

Hexavalent Chromium Contamination at U.S. Army Ammunition Facilities

Prepared by
Citizens for Safe Water Around Badger (CSWAB)
January 9, 2013

Chromium is a naturally-occurring element found in rocks, animals, plants, and soil, where it exists in combination with other elements to form various compounds. The three main forms of chromium are chromium (0), chromium (III), and chromium (VI). Chromium can change from one form to another in water and soil, depending on the conditions present. Very small amounts of chromium (III) are needed for human health. However, hexavalent chromium (Chromium VI) is a known human carcinogen and mutagen.

The metal chromium, which is the chromium (0) form, is used for making steel. Chromium (VI) and chromium (III) are used for chrome plating, dyes and pigments, leather tanning, and wood preserving. At the U.S. Army Ammunition facilities surveyed for this report, chromium (VI) was associated with a variety of other sources and activities including: evaporation/percolation ponds, open burning of military propellants, live firing, explosives wash-out wastewater facilities, TNT leaching beds and production, thermal treatment of small arms munitions, and open burning/open detonation of explosives.



At the majority of sites surveyed, the U.S. Army utilized environmental test methods capable of detecting and quantifying chromium (III) and chromium (VI). At Army facilities where testing for chromium was not speciated (reporting only total chromium), federal health officials, the U.S. Environmental Protection Agency and state regulators consistently required that risk-based cleanup goals and screening levels be based on the most toxic form of chromium which is chromium (VI). The one exception is **Badger Army Ammunition Plant (WI)** where the U.S. Army has calculated risk based on total chromium. State health officials have been asked to review and comment on the Army's methodology at this site.

(Please note that the following is only a partial list of Army ammunition facilities with known or potential chromium VI contamination.)

Name of Facility	Chromium VI Detected in Environment	Contaminated Media	Reported Chromium VI Concentrations	Source (manufacturing process, spill, etc.)	Reference/s
Anniston Army Depot, Ammunition Storage Area, AL	YES	Groundwater	Not found	Explosives wash-out wastewater/TNT washout facility Solid Waste Management Unit (SWMU) 10. Leaching soils and sediment contamination identified as source of groundwater contaminants	U.S. EPA Superfund Record of Decision: Anniston Army Depot, September 18, 2006

Anniston Army Depot (continued)	YES	Groundwater	Not found	TNT leaching beds which received slurries of explosive waste from munitions. Site designation: SWMU 11	U.S. EPA Superfund Record of Decision: Anniston Army Depot, September 18, 2006
	YES	Groundwater	Concentrations ranged from 0.87 to 551 ug/l	Decontamination oven used to deactivate small arms munitions by burning. Site designation: SWMU 35	U.S. EPA Superfund Record of Decision: Anniston Army Depot, September 18, 2006
Badger Army Ammunition Plant, WI	No record of environmental testing for chromium VI found Proposed soil remediation goals are based on <u>total</u> chromium	Surface soil/sediments (total chromium only – testing not speciated)	Maximum concentration total chromium: 110 mg/kg. The Army has proposed a remedial goal of 35.5 mg/kg for total chromium based on historical mean background concentrations. Wisconsin Administrative Code NR 720 Residual Contaminant Levels are 14 mg/kg for chromium VI and 16,000 mg/kg for chromium III	Final Creek, Settling Ponds and Spoils Disposal Area which received industrial and sanitary wastewater during active production years. “Acids used at BAAAP could have dissolved (chromium) from machinery. These dissolved metals then could have been discharged via wastewater to the Settling Ponds Area. The background concentration for total chromium was derived by calculating the mean concentration of five soil samples.” (U.S. Army, 2012)	U.S. Army, Alternative Feasibility Study Final Creek, Settling Ponds, and Spoils Disposal Areas, Badger Army Ammunition Plant, August 2012
Iowa Army Ammunition Plant, IA	PRESUMED Soil remediation goals for human ingestion/dermal contact are based on chromium VI	Surface Soil	Total Chromium was detected as high as 2,110 mg/kg (Chromium testing was not speciated)	At the West Burn Pads, RDX was the explosive with the highest reported value, and chromium was the metal with the highest reported value. Chromium was also detected at the East Burn Pads and Firing Site. (Site IAAP-032)	Draft Final Five-Year Review Report, Iowa Army Ammunition Plant, Middletown, Iowa, February 2006

Isla de Vieques Bombing Range, Vieques, Puerto Rico	PRESUMED “Although some or all of the chromium detected on Vieques could be chromium III, an essential nutrient; as a conservative approach to the health evaluation, ATSDR assumed that all of the chromium was the more harmful chromium VI.” (ASTDR, 2003)	Soil	700 parts per million (maximum concentration)	Live firing, open detonation and disposal of munitions. Ordnance casings and high explosives components were identified as an expected source of Chromium VI	U.S. Agency for Toxic Substances and Disease Registry (ATSDR), Petitioned Public Health Assessment, Soil Pathway Evaluation, Isla de Vieques Bombing Range, Vieques, Puerto Rico, February 7, 2003.
		Air	Estimated Annual Average Ambient Air Concentration in Residential Areas: 3.62e-07 µg/m3		
Louisiana Army Ammunition Plant	YES	Surface Soil (0-6 inches)	1.48 to 13.9 ug/g	Y-Line Metal Parts Manufacturing Area. The facility housed an assembly line for forging, machining, and painting 155-mm shells. From the early 1960s until 1994, shells were etched in a chromium etching bath at the west end of Building 2600 and then rinsed with a chromic acid solution	Final Record of Decision for the Y-Line Soils, Louisiana AAP, February 2002, U.S. EPA website Public Health Assessment, U.S. Agency for Toxic Substances and Disease Registry, June 11, 2003
Radford Army Ammunition Plant, VA	PRESUMED Both USEPA and the Virginia Department of Environmental Quality requested that risk-based goals for chromium be based on chromium VI	Soil	Total chromium detections ranged from 18.6 to 51.5 mg/kg, exceeding the Chromium VI Residential Risk-Based Concentration of 23 mg/kg	SWMU 6: Acid Wastewater Lagoon located in the Main Manufacturing Area	United States Army Corps of Engineers, Radford Army Ammunition Plant, Virginia, SWMU 6 Decision Document, Final, October 2002

