

# **Public Health Assessment**

**Final Release**

**ATK Solid Rocket Motor Static Tests**

**ATK Promontory Facility, Box Elder County, Utah**

**Prepared by  
Utah Department of Health**

April 22, 2015

Prepared under a Cooperative Agreement with the  
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Agency for Toxic Substances and Disease Registry  
Division of Community Health Investigations  
Atlanta, Georgia 30333

## THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR's Cooperative Agreement Partner pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR's Cooperative Agreement Partner has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR's Cooperative Agreement Partner addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR's Cooperative Agreement Partner which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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## PUBLIC HEALTH ASSESSMENT

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ATK Promontory Facility, Box Elder County, Utah

Prepared by:

Environmental Epidemiology Program  
Bureau of Epidemiology  
Utah Department of Health  
Under a Cooperative Agreement with the  
Agency for Toxic Substances and Disease Registry

**TABLE OF CONTENTS**

SUMMARY .....4

PURPOSE AND HEALTH ISSUES .....7

    Land Use and Demographics ..... 9

    Physical Characteristics ..... 11

    Site History ..... 13

    The DM-2 and DM-3 SRM Static Tests ..... 14

    Sampling and Meteorology ..... 20

DISCUSSION .....22

    Nature and Extent of Contamination ..... 22

    Exposure Pathways Analysis ..... 23

*Completed Exposure Pathways* .....24

*Potential Exposure Pathways* .....24

    Exposure Dose Estimate and Toxicological Evaluation ..... 26

*Evaluation Process* .....26

*Air* .....27

*Soil* .....27

*Water* .....28

    Health Effects of Known Contaminants ..... 30

*Contaminants Exceeding Screening Levels* .....30

*Airborne Caustics and Corrosives* .....33

*Chemicals Found in Rocket Motor Exhaust* .....35

DATA LIMITATIONS .....39

CHILDREN’S HEALTH CONSIDERATIONS .....40

COMMUNITY HEALTH CONCERNS .....40

CONCLUSIONS .....41

RECOMMENDATIONS .....42

PUBLIC HEALTH ACTION PLAN .....43

AUTHORS .....45

REFERENCES .....47

APPENDIX A: MAPS OF STUDY AREA .....54

APPENDIX B: DATA TABLES .....62

APPENDIX C: EXPOSURE DOSE EQUATIONS .....83

APPENDIX D: ACRONYMS AND TERM DEFINITIONS .....85

APPENDIX F: SECOR MODELS .....92

APPENDIX G: SITUATION ANALYSIS .....96

APPENDIX H: PUBLIC COMMENTS .....126

## FIGURES, TABLES, AND MAPS

**Figure A.** Average monthly precipitation recorded at the Thiokol Plant weather monitoring station from June 1962 through December 2009 (WRCC, 2010). ..... 12

**Figure B.** Average daily high and low temperatures recorded at the Thiokol Plant weather monitoring station from 1981 through 2010 (WRCC, 2010). ..... 12

**Figure C.** Aerial view of the T-97 Static Test Stand, ATK Promontory, Box Elder County, Utah, showing the stand and the area behind the stand that is impacted by static tests. .... 16

**Figure D.** The DM-2 Solid Fuel Rocket Motor mounted in the T-97 Immobile Static Test Stand at the ATK Promontory Test Facility in Box Elder County, Utah. This view is looking northwest. .... 17

**Figure E.** The combustion exhaust of the DM-2 Solid Fuel Rocket Motor after ignition while mounted on the T-97 Test Platform, ATK Promontory, Box Elder County, Utah. This view is looking east. .... 18

**Figure F.** The exhaust plume raised by the DM-2 Solid Fuel Rocket Motor while mounted on the T-97 Test Platform, ATK Promontory, Box Elder County, Utah. This view is looking east. 19

**Table A.** Modeled emission quantities resulting from a static test firing of a 1.4 million pound solid rocket motor at the ATK Promontory T-97 Test Platform (SECOR, 2001). ..... 21

**Table B.** Modeled maximum total solid particulate and HCl concentrations in residential areas near ATK Promontory. Results represent the DM-2 static test on August 30, 2011 using the permitting model results (SECOR, 2001). ..... 21

**Table C.** Meteorological data from the Promontory Point, Utah weather station for August 30, 2010 (MesoWest, 2010). ..... 23

**Table D.** Plume fallout material sampling results for Faust Valley. .... 28

**Table E.** Arsenic exposure calculations for sampled water sources. .... 29

**Table F.** Theoretical lifetime excess (potential lifetime) cancer risk from drinking arsenic in sampled well water. .... 30

**Map 1.** Map of the ATK Promontory facility and surrounding communities in eastern Box Elder County, Utah (test site starred). ..... 55

**Map 2.** Map of north of the ATK Promontory site showing the location of the Cooperative Wildlife Management Units (CWMU) in Box Elder County, Utah (test site starred). ..... 56

**Map 3.** Map of the location of soil samples collected by UDEQ during November 8-17, 2010 in the west side of Bear River Valley, Box Elder County, Utah. .... 57

**Map 4.** Map of the location of pedon soil samples collected at the Public Shooting Grounds, Bear River Valley, Box Elder County, Utah, by National Cooperative Soil Survey in June 2000. .... 58

**Map 5.** Map of the location of well water samples collected by UDEQ during November 8-17, 2010 in the west side of Bear River Valley, Box Elder County, Utah. .... 59

**Map 6.** Faust Valley Road site location, Box Elder County, Utah. .... 60

**Map 7.** DM-3, 2011 air sampling locations. Faust Valley Road, sample and SRM locations, Box

Elder County, Utah. .... 61

**Table 1.** Analytical results of soil samples taken from sites along Faust Valley Road (see Map 3) in Box Elder County, Utah between November 8, 2010 and November 17, 2010. All values are given in milligrams of analyte per kilogram soil (mg/kg). .... 63

**Table 2.** Pedon soil survey data by the National Cooperative Soil Survey for the Public Shooting Grounds, eastern part Box Elder County, Utah pedon (02UT003003) sampled June 2000 (NCSS 2011) and background samples taken at the T-97 test stand site on ATK Promontory property (Map 4). All values are given in milligrams of analyte per kilogram soil (mg/kg). .... 67

**Table 3.** Analytical results of well water samples taken from sites along Faust Valley Road (see Map 5) in Box Elder County, Utah between November 8, 2010 and November 17, 2010. All values are given in micrograms of analyte per liter water (µg/L). .... 70

**Table 4.** Analytical results for EPA SW-846 Method 8270 semivolatile organic compounds in test-fire soil in milligrams per kilogram (mg/kg). .... 74

**Table 5.** Analytical results for EPA SW-846 Method 6010C metals in test-fire soil in milligrams per kilogram (mg/kg). .... 78

**Table 6.** Analytical results for EPA Method 6850 perchlorate in test-fire soil in milligrams per kilogram (mg/kg). .... 80

**Table 7.** Analytical results for EPA Method 300.0 inorganic anions in test-fire soil in milligrams per kilogram (mg/kg). .... 81

**Table 8.** Analytical results for EPA SW-846 Method 9045 pH in test-fire soil. .... 82

## SUMMARY

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### INTRODUCTION

The Environmental Epidemiology Program (EEP) at the Utah Department of Health prepared this public health assessment at the request of the Utah Department of Environmental Quality (UDEQ) to evaluate human health risks from potential exposure to burn products during and immediately after the solid fuel rocket motor (SRM) static tests at the Alliant Techsystems, Inc. (ATK) Promontory facility. Residents of the nearby communities of Penrose, Thatcher, and Bothwell, Utah, have expressed concern about health hazards posed by burn products and debris generated by the static test.

On August 30, 2010, ATK Promontory conducted a static test of the five-stage DM-2 SRM as part of a contract with the National Aeronautics and Space Administration's Ares space exploration program. The static test consumed approximately 1,400,000 pounds of solid fuel, consisting primarily of aluminum oxide and perchlorate compounds. The exhaust of the rocket motor has sufficient force to scour soil and rock from the test site and carry that material a substantial distance.

On September 28, 2010, the U.S. Environmental Protection Agency (EPA) received a petition from a concerned citizen living in Thatcher, UT. This petition requested that EPA investigate the environmental and health impacts of the DM-2 test and previous rocket tests on communities surrounding ATK Promontory. Specifically, the petition complained of the large plume of smoke and debris generated during the test and resultant fall-out on those communities. The community's concern is that the plume of smoke and debris exposes residents to hazardous contaminants through air, soil and ground water exposure routes.

During November 2010, UDEQ's Division of Environmental Response and Remediation and EPA conducted preliminary site assessments that included soil sampling from properties in Penrose and Thatcher as well as groundwater from water systems in those communities.

UDEQ and EPA held a public availability session in February 2011 to gather community concerns. Based on health concerns identified by residents of the area during that meeting, UDEQ

asked the EEP, of the Utah Department of Health (UDOH) to conduct this Public Health Assessment (PHA) on May 23, 2011.

Additional assessment data were collected by EPA and UDEQ during a subsequent SRM test (DM-3) on September 8, 2011.

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CONCLUSION 1

The EEP cannot conclude whether the DM-2 and DM-3 rocket motor tests at the ATK Promontory site could have harmed people’s health. The reason for this is that no useful outdoor air data were collected to assess the air exposure pathway and perchlorate was not found in soil and ground water samples.

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BASIS FOR DECISION

The EEP identified several potential pathways that could result in exposure. No data were available to assess the air pathway. Perchlorate was not found in the soil and ground water samples. Debris samples collected during the DM-3 SRM test indicate the presence of short-lived, airborne pH basic (pH 9.77-11) sediment material and some forms of phosphorus. Unfortunately, there is no way to verify whether or not caustic sediment traveled to surrounding human populations because it is so short-lived in the environment. While potential exposure of surrounding residents to this irritant is plausible, the EEP does not consider this temporary exposure to be a persistent health hazard.

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NEXT STEPS

The EEP will describe the process and basis for this decision as part of the presentation of this PHA to the community.

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CONCLUSION 2

One sample from one groundwater source indicated an estimated level of arsenic that exceeds the calculated chronic oral exposure dose Minimal Risk Level (MRL) for children.

The presence of arsenic in groundwater samples is consistent with the natural hydrogeology of the region and is very unlikely to be a result of site-related activities.

The EEP cannot conclude whether the potential ingestion of arsenic from water wells connected to the sampled groundwater aquifers could harm people’s health.

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BASIS FOR DECISION

The calculated dosages for arsenic exposure are well below those known to result in non-cancer health effects. Because only one water sample from this region’s aquifer indicated the presence of

very low arsenic levels, the EEP cannot conclude whether the consumption of arsenic from water wells in this region could constitute a health hazard.

Based upon the low arsenic values observed in the test-fire soil fallout samples (6.84 ppm, Appendix B, Table 5), and the naturally occurring presence of arsenic in many groundwater aquifers in Utah, it is very unlikely that debris from the ATK SRM tests present a substantial contribution to the arsenic detected in the ground waters sampled in the region.

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NEXT STEPS

The EEP recommends further sampling of the potential drinking water sources in the area, both public and private. The EEP will assist the Bear River Health Department (BRHD) in evaluating follow-up sampling results. The EEP will work with BRHD and the Cancer Control Program at the UDOH to provide awareness training and screening assistance for these communities.

## **PURPOSE AND HEALTH ISSUES**

### **The Environmental Epidemiology Program**

The EEP is a program within the Bureau of Epidemiology in the Utah Department of Health (UDOH). The EEP has a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR) to conduct site-specific health assessments following ATSDR assessment protocols (ATSDR, 2005b). The information provided is valid, reliable, and based on the best available science and data.

### **Health Issues**

The EEP at the Utah Department of Health prepared this public health assessment (PHA) at the request of the Utah Department of Environmental Quality (UDEQ) to evaluate human health risks from potential exposure to burn products during and immediately after the solid rocket motor static tests at the Alliant Techsystems, Inc. (ATK) Promontory facility. Residents of the nearby communities of Penrose, Thatcher, and Bothwell, Utah, have expressed concern about the burn products and debris generated by the static test.

The ATK Promontory facility is part of the ATK Aerospace Systems Division. The facility was originally developed as a rocket manufacturing and test facility by Thiokol Chemical Corporation in the 1950s. ATK is one of the largest aerospace and defense contractors for the US Government. ATK has a contract to design, develop, manufacture, test and refurbish the Space Shuttle Solid Rocket Boosters. More recently, ATK has worked on development, manufacturing, and testing of solid rocket motor components for the Ares family of rocket systems. Static test firing of solid rocket motors involves ignition of a solid rocket motor while it is anchored in a horizontal position. This allows ATK to monitor and evaluate the performance of the rocket motor's propellant, mechanical structures, and control systems.

The mission of ATSDR is to serve the public by applying the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and disease(s) related to toxic substances. UDEQ requested that the EEP conduct this assessment to identify public health hazards posed by the burn products and scour debris generated by the static test and emitted into the air at the Promontory facility. The PHA process serves as a mechanism to help ATSDR and state health departments determine where public health action should be addressed and for whom. The primary objective of this assessment is to determine if residents living in communities nearest the Promontory facility were exposed to hazardous materials resulting from rocket motor static tests at that facility, and if so, to develop appropriate public health interventions.

## BACKGROUND

### *ATK Promontory*

The ATK Launch Systems Promontory (hereafter ATK Promontory) facility is 19,378 acres of land in the Blue Creek Valley north of the Great Salt Lake along State Highway 83 (Map 1, Appendix A). Appendix A contains maps and graphics regarding the site. ATK Promontory is one of the facilities operated by ATK Aerospace Systems, one of several organizational units of Alliant Techsystems Inc. (ATK). ATK Aerospace Systems operates facilities throughout the United States, including four other Utah facilities located in the cities of Magna, Brigham City, Clearfield, and Logan (ATK, 2011a).

The ATK Promontory site centroid coordinates are 41.659 north, -112.441 west. The site is located on the southwest foothills of the Blue Spring Hills mountain range with a site elevation between 4,400 and 4,600 feet above mean sea level. ATK Promontory is accessed via State Highway 83 from Blue Creek Valley. This valley is bounded by Blue Spring Hills mountain range to the east and the Promontory and Engineer Mountains to the west. The Blue Spring Hills consists of two ridge lines. The western ridge line ranges between 4,800 and 6,167 feet. This ridge line is approximately 2.5 miles east of ATK Promontory. Faust Valley breaks the western ridge line just north of the northern boundary of ATK Promontory. The eastern ridge includes Thatcher Mountain at 6,240 feet. Bear Creek Valley is a large prairie grassland valley east of the Blue Spring Hills Mountains. Bear Creek Valley is oriented north-south and has a number of residential areas and communities within it (USGS, 1972a; USGS, 1972b).

The ATK Promontory facilities are located primarily on lacustrine and alluvial deposits that form the ancient Bonneville Lake bed. Projecting from this layer is limestone with minor amounts of sandstone rocky outcrops (USGS, 1991).

UDEQ has issued several permits to ATK Promontory. Those relevant to this PHA are the Title V Operating Permit No. 300003002 issued July 6, 2010 (UDEQ, 2010) and the Hazardous Waste Storage Permit No. UTD009081357 (UDEQ, 2008).

The Title V Operating Permit allows for ATK Promontory to conduct tests of solid fuel rocket motors (SRMs) and to dispose of explosive or combustible waste materials through open air burning. This permit and associated documents specify what meteorological conditions must be present in order to conduct these activities.

ATK Promontory has two solid fuel rocket motor test stands designated T-24 and T-97. Only the T-97 test stand is able to support a static test for the larger five-segment SRMs.

## Land Use and Demographics

### ***Blue Creek Valley***

Blue Creek Valley is oriented north and south. The valley is relatively narrow at the southern end and is bounded by the Blue Spring Hills on the east and the Engineer Mountain to the west. North of Engineer Mountain, the valley widens to 5-8 kilometers (km) and is bordered by the Promontory Mountain Range to the west. Blue Creek Valley is primarily rural agricultural land. The northern end of the valley is suitable for farmlands. The southern end of the valley provides limited grazing areas. The southern margin of the valley transitions into highly alkaline sediment soils and marshland and estuaries adjacent to the North Bay of the Great Salt Lake. When dry, these soils support a salt layer on the surface. Some of the marshlands and estuaries are designated as state waterfowl management areas.

Howell, Utah is a small community in Blue Creek Valley located 10 miles (17 km) north of the T-97 test area. This rural agriculture community has a population of 245 in 86 households (U.S. 2010 Census). The community is predominately Caucasian (97.1%). 8.2% of children are under age five and 28.6% are under age nineteen (USCB, 2011a). In 2010, the median household income was \$46,667. Approximately 15.7% of the population lived below the poverty level (USCB, 2011b). Drinking water for Howell comes from four ground water wells (UDEQ, 2000).

Blue Creek Reservoir is located northwest of Howell on the west side of Anderson Hill and is 11.6 miles (18.7 km) north of the T-97 test area. This 0.2 square mile water body provides agricultural irrigation water to farms in Blue Creek Valley and is used for sports fishing.

Blue Creek Valley Cooperative Wildlife Management Unit (CWMU) is a 7,448 acre wildlife management and hunting unit north of Howell and just south of the Utah-Idaho state border. Agricultural is the dominate land type in the Blue Creek Valley CWMU, covering three quarters of the region. The remainder of the region is a combination of sagebrush shrubland and semi-desert grasslands. During appropriate seasons, camping and hunting are allowed in this management unit (UDNR, 2011) (Map 2, Appendix A).

### ***Blue Spring Hills***

The Blue Spring Hills soils are primarily limestone with some transitional quartzite and siltstone. The foothills consist of lacustrine and alluvial deposits of silt to gravel with outcrops of limestone. The land covering includes sagebrush shrublands with patches of Pinyon-Juniper woodlands, invasive annual grasslands, and semi-desert grasslands scattered throughout. These hills are used as agricultural grazing ranges and pasture lands.

Blue Spring Hills CWMU is an 8,838 acre wildlife management and hunting unit located in the Blue Spring Hills, east of Howell, south of Interstate Highway 84 and north of Faust Valley. The

Blue Spring Hills CWMU consists of sagebrush shrublands with patches of Pinyon-Juniper woodlands, invasive annual grasslands, and semi-desert grasslands. During appropriate seasons, camping and hunting are allowed in this management unit (UDNR, 2011) (Map 2, Appendix A).

### ***Bear River Valley***

Bear River Valley is a large rural agricultural valley east of the Blue Spring Hills and West Hills, and west of the Wellsville Mountains of the Wasatch Front. The Bear River runs from the north to the south through the eastern portion of the valley. The smaller Malad River also runs from the north to the south 1-2 miles west of the Bear River and eventually joins the Bear River at the south end of the valley, just before the Bear River empties into the North Bay of the Great Salt Lake. There are a number of other small creeks and agricultural canals found throughout the valley. Small rural towns and unincorporated communities surrounded by farms and farmlands are found on the west and east side. Great Salt Lake marshlands and estuaries protrude northward from the northern shores of the North Bay of the Great Salt Lake. This marshland contains a number of important state waterfowl management areas. The shoreline of the Great Salt Lake changes dramatically depending on the drought cycle. When low, the Great Salt Lake beach consists of large areas of lake sediment and mud flats.

Thatcher, Utah is a small farming town located along Utah State Highway U-102 five to six miles north east of the T-97 test site on the west side of Bear Creek Valley. This rural agriculture community has a population of 789 persons and 230 homes. The town is predominately Caucasian (95.9%). Approximately 10% are under the age of 5 and 31% are 19 or younger (USCB, 2011c).

Associated with Thatcher are the two unincorporated farming communities of Penrose and Bothwell. Penrose is located along the last seven miles of the southern end of State Highway U-102. This community is approximately 3.7 miles (6.0 km) east of the T-97 test site. There are approximately thirty homes in the Penrose area. Bothwell is located northeast of Thatcher, approximately 7.1 miles (11.4 km) northeast of the T-97 test site. Bothwell has approximately 100 homes. Marble Hills is a new housing development on the side hills north of Thatcher and west of Bothwell. This neighborhood has approximately seventy homes and is located 5.3 miles (8.5 km) northeast of the T-97 test site.

On the east side of Bear River Valley are a number of larger towns located southeast, east, and northeast of ATK Promontory along US I-15 and US I-84. The closest of these is Tremonton 11.8 miles (19 km) northeast of the T-97 test site. Other communities include Bear River City, Brigham City, Corinne, Dewyville, Elwood, and Honeyville.

Bear River National Migratory Bird Refuge was created in 1928. This 74,000 acre refuge consists of open water, marsh, uplands, and alkali mudflats along the northern shore of the North Bay of the Great Salt Lake and the delta where Bear River empties into the bay. The western section is 6.6 miles (10.7 km) south of ATK Promontory. There are a number of public facilities

associated within the refuge including a visitor center and bird watching locations. Bird hunting and fishing are allowed in some sections of the refuge (USFWS, 2011).

## **Physical Characteristics**

### ***Geology***

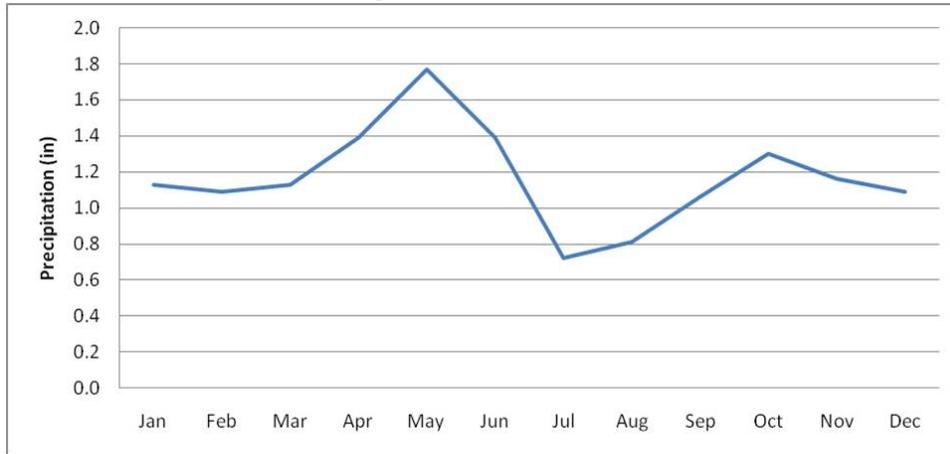
The Blue Spring Hills is a north-trending range of the Great Basin and Range province and is mostly composed of Oquirrh Formation rocks. At the location of the T-97 test platform, the Blue Spring Hills ridgelines consist of a light to medium gray limestone and minor brown sandstone that is thickly to medium bedded, fossiliferous, and locally cherty. The valley areas are filled with unsorted alluvial deposits that were partly reworked by the shoreline process of the ancient Lake Bonneville. These deposits contain patches of lacustrine silt and marl, as well as more recent local alluvium covering lacustrine deposits, and marly sand of mixed alluvial and lacustrine origin (USGS, 1991).

The underlying bedrock for both the Blue Spring Valley and Bear River Valley consists of thin- to thick-bedded, fine to course-grained sandstone, locally cross-bedded with inter-bedded limestone or dolomite. There are a number of fault lines that run north to south through both valleys as well as the Blue Spring Hills (Jordan et al., 1988; USGS, 1991).

### ***Meteorology***

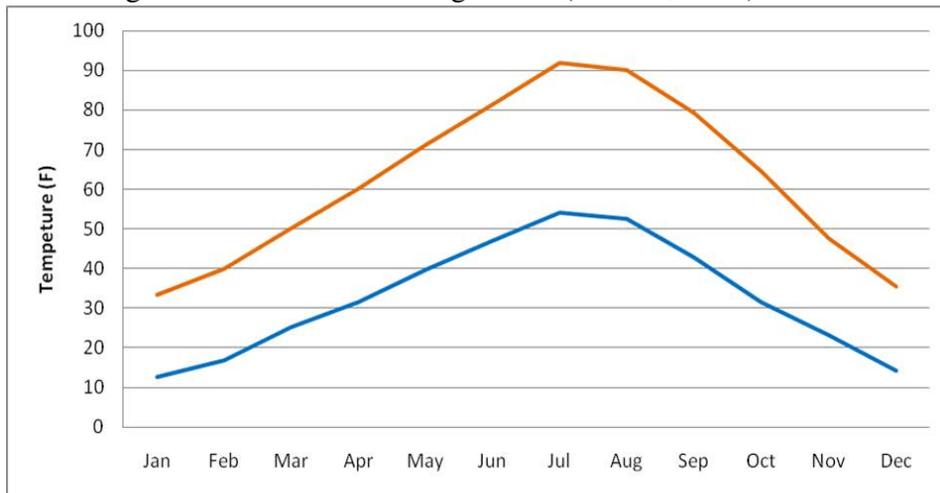
The climate of eastern Box Elder County is arid to semi-arid. The northern arms, bays, and shores of the Great Salt Lake are a major water feature within eastern Box Elder County and have a significant effect on the climate in this region. The Blue Creek and Bear River valleys receive about 14 to 16 inches of precipitation per year. Eastern Box Elder County experiences all four seasons. Spring (April, May, and June) is the wettest season, receiving 32% of the annual precipitation. July and August are typically the driest months, followed by a slight increase peaking in October (Fig. A) (WRCC, 2010).

**Figure A.** Average monthly precipitation recorded at the Thiokol Plant weather monitoring station from June 1962 through December 2009 (WRCC, 2010).



The 16-year daily temperature averages ranges from 10.5° F for the mid-winter low to 92.3° F for the mid-summer high. The difference between daily low and high temperatures ranges from 19.7° F to 38.5° F, with the greatest difference occurring in July and August (Fig. B) (WRCC, 2010).

**Figure B.** Average daily high and low temperatures recorded at the Thiokol Plant weather monitoring station from 1981 through 2010 (WRCC, 2010).



The prevailing wind direction is typically from the south or southwest off the lake surface. The Great Salt Lake develops “lake effect” phenomena that can result in cloud burst conditions, particularly in the winter.

### ***Hydrogeology of the Area***

Both the Blue Creek Valley and the western Bear River Valley are of arid to semi-arid climate with approximately 14 inches of precipitation per year at the valley floor and 20 inches in the Blue Spring Hills mountain range. Water that falls onto the ground in these areas generally evaporates or infiltrates directly into ground surface deposits. There are few (Blue Creek and Salt Creek) perennial streams and surface water other than man made reservoirs. The North Lake wetlands are almost nonexistent. Usable water for this area is provided by canals that redirect and distribute water from reservoirs and the two perennial streams and from groundwater wells. Three water service districts, the Bothwell Cemetery and Water Corporation, the Marble Hills Subdivision, and the Thatcher-Penrose Service District, provide approximately 400 acre-feet of potable water per year and 75 acre-feet of secondary-use water per year. A transportation system is in place to move water from other service districts, such as Tremonton, if necessary (UDNR, 2007).

## **Site History**

In the mid-1950s, Thiokol Chemical Corporation (Thiokol) purchased the lands that are now occupied by ATK Promontory to expand its missile production and testing capabilities. The first tests of solid rocket motor engines at this site occurred in 1956. In 1974, Thiokol was awarded the contract to build the reusable solid fuel rocket motors (RSRM) boosters for the Space Shuttle program. Thiokol underwent a number of organizational changes and mergers starting in 1958. The most recent merger in 2001 formed ATK Promontory (ATK, 2011a).

The primary work at ATK Promontory is the manufacturing, testing, and shipping of solid fuel rocket engines. ATK Promontory produces a variety of solid fuel rocket motors for different purposes, including the large RSRM systems that were used by the National Aeronautics and Space Administration (NASA) for the Space Shuttle program. Work activities and employment at ATK Promontory vary depending on production contracts. Typically, employment is between 3,000 and 5,000 employees. In addition to the RSRM systems, ATK Promontory also produces motors for military missile systems, such as the Peacekeeper, Trident, Minuteman, Poisson, Short Range Attack Missile (SRAM), and the High-Speed Anti-Radiation Missile (HARM) systems. ATK Promontory also manufactures some non-missile military munitions, such as flares and non-military explosives like the igniter components for passive restraint systems (e.g., automobile air bags) (ATK, personal communication, 2011). Additionally, ATK manufactures several series of SRMs that could be used for commercial purposes (e.g., launch systems, satellite control, etc.) (ATK, 2011b). The process of manufacturing SRMs includes the manufacturing of the solid fuel propellant and some of the mechanical components of the engine (ATK, personal communication, 2011).

Each Space Shuttle RSRM contains approximately 1,000,000 lbs. of propellant. This propellant is mixed in 600 gallon bowls located in three different mixer buildings. The propellant is then taken to a casting building for casting into the rocket motor segments. Four segments are then

combined to form the motor part of the RSRM. A major feature of the shuttle RSRM is that the mechanical components are reusable. After each shuttle launch, the two RSRMs were recovered and returned to the ATK Promontory to be refurbished and prepared for use again (NASA, 2006).

**Toxic Release Inventory:** ATK Promontory is one of Utah's Toxic Release Inventory (TRI) sites (EPA's TRI site identification: 84302MRTNT9160N). Reportable releases include on-site and off-site releases into the air, water and soils. In 2009, ATK Promontory released a total of 136,318 lbs. of aluminum to on-site landfills or off-site disposal. ATK also released 781,602 pounds of hydrochloric acid as fugitive air emissions (EPA, 2011b).

## The DM-2 and DM-3 SRM Static Tests

The first static test firing of an RSRM at the ATK Promontory facility (then known as Thiokol) occurred on July 18, 1977. A total of 52 static test firings of the RSRM systems have taken place at the ATK Promontory facility, the last occurring on September 8, 2011 (ATK, personal communication, 2011).

Subsequent to the RSRM, the Development Motor (DM) was produced for the Ares launch system. The DM was modified from the four-segment Space Shuttle RSRM to a five-segment system. Each DM contains 1,381,700 lbs. of propellant. On ignition, the DM burns for 122.8 seconds and reaches a maximum chamber pressure of 947.3 pounds per square inch absolute and a chamber gas temperature of 5,630 ° F. It generates approximately 3,600,000 lbs. of thrust (ATK, 2009).

The DM propellant is essentially the same as that used in the RSRM. The DM propellant (extrapolated from the formulation for the RSRM for the mass of the DM) consists of 961,663 lbs. (69.6% of total propellant weight) of ammonium perchlorate ( $\text{NH}_4\text{ClO}_4$ ), 221,072 lbs. (16%) of powdered aluminum, 5,527 lbs. (0.4%) of iron oxide, 166,357 lbs. (12.04%) of a polymer of polybutadiene and acrylonitrile, and 27,081 lbs. (1.96%) of an epoxy curing agent (NASA, 2000).

The T-97 static test site is designed so that the rocket motor is mounted horizontally onto the test stand (Figures C and D). The exhaust of the rocket motor is oriented towards an outcrop of rock on the hill side. Upon ignition, the rocket motor exhaust scours this rock outcrop resulting in some dirt entrainment into the total exhaust product. The modeled exhaust constituents following after-burn of the 1,400,000 pounds of propellant are: aluminum oxide ( $\text{Al}_2\text{O}_3$ , 26.5%), carbon dioxide ( $\text{CO}_2$ , 36.0%), hydrogen chloride (HCl, 18.5%), water ( $\text{H}_2\text{O}$ , 8.3%),

nitrogen gas (N<sub>2</sub>, 7.7%), free chlorine (Cl, 3.66%), and oxides of nitrogen (NO<sub>x</sub>, 2.3%). Combustion of exhaust gasses continues for some distance after the exhaust nozzle exit plane. Some of these combustion products may be consumed or react with materials from the dirt entrainment while still within the combustion zone of the exhaust (ATK, 2011b; SECOR, 2001). Figures E and F are of the burn and plume generated by the ignition of the DM-2 rocket motor.

Three static tests were scheduled for the DM before the cancellation of the NASA Constellation Program. The first test, DM-1, occurred on September 10, 2009 (NASA, 2009). The second test, DM-2, occurred on August 31, 2010 at 9:27 a.m. Mountain Daylight Time (MDT) (B. Maulding, personal communications, July 27, 2011). A third test, DM-3, occurred on the afternoon of September 8, 2011. See Maps 4 and 5 in Appendix A. This PHA addresses public health concerns regarding the DM-2 and DM-3 static test firings.

**Figure C.** Aerial view of the T-97 Static Test Stand, ATK Promontory, Box Elder County, Utah, showing the stand and the area behind the stand that is impacted by static tests.



**Figure D.** The DM-2 Solid Fuel Rocket Motor mounted in the T-97 Immobile Static Test Stand at the ATK Promontory Test Facility in Box Elder County, Utah. This view is looking northwest.



**Figure E.** The combustion exhaust of the DM-2 Solid Fuel Rocket Motor after ignition while mounted on the T-97 Test Platform, ATK Promontory, Box Elder County, Utah. This view is looking east.



**Figure F.** The exhaust plume raised by the DM-2 Solid Fuel Rocket Motor while mounted on the T-97 Test Platform, ATK Promontory, Box Elder County, Utah. This view is looking east.



## Sampling and Meteorology

On September 28, 2010, the EPA Superfund Site Assessment Program was contacted by a concerned citizen living in Thatcher, Utah, who believed that the activities at ATK Promontory were negatively affecting the health and property of the residents living in the communities on the west side of Bear River Valley (Penrose, Thatcher, Marble Hills, and Bothwell). This citizen petitioned EPA to conduct an assessment of the health effects of the SRM static tests. The EPA contacted Utah's Department of Environmental Quality, who in turn requested the EEP to conduct this PHA.

The petitioner was concerned about the adverse effects of chemicals released into the environment from the DM-2 and previous SRM tests on humans, animals, and property. As a result of this petition, UDEQ initiated a preliminary assessment and site investigation in cooperation with EPA. UDEQ and EPA conducted a public availability session in February 2011 to allow concerned residents of the communities to express concerns related to ATK Promontory activities.

**Air:** No air monitoring data were collected during or after the DM-2 static test in 2010. Air monitoring was conducted during the DM-3 test on September 8, 2011. The locations of the air sampling sites are found in Appendix A. The results are found in Appendix B. Ambient air samples were measured for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, inorganic anions, and perchlorate. In addition, collection tarps were used to capture deposition samples from the rocket motor test plume. Sampling locations were northeast, east, and southeast of the SRM test pad (Map 7, Appendix A). On the day of the DM-3 test, the rocket plume traveled south-southwest and did not impact air sampling locations; therefore, air test results reflect background air conditions in the Faust Valley Region (EPA, 2012).

Table A presents the modeled production of total solid particulate (TSP), particulate matter of 10 microns or less (PM10), total nitrogen oxide species (NOx), and HCl during each SRM test. As part of the permitting process, air quality impact analyses and modeling were conducted, which included modeling the air HCl concentrations at varying distances from the site and under a range of meteorological conditions (SECOR, 2001). Based on these model results, the concentration of HCl at the center of each residential area using worst-case (most concentrating) meteorological conditions is presented in Table B. From the models, it is projected that exposure to air contaminants could start between one and seven minutes following test initiation and last between twelve to fourteen minutes. Maximum projected exposures (presented in Table B) would have lasted less than two minutes (SECOR, 2001). See Appendix F for SECOR modeling details.

**Table A.** Modeled emission quantities resulting from a static test firing of a 1.4 million pound solid rocket motor at the ATK Promontory T-97 Test Platform (SECOR, 2001).

Pollutant Emissions per Motor	Motor Exhaust	Entrained Dirt Materials	Total
Total solid particulate (TSP) matter	423,024 lbs.	19,400 lbs.	442,424 lbs.
Particulate matter less than or equal to ten micrometers in diameter (PM10)	165,979 lbs.	9,700 lbs.	174,679 lbs.
Nitrogen oxides (NO <sub>x</sub> )	37,380 lbs.		37,380 lbs.
Hydrogen chloride (HCl)	287,420 lbs.		287,420 lbs.

**Table B.** Modeled maximum total solid particulate and HCl concentrations in residential areas near ATK Promontory. Results represent the DM-3 static test on August 30, 2011 using the permitting model results (SECOR, 2001).

	Distance (m)	Maximum Concentration (µg/m <sup>3</sup> )	
		Total Solid Particulate	Hydrogen Chloride
Southwest corner of Penrose	4,600	3,025	320
Center of Penrose	6,400	4,068	185
Center of Marble Hills	7,800	7,828	356
Center of Thatcher	8,800	6,237	284
Center of Bothwell	12,800	8,263	142

**Soil:** After the DM-2 static test, representatives from UDEQ’s Division of Environmental Response and Remediation collected and analyzed soil samples from six sites in west Bear River Valley. Map 3 in Appendix A presents the locations of the six sample sites. These samples were analyzed for twenty-five metals, seven anions, and perchlorate. The results of the analysis for these samples are presented in Table 1, Appendix B.

As heavy metals are known to occur in soils throughout Utah, this investigation attempts to address whether heavy metals found in the collected soil samples are the result of contamination from entrained soils lifted into the air by SRM testing, or if any metals found are naturally occurring.

To address this question, sample data were compared to data on soil collected from various locations surrounding the SRM test site. The National Soil Survey Center analyzed these “pedon” soil sample columns for their elemental and molecular make-up. A pedon is the smallest three-dimensional volume of soil that can be recognized. The closest pedon (02UT003003) with a complete analysis is located 4.5 miles (7.2 km) south of Penrose and just north of Pintail Lake (NCSS, 2011). This sample was collected in June 2000.

Pedons taken from the Public Shooting Grounds Area of Utah in June 2000, as well as soil samples collected at the T-97 test site by ATK Promontory (NCSS, 2000), were used for comparison against UDEQ collected soil samples. The locations of the pedon soil sampling are presented in Map 4 in Appendix A. The data for both pedon soil samples and T-97 soil samples are presented in Table 2 of Appendix B.

Along with UDEQ collected soil samples, plume fallout material collected by EPA and UDEQ just south-southwest of the rocket testing facility (designated FV9OP in Tables 4 through 8, Appendix B) immediately following the DM-3 test on September 8, 2011 was also evaluated. This sample was analyzed for pH, SVOCs, metals, and perchlorate (EPA, 2012). Since the fallout would be deposited on the surface soil, this sample gives further context to the above mentioned comparisons.

**Ground Water:** UDEQ collected and analyzed ground water samples from eight residential wells and yard hydrants located in west Bear River Valley. These water sources are used as drinking water by the residents (UDEQ, 2011). Map 5 in Appendix A presents a map showing the locations of the eight sample wells. These samples were analyzed for the twenty-five metals, seven anions, and perchlorate. The results of the sample analysis are presented in Appendix B Table 3.

**Weather:** Due to the direct impact of local weather on rocket plume migration, the EEP obtained prevailing meteorological data for the ATK testing area. The closest Mesonet meteorological station is at Promontory Point approximately 26.7 miles (43.0 km) south of the T-97 test stand (MesoWest, 2010). Wind data obtained for this station are shown in Table C.

## DISCUSSION

### Nature and Extent of Contamination

Contaminants associated with the SRM static test consist of propellant burn products and materials scoured from the test site by rocket motor exhaust.

The presence of arsenic in groundwater samples is consistent with the natural hydrogeology of the region (Welch et al., 2000). USGS reports indicate the presence of arsenic in the Cache Valley and Lower Bear River aquifers to range between 1-10 µg/L (USGS, 1994). Therefore, it

**Table C.** Meteorological data from the Promontory Point, Utah weather station for August 30, 2010 (MesoWest, 2010).

Date	Time	Temperature (°F)	Wind		
			Speed (mph)	Gust (mph)	Direction
August 30, 2010	9:00 a.m.	45.0	5	11	SW
	9:15 a.m.	44.6	5	10	S
	9:30 a.m.	44.8	4	5	SSW
	9:45 a.m.	46.0	5	9	SSW
	10:00 a.m.	46.3	7	12	SW
	10:15 a.m.	47.4	6	15	SW
	10:30 a.m.	47.0	6	11	SSW
	10:45 a.m.	46.4	6	9	S

is very unlikely that arsenic present in groundwater results from site-related activities. As such, an exposure pathway for arsenic in groundwater was not evaluated. However, a toxicological evaluation for this arsenic exposure was included in the contaminant evaluation section.

### Exposure Pathways Analysis

To determine if populations (residents, visitors, and workers) near the DM-2 and DM-3 rocket motor static test event are exposed to contaminants related to that event, ATSDR evaluates the environmental and human components that lead to human exposure. An exposure pathway consists of five elements (ATSDR, 2005):

- (1) A source of contamination;
- (2) Transport through an environmental medium;
- (3) A point of exposure;
- (4) A route of exposure; and
- (5) A receptor population;

ATSDR categorizes an exposure pathway as either “complete”, “potential”, or “eliminated.” A completed exposure pathway is such that all five exposure pathway elements are confirmed to exist and indicate that exposure to contaminants has occurred in the past, is occurring, or will

occur in the future. A potential exposure pathway is such that at least one of the five exposure pathway elements has not been confirmed, but it may exist and that exposure to contaminants may have occurred in the past, may be occurring now, or may occur in the future. An exposure pathway can be eliminated if at least one of the five elements is missing and will never be present (ATSDR, 2005).

When an exposure pathway is identified, comparison values (CVs) for environmental media (e.g., air, soil, drinking water, etc.) are used as guidelines for selecting contaminants for further evaluation. To protect susceptible populations, the CVs for children are used when available (ATSDR, 2005).

The SRM static tests resulted in the emission of rocket motor burn products and materials scoured from the ground by the exhaust of the rocket motor into the air. These materials disperse via the air and then deposit onto the ground at distances down-wind from the test event site. Over time, some deposited material may be leached into the ground water. This PHA will consider the exposure pathways for ambient air, the soil, and ground-source drinking water. Soil samples and groundwater samples were collected on properties located in the potentially impacted communities near the ATK Promontory facility.

### ***Completed Exposure Pathways***

A completed exposure pathway exists when there is direct evidence or a strong likelihood that people have or are now coming into contact with site-related contaminants (ATSDR, 2005). All of the pathways considered in this PHA required movement of contaminants from the SRM static test site across the Blue Spring Hills and into communities in northern Blue Creek Valley (i.e., Howell) or Bear River Valley (i.e., Penrose, Thatcher, Bothwell, etc.). No air monitoring data were collected to provide direct evidence of this movement. In addition, no soil sampling data indicated that contaminants were present in excess of CVs (See Appendix B, Table 1). Therefore, this PHA does not consider any water, air, or soil exposure pathways complete.

### ***Potential Exposure Pathways***

#### **Ambient Air: Past, Present, and Future**

Although this PHA does not consider air and soil exposure pathways to be complete because no sampling data indicated that contaminants were present in excess of CVs, the potential exposures of concern are combustion products and scoured soils in the post-exhaust combustion column from the SRM static tests. The DM-2 SRM static test resulted in a plume thick with dust that reached an estimated 14,000 to 16,000 feet in height. The winds at the time of the static test and for the next hour were from the southwest towards the northeast. The plume was high enough to cross the Blue Spring Hills Mountains into Bear River Valley and over the communities of Penrose, Thatcher, and Bothwell. Dust in the plume would have been deposited along this path.

The combustion products at the nozzle exit plane have been modeled to be aluminum oxide (estimated to be 417,700 lbs. of  $Al_2O_3$ ), HCl (estimated to be 317,500 lbs. of HCl), and other gasses. Combustion of exhaust gasses continues for some distance after the exhaust nozzle exit

plane. Some of these combustion products at the exit plane may be consumed or react with materials from dirt entrainment while still within the combustion zone of the exhaust. The combustion models indicate that the ammonium perchlorate is completely consumed in combustion (ATK, 2011b; SECOR, 2001).

The thrust and combustion of gasses exiting the nozzle were directed toward a natural rocky outcrop berm on the hillside. The thrust and combustion of gasses create an environment that scours and entrains particulate material originating from the soils of this berm. The chemistry of the berm (described previously) is primarily limestone and sandstone with traces of a variety of heavy metals natural to the soils of the Blue Spring Hills.

During the transportation of these contaminants (combustion products and the entrained soil particulate matter), additional chemical reactions occur with other gasses or entrained soil particulate matter in the plume. From observations of the DM-3 test, particulate matter falls out of the plume very quickly. No measurements were made during the DM-2 static test to determine how far particulate matter migrated downwind from the test site. Observations of residents in Bear River Valley indicate that some particulate matter continued to be present in the plume and underwent deposition as the plume entered Bear River Valley. The plume is assumed to have followed a typical dispersion behavior based on the wind and temperature conditions (neutral stability) at the time of the test. As the plume moved downwind, it would have increased in size (volume) both along the movement axis and expanded outward perpendicular to the movement axis. This results in a dilution of the contaminants in the plume, with the highest concentration in the center of the plume and the lowest concentrations towards the outer margin. Persons who were directly under the movement path of the plume could have potentially experienced higher exposures than those who were under the outer margins of the plume. There are no measurements of the concentration of the particulate matter or gasses in the plume downwind of the test site for the DM-2 test. As stated, the air samples collected during the DM-3 test were not impacted by the rocket plume.

The contaminants in the air include aluminum oxide, HCl, particulate matter, lime compounds, and heavy metals. A past exposure pathway for ambient air potentially existed for a period shortly (several hours at most) after the DM-2 static test until the plume completely dispersed or moved beyond the exposed population. DM-3 sampling data indicated that no exposure occurred to the surrounding communities during that test event.

The potential air exposure pathway is detailed as follows:

<u>Exposure element</u>	<u>Air Contaminants</u>
1) A source of contamination.....	Combustion and soil scour products from the DM-2 solid fuel rocket motor static test on August 31, 2010 at the ATK Promontory test site.
2) Transport through environmental medium...	Air transport of the plume across the Blue Spring Hills mountain range into Bear River Valley. This element of the pathway is uncertain.
3) A point of exposure.....	Ambient air.
4) A route of human exposure.....	Inhalation; ingestion of particulate matter in the air.
5) A receptor population.....	Residents of Penrose, Thatcher, and Bothwell.

## **Exposure Dose Estimate and Toxicological Evaluation**

### *Evaluation Process*

The EEP uses a standard process to investigate chemicals of concern for exposure. This process involves consideration of the exposure pathway, comparing environmental sampling data with published CVs, conducting a dose and risk assessment for contaminants at concentrations above the appropriate CV for that contaminant, and considering the public health implications.

**Screening:** The EEP examined the types and concentrations of each chemical of concern for each media type (soil and groundwater) in which the chemical was measured. The EEP also considered modeled exposure levels based on air dispersion modeling. ATSDR approved CVs were used to screen for chemicals of concern. Where no ATSDR approved CV is available, EPA references (reference dose (RfD) or reference concentration (RfC)) are used. A CV is a media-specific concentration of a contaminant that can be reasonably assumed to be harmless for most members of a population. The development of a CV includes consideration of the sensitivity of a fetus or developing child and are therefore conservative concentrations used to ensure the protection of sensitive populations. The use of a CV is to determine which chemicals require further evaluation. It is important to stress that contaminant concentrations in excess of a CV does not necessarily indicate a health risk. That determination is made through an exposure dose calculation.

Soil and groundwater samples for perchlorate, selected metals, and other elements were taken at representative properties in Penrose and Thatcher between November 8<sup>th</sup>, 2010 and November 17<sup>th</sup>, 2010. Six soil samples were evaluated for twenty-five metals (aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, fluoride, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, silver, sodium, thallium,

vanadium, and zinc), seven anions (chloride, fluoride, nitrate, nitrite, sulfate, sulfide, and phosphate) and perchlorate. Some of these analytes (i.e., calcium, chloride, etc.) are essential nutrients and do not pose a public health risk. For those analytes, no CV is established and concentrations are presented for completeness. Nine groundwater samples were analyzed for the same analytes.

Appendix B, Table 1 presents the laboratory results and the CVs for analytes found in soil samples. No analytes were found to be above the CVs, indicating that no further evaluation needs to be conducted for the soil exposure pathway. Appendix B, Table 2 presents data from a National Cooperative Soil Survey pedon (soil sample column) sampled from the Public Shooting Grounds located near the southern tip of the Blue Spring Hills mountain range and from soil assessments taken at the T-97 test stand site on ATK Promontory property. These data are presented as normal ranges of soil chemistry for comparison. Appendix B, Table 3 presents laboratory results and the CVs for analytes found in ground water samples. Arsenic was found at two well locations at concentrations (9.6 and 3.4  $\mu\text{g/L}$ ) higher than the CV (3.0  $\mu\text{g/L}$ ), but less than the EPA designated maximum contaminant level (MCL).

### ***Air***

Air sampling was performed by the EPA and UDEQ during a subsequent solid rocket motor test (DM-3) on September 8, 2011. This air sampling event did not successfully collect rocket exhaust data due to prevailing meteorological conditions on the testing date. Therefore, it is not possible for the EEP to provide an exposure evaluation for airborne contaminants of concern.

### ***Soil***

Table D presents the concentrations of those chemicals found through sampling of plume fallout material and the health-based CVs used to screen those chemicals for further analysis.

#### **Phosphorus**

The plume fallout material sample (FV9OP) contained a concentration of phosphorus that exceeded screening values (Table D and Appendix B, Table 5). The implication of this analysis is difficult to interpret. Although elemental (white) phosphorus is a hazardous and highly caustic substance, it is not a known by-product of SRM exhaust. The native soils at the ATK test site and surrounding regions have high amounts of naturally occurring phosphorus (Appendix B, Table 2). These phosphate containing soils likely became entrained in the exhaust plume during the SRM test and settled out with the rest of the test fire fallout debris. The test method used by ALS laboratories to assess the metals in the fallout sample (EPA method SW-6010C, EPA 2012) determines gross phosphorus in a sample and does not indicate its current form (inorganic phosphate salts, mineral apatite, white phosphorus, etc.). As the naturally occurring soil levels for phosphorus (in mineral and salt composition) are high, it must be assumed that the forms of phosphorus collected from the fallout samples are also these more benign forms. Though it is unlikely that the exhaust plume contains appreciable amounts of elemental phosphorus, rapid oxidation in the atmosphere would alleviate concerns of an exposure hazard. Given the physical characteristics of this element, the EEP does not predict that speciation of the form of

phosphorous using EPA test 7580 (EPA, 1996) would contribute to the assessment of this site nor would it rationalize the cost and technical challenges (such as an oxygen-free environment) involved in collecting a sample for this assay. Though the EEP cannot determine the species of phosphorus contained in the test-fire fallout debris, conventional understanding of the physical and chemical behavior of the element leads us to conclude that the presence of elevated phosphorous in test-fire fallout debris does not pose a health hazard.

**Table D.** Plume fallout material sampling results for Faust Valley.

<b>Contaminant</b>	<b>Concentration in Sample FV9OP<sup>a</sup> (ppm)</b>	<b>Soil Comparison Values (CV, ppm)</b>	<b>CV Source</b>
Aluminum Oxide	47,500	50,000	ATSDR Chronic EMEG (Child), 2012
Arsenic	6.84	15	ATSDR Chronic EMEG (Child), 2012
Calcium Hydroxide	NA	NA	NA
Calcium Oxide	NA	NA	NA
Hydrogen Chloride	NA	NA	NA
Perchlorate	0.0062	35	ATSDR Chronic EMEG (Child), 2012
Phosphorus <sup>b</sup>	<b>1,180<sup>b</sup></b>	<b>10<sup>b</sup></b>	ATSDR Intermediate EMEG (Child), 2012

<sup>a</sup> Sample FV9OP consists of plume fallout material collected by EPA and UDEQ south-southwest of the rocket testing facility following the DM-3 test on September 8, 2011.

<sup>b</sup> Phosphorus is reported as total phosphorus; the CV for white phosphorus is provided. There is no indication that any of the phosphorus found in the fallout sample was in the form of white phosphorus.

**Water**

**Arsenic**

Although the arsenic detected in one residential well is very likely not the result of SRM testing at the ATK Promontory site, the toxicological evaluation of this substance is important information for area residents. Water from sample well 002 contained 9.6 µg/L of arsenic (Table E).

The ATSDR chronic environmental media evaluation guide (EMEG) for children’s exposure to arsenic in drinking water is 3 ppb. Concentrations at two sampling locations exceeded this value (Table 3, Appendix B). Groundwater exposures were assessed because well and yard hydrants sampled are used as a drinking source (UDEQ, 2011). Drinking water exposure dose estimates were calculated for exposure to arsenic. Appendix C provides the formulas used for these calculations. The estimated exposure dose for arsenic was compared to the ATSDR minimum

risk level (MRL). The MRL is a value based on published reports that determine the concentration at which no observable increase in the frequency or severity of adverse health effects (the NOAEL) occurs. The NOAEL is then reduced by standard factors to account for the amount of uncertainty associated with those investigations. The investigations used to determine effect levels include both human epidemiological and animal exposure studies. An estimated exposure dose above the MRL may pose a health concern for some individuals in the exposed population (ATSDR, 2005).

The ATSDR publishes different MRLs for oral exposure based on the duration of exposure. Acute duration exposures last for a short period of time (1 to 14 days), intermediate exposures between 15 and 364 days, and chronic exposures persist for 365 days or longer (ATSDR, 2005). Since chronic MRLs are the lowest values and the water sources sampled for this investigation are thought to be used all year as potable water, only chronic (the most conservative/protective) MRL values were used for comparison to the exposure dose estimates.

The estimated exposure dose was calculated for an average adult (70 kg) and an average child (16 kg) using the equations found in Appendix C. These calculations assume the consumption of 2 liters of water per day for an adult and 1 liter of water per day for a child.

**Table E.** Arsenic exposure calculations for sampled water sources.

Analyte	Sample Location	Ground Water Concentration µg/L	Chronic Oral MRL mg/kg/day	Estimated Exposure Dose mg/kg/day	
				Child	Adult
Arsenic	002	9.6	0.0003	<b>0.0006</b>	0.0003
	006	3.4	0.0003	0.0002	0.0001

Water samples from two sites (See Table E and Table 3, Appendix B) showed quantifiable levels of arsenic. Only the estimated chronic oral exposure dose for arsenic at site 002 (in bold, see Map 5, Appendix A) suggests an elevated arsenic concentration. Further water sampling from this region’s aquifer is necessary before the EEP can determine if any potential health hazard is present.

**Cancer Risk Assessment**

Arsenic is classified as a known human carcinogen (ATSDR, 2007). The equations used to calculate cancer risk are located in Appendix C. The results of these calculations are detailed in Table F.

**Table F.** Theoretical lifetime excess (potential lifetime) cancer risk from drinking arsenic in sampled well water.

Contaminant	Cancer Risk Guideline	Potential Lifetime Cancer Risk
Arsenic	$>1 \times 10^{-4}$	$5.02 \times 10^{-4}$

Data in Table F show the calculated theoretical lifetime (70 years (13 child years and 57 adult years)) excess cancer risk attributable to arsenic for children drinking well water with an arsenic concentration of 9.6 µg/L. The level of total cancer risk that is of concern is a matter of personal, community, and regulatory judgment. In general, the EPA considers excess cancer risks that are below about 1 chance in 1,000,000 ( $1 \times 10^{-6}$  or 1E-06) to be so small as to be negligible, and risks above 1 chance in 10,000 ( $1 \times 10^{-4}$  or 1E-04) to be sufficiently large to warrant further investigation and possible remediation. Excess cancer risks that range between 1E-06 and 1E-04 are generally considered to be ‘acceptable’ (EPA, 1991) because it is likely to be impossible to distinguish these potential excess cases from background levels of cancer.

Although this calculated risk value is in excess of EPA’s cancer risk value of 1 in 10,000, it is important to note that documented cancers related to chronic oral arsenic exposure are associated with doses beginning at 1.4E-02 mg/kg/day (ATSDR, 2007). The calculated potential exposure dose for children, 6E-04 mg/kg/day (Table E), is much less than this value.

## Health Effects of Known Contaminants

This section provides a summary of the known health effects of chemicals of concern that were identified through the environmental sampling and evaluation process, community concerns, or scientific literature regarding rocket motor tests.

### *Contaminants Exceeding Screening Levels*

#### **Arsenic**

Arsenic is a naturally occurring element that is widely distributed in the Earth’s crust. Arsenic is classified chemically as a metalloid, having both properties of a metal and a nonmetal; however, it is frequently referred to as a metal. Elemental arsenic (sometimes referred to as metallic arsenic) is a steel grey solid material. Arsenic is usually found in the environment combined with other elements such as oxygen, chlorine, and sulfur. Arsenic combined with these elements is called inorganic arsenic. Arsenic combined with carbon and hydrogen is referred to as organic arsenic (ATSDR, 2007). The different forms of arsenic have very different toxicities.

Since arsenic is found naturally in the environment, people are exposed to some arsenic by eating food, drinking water, or breathing air. Children may also be exposed to arsenic by eating soil. Analytical methods used by scientists to determine the levels of arsenic in the environment

generally do not determine the specific form of arsenic present. Therefore, we do not always know the form of arsenic exposure a person has experienced. Some forms of arsenic may be so tightly attached to particles or embedded in minerals that they are not taken up by plants and animals (ATSDR, 2007).

The concentration of arsenic in soil varies widely, generally ranging from about 1 to 40 ppm with an average level of 3.4 ppm. Soils in the vicinity of arsenic-rich geological deposits, some mining and smelting sites, or agricultural areas where arsenic pesticides have been applied in the past may contain much higher levels of arsenic. The concentration of arsenic in natural surface and groundwater is generally about 1 ppb, but may exceed 1,000 ppb in contaminated areas or where arsenic levels in soil are high. Groundwater is far more likely to contain high levels of arsenic than surface water. Surveys of U.S. drinking water indicate that about 80% of water supplies have less than 2 ppb of arsenic, but 2% of supplies exceed 20 ppb of arsenic. Levels of arsenic in food range from about 20 to 140 ppb. Levels of inorganic arsenic, the form of most concern, are far lower. Levels of arsenic in the air generally range from less than 1 to about 2,000 ng/m<sup>3</sup> depending on location, weather conditions, and the level of industrial activity in the area. Urban areas generally have mean arsenic levels in air ranging from 20 to 30 ng/m<sup>3</sup> (ATSDR, 2007).

After ingestion of arsenic from water, soil, or food, most is quickly absorbed. Both inorganic and organic forms leave the body in the urine. Most of the inorganic arsenic will be gone within several days, although some will remain in the body for several months or even longer. Organic arsenic leaves the body within several days (ATSDR, 2007).

Inorganic arsenic has been recognized as a human poison since ancient times, and large oral doses (above 60,000 ppb in water, which is 10,000 times higher than 80% of U.S. drinking water arsenic levels) can result in death. If a person swallows lower levels of inorganic arsenic (ranging from about 300 to 30,000 ppb in water; 100-10,000 times higher than most U.S. drinking water levels), that person may experience irritation of the stomach and intestines with symptoms such as stomachache, nausea, vomiting, and diarrhea. Other effects a person might experience from swallowing inorganic arsenic include decreased production of red and white blood cells, which may cause fatigue, abnormal heart rhythm, blood-vessel damage resulting in bruising, and impaired nerve function causing a "pins and needles" sensation in that person's hands and feet (ATSDR, 2007).

Perhaps the single-most characteristic effect of long-term oral exposure to inorganic arsenic is a pattern of skin changes. These include patches of darkened skin and the appearance of small "corns" or "warts" on the palms, soles, and torso, and are often associated with changes in the blood vessels of the skin. Skin cancer may also develop. Swallowing arsenic has also been reported to increase the risk of cancer in the liver, bladder, and lungs. The Department of Health and Human Services (DHHS) has determined that inorganic arsenic is known to be a human carcinogen (a chemical that causes cancer). The International Agency for Research on Cancer

(IARC) has determined that inorganic arsenic is carcinogenic to humans. EPA also has classified inorganic arsenic as a known human carcinogen (ATSDR, 2007).

Children who are exposed to inorganic arsenic may present many of the same effects as adults, including irritation of the stomach and intestines, blood vessel damage, skin changes, and reduced nerve function. Thus, all health effects observed in adults are of potential concern in children. There is also some evidence that suggests that long-term exposure to inorganic arsenic in children may result in lower IQ scores. It is not known if absorption of inorganic arsenic from the gut differs from children to adults (ATSDR, 2007).

There is some evidence that exposure to arsenic in early life (including gestation and early childhood) may increase mortality in young adults (ATSDR, 2007).

There is some evidence that inhaled or ingested inorganic arsenic can be harmful to pregnant women or their unborn babies, although the studies are not definitive. Studies in animals show high doses of inorganic arsenic that cause illness in pregnant females can also cause low birth weight, fetal malformations, and even fetal death. Arsenic can cross the placenta and has been found in fetal tissues (ATSDR, 2007).

In animals, exposure to organic arsenic compounds can also cause low birth weight, fetal malformations, and fetal deaths. The dose levels that cause these effects also result in effects in the mothers (ATSDR, 2007).

#### MRL for Arsenic Exposure

Oral	0.0003 mg/kg/day chronic exposure (365 days or longer)
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### **Phosphorus**

Both phosphorus and nitrogen are essential nutrients for the plants and animals. Since phosphorus is the nutrient in short supply in most fresh waters, even a modest increase in phosphorus can, under the right conditions, set off a whole chain of undesirable events in a stream, including accelerated plant growth, algae blooms, low dissolved oxygen, and the death of certain fish, invertebrates, and other aquatic animals (EPA, 2012b).

There are many sources of phosphorus, both natural and human; these include soil and rocks, wastewater treatment plants, runoff from fertilized lawns and cropland, failing septic systems, runoff from animal manure storage areas, disturbed land areas, drained wetlands, water treatment, and commercial cleaning preparations. National Cooperative Soil Survey (NCSS) soil samples of the area surrounding the ATK site indicate that high amounts of phosphorus are naturally occurring in these soils (Appendix B, Table 2).

Pure, "elemental" phosphorus (P) is rare. In nature, phosphorus usually exists as part of a phosphate molecule (PO<sub>4</sub>). Phosphorus in aquatic systems occurs as organic phosphate and inorganic phosphate. Organic phosphate consists of a phosphate molecule associated with a

carbon-based molecule, as in plant or animal tissue. Phosphate that is not associated with organic material is inorganic. Inorganic phosphorus is the form required by plants. Animals can use either organic or inorganic phosphate. Naturally occurring phosphorus is usually found as a form of apatite.

Pure white phosphorus is a colorless-to-white waxy solid, but commercial white phosphorus is usually yellow. Therefore, it is also known as yellow phosphorus. White phosphorus is also called phosphorus tetramer and has a garlic-like smell. In air, it catches fire at temperatures 10-15 degrees above room temperature. Because of its high reactivity with oxygen in air, white phosphorus is generally stored under water. White phosphorus does not occur naturally. Industries produce it from naturally occurring phosphate rocks (ATSDR, 1997).

MRL for White Phosphorus Exposure

Inhalation	no data
Oral (MRL)	2 µg/kg/day intermediate exposure (15-365 days)
Oral (RfD)	0.2 µg/kg/day chronic exposure (365 days or longer)

***Airborne Caustics and Corrosives***

This section details the known and most likely airborne contaminants based upon sampling and soil analysis that would contribute to the reported skin irritation experienced by residents following SRM tests at the ATK Promontory site.

The presence of HCl as an air contaminant, though not verified in sample data, is nevertheless likely to be present based upon the nature of the rocket engine fuel exhaust. Lime compounds (calcium oxide (CaO) and calcium hydroxide (Ca(OH)<sub>2</sub>), though not specifically assayed for in the test-fire fallout samples, are the most likely contributor to the alkaline pH (i.e., a pH higher than 7) observed in those samples. Both of these compounds in sufficient concentrations will result in a burning sensation on the skin during exposure. The complaints by residents regarding skin irritation when outdoors following the SRM tests and the unusually fast corrosion of metallic objects on their properties is most simply explained by to these probable exposures. All of these compounds are extremely short-lived. Furthermore, air modeling of HCl concentrations indicates potential exposures that could result in temporary skin irritation, though not any health hazards beyond this.

Soil particles scoured by the force of the thrust from the combustion of the solid rocket fuel is entrained in the plume. These particles include the silicate minerals of limestone and sandstone and the metals or anions that are associated with those minerals. Table 2 in Appendix B provides information obtained through soil characterization by NCSS at a site near ATK Promontory and by ATK for the T-97 test site. This table provides background values for comparison with soil samples taken after the DM-2 static test at locations along the Faust Valley Road. In addition, the test-fire fallout material sample collected during the DM-3 test offer insight into the contributions made by the rocket plume to peripheral properties (Tables 4-8, Appendix B). The major addition from this sampling is phosphorus (Table 5). Further analysis performed by

University of Utah Geophysics laboratories strongly suggest the rapid formation of CaO and Ca(OH)<sub>2</sub> (EPA, 2012).

### Calcium Oxide

Commonly known as quicklime, calcium oxide is a caustic substance that has a very alkaline pH. Inhalation of dust is highly irritating and possibly corrosive to the upper respiratory tract. It may cause coughing, sneezing, labored breathing, and possibly burns with perforation of the nasal septum. Ingestion may result in abdominal pain, nausea, and vomiting. It may also cause serious alkali burns in mouth and throat. Skin and eye contact may result in corrosive (burning) damage, redness, blurred vision, and pain (MSDS, 2012). Calcium oxide is generated when calcite, also known as calcium carbonate (CaCO<sub>3</sub>), is heated above 825°F. In the environment, calcium oxide will react spontaneously with CO<sub>2</sub> and will convert back to calcium carbonate over time. If water is available, calcium oxide will rapidly react with it to form the more caustic calcium hydroxide (NIOSH, 2010a).

#### Occupational Limits for Calcium Oxide Exposure (NIOSH, 2010b)

OSHA:	PEL 8 hour time weighted average (TWA) 5 mg/m <sup>3</sup>
NIOSH:	REL 8 hour TWA 2 mg/m <sup>3</sup>

### Calcium Hydroxide

Commonly known as Portlandite, this substance possesses similar, yet more caustic, properties than calcium oxide (MSDS, 2012). In the environment, calcium hydroxide readily absorbs CO<sub>2</sub> to form the relatively innocuous compound calcite (NIOSH, 2010a). Thus, the lifecycle of these caustic agents can be appreciated as the intense heat of the SRM initially scours calcite from the mountainside forming calcium oxide, which combines with atmospheric water molecules to form calcium hydroxide, which in turn reacts with atmospheric carbon dioxide to re-form as calcite.

#### Occupational Limits for Calcium Hydroxide Exposure (NIOSH, 2010a)

OSHA:	PEL 8 hour TWA 15 mg/m <sup>3</sup> (total), 5 mg/m <sup>3</sup> (resp)
NIOSH:	REL 8 hour TWA 5 mg/m <sup>3</sup>

### Hydrogen Chloride

Gaseous HCl levels reaching concentrations of a few parts-per-billion (ppb) have been measured in polluted outdoor air and in some indoor settings (Raff et al., 2009). Sources include salt water, volcanic eruptions, incineration of municipal waste, mining and refining activities, industrial and manufacturing processes, application and decay of organochlorine compounds, and the combustion of biomass, petroleum products, and coal. Exposure to atmospheric HCl can occur by inhalation, contact to the skin or eye surface, or by ingestion of saliva that has absorbed HCl. Atmospheric HCl reacts with water on the surfaces of the eye and respiratory tract to form hydrochloric acid. HCl is irritating and corrosive to the eyes, skin, and mucous membranes. The greatest impact is on the upper respiratory tract; exposure to high concentrations can rapidly lead to swelling and spasm of the throat and suffocation (OSHA, 2011).

Only about 50% of persons exposed at the OSHA PEL (5 ppm) can detect the odor of HCl. Therefore, detecting the odor may not provide adequate warning of exposure. Exposure to high concentrations can cause laryngitis, bronchitis, and pulmonary edema. Brief exposures (up to a few minutes) to concentrations in the range of 1,300 to 2,000 ppm are lethal to humans. In workers, exposure to 50 to 100 ppm for 1 hour was barely tolerable; short exposure to 35 ppm caused irritation of the throat, and 10 ppm was considered the maximal concentration allowable for prolonged exposure. Workers who are chronically exposed to low levels of HCl can become acclimatized to HCl. Children exposed to the same levels of HCl as adults may receive larger doses because they have greater lung surface area-to-body weight ratios and increased inhalation volumes-to-weight ratios. In addition, they may be exposed to higher levels than adults in the same location because of their short stature and the higher levels of HCl found nearer to the ground. Dental discoloration and erosion of exposed incisors may occur during prolonged exposure to low HCl concentrations. Hydrochloric acid causes burns of the skin and mucous membranes; the severity of the burns depends on the concentration of the solution. Burns may progress to ulcerations and lead to keloid and retractile scarring. Contact of the eyes with aqueous solutions may produce reduced vision or blindness. HCl is not absorbed through the skin (ATSDR, 2011; OSHA, 2011) unless very concentrated HCl burns the skin sufficiently to expose blood vessels. The environmental half-life of HCl under normal conditions is about three-to-five minutes (Raff et al., 2009; Ravishankara, 2009).

EPA RfC for HCl Exposure

Oral:	No data
Inhalation RfC:	0.02 mg/m <sup>3</sup>

EPA Acute Exposure Guideline Levels (AEGLs) for HCl Exposure in ppm

	<u>10 min</u>	<u>30 min</u>	<u>60 min</u>	<u>4+ hrs</u>
AEGL 1	1.8	1.8	1.8	1.8
AEGL 2	100	43	22	11
AEGL 3	620	210	100	26

***Chemicals Found in Rocket Motor Exhaust***

This section details those chemicals known to be present in rocket motor exhaust. Though air sampling was carried out, the lack of data due to meteorological conditions makes evaluating air exposures to these chemicals impossible. Though exposure cannot be confirmed, the EEP believes that this information is useful for the benefit of the community.

**Ammonium Perchlorate**

Ammonium perchlorate (NH<sub>4</sub>ClO<sub>4</sub>) is an inorganic salt of ammonia and perchloric acid. The important use of ammonium perchlorate is as the oxidizer for solid propellants. When mixed with a fuel (e.g., powdered aluminum), it can generate a combustion that is sustainable within a vacuum. Perchlorates confer little acute toxicity. Chronic exposure may result in various thyroid problems, as perchlorate interferes with iodine metabolism (ATSDR, 2008c).

### Aluminum Oxide

Aluminum is a soft, durable, lightweight, ductile, and malleable metal that has many industrial uses. Aluminum is naturally released to the environment from the weathering of rock and volcanic activity. Human activities, such as mining and aluminum-based manufacturing, release additional aluminum into the environment. The background atmospheric levels for aluminum are usually low, typically about 0.005 to 0.18  $\mu\text{g}/\text{m}^3$ . Aluminum levels in surface water are also usually very low, typically  $<0.1$  mg/L. Surface waters that are acidic may have higher levels of soluble aluminum (ATSDR, 2008a).

Aluminum is the most abundant and widely distributed metallic element in the earth's crust (approximately 8% by weight) and the third most abundant of all elements (after oxygen and silicon) (Karamalidis and Dzombak, 2010). Because aluminum atoms are very reactive, it is never found as a pure metal in nature. Aluminum is found in combination with other elements, most commonly oxygen, silicon, and fluorine. Pure aluminum used in explosives and rocket propellants must be refined. Upon combustion, the aluminum contained in solid rocket fuel is converted to aluminum oxide ( $\text{Al}_2\text{O}_3$ ). Aluminum oxides and hydroxides (as well as other aluminum compounds) are found everywhere in nature.

People can be exposed to aluminum oxide, also known as alumina or corundum, by breathing, ingesting or directly being in contact with aluminum oxide particles. Ingested aluminum is usually not harmful and is rapidly excreted. People with kidney disease may not be able to excrete absorbed aluminum from the body, resulting in an accumulation of higher levels of aluminum in their blood. Inhaled aluminum oxide can irritate the nose and throat and damage the lungs (ATSDR, 2008a).

The lungs and nervous system seem to be the most sensitive targets for aluminum toxicity. Chronic exposure through inhalation of aluminum fumes and airborne particles may result in subclinical neurological effects such as impairment on neurobehavioral tests for psychomotor and cognitive performance and may increase incidence of subjective neurological symptoms. Inhalation of aluminum rarely results in overt symptoms of neurotoxicity. Chronic inhalation exposure to aluminum fumes and dust has been associated with impaired lung function, fibrosis, irritation, and inflammation; however, this does not always occur (ATSDR, 2008a).

The primary health concern due to chronic oral exposure is the development of neurological symptoms and possibly some skeletal changes in persons who are unable to excrete ingested aluminum (e.g., persons who have kidney disease). High level oral exposure to aluminum may result in impaired production of and damage to red blood cells (ATSDR, 2008a).

Of particular concern is the association of aluminum exposure among susceptible individuals to the development of neurodegenerative changes in the brain such as Alzheimer's Disease, the Guamanian Parkinsonian-ALS constellation of diseases, and Hallervorden-