to be the maximum amount of time anyone could be present at the range.
[c]The Range Maintenance Soldiers will be engaged in light activity 75% of the time and moderate activity 25% of the time.
[d]Value is the same as that cited in FWHHRAM for all receptors except the National Guard Trainee. The lower National Guard Trainee value is not used because the Range Maintenance Soldier will not be generating large quantities of dust (i.e., there will be no tanks).
FWHHRAM = *RVAAP's Facility-Wide Human Health Risk Assessor's Manual* (USACE 2005b).
RAGS = Risk Assessment Guidance for Superfund.
SVOC = Semivolatile organic compound.
VOC = Volatile organic compound.

3.2 QUANTIFICATION OF INTAKE

Intake is defined as the amount of contaminant that could be in contact with the body (e.g., lungs and gut) per unit body weight per unit time. Dose is defined as the amount of contaminant that could be absorbed into the bloodstream per unit body weight per unit time. For this Supplemental HHRA, the intakes (for inhalation and ingestion exposures) and doses (for dermal exposures) were quantified for the Revised National Guard Range Maintenance Soldier using methods presented in the FWHHRAM (USACE 2005b). The equations used to estimate intake and dose are the same as those used in the FFS HHRA (SAIC 2004) and are presented in the following subsections. The exposure parameters used in these equations are provided in Table 3-2; chemical-specific factors used in these equations are shown in Table 3-3.

Table 3-3. Chemical-Specific Exposure Parameters

COPC	Dermal Absorption Factor[a] (unitless)	Soil Volatilization Factor[b] (m^3/kg)
Aluminum	0.001	
Antimony	0.001	
Arsenic	0.03	
Barium	0.001	
Cadmium	0.001	
Chromium	0.001	
Copper	0.001	
Manganese	0.001	
Thallium	0.001	
Vanadium	0.001	
Zinc	0.001	
1,2-Dimethylbenzene	0.01	8.07E+03
2,4,6-Trinitrotoluene	0.1	
2,4-Dinitrotoluene	0.1	
2-Methylnaphthalene	0.1	2.59E+05
2-Nitrotoluene	0.1	
Benz(*a*)anthracene	0.13	
Benzo(*a*)pyrene	0.13	
Benzo(*b*)fluoranthene	0.13	
Dibenz(*a*,*h*)anthracene	0.13	
HMX	0.1	
Heptachlor epoxide	0.1	
Indeno(1,2,3-*cd*)pyrene	0.13	
PCB-1254	0.14	
PCB-1260	0.14	
RDX	0.1	

[a]Chemical-specific absorption factor values from *Risk Assessment Guidance for Superfund* (RAGS) Part E (EPA 2004b). When chemical-specific values are not available, the following default values from *RVAAP's Facility Wide Human Health Risk Assessor's Manual* (USACE 2004) are used:
semivolatile organic compounds = 0.1, volatile organic compounds (VOCs) = 0.01, inorganics = 0.001.
[b]Volatilization factors calculated using methods from the *Soil Screening Guidance: User's Guide* (EPA 1996), using site-specific parameter values for Cleveland, Ohio. Only used for VOCs.
COPC = Chemical of potential concern.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazoxine.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

3.2.1 Soil Exposure Pathways

Incidental ingestion of soils was estimated for chemicals using Equation 3-1:

$$Chemical\ Intake\ (mg/kg-day) = \frac{C_S \times IR_S \times EF \times ED \times FI \times ET \times CF}{BW \times AT}, \quad \textbf{(3-1)}$$

where

C_s	=	chemical concentration in soils (mg/kg),
IR_s	=	ingestion rate (kg/day),
EF	=	exposure frequency (days/year),
ED	=	exposure duration (years),
FI	=	fraction ingested (value of 1, unitless),
ET	=	exposure time adjustment (hr/day),
CF	=	conversion factor for ET (day/hr),
BW	=	body weight (kg),
AT	=	averaging time (days) for carcinogens or noncarcinogens.

The dermally absorbed dose (DAD) from chemicals in soils was calculated by using Equation 3-2.

$$Chemical\ DAD\ (mg/kg-day) = \frac{C_s \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}, \quad \textbf{(3-2)}$$

where

C_s	=	chemical concentration in soils (mg/kg),
CF	=	conversion factor [$(10^{-6}$ kg/mg$) \times (10^4$ cm^2/m$^2)$],
SA	=	skin surface area exposed to soil (m^2/event),
AF	=	soil to skin adherence factor (mg/cm^2),
ABS	=	chemical-specific absorption factor [Table 3-3; when chemical-specific values are not available, the following defaults are used: 0.1% for inorganics, 1.0% for volatile organic compounds (VOCs), and 10% for semivolatile organic compounds],
EF	=	exposure frequency (events/year),
ED	=	exposure duration (years),
BW	=	body weight (kg),
AT	=	averaging time (days) for carcinogens or noncarcinogens.

Inhalation of soils was calculated using Equation 3-3:

$$Chemical\ Intake\ (mg/kg-day) = \frac{C_s \times IR_a \times EF \times ED \times (VF^{-1} + PEF^{-1}) \times ET \times CF}{BW \times AT}, \quad \textbf{(3-3)}$$

where

C_s	=	chemical concentration in soils (mg/kg),
IR_a	=	inhalation rate (m^3/day),
EF	=	exposure frequency (days/year),

ED	=	exposure duration (years),
VF	=	volatilization factor [chemical-specific (Table 3-3), m^3/kg],
PEF	=	particulate emission factor (m^3/kg),
ET	=	exposure time adjustment (hr/day),
CF	=	conversion factor for ET (day/hr),
BW	=	body weight (kg),
AT	=	averaging time (days) for carcinogens or noncarcinogens.