Radford AAP (continued)	Soil	Concentrations of total chromium were detected as high as 53.4 mg/kg, exceeding the adjusted residential soil screening level of 23.5 mg/kg for chromium VI. Both USEPA and the Virginia Department of Environmental Quality requested that risk-based goals for chromium be based on chromium VI	SWMU 13: Open burning of waste and off-specification energetics beginning in 1941. Material burned at the open burning ground has consisted of waste explosives, propellants, and laboratory waste. Three types of propellant wastes have been burned including single base (nitrocellulose), double base (nitrocellulose and nitroglycerin), and triple base (nitrocellulose, nitroglycerin, and nitroguanidine)	Radford Army Ammunition Plant, Work Plan Addendum, Work Plan Addendum, RCRA Facility Investigation at Solid Waste Management Unit 13, Final, July 2008	
	Surface Water	Concentrations of total chromium detected as high as 78.8 ug/l, exceeding the USEPA Region III Biological Technical Assistance Group Screening Level of 2 ug/l for chromium VI			
	Subsurface Soil	Total chromium detected as high as 38.8 ug/g in subsurface soils. Residential Risk-Based goals were based on Chromium VI	SWMU 31: Coal Ash Settling Lagoons		U.S. Army Corps of Engineers, Work Plan Addendum 009 – SWMU 31 and Horseshoe Area Groundwater Study, Radford Army Ammunition Plant, September 2002
	Sediment	Total chromium was detected as high as 34.2 ug/g in sediments. USEPA Region III requested that the screening value be based on chromium VI			

Ravenna Army Ammunition Plant, OH	YES	Soil	25 mg/kg (exceeded the National Guard Trainee risk-based soil cleanup goal of 16 mg/kg)	Central Burn Pits	Final Action Memorandum for Central Burn Pits (RVAAP-49) Ravenna Army Ammunition Plant, Ravenna, Ohio, June 2007
	YES	Soil	Chromium VI detections ranged from 1 to 81.9 mg/kg, exceeding the EPA Region 9 Residential Preliminary Remediation Goal of 22 mg/kg	Source not noted	Draft Facility-Wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio, September 2008
		Groundwater	Maximum detection: 10 ug/l		
		Sediments	Maximum detection: 33 mg/kg		
Riverbank Army Ammunition Plant, CA	YES	Surface sediments	up to 1.5 mg/kg	Evaporation/percolation ponds that contain wastewater from the plant	Public Health Assessment, Riverbank Army Ammunition plant, California, Federal Facilities Assessment Branch Division of Health Assessment and Consultation, U.S. Agency for Toxic Substances and Disease Registry, September 30, 1997
	YES	Sediments in stormwater reservoir	"three times background levels"	Stormwater from "main plant area"	U.S. Army, Riverbank Installation Action Plan, 2001
	YES	Groundwater	Levels of chromium VI in three nearby residential groundwater wells were consistently detected above the 50 ug/l	The former redwood tanks represent the location of a past release of wastewater containing hexavalent chromium, which resulted in contamination of groundwater at Riverbank and the surrounding area. The	Final Site Investigation Report, Riverbank Army Ammunition Plant, Riverbank, California Prepared for U.S. Army Corps of Engineers, March 2008 U.S. EPA Region 9/U.S. Army Federal Facilities Agreement, Riverbank Army Ammunition

Riverbank AAP (continued)				redwood tanks were replaced in 1972 with a concrete tank	Plant, April 1990
Sacramento Army Depot, CA	YES	Soil and Groundwater	Not quantified	Contaminated soils and debris at the South Post Burn Pits. Metals, including Cr, detected to a depth of approximately 20 feet below surface. Buried materials included plating shop wastes and paint sludges containing lead chromate, chrome, green zinc chromate, cobalt, titanate and red oxide	U.S. Army Corps of Engineers, Five Year Review, Former Sacramento Army Depot, Sacramento, California, December 2001
Sierra Army Depot, CA	YES (Chromium trivalent and Chromium hexavalent)	Air	Not quantified. (Greater than 10 pounds of air emissions per year)	Open burning/open detonation of explosives, propellants and other munitions wastes	U.S. Agency for Toxic Substances and Disease Registry, Health Consultation – Air Pathway Evaluation, Sierra Army Depot, California, November 7, 2003
Sunflower Army Ammunition Plant, KS	YES	Surface water	Not found	Historical discharge of wastewater from the North Acid. An Army risk assessment identified hexavalent chromium as the primary contaminant of concern in surface water	U.S. Army, Installation Action Plan, Sunflower Army Ammunition Plant, 2001
Volunteer Army Ammunition Plant, TN	PRESUMED “Because no information about the form of chromium detected was available, ATSDR assumed that all the chromium found at VAAP was present in its more toxic form – chromium VI.” (ATSDR, 2004.	Sediment	12,000 mg/kg (maximum concentration)	Emissions and discharges associated with production of trinitrotoluene (TNT) and the acids required for TNT production.	U.S. Agency for Toxic Substances and Disease Registry, Public Health Assessment, Volunteer Army Ammunition Plant, Chattanooga, TN, September 7, 2004
		Surface Water	0.054 mg/l (maximum concentration)		
		Surface Soil	12,000 mg/kg (maximum concentration)		