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Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
°C	degrees Centigrade
°F	degrees Fahrenheit
ACWA	Assembled Chemical Weapons Alternatives
ADAF	age dependent adjustment factor
AEGL	Acute Exposure Guideline
AERMAP	AERMOD Terrain Data Preprocessor Program
AERMET	AERMOD Meteorological Data Preprocessor Program
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AFA	Agent Filter Area
AFS	air filtration system
Agent T	bis-2-[2-chloroethyl thio] ethyl or $C_8H_{16}Cl_2OS_2$
AIEC	Acute Inhalation Exposure Criteria
ANS	Agent Neutralization System
APB	Agent Processing Building
ATSDR	Agency for Toxic Substances and Disease Registry
AWS	Agent/Water Separator
BPIPPRM	Building Profile Input Program for PRIME
BPT	Bechtel Pueblo Team
BRS	Brine Reduction System
BTS	Biotreatment System
$C_{(air)}$	calculated chemical-specific concentration in air
Cal EPA	California Environmental Protection Agency
CAS	Chemical Abstracts Service
CBRNIAC	Chemical, Biological, Radiological & Nuclear Defense Information Analysis Information Center
CCR	Code of Colorado Regulations
CDC	Centers for Disease Control and Prevention
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Regulations
CHWRs	Colorado Hazardous Waste Regulations
cm	centimeter
cm^2/s	square centimeters per second
COPC	chemical of potential concern
CSF	cancer slope factor
Cy	maximum ground-level unit response concentration
D_a	diffusivity in air
D_R	calculated chemical-specific deposition rate
D_w	diffusivity in water
D_Y	maximum ground-level unit response deposition rate
day/yr	days per year
DEM	digital elevation model
DPE	demilitarization protective ensemble
EDS	Explosive Destruction System
ERB	Enhanced Reconfiguration Building
ERPG	Emergency Response Planning Guideline
ft	feet

Acronym/ Abbreviation	Definition
ft/s	feet per second
Fv	fraction of a COPC in the vapor phase
g/m^2-yr	grams per square meter per year
g/s	grams per second
H	Henry's Law constant
ha	hectare
HD	sulfur mustard or bis-(2-chloroethyl) sulfide or $C_4H_8Cl_2S$
HEAST	Health Effects Assessment Summary Tables
HEPA	high-efficiency particulate air
HHRAP	Human Health Risk Assessment Protocol
HI	hazard index
HI_A	acute hazard index
hr/day	hours per day
HT	mixture of approximately 60 percent HD and 40 percent Agent T (bis-2-[2-chloroethyl thio] ethyl, or $C_8H_{16}Cl_2OS_2$)
HQ	hazard quotient
HQ_A	acute hazard quotient
ICB™	Immobilized Cell Bioreactor
IRIS	Integrated Risk Information System
IUR	inhalation unit risk
K	Kelvin
kg	kilogram
kg/day	kilograms per day
km	kilometer
lb/hr	pounds per hour
LOAEL	lowest-observed-adverse-effect-level
$\mu g/m^3$	microgram(s) per cubic meter
m	meter
m/s	meter(s) per second
m^2	square meter
m^3/hr	cubic meter(s) per hour
mg COPC/kg of body weight-day	milligram(s) of COPC per kilogram of body weight per day
mg/m^3	milligram(s) per cubic meter
mℓ/hr	milliliter(s) per hour
mm	millimeter
mph	mile(s) per hour
MPHRA	Multiple Pathway Health Risk Assessment
MRL	minimal risk level
MSM	munitions service magazine
MTU	Munitions Treatment Unit
MWS	Munitions Washout System
NCEA	National Center for Environmental Assessment
NED	National Elevation Dataset
OEHHA	Office of Environmental Health Hazard Assessment
OSWER	Office of Solid Waste and Emergency Response
OTS	Offgas Treatment System
Pa-m^3/mol	Pascal-cubic meter(s) per mole

Acronym/ Abbreviation	Definition
PCAPP	Pueblo Chemical Agent-Destruction Pilot Plant
PCB	polychlorinated biphenyl
PCD	Pueblo Chemical Depot
PEO	Program Executive Office
PRRS	Paint Residue Removal System
PPE	personal protective equipment
PPRTV	Provisional Peer Reviewed Toxicity Value
PRG	preliminary remediation goal
Q	estimated chemical-specific stack emission rate
rcl	cuticular resistance
RCRA	Resource Conservation and Recovery Act
RD&D	Research, Development, and Demonstration
RDX	Royal Demolition Explosive
REL	Reference Exposure Level
RfC	inhalation reference concentration
RfD	reference dose
RME	reasonably maximally exposed
RSL	USEAP Region IX Regional Screening Level
s/cm	second(s) per centimeter
SDS	spent decontamination solution
SDU	Supplemental Decontamination Unit
STEL	short-term exposure limit
TEEL	Temporary Emergency Exposure Limit
TNT	trinitrotoluene
US	United States
USACHPPM	US Army Center for Health Promotion and Preventive Medicine (now known as USAPHC)
USAPHC	US Army Public Health Command (formerly USACHPPM)
USDA	US Department of Agriculture
USEPA	US Environmental Protection Agency
USGS	US Geological Survey
UTM	Universal Transverse Mercator
VOC	volatile organic compound
VSL	vapor screening level
WRS	Water Recovery System
WTS	Waste Transfer Sub-system
yr	year