The general particulate emission factor (PEF) value used for the Revised National Guard Range Maintenance Soldier is the default value for Cleveland, Ohio, assuming a 0.5-acre source area (9.24E+08 m^3/kg). This PEF value was calculated using EPA Soil Screening Guidance on-line at http://risk.lsd.ornl.gov/epa/ssl1.htm (EPA 1996). Contamination tends to be limited to small areas; therefore, a 0.5-acre contaminated source area is considered appropriate.

3.3 EXPOSURE POINT CONCENTRATIONS

The exposure point concentration (EPC) represents the chemical concentration a receptor is likely to come in contact with over the duration of exposure. Exposure concentrations from direct contact with environmental media (e.g., soils) are based on the sampling results of the media as described below.

Exposure from the three direct contact pathways (ingestion, dermal contact, and inhalation) represents exposure to media at the source, and the EPC is based on data collected at the source. Current measured concentrations of chemicals were used to represent future concentrations in the medium of interest.

The EPCs developed for each COPC represent a UCL_{95} on the mean or the maximum detected value for all locations within the exposure unit, whichever is smaller. EPCs were calculated using EPA guidance, *Supplemental Guidance to RAGS: Calculating the Concentration Term* (EPA 1992). The data were tested using the Shapiro-Wilk test to determine distribution, normal or lognormal, of the concentrations. The UCL_{95} on the mean was calculated using the normal distribution equation (see Equation 3-4) when the concentrations are normally distributed, when concentrations are not judged to be normally or lognormally distributed, when the data set contains fewer than five detections, or when the frequency of detection is less than 50%. For these situations, the UCL_{95} on the mean is calculated using the following equation:

$$UCL_{95}(normal) = \bar{x}_n + \frac{(t)(s_x)}{\sqrt{n}}, \qquad \textbf{(3-4)}$$

where

$\bar{x}_n$	=	mean of the untransformed data,
t	=	student-t statistic,
s_x	=	standard deviation of the untransformed data,
n	=	number of sample results available.

For lognormally distributed concentrations, the UCL_{95} on the mean is calculated using the following equation:

$$UCL_{95}(lognormal) = e^{\left(\bar{x}_l + 0.5(s_l^2) + \frac{(S_l)(H)}{\sqrt{n-1}}\right)} \qquad \textbf{(3-5)}$$

where

e	=	constant (base of the natural log, equal to 2.718),
$\bar{x}_l$	=	mean of the transformed data [l = log (x)],
s_l	=	standard deviation of the transformed data,
H	=	H-statistic,
n	=	number of sample results available.

3.4 INTAKE RESULTS

Results of the exposure assessment are presented in tabular format in Chapter 5. These results are combined with information presented in Chapter 4 (Toxicity Assessment) to estimate risks and hazards for the National Guard Range Maintenance Soldier in Chapter 5.

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4.0 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to evaluate the potential for COPCs to cause adverse health effects in exposed individuals. Where possible, it provides an estimate of the relationship between the intake or dose of a COPC and the likelihood or severity of adverse health effects as a result of that exposure. Toxic effects have been evaluated extensively by EPA. This chapter provides the results of the EPA evaluation of the chemicals identified as COPCs in deep surface soil at WBG.

4.1 TOXICITY INFORMATION AND EPA GUIDANCE FOR NONCARCINOGENS

Noncarcinogenic effects are evaluated by comparing an exposure or intake/dose with a reference dose (RfD) or reference concentration (RfC). The RfD and RfCs are determined using available dose-response data for individual chemicals. Scientists determine the exposure concentration or intake/dose below which no adverse effects are seen and add a safety factor (from 10 to 1,000) to determine the RfD or RfC. RfDs and RfCs are identified by scientific committees supported by EPA. The RfDs available for the COPCs present in WBG media are listed in Table 4-1. Values are primarily from the Integrated Risk Information System (IRIS, EPA 2005). Toxicity values not available from IRIS are provisional values from the Superfund Health Risk Technical Support Center (aluminum) and the Health Effects Assessment Summary Tables (barium, copper, and vanadium) (EPA 1997b). In this Supplemental HHRA, RfCs, measured in milligrams per cubic meter, were converted to RfDs expressed in units of milligrams per kilogram body weight per day by using the default adult inhalation rate and body weight [i.e., (RfC × 20 m^3/day)/70 kg = RfD] (EPA 1989).

Chronic RfDs are developed for protection from long-term exposure to a chemical (from 7 years to a lifetime); subchronic RfDs are used to evaluate short-term exposure (from 2 weeks to 7 years) (EPA 1989). Because the one potential receptor at WBG is not considered to have short-term exposures, this Supplemental HHRA uses only chronic RfDs.

Toxic effects are diverse and measured in various target body organs (e.g., they may range from eye irritation to kidney or liver damage). EPA is currently reviewing methods for accounting for the difference in severity of effects; however, existing RfDs do not address this issue.

4.2 TOXICITY INFORMATION AND EPA GUIDANCE FOR CARCINOGENS

For carcinogens, risks are estimated as the probability that an individual will develop cancer over a lifetime as a result of exposure to the carcinogen. Cancer risk from exposure to contamination is expressed as excess cancer risk, which is cancer occurrence in addition to normally expected rates of cancer development. Excess cancer risk is estimated using a cancer slope factor (CSF). The CSF is defined as a plausible upper-bound estimate of the probability of a response (i.e., cancer) per unit intake of a chemical over a lifetime (EPA 1989).

EPA expresses inhalation cancer potency as unit risk based on chemical concentration in air (i.e., risk per µg of chemical per m^3 of ambient air). These unit risks were converted to CSFs expressed in units of risk per mg of chemical per kg body weight per day by using the default adult inhalation rate and body weight [i.e., (Unit Risk × 70 kg × 1,000 µg/mg)/ 20 m^3/day].

Table 4-1. Noncarcinogenic RfDs for Winklepeck Burning Grounds Risk Characterization

Analyte	Oral Chronic RfD (mg/kg-day)	Confidence Level	%GI Absorption[a]	Dermal Chronic RfD (mg/kg-day)	Inhalation Chronic RfD (mg/kg-day)	RfD Basis (vehicle)	Critical Effect	Uncertainty/ Modifying Factor
Aluminum	1.0E+00	NA	1	1.0E+00	1.4E-03	NA	NA	(O) UF = 10
Antimony	4.0E-04	Low	0.15	6.0E-05		Oral, oral-water	Gastrointestinal, liver, cardiovascular, and developmental toxicity	(O) UF = 1,000
Arsenic	3.0E-04	Medium (O)	0.95	3.0E-04		Oral, oral-water	Hyperpigmentation and keritosis and possible vascular complication	(O) UF = 3
Barium	7.0E-02	Medium (O)	0.07	4.9E-03	1.4E-04	Oral, oral-water, inhalation	(O) Increased blood pressure (human) (I) Baritosis (human)	(O) UF = 3 (I) UF = 1,000
Cadmium	1.0E-03	High	0.025	2.5E-05		Oral, oral-water	Renal toxicity, osteomalacia, osteoporosis, and significant proteinuria	(O) UF = 1,000
Chromium (as Chromium III)	1.5E+00	Low (O)	0.013	2.0E-02	--	Oral (rat)	Reduced liver/spleen weight	(O) UF = 100
Copper	4.0E-02	NA	1	4.0E-02		NA	NA	NA
Manganese	4.6E-02	NA	0.04	1.8E-03	1.4E-05	Oral: water, inhalation	(O) Lethargy, tremors, mental disturbance, muscle tonus, and central nervous system effects	(O) UF = 1 (O) MF = 3 (I) UF = 1,000
Thallium (as thallium carbonate)	8.0E-05	Low	1	8.0E-05		Oral (rat)	Increased levels of SGOT and LDH	UF = 3,000
Vanadium	7.0E-03	NA	0.026	1.8E-04	--	Inhalation	(I) Respiratory system	(O) MF=1 (O) UF=100
Zinc	3.0E-01	Medium	0.3	9.0E-02		Oral	(O) Copper deficiency and hypochromic microcytic anemia (human) (I) Pulmonary and gastrointestinal effects (human)	UF = 100
1,2-Dimethylbenzene	2.0E+00	NA	1	2.0E+00		NA	NA	NA
2,4,6-Trinitrotoluene	5.0E-04	Medium	1	5.0E-04		Oral (dog)	Liver effects	UF = 1,000
2,4-Dinitrotoluene	2.0E-03	High	1	2.0E-03		Oral (dog)	Neurotoxicity, biliary tract hyperplasia	UF = 100
2-Methylnaphthalene	4.0E-03	Low	1	4.0E-03		Oral (mouse)	Pulmonary alveolar proteinosis	UF = 1,000

Table 4-1. Noncarcinogenic RfDs for Winklepeck Burning Grounds Risk Characterization (continued)

Analyte	Oral Chronic RfD (mg/kg-day)	Confidence Level	%GI Absorption[a]	Dermal Chronic RfD (mg/kg-day)	Inhalation Chronic RfD (mg/kg-day)	RfD Basis (vehicle)	Critical Effect	Uncertainty/ Modifying Factor
2-Nitrotoluene	1.0E-02	NA	1	1.0E-02	--	NA	NA	NA
HMX	5.0E-02	Low	1	5.0E-02		Oral (rat)	Hepatic lesions	UF = 1,000
Heptachlor Epoxide	1.3E-05	Low	1	1.3E-05		Oral (dog)	Increased liver weight	UF = 1,000
PCB-1254	2.0E-05	NA	0.8	2.0E-05		Oral: capsule (monkey)	Immune system toxicity (monkey)	UF = 300
RDX	3.0E-03	High	1	3.0E-03		Oral (rat)	Inflamed prostate	UF = 100

[a]% Gastrointestinal (GI) absorption values from EPA 2004a.
(O) Indicates oral.
(I) Indicates inhalation.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
NA = Not available.
MF = Modifying factor (the default modifying factor is 1).
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RfD = Reference dose.
UF = Uncertainty factor.

CSFs used in the evaluation of risk from carcinogenic COPCs are from IRIS (EPA 2005) and are listed in Table 4-2.

4.3 ESTIMATED TOXICITY VALUES FOR DERMAL EXPOSURE

Oral and inhalation RfDs and CSFs are currently available. Dermal RfDs and CSFs were estimated from oral toxicity values using chemical-specific gastrointestinal absorption factors (GAFs) to calculate total absorbed dose. This conversion is necessary because most oral RfDs and CSFs are expressed as the amount of chemical administered per time and body weight; however, dermal exposure is expressed as an absorbed dose. Dermal toxicity factors are calculated from oral toxicity factors as shown below (EPA 2004b):

$$RfD_{dermal} = RfD_{oral} \times GAF$$

$$CSF_{dermal} = CSF_{oral}/GAF$$

Per the FWHHRAM (USACE 2005b), dermal CSFs and RfDs are estimated from the oral toxicity values using chemical-specific GAFs to calculate the total absorbed dose only for chemicals with GAF values < 0.5. Chemical-specific GAF values available from EPA's *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* (EPA 2004b) are used whenever possible. Not all COPCs have specific GAF values. When quantitative data are insufficient, a default GAF is used. A default value of 1.0 for organic and inorganic chemicals is used (EPA 2004b).

The GAF and resulting dermal toxicity values used in this HHRA are listed in Tables 4-1 and 4-2.

4.4 ASSUMPTIONS USED IN THE TOXICITY ASSESSMENT

Assumptions made in assigning toxicity values for COPCs at WBG are listed below.

- Total chromium is evaluated as chromium III because separate data are available for hexavalent chromium (note – hexavalent chromium was eliminated during the COPC screen).

- Thallium as a metal is evaluated using the toxicity values for thallium carbonate. This is the form of thallium with the most conservative toxicity values.

- Toxicity equivalency factors (TEFs) are applied to carcinogenic polycyclic aromatic hydrocarbons (cPAHs) (EPA 1993). The following TEFs are used to convert the cPAHs identified as COPCs at WBG to an equivalent concentration of benzo(*a*)pyrene.

cPAH	TEF
Benzo(*a*)pyrene	1
Benz(*a*)anthracene	0.1
Benzo(*b*)fluoranthene	0.1
Dibenz(*a*,*h*)anthracene	1
Indeno(1,2,3-*c*,*d*)pyrene	0.1

Table 4-2. Cancer Slope Factors for Winklepeck Burning Grounds Risk Characterization

Analyte	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	% GI Absorption[a]	Dermal Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$	EPA Class	TEF	Type of Cancer
Arsenic	1.5E+00	0.95	1.5E+00	1.5E+01	A		Respiratory system tumors
Cadmium		0.025		6.3E+00	B1		Respiratory tract and lung tumors
2,4,6-Trinitrotoluene	3.0E-02	1	3.0E-02		C		Bladder transitional cell papilloma
2,4-Dinitrotoluene	6.8E-01	1	6.8E-01		B2		Liver carcinoma, mammary adenomas, fibromas (mouse)
Benz(*a*)anthracene	7.3E-01	0.58	7.3E-01	3.1E-01	B2	0.1	Stomach tumors (mouse)
Benzo(*a*)pyrene	7.3E+00	0.58	7.3E+00	3.1E+00	B2	1.0	Stomach, nasal cavity, larynx, tracheal, and pharynx
Benzo(*b*)fluoranthene	7.3E-01	0.58	7.3E-01	3.1E-01	B2	0.1	Tumors
Dibenz(*a*,*h*)anthracene	7.3E+00	0.58	7.3E+00	3.1E+00	B2	1.0	Immunodepressive effects (mouse)
Heptachlor epoxide	9.1E+00	1	9.1E+00	9.1E+00	B2		Hepatocellular carcinoma (mouse)
Indeno(1,2,3-*cd*)pyrene	7.3E-01	0.58	7.3E-01	3.1E-01	B2	0.1	Tumors
PCB-1254	2.0E+00	0.8	2.0E+00	2.0E+00	B2		Liver hepatocellular adenomas, carcinomas, cholangiomas, or cholangiocarcinomas (rat)
PCB-1260	2.0E+00	0.8	2.0E+00	2.0E+00	B2		Liver tumors (rat)
RDX	1.1E-01	1	1.1E-01		C		Liver hepatocellular carcinomas/adenomas (mouse)

[a]% Gastrointestinal (GI) absorption values from EPA 2004b.
EPA = U. S. Environmental Protection Agency.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
TEF = Toxicity equivalence factor - based on the relative potency of each carcinogenic polycyclic aromatic hydrocarbon relative to that of benzo(*a*)pyrene.

4.5 CHEMICALS WITHOUT EPA TOXICITY VALUES

No RfDs or CSFs are available for some detected chemicals at WBG because the noncarcinogenic and/or carcinogenic effects of these chemicals have not yet been determined. Although these chemicals may contribute to health effects from exposure to contaminated media at WBG, their effects cannot be quantified at the present time. In addition, epidemiological studies have indicated that several chemicals are not carcinogenic; consequently, these species do not have CSFs. A qualitative summary of toxicity information for WBG COPCs is presented in the Toxicity Profiles Section of the Final Remedial Investigation Report for WBG (USACE 2001). COPCs evaluated qualitatively in this HHRA for WBG include three explosives (2-amino-4,6-DNT; 4-amino-2,6-DNT; and nitrocellulose) and two polycyclic aromatic hydrocarbons (PAHs) [benzo(*g*,*h*,*i*)perylene and phenanthrene].

Previously withdrawn or provisional toxicity values are used for one COPC at WBG; benzo(*a*)pyrene uses a provisional inhalation CSF. Without this provisional value, the inhalation pathway could not be quantitatively evaluated for this chemical.

No RfDs or CSFs are available for lead. EPA (2003) recommends the use of the Interim Adult Lead Methodology (ALM) to support its goal of limiting risk of elevated fetal blood lead concentrations due to lead exposures to women of child-bearing age. This ALM is used to estimate the probability that the fetal blood lead level will exceed 10 μg/dL as a result of maternal exposure. Two equations are available to evaluate blood lead levels. The first requires only a soil ingestion rate and was considered most appropriate for the analysis at WBG. Complete documentation of the ALM is available at http://www.epa.gov/superfund/programs/lead/prods.htm. The model-supplied default values were used for all parameters with the exception of the site-specific media concentration and exposure frequency. Input parameters and results of this ALM are provided in Table 4-3; results of this model are discussed in Chapter 5.

Table 4-3. Winklepeck Burning Grounds Deep Surface Soil Calculations of Blood Lead Concentrations (PbBs): Revised National Guard Range Maintenance Soldier

Exposure Variable	PbB Equation[a]		Description of Exposure Variable	Units	Range Maintenance Soldier	
	1*	2*			GSDi = 1.8	GSDi = 2.1
PbS	X	X	Soil lead concentration	µg/g or mg/kg	170	170
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	X	X	Biokinetic slope factor	µg/dL per µg/day	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	1.8	2.1
PbB_0	X	X	Baseline PbB	µg/dL	2.2	1.7
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	G/day	0.1	0.1
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	G/day	0.1	0.1
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--
K_{SD}		X	Mass fraction of soil in dust	--	--	--
$AF_{S, D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S, D}$	X	X	Exposure frequency (same for soil and dust)	days/year	330	330
$AT_{S, D}$	X	X	Averaging time (same for soil and dust)	days/year	365	365
PbB_{adult}	**PbB of adult receptor, geometric mean**			µg/dL	2.9	2.4
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers			µg/dL	7.0	7.4
PbB_t	Target PbB level of concern (e.g., 10 µg/dL)			µg/dL	10.0	10.0
$P(PbB > PbB_t)$	Probability that $PbB > PbB_t$, assuming lognormal distribution			%	1.2%	2.0%

[a]Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}). When IRS = IR_{S+D} and WS = 1.0, the equations yield the same $PbB_{fetal,0.95}$.
PbB = Blood lead concentration.
* Equation 1, based on Equations 1 and 2 in U. S. Environmental Protection Agency (EPA) (2003). EPA Technical Review Workgroup for Lead, Adult Lead Committee.

$$PbB_{adult} = (PbS * BKSF * IR_{S+D} * AF_{S,D} * EF_{S,D} / AT_{S,D}) + PbB_0$$

$$PbB_{fetal, 0.95} = PbB_{adult} * (GSD_i^{1.645} * R)$$

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5.0 RISK CHARACTERIZATION

The purpose of the Supplemental HHRA is to evaluate the information obtained through the exposure and toxicity assessments to estimate potential risks and hazards. Potential carcinogenic effects are characterized by using projected intakes and chemical-specific dose-response data (i.e., CSFs) to estimate the probability that an individual will develop cancer over a lifetime. Potential noncarcinogenic effects are characterized by comparing projected intakes of contaminants to toxicity values (i.e., RfDs). The numerical risk and hazard estimates presented in this chapter must be interpreted in the context of the uncertainties and assumptions associated with the risk assessment process and with the data upon which the risk estimates are based. The risk characterization methodology is discussed in Section 5.1 and results are presented in Section 5.2.

5.1 METHODOLOGY

Risk characterization integrates the findings of the exposure and toxicity assessments to estimate the potential for receptors to experience adverse effects as a result of exposure to contaminated media at WBG.

5.1.1 Risk Characterization Methodology for Carcinogens

For carcinogens, risk is expressed as the probability that an individual will develop cancer over a lifetime as a result of exposure to the carcinogen. Cancer risk from exposure to contamination is expressed as the incremental lifetime cancer risk (ILCR), or the increased chance of cancer above the normal background rate of cancer. In the United States, the background chance of contracting cancer is approximately 3 in 10, or 3×10^{-1} (American Cancer Society 2005). The calculated ILCRs are compared to the range specified in the National Oil and Hazardous Substances Pollution Contingency Plan of 1E-06 to 1E-04, or 1 in 1 million to 1 in 10,000 exposed persons developing cancer (EPA 1990). ILCRs below 1E-06 are considered acceptable. ILCRs above 1E-04 are considered unacceptable. The range between 1E-06 and 1E-04 is of concern, and any decisions to address ILCRs further in this range, either through additional study or engineered control measures, should account for the uncertainty in the risk estimates. Ohio Environmental Protection Agency (Ohio EPA) Division of Emergency and Remedial Response, uses 1E-05 as the official target risk goal for development of cleanup goals (Ohio EPA 2004). The ILCR is calculated using the equation below (EPA 1989):

$$ILCR = I \times CSF \qquad \textbf{(5-1)}$$

where

I	=	chronic daily intake or DAD calculated in the exposure assessment (mg/kg-day),
CSF	=	cancer slope factor $(mg/kg\text{-}day)^{-1}$.

For a given exposure pathway, the total risk to a receptor exposed to several carcinogenic COPCs is the sum of the ILCRs for each carcinogen as shown below:

$$ILCR_{total} = \Sigma ILCR_{i} \qquad \textbf{(5-2)}$$

where

$ILCR_{total}$	=	total probability of cancer incidence associated with all carcinogenic COPCs,
$ILCR_i$	=	ILCR for the i^{th} COPC.

5.1.2 Risk Characterization Methodology for Noncarcinogens

In addition to developing cancer from exposure to contaminants, an individual may experience other toxic effects. The term “toxic effects” is used here to describe a wide variety of systemic effects ranging from minor irritations, such as eye irritation and headaches, to more substantial effects such as kidney or liver disease and neurological damage. The risks associated with toxic (i.e., noncarcinogenic) chemicals are evaluated by comparing an estimated exposure (i.e., intake or dose) from site media to an acceptable exposure expressed as an RfD. The RfD is the threshold level below which no toxic effects are expected to occur in a population, including sensitive subpopulations. The ratio of intake over the RfD is the HQ (EPA 1989) and is calculated as:

$$HQ = I/RfD \qquad \textbf{(5-3)}$$

where

I	=	daily intake of a COPC (mg/kg-day),
RfD	=	reference dose (mg/kg-day).

The HQs for each COPC are summed to obtain a hazard index (HI) as shown below:

$$HI = \Sigma HQ_i \qquad \textbf{(5-4)}$$

where

HI	=	hazard index for all toxic effects,
HQ_i	=	hazard quotient for the i^{th} COPC.

An HI greater than 1 has been defined as the level of concern for potential adverse noncarcinogenic health effects (EPA 1989). This approach differs from the probabilistic approach used to evaluate carcinogens. An HQ of 0.01 does not imply a 1 in 100 chance of an adverse effect, but indicates only that the estimated intake is 100 times less than the threshold level at which adverse health effects may occur.

5.1.3 Identification of Chemicals of Concern

COCs are defined as those contaminants that have an ILCR greater than 1E-06 and/or an HI greater than 1 for a given land use scenario and that are not eliminated by the uncertainty analysis.

5.2 RISK CHARACTERIZATION RESULTS

Risks are characterized for the Revised National Guard Range Maintenance Soldier exposed to deep surface soil (0 to 4 ft BGS) at WBG. Risk and hazard results for direct contact with COPCs in deep surface soil are presented in Tables 5-1 and 5-2, respectively. Direct contact includes incidental ingestion of soil, inhalation of VOCs and particulates *(*i.e., dust), and dermal contact with soil.

Table 5-1. Carcinogenic Intakes and Risks for Revised National Guard Range Maintenance Soldier Exposed to Deep Surface Soil

COPC	EPC (mg/kg)	Daily Intake (mg/kg-day) Ingestion	Daily Intake (mg/kg-day) Dermal	Daily Intake (mg/kg-day) Inhalation	Risk Ingestion	Risk Dermal	Risk Inhalation	Total Risk Across all Pathways	COC[a]
Industrial–- Range Maintenance Soldier									
Aluminum	1.3E+04	3.0E-03	6.0E-05	9.1E-07					
Antimony	7.3E+00	1.7E-06	3.3E-08	5.0E-10					
Arsenic	1.3E+01	3.1E-06	1.8E-06	9.2E-10	4.6E-06	2.8E-06	1.4E-08	7.4E-06	R
Barium	4.5E+02	1.0E-04	2.0E-06	3.1E-08					
Cadmium	1.2E+01	2.8E-06	5.5E-08	8.3E-10			5.2E-09	5.2E-09	
Chromium	2.1E+01	4.8E-06	9.5E-08	1.4E-09					
Copper	3.2E+02	7.3E-05	1.4E-06	2.2E-08					
Manganese	6.7E+02	1.5E-04	3.1E-06	4.6E-08					
Thallium	5.1E-01	1.2E-07	2.3E-09	3.5E-11					
Vanadium	2.3E+01	5.2E-06	1.0E-07	1.6E-09					
Zinc	4.8E+02	1.1E-04	2.2E-06	3.3E-08					
Inorganics Pathway Total					4.6E-06	2.8E-06	1.9E-08	7.4E-06	
1,2-Dimethylbenzene	7.5E-03	1.7E-09	3.4E-10	6.0E-08					
2,4,6-Trinitrotoluene	1.2E+02	2.7E-05	5.4E-05	8.1E-09	8.2E-07	1.6E-06		2.4E-06	R
2,4-Dinitrotoluene	2.4E-01	5.6E-08	1.1E-07	1.7E-11	3.8E-08	7.5E-08		1.1E-07	
2-Methylnaphthalene	1.2E+00	2.9E-07	5.7E-07	8.5E-11					
2-Nitrotoluene	8.0E-01	1.9E-07	3.7E-07	5.5E-11	4.3E-08	8.4E-08		1.3E-07	
Benz(*a*)anthracene	6.6E-01	1.5E-07	3.9E-07	4.6E-11	1.1E-07	2.9E-07	1.4E-11	4.0E-07	
Benzo(*a*)pyrene	6.6E-01	1.5E-07	3.9E-07	4.6E-11	1.1E-06	2.9E-06	1.4E-10	4.0E-06	R
Benzo(*b*)fluoranthene	6.9E-01	1.6E-07	4.1E-07	4.7E-11	1.2E-07	3.0E-07	1.5E-11	4.1E-07	
Dibenz(*a,h*)anthracene	3.4E-01	7.8E-08	2.0E-07	2.3E-11	5.7E-07	1.5E-06	7.3E-11	2.0E-06	R
HMX	1.3E+01	3.0E-06	5.9E-06	8.9E-10	--	--	--	--	
Heptachlor epoxide	2.8E-02	6.6E-09	1.3E-08	2.0E-12	6.0E-08	1.2E-07	1.8E-11	1.8E-07	
Indeno(1,2,3-*cd*)pyrene	6.3E-01	1.4E-07	3.7E-07	4.3E-11	1.1E-07	2.7E-07	1.3E-11	3.8E-07	
PCB-1254	5.1E-02	1.2E-08	3.3E-08	3.5E-12	2.4E-08	6.5E-08	7.0E-12	8.9E-08	
PCB-1260	1.0E-01	2.4E-08	6.5E-08	7.0E-12	4.7E-08	1.3E-07	1.4E-11	1.8E-07	
RDX	7.5E+01	1.7E-05	3.4E-05	5.1E-09	1.9E-06	3.7E-06	--	5.6E-06	R
Organics Pathway Total					4.9E-06	1.1E-05	3.0E-10	1.6E-05	
Pathway Total – Chemicals					9.6E-06	1.4E-05	1.9E-08	2.3E-05	

[a] COPCs are identified as COCs if the total incremental lifetime cancer risk across all pathways is > 1E-06 (R).
COC = Chemical of concern.
COPC = Chemical of potential concern.
EPC = Exposure point concentration.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
-- = No values calculated due to lack of toxicity value.

Table 5-2. Noncarcinogenic Intakes and Hazards for Revised National Guard Range Maintenance Soldier Exposed to Deep Surface Soil

COPC	EPC (mg/kg)	Daily Intake (mg/kg-day)			HQ			Total HI Across all Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
Industrial - Range Maintenance Soldier									
Aluminum	1.3E+04	8.5E-03	1.7E-04	2.5E-06	8.5E-03	1.7E-04	1.8E-03	1.0E-02	
Antimony	7.3E+00	4.7E-06	9.3E-08	1.4E-09	1.2E-02	1.5E-03	--	1.3E-02	
Arsenic	1.3E+01	8.7E-06	5.1E-06	2.6E-09	2.9E-02	1.7E-02	--	4.6E-02	
Barium	4.5E+02	2.9E-04	5.7E-06	8.6E-08	1.4E-03	4.1E-04	6.0E-04	2.4E-03	
Cadmium	1.2E+01	7.7E-06	1.5E-07	2.3E-09	7.7E-03	6.1E-03	--	1.4E-02	
Chromium	2.1E+01	1.3E-05	2.7E-07	4.0E-09	9.0E-06	1.4E-05	--	2.3E-05	
Copper	3.2E+02	2.0E-04	4.0E-06	6.1E-08	5.1E-03	1.0E-04	--	5.2E-03	
Manganese	6.7E+02	4.3E-04	8.6E-06	1.3E-07	9.4E-03	4.7E-03	9.1E-03	2.3E-02	
Thallium	5.1E-01	3.3E-07	6.5E-09	9.8E-11	4.1E-03	8.1E-05	--	4.2E-03	
Vanadium	2.3E+01	1.5E-05	2.9E-07	4.4E-09	2.1E-03	1.6E-03	--	3.7E-03	
Zinc	4.8E+02	3.1E-04	6.2E-06	9.3E-08	1.0E-03	6.8E-05	--	1.1E-03	
Inorganics Pathway Total					8.0E-02	3.2E-02	1.1E-02	1.2E-01	
1,2-Dimethylbenzene	7.5E-03	4.9E-09	9.6E-10	1.7E-07	2.4E-09	4.8E-10	--	2.9E-09	
2,4,6-Trinitrotoluene	1.2E+02	7.6E-05	1.5E-04	2.3E-08	1.5E-01	3.0E-01	--	4.5E-01	
2,4-Dinitrotoluene	2.4E-01	1.6E-07	3.1E-07	4.7E-11	7.8E-05	1.5E-04	--	2.3E-04	
2-Methylnaphthalene	1.2E+00	8.0E-07	1.6E-06	2.4E-10	2.0E-04	4.0E-04	--	6.0E-04	
2-Nitrotoluene	8.0E-01	5.2E-07	1.0E-06	1.5E-10	5.2E-05	1.0E-04	--	1.5E-04	
Benz(a)anthracene	6.6E-01	4.3E-07	1.1E-06	1.3E-10	--	--	--	--	
Benzo(*a*)pyrene	6.6E-01	4.3E-07	1.1E-06	1.3E-10	--	--	--	--	
Benzo(*b*)fluoranthene	6.9E-01	4.4E-07	1.1E-06	1.3E-10	--	--	--	--	
Dibenz(*a*,*h*)anthracene	3.4E-01	2.2E-07	5.7E-07	6.6E-11	--	--	--	--	
HMX	1.3E+01	8.3E-06	1.6E-05	2.5E-09	1.7E-04	3.3E-04	--	5.0E-04	
Heptachlor epoxide	2.8E-02	1.8E-08	3.6E-08	5.5E-12	1.4E-03	2.8E-03	--	4.2E-03	
Indeno(*1,2,3-cd*)pyrene	6.3E-01	4.1E-07	1.0E-06	1.2E-10	--	--	--	--	
PCB-1254	5.1E-02	3.3E-08	9.1E-08	9.9E-12	1.7E-03	4.6E-03	--	6.2E-03	
PCB-1260	1.0E-01	6.6E-08	1.8E-07	2.0E-11	--	--	--	--	
RDX	7.5E+01	4.8E-05	9.5E-05	1.4E-08	1.6E-02	3.2E-02	--	4.8E-02	
Organics Pathway Total					1.7E-01	3.4E-01		5.1E-01	
Pathway Total – Chemicals					2.5E-01	3.7E-01	1.1E-02	6.4E-01	

[a]COPCs are identified as COCs if the total HI across all pathways is > 1 (H).
COC = Chemical of concern.
COPC = Chemical of potential concern.
EPC = Exposure point concentration.
HI = Hazard index.
HQ = Hazard quotient.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
-- = No values calculated due to lack of toxicity value.

The total HI for all COPCs in deep surface soil (0.64) is less than 1 (the level of concern for potential adverse noncarcinogenic health effects). The total ILCR (2.3E-05) is less than 1E-04 (EPA's unacceptable level) and on the order of 1E-05 [the official target risk goal for development of cleanup goals per Ohio EPA (2004)]). Five COCs are identified for the Revised National Guard Range Maintenance Soldier exposed to soil at WBG (Table 5-3), including arsenic, two explosives [hexahydro-1,3,5-trinitro-1,3,5-trazine (RDX) and 2,4,6-trinitrotoluene (TNT)], and two PAHs [benzo(*a*)pyrene and dibenz(*a*,*h*)anthracene]. All COCs have chemical-specific HQs <1 and chemical-specific ILCRs < 1E-05.

Table 5-3. Total Hazards/Risks and COCs for Direct Contact with Surface Soil by Revised National Guard Range Maintenance Soldier

Noncarcinogens		Carcinogens	
HI	**COCs**	**ILCR**	**COCs**
0.6	None	2E-05	Arsenic RDX 2,4,6-Trinitrotoluene Benzo(*a*)pyrene Dibenz(*a*,*h*)anthracene

COC = Chemical of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine.

The primary contributor to the total ILCR of 2.3E-05 is arsenic with an individual ILCR of 7.4E-06. The estimated risk from exposure of the Revised National Guard Range Maintenance Soldier receptor to the background criterion for arsenic (15.4 mg/kg) is 8.5E-06. Thus, risk to this receptor from arsenic at WBG is below the risk associated with the background concentration of this metal.

The total ILCR associated with organic COPCs is 1.6E-05. This total ILCR is associated primarily with the four organic COCs.

Of the five COCs, one (arsenic) is a class A carcinogen associated with lung tumors; the two PAHs [benzo(*a*)pyrene (larynx/stomach tumors), and dibenz(*a,h*)anthracene (Immunodepressive effects)] are Class B2 probable carcinogens, and the explosives [RDX (Liver hepatocellular carcinomas) and 2,4,6-TNT (bladder transitional cell papilloma)] are Class C possible carcinogens.

Limitations of the additive risk approach for multiple carcinogens are (1) the chemical-specific slope factors represent the upper 95th percentile estimate of potency; therefore, summing individual risks can result in an excessively conservative estimate of total lifetime cancer risk; and (2) the target organs of the five carcinogenic COCs are different so the risks would not be additive.

Lead was identified as a COPC in deep surface soil at WBG. For the Revised National Guard Range Maintenance Soldier exposed to deep surface soil, the ALM indicated that the estimated probability of fetal blood lead concentrations exceeding acceptable levels was 2% or less (see Table 4-3). Based on these results, lead was not considered a COC in this Supplemental HHRA.

Based on these results, residual soil contamination at WBG does not represent an unacceptable risk, even if a National Guard Range Maintenance Soldier spends as much as 12 hrs/day, 330 days/year at the site.

5.2.1 Cleanup goals

Only five COCs are identified (all carcinogens), each with a chemical-specific ILCR < 1E-05 and each with a different critical endpoint associated with its CSF. Therefore, the risk-based cleanup goals developed in the FFS (SAIC 2004) for the National Guard Range Maintenance Soldier result in remediation protective of the Revised National Guard Range Maintenance Soldier and no new cleanup goals are needed.

5.2.2 Uncertainty Analysis

Uncertainties associated with data evaluation, exposure assessment, toxicity assessment, and risk characterization are the same as those previously described in the FFS (SAIC 2004). Uncertainty unique to this Supplemental HHRA is associated with the exposure time and exposure frequency assumed for the Revised National Guard Range Maintenance Soldier. To minimize future land use restrictions by the National Guard, a worst-case exposure scenario was evaluated. This worst-case scenario assumes a Revised National Guard Range Maintenance Soldier works full-time (12 hrs/day, 7 days/week, approximately 47 weeks/year) at WBG. This is a much greater exposure time and exposure frequency than that estimated for an actual National Guard Range Maintenance Soldier as evaluated in the FFS (SAIC 2004) and represents the maximum amount of time a National Guard Soldier could be expected to spend at WBG.

6.0 SUMMARY AND CONCLUSIONS

This supplemental HHRA evaluated potential risks to a Revised National Guard Range Maintenance Soldier exposed to deep surface soil 12 hrs/day, 330 days/year. The same process was used to generate conclusions regarding human health risks and hazards associated with contaminated media at WBG as that used to evaluate the National Guard Range Maintenance Soldier in the FFS (SAIC 2004). The data set used excluded soil samples removed or to be removed per the proposed plan.

Residual soil contamination at WBG does not represent an unacceptable risk even if a National Guard Range Maintenance Soldier spends as much as 12 hrs/day, 330 days/year at the site based on the results of this Supplemental HHRA, as summarized below.

- The total HI (0.64) is less than 1 (the level of concern for potential adverse noncarcinogenic health effects).
- The total ILCR (2.3E-05) is less than 1E-04 (EPA's unacceptable level) and on the order of 1E-05 [the official target risk goal for development of cleanup goals per Ohio EPA (2004)].
- The primary contributor to the total ILCR is arsenic, which is largely associated with background.
- Chemical-specific ILCRs are all less than 1E-05, and the five COCs contributing to the total ILCR have differing cancer classifications and endpoints. The chemical-specific slope factors represent the upper 95th percentile estimate of potency; therefore, summing individual risks can result in an excessively conservative estimate of total lifetime cancer risk; and the target organs of the five carcinogenic COCs are different, so the risks would not be additive.

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Comment Responses for Draft
Supplemental Human Health Risk Assessment for Revised Range Maintenance Soldier
at the Former Winklepeck Burning Grounds, Ravenna, Ohio
Rev. 04/25/06

Comment Number	Page or Sheet	Comment	Recommendation	Response
		Ohio EPA NEDO DERR (E. Mohr)		
1	Page 3-1, lines 12 - 13	On page 3-1, lines 13 – 14 are repetitive with respect to lines 12 – 13 on the same page. Remove this repetitive text from the final document.		Agree. Lines 13 and 14 repetitive text has been deleted as follows: "Therefore, a National Guard Range Maintenance Soldier is considered to be the relevant receptor for WBG."
2	General	During partnering meetings that are scheduled for the beginning of May 2006, Ohio EPA requests that we discuss the issue of whether or not the exposure assumptions that have been made for the various Ohio Army National Guard (OHARNG) receptors are still acceptable. If not, then we will need to re-think this issue on an installation wide basis, agree upon exposure parameters, and then adjust the existing Facility-wide Human Health Risk Assessment Manual.		Response: Comment noted. To be discussed and addressed by the RVAAP Team in context of the FWHHRAM. No text change required.
		OHARNG/RTLS (LTC Tadsen/K. Elgin/T. Morgan)		
1	Pg 3-1, Line 12-14	"OHARNG intends to use WBG as a Mark 19 Grenade Machinegun Range; therefore a National Guard Maintenance Soldier is considered to be the relevant receptor for WBG. Therefore, a National Guard Range Maintenance Soldier is considered to be	Delete second sentence.	Agree. See response to Ohio EPA comment No. 1

Comment Number	Page or Sheet	Comment	Recommendation	Response
		the relevant receptor for WBG." Repetitive sentence		