1 INTRODUCTION

1.1 WHAT DOES THIS REPORT REPRESENT?

This report presents the results of a screening-level Multiple Pathway Health Risk Assessment (MPHRA) performed for the hazardous waste treatment operations to be conducted at the Pueblo Chemical Depot (PCD) located east of Pueblo, Colorado. These hazardous waste treatment operations include the Pueblo Chemical Agent-Destruction Pilot Plant (PCAPP) and the Explosive Destruction System (EDS) that will support PCAPP operations. A screening-level MPHRA employs conservative assumptions to acquire a reasonable maximum estimate of potential impacts. If the screening level results are acceptable then no further refinement of the assumptions is deemed necessary. The objectives of this screening-level MPHRA are to (1) evaluate how chemicals reasonably expected to be present in PCAPP and EDS air emissions can be transported through the environment and into the food chain, (2) assess how different people (human receptors) can directly or indirectly come into contact with these substances (exposure pathways), and (3) calculate the cumulative risks (cancer effects) and hazards (noncancer effects) for each exposure scenario. The screening-level MPHRA was performed to obtain a reasonable maximum estimate of potential risks and hazards in order to determine whether a more detailed site-specific assessment is warranted.

The results of the MPHRA represent the incremental risk to human health presented by operation of PCAPP and EDS processes. As such, risks presented by other environmental conditions that may exist in the area (e.g., ambient levels of persistent pesticides in soil caused by human activity and non-PCAPP or EDS air emission sources) are not included in the assessment.

1.2 WHAT IS THE MISSION OF THE PCD?

The PCD's current mission is to safely store and protect chemical weapons that are part of the national stockpile of chemical weapons containing mustard (a chemical blister agent), while establishing the conditions to return depot land and facilities back to the Pueblo community.

1.2.1 What is the History of the PCD?

Construction of the Pueblo Ordnance Depot, located east of Pueblo, Colorado, began in February 1942, and the first railcar load of ammunition was received in August 1942. Although originally planned for the storage and supply of ammunition, the facilities were expanded almost immediately to receive, store, and issue general supplies to support World War II.

In 1946, the depot was assigned the mission of maintaining and overhauling artillery, fire control, and optical equipment. Two years later, ammunition renovation and demilitarization were added to that mission. During the Korean War, shipments of general supplies and ammunition increased, and the depot reached its highest civilian strength of nearly 8,000 employees. Missile maintenance was added to the depot's mission in the 1950s, and in 1962 the depot was renamed Pueblo Army Depot. In 1976, Pueblo was given depot activity status and assigned to the Tooele Army Depot Complex.

In 1988, the PCD was put on the list of installations recommended for realignment by the 1988 Base Realignment and Closure Commission. The PCD is now part of the Soldier Biological and Chemical Command. Its current missions are to provide limited maintenance to prevent the

deterioration of active facilities, manage the chemical agent stockpile, and prepare for chemical munitions destruction.

1.2.2 How Large is the PCD and What is Stored There?

The PCD complex consists primarily of storage igloos, loading/warehouse buildings, administrative support facilities, and on-base housing. Currently, the PCD occupies approximately 9,300 hectares (ha) (23,000 acres) in an area that is roughly rectangular. Numerous buildings and earth-covered, concrete igloos are located at the PCD. Chemical munitions are stored in 98 igloos in an area referred to as the G-Block, so called because all igloo numbers are preceded by the letter "G." Entry to these igloos is restricted and only done for periodic inspections. The PCAPP is located in the northeastern portion of the PCD and encompasses approximately 34 ha (85 acres). The EDS operation is located west-southwest of the PCAPP and occupies a small footprint of approximately 0.7 ha (2 acres).

The munitions currently stockpiled at the PCD include 155-millimeter (mm) projectiles, 105-mm projectiles, and 4.2-inch mortar rounds. In general, these munitions have a metal casing containing a chemical agent and an explosive burster to disperse the chemical agent. An estimated 2,600 tons of chemical agent are contained in the stockpiled munitions. The chemical agents contained in the munitions are sulfur mustard (HD) and HT (a mixture of HD and Agent T). HD and HT also are stored at PCD in DOT containers. HD (bis-(2-chloroethyl) sulfide, or $C_4H_8Cl_2S$) is a purified form of mustard. HT is a mixture that contains approximately 60 percent HD and 40 percent Agent T (bis-2-[2-chloroethyl thio] ethyl ether, or $C_8H_{16}Cl_2OS_2$), which was used to increase the effectiveness of the mustard agent. HD and HT are chemically and toxicologically related and are treated as a single compound represented by HD for the purposes of this MPHRA, as was done by the Center for Disease Control and Prevention (CDC) (CDC, 2003).

The explosives associated with these munitions include trinitrotoluene (TNT), tetryl, tetrytol (a mixture of tetryl and TNT), Composition A5 (a mixture of Royal Demolition Explosive [RDX] and stearic acid), Composition B4 (a mixture of RDX and TNT), fuzes, and propellants. Except for some energetics compounds to be treated in the EDS, non-agent-contaminated and stable energetics compounds such as TNT, tetryl, and M1/M6 components will be treated off site and are not addressed in any further detail in this MPHRA.

1.3 WHAT ARE PCAPP AND EDS?

PCAPP is owned by the US Army. The United States (US) Department of Defense, through the Program Executive Office (PEO) Assembled Chemical Weapons Alternatives (ACWA), has been assigned the responsibility for safe destruction of the chemical weapons stockpile at the PCD. Bechtel National, Inc. was contracted to design, construct, operate, and close the PCAPP, a facility for destroying munitions containing mustard (a chemical blister agent) that are stored at the PCD.

In August of 2013, PEO ACWA selected the EDS process to augment the PCAPP for the safe destruction of chemical munitions unsuited for processing by PCAPP's automated equipment (i.e., munitions that are leaking or deteriorated or contain contaminated energetics compounds). The Joint Project Manager for Elimination, through an Interservice Support Agreement with PEO ACWA, has been delegated responsibility for planning, executing, and completing EDS operations at the PCD. The EDS will be operated by the Edgewood Chemical and Biological Command. Both PCAPP and EDS will employ process units that have the potential to generate air pollutant emissions.

1.4 WHAT ARE THE GENERAL CHARACTERISTICS OF THE AREA AROUND THE PCD?

1.4.1 Location and Topography

The PCD is located in southern Colorado, approximately 160 kilometers (km) (100 miles) south-southeast of Denver. Figures 1-1 and 1-2 show the location of the PCD. Figure 1-3 presents a topographical map for the PCD and the surrounding area. The depot lies near three small communities, all of which are within 8 km (5 miles) of the installation. The closest, North Avondale, is less than a mile south of the installation. The other nearby communities, Avondale and Boone, are shown in Figure 1-2.

The depot is situated on an alluvial terrace within the drainage basin of the Arkansas River. The river flows from the mountains in the west along the southern boundary of the PCD and east to Kansas. The area's topography is generally characterized by rolling hills and moderate slopes with elevations ranging from 1,364 meters (m) (4,474 feet [ft]) to 1,468 m (4,814 ft) above mean sea level. Except for the windblown sand in the northeastern corner of the PCD, most of the PCD area is covered by an alluvial deposit.

1.4.2 Surface Water and Groundwater

The PCD is located in the Arkansas River drainage basin, on an alluvial terrace north of the river that rises approximately 46.5 m (150 ft) above the river. The alluvial terrace is underlain by the relatively impermeable Pierre Shale. Surface runoff is low because of the low precipitation rate and potentially high rate of evaporation. The surface of the alluvial terrace slopes toward the Arkansas River; surface runoff is also generally to the south.

The Arkansas River lies 2 km (1.2 miles) to the south of the PCD (see Figure 1-3). The river is a source of industrial and agricultural water in the area. Pueblo Reservoir, located approximately 8 km (5 miles) west of the City of Pueblo, is used for water storage and flood regulation on the Arkansas River. High flows generally occur in the early summer months, and low flows occur in the winter. The City of Avondale groundwater well for the public water supply is located directly south of the PCD. From the PCD, the next downstream municipal water supply on the Arkansas River is Rocky Ford, approximately 32 km (20 miles) east of the PCD.

The PCD has approximately 25 ha (63 acres) of palustrine wetlands and 45 ha (110 acres) of riverine wetlands, for a total of approximately 70 ha (173 acres) of wetlands. Most of the other ponds and wetlands overlying the alluvial terrace aquifer on the PCD are contact springs, where the aquifer erupts from bluffs or otherwise incised features. Significant among these are the Spring Pond along the upper Boone Creek drainage, the Ammunition Workshop Site Pond that terminates the drainage from a seep in the southwestern portion of the depot, and the seeps along the bluff in the northwestern portion of the PCD. The Lynda Ann Reservoir is a man-made feature on the Boone Creek. It is fed primarily by groundwater, by Boone Creek, and by runoff from the surrounding area.

Chico Creek flows along the west side of the PCD. The northern and central portions of this creek are typically perennial in nature. In the southern portion, flowing water is evident only after local or upstream precipitation events, especially during the summer season. Water is typically more abundant in the creek during the winter months.

Figure 1-1. Location of Pueblo Chemical Depot (regional setting).

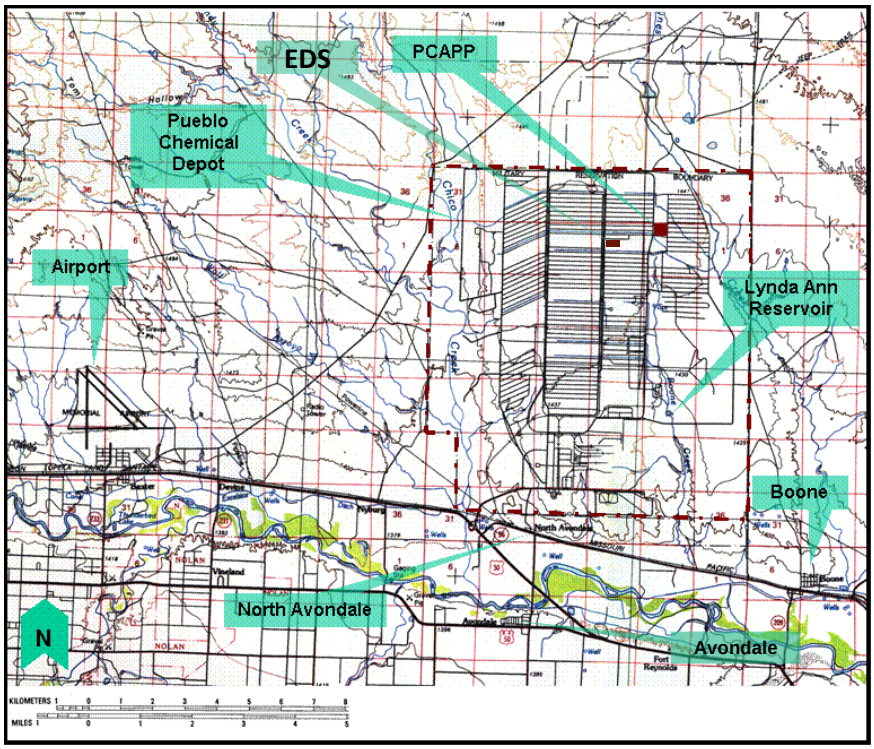

Figure 1-2. Location of Pueblo Chemical Depot (local setting).

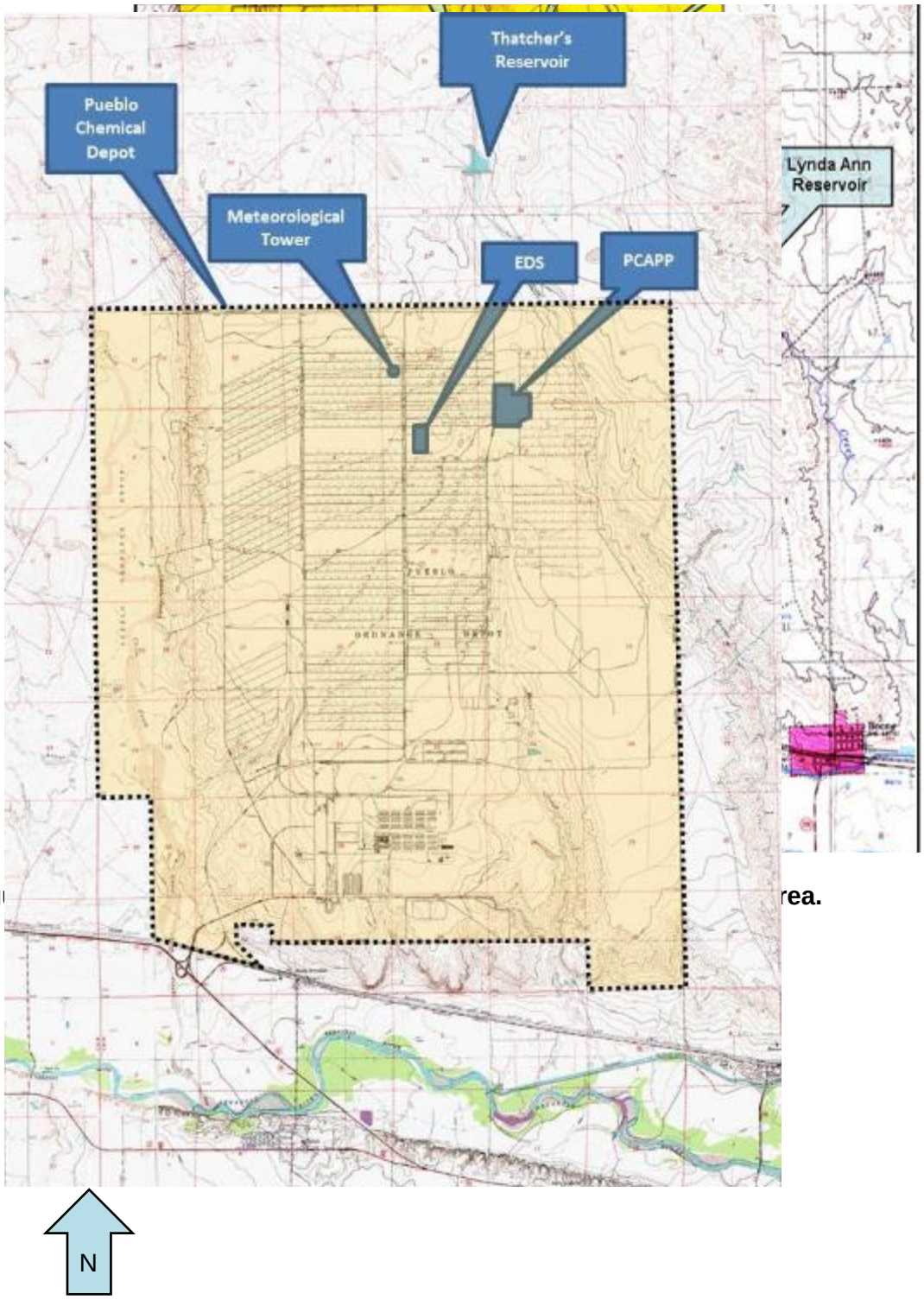
Thatcher's Reservoir
Pueblo Chemical Depot
Lynda Ann Reservoir
Meteorological Tower
EDS
PCAPP
N

Fig **rea.**

The two other primary drainage systems on the PCD are Boone Creek, which starts in the northeastern portion of the PCD and runs south to Lynda Ann Reservoir, then south again to the PCD boundary; and Haynes Creek, which enters the depot along the northern boundary, courses across the northeastern corner of the site, and exits the east side. A smaller drainage system exits the PCD along the southern border. This system is generally referred to as the Unnamed Creek. These three drainage systems are ephemeral or intermittent in nature (US Army, 2002).

1.4.3 Climate

The PCD climate is semi-arid and marked by large daily temperature variations, driven by significant radiative heating and cooling due to PCD elevation and low humidity. The peak temperature reaches 32 degrees Celsius (°C) (90 degrees Fahrenheit [°F]) or higher about half the time during the summer, with low relative humidity. Summer nights are invariably cool, 15°C (60°F) or less, since mountain breezes prevail from shortly after sunset to about noon the following day. The sun shines about 76 percent of the time. Winter is comparatively mild due to the abundant sunshine and the protection afforded by the nearby mountains. Temperatures reach 10°C (50°F) or higher in the winter. The temperature drops to well below freezing about eight times during the winter. Cold spells are generally broken after a few days by chinook winds, a very dry, warm, downslope westerly wind. Snowfall averages about 79 centimeters (cm) (31 inches) per year.

The probability of measurable precipitation in summer is one day out of four and in winter one day out of eight. Summer rains usually occur in the form of afternoon thunderstorms. Annual precipitation is less than 30.5 cm (12 inches) (NCDC, 2003). Blowing dust frequently develops during the spring months of abnormally dry years, especially in areas where dry farming has been attempted.

The local diurnal wind pattern typically blows up valley from the southeast during the day and down valley from the northwest at night. Average wind speed ranges from 3.1 meters per second (m/s) (7 miles per hour [mph]) in the fall and early winter to 4.9 m/s (11 mph) in the spring. Stronger winds generally originate from the mountains.

1.4.4 Land Use and Demographics

Data from the US Census Bureau for 1990, 2000, and 2010 indicate that the population of Pueblo County and surrounding counties generally increased between 1990 and 2010 (US Census Bureau, 1992; 2002; 2012). The population of Pueblo County was estimated to have increased from 123,051 in 1990, to 141,472 in 2000, and to 159,063 in 2010. Of the estimated 159,063 people living in Pueblo County in 2010, about 106,595, or 67 percent, resided in the City of Pueblo.

Land surrounding the PCD is sparsely populated and is used primarily for agricultural purposes (open pastures for cattle and irrigated fields for raising crops). Ranches and farms exist sporadically around the PCD, with the closest ranch located less than 1.6 km (less than 1 mile) north of the depot. Situated farther north is a High Speed Ground Test Center that is operated by the Transportation Technology Center. About 3.2 km (2 miles) south of the PCD is the Avondale Elementary School for children from kindergarten through grade 5. The areas east and west of the PCD are sparsely inhabited along Highway 50/96.

Land use within the PCD is primarily industrial and administrative. A housing area and three transient quarters are also located close to the south gate. The housing area has a few full-time

residents, and the transient quarters are frequently occupied. Workers at the installation include PCD staff and contract employees. Although livestock grazing was once permitted within the PCD, this practice was terminated in 1998 with the expiration of the lease contract. Much of the PCD is still undeveloped, and it is not uncommon to see wildlife on the installation.

1.5 WHY MUST A MPHRA BE PERFORMED FOR THE PCAPP AND EDS?

On December 11, 2003, ACWA submitted a Resource Conservation and Recovery Act (RCRA) Research, Development, and Demonstration (RD&D) permit application for the PCAPP. On March 19, 2004, the State of Colorado Department of Public Health and Environment (CDPHE) issued a Notice of Completeness and subsequently issued a draft permit for Stage I. Final approval for Stage I was issued by CDPHE on July 1, 2004. As a condition of the approval, the Permittee was required to complete an MPHRA to evaluate PCAPP process emissions. To address CDPHE's requirement, in 2008 the BPT issued a report to CDPHE detailing the results of an MPHRA that had been conducted to assess the potential cumulative impacts of emissions produced by the processes included in the preliminary PCAPP design. The 2008 MPHRA report demonstrated the design is protective of human health using acceptable risk criteria for hazardous waste emissions established under the Colorado Hazardous Waste Regulations (CHWRs). The 2008 MPHRA report therefore received CDPHE approval, and permission was given for construction to proceed on PCAPP facilities.

At the time the 2008 MPHRA report was issued, the EDS was not included as part of the PCAPP process. In 2012, however, ACWA prepared an Environmental Assessment pursuant to the National Environmental Policy Act to evaluate the environmental impacts of four alternative technologies that could be used to destroy the munitions and other energetics components unsuitable for PCAPP processing. At that time a separate MPHRA was prepared and submitted to CDHPE to evaluate the transport pathways and health risks of the emissions from the four alternative technologies. In addition to supporting the Environmental Assessment, the 2012 MPHRA was used to support a RCRA permit modification request to include the selected technology at PCD. Ultimately ACWA selected the EDS as the preferred technology, and on December 12, 2013, CDPHE issued a RCRA permit for construction of the proposed EDS operation.

The original 2008 MPHRA for PCAPP and the 2012 MPHRA that included EDS impacts were developed as separate assessments to support CDPHE's issuance of construction approvals. As a condition of the original approvals, an integrated MPHRA was to be performed that included the cumulative impacts of the PCAPP and the EDS. The integrated MPHRA also was required to incorporate any updated design information and test results that had been developed since the original MPHRAs.

1.6 WHO OVERSAW THE PLANNING AND CONDUCT OF THIS MPHRA?

The planning and conduct of this MPHRA was performed by the BPT, overseen by the US Army, and reviewed at various stages with CDPHE. The planning process included preparation of a draft MPHRA protocol that was submitted to CHPHE and subsequently revised to reflect discussions between project participants. The CDPHE provided their approval of the revised protocol to PCD and ACWA on April 28, 2015.

1.7 WHAT WAS THE GENERAL METHOD FOR PERFORMING THIS MPHRA?

This screening-level MPHRA was conducted to allow for the most efficient and effective use of resources by focusing resources on areas that are considered “risk drivers,” rather than areas that do not appreciably affect the risk outcome. Had the screening-level MPHRA revealed unacceptable risks or hazards, a more sophisticated level of analysis would have been performed. In this way, the requisite level of sophistication in the analysis is commensurate with the significance of the results. For example, if the screening-level assessment shows that a primary pollutant and exposure pathway drives the risk evaluation to an unacceptable level, then site-specific data collection of values related to that pollutant and exposure pathway should be targeted, while general conservative values can be used for other exposure pathways. Therefore, significant resources would not have to be spent on collecting site-specific information on other exposure pathways that will not significantly affect the final results of the assessment.

For this screening-level MPHRA, detailed engineering and data collection/assessment activities were performed to adequately characterize emissions from PCAPP and EDS operations, calculate air concentrations and deposition rates resulting from PCAPP and EDS emissions through air dispersion modeling, and select the proper exposure scenarios for evaluation. Emissions were estimated using design information, data acquired from sampling during bench-scale and pilot-scale process testing, and existing data from other similar facilities. Also, because this screening-level MPHRA was performed to obtain a reasonable maximum estimate of the potential risk in order to determine whether a more detailed site-specific assessment is warranted, site-specific information such as land use, population densities, and activity patterns were not used. Instead, general conservative values were used to calculate the potential risk for a theoretical reasonably maximally exposed (RME) individual. For example, the screening-level MPHRA was conducted assuming that an individual will have an almost daily diet (350 days per year) for the entire exposure duration (up to 40 years) consisting of beef, pork, poultry, fish, vegetables, and fruits raised or harvested at the theoretical location of the maximum media concentrations. Therefore, the screening-level MPHRA combines conservative exposure assumptions with annual average media concentrations at the maximum impact location, that results in an exposure estimate that is approximately the 95th percentile of the distribution representing the RME individual.

1.8 WHAT IS THE PROCESS FOR PERFORMING AN MPHRA?

Figure 1-4 presents an overview of the MPHRA process. This process consists of five major components that were adopted by the US Environmental Protection Agency (USEPA) to provide a consistent process for evaluating and documenting health risks. For purposes of this screening-level MPHRA, the major components are as follows:

- *Data Collection and Evaluation*, which consists of collecting pertinent information needed to characterize the facility. This includes meteorological data, facility operational parameters, lists of chemicals that may impact human health, and estimates of emissions. This also includes identifying the chemicals of potential concern (COPCs) and determining where site-specific information should be used, such as location and size of surface water bodies, or where conservative default data should be used, such as the location and magnitude of land use types.

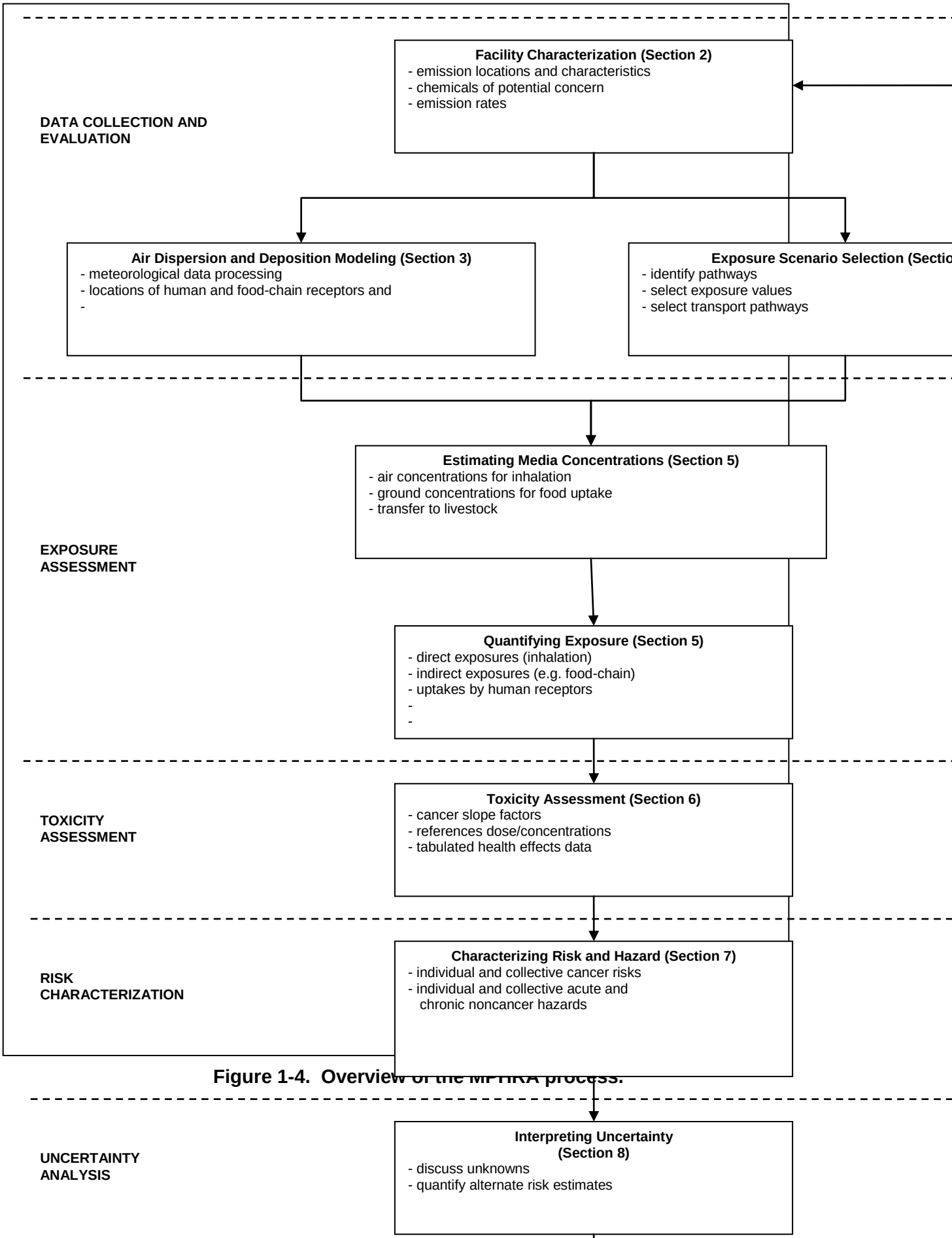

Figure 1-4. Overview of the MPHRA process.

- *Exposure Assessment*, which includes defining the study area; identifying the theoretical RME individual; identifying how the RME individual contacts a COPC (exposure pathway); determining the concentration of each COPC in each medium; and estimating the amount of COPC to which the RME individual is exposed (intake or dose). The theoretical RME individual represents the theoretical individual who receives the reasonably maximum amount of exposure for each exposure pathway scenario (for example, the subsistence farmer).

- *Toxicity Assessment*, which involves determining the health effects of chemicals and how the appearance of these adverse effects depends on exposure level (dose).

- *Risk Characterization*, which is the quantification of risks and hazards determined by combining exposure information with toxicity information. This identifies the types of effects that may occur and provides information on the probability (risk) or severity (hazards) of those effects. Risks are quantified for chronic exposures, and hazards are quantified for both acute and chronic exposures.

- *Uncertainty Analysis*, which summarizes how uncertainty may affect the results generated in the risk characterization section and evaluates the likely direction and magnitude of the error that may be introduced by the uncertainties. This may be done either in a qualitative discussion or may be performed quantitatively. It is important to recognize that this assessment of uncertainty is not the same as the assessment of variability that is included in the exposure assessment section. Uncertainty is a consequence of imperfect knowledge or data and can be reduced by obtaining more accurate data. In contrast, variability is an inherent property of an exposed population and cannot be changed by obtaining more accurate data.

1.9 WHAT SPECIFIC REQUIREMENTS EXIST FOR PERFORMING A MPHRA?

The PCAPP and EDS will employ various process units that have the potential to emit air pollutants. Many of these units are considered Miscellaneous Units under the CHWRs. Requirements for the design and operation of Miscellaneous Units are described under CHWR 6 Code of Colorado Regulations (CCR) 1007-3, Part 264, Subpart X.

CHWR 6 CCR 1007-3, Section 264.601(c) requires that Miscellaneous Units be operated and designed in a manner that is consistent with the protection of human health and the environment. Protection of human health and the environment includes, but is not limited to, the prevention of any release that may have adverse effects on human health or the environment due to the migration of chemicals in the air, considering a number of factors. Among these factors are the atmospheric and meteorological characteristics of the surrounding area, the potential for health risk caused by human exposure to emitted chemicals, and the potential for damage to domestic animals, crops, and vegetation caused by exposure to emitted chemicals.

Under Part 264, Subpart X of the CHWR, CDPHE is authorized to apply the hazardous waste unit standards in other subparts of Part 264 to Miscellaneous Units under Subpart X as appropriate. In determining the appropriate permit conditions for Miscellaneous Units, CDPHE made reference to the following citation:

> "selected features of design and operation, technical performance, containment, and environmental performance standards, as well as the risk-based assessment will be specified, so that the overall objective of protecting human health and the environment is

achieved" (Federal Register Vol. 52, No. 237, December 10, 1987; page 46951 – Subpart X final rule).

Specific provisions for conducting an MPHRA are provided in other subparts of Part 264. These provisions, which have been incorporated into the MPHRA performed for the PCAPP and EDS, include:

- providing an estimate of stack emissions
- defining the basis for the stack emission estimates
- considering all (Part 261, Appendix VIII) compounds reasonably expected to be in the waste or in the emissions in this estimate
- performing air dispersion modeling for the estimated emissions using an air dispersion model approved for this application
- defining assumptions and inputs to the dispersion model and risk calculations
- performing risk calculations using the results obtained from the air dispersion model
- examining exposure to adults, children, and infants including the following exposure pathways:
  - direct inhalation
  - dermal exposure
  - exposure resulting from deposition of metallic and organic compounds in soil and surface water, and subsequent ingestion of local and homegrown foodstuffs or fish

1.10 WHAT OTHER GUIDANCE WAS USED WHEN PERFORMING THE MPHRA?

The methodology employed in conducting the MPHRA was based on CDPHE and USEPA guidance and generally follows the fundamental process adapted by USEPA from well-established chemical risk assessment principles and procedures, such as *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (HHRAP) (USEPA, 2005a), *Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions* (USEPA, 1998), *Guidance for Performing Screening Level Risk Analysis at Combustion Facilities Burning Hazardous Waste* (USEPA, 1994a), and *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* (USEPA, 1989). In all cases, the most recent guidance is used and is supplemented, when necessary, with guidance provided in older documents.

1.11 HOW MIGHT CDPHE USE THE RESULTS OF THE MPHRA?

CDPHE is issuing approvals to ACWA in stages. Before issuing an approval, CDPHE must be convinced that operation of the PCAPP or EDS will adhere to the human health-based standards adopted in the CHWR. Upon review and acceptance of the bases and results of the MPHRA, and in concert with its review of the engineering design aspects of the PCAPP and EDS, CDPHE will issue the final stage approval to allow for full operation of the units. This full operation will follow systemization and limited operation of PCAPP and EDS units to demonstrate the effectiveness of the processes during which time actual emissions will be monitored to support the MPHRA findings. CDPHE will use the results obtained for the MPHRA, in concert with the other RCRA RD&D permit application submittals, to establish safe operating levels for the systems. The MPHRA will be updated and rerun using the test results obtained during pilot-scale operations.

1.12 HOW IS THIS REPORT ORGANIZED?

The remaining sections of this report provide a brief overview of data used to develop and conduct the MPHRA. Figure 1-4 maps each section of this report to one of the major components of the MPHRA process.

- *Data Collection and Evaluation*: Section 2 presents an overview of the PCAPP and EDS facilities and operation. Section 3 describes the sources and use of area meteorological data and processes for determining ambient air concentrations and deposition rates by air dispersion modeling, as the results from this effort are needed to conduct the MPHRA. Section 4 discusses the exposure scenarios and data on human activity rates as well as information about human uptakes of contaminated media.
- *Exposure Assessment*: Section 5 discusses the exposure and dose calculations and summarizes the results.
- *Toxicity Assessment*: Section 6 presents the methods for identifying chemical toxicity data and summarizes the toxicity data used in this MPRHA.
- *Risk Characterization*: Section 7 presents the methodologies used and results obtained for the risk and hazard characterizations.
- *Uncertainty Analysis*: Section 8 presents an analysis of the uncertainty of the MPHRA and discusses the impact of uncertainties on the results and conclusions drawn in this assessment.

A number of appendixes are also provided. Appendix A provides details on the COPC selection process. Appendix B provides details on emission characterization efforts. Appendix C presents information pertaining to the meteorological data pre-processing required for the air dispersion modeling used in the MPHRA. Appendix D describes the media transfer, uptake, and risk calculation methods, and Appendix E presents an example hand-calculation of these calculations. Appendix F presents a list of all parameter values for every variable used in the MPHRA calculations. Appendix G presents detailed summary tables of the calculated media concentrations, exposure estimates, and risks from the exposure and risk calculator spreadsheets. Appendix H and Appendix I present the detailed output tables obtained from the chronic and acute risk calculator spreadsheets, respectively, developed for this MPHRA; this output was summarized to provide the information in Sections 5 through 8 of this report.

1.13 WHAT OTHER INFORMATION SHOULD BE REVIEWED WHEN EVALUATING THIS REPORT?

Relevant information from the MPHRA protocol is included in this report. To assist in understanding underlying inputs and assumptions of this report, information is available in the CDPHE Pueblo Chemical Depot/PCAPP website currently located at the following link:

https://www.colorado.gov/pacific/cdphe/pcapp

This website provides access to select documents from the administrative record including:

- RCRA (RD&D) Permit Modification Requests for PCAPP and EDS tracking form
- Draft Multiple Pathway Health Risk Assessment Protocol (2007)
- a description of the Information Repositories located throughout Pueblo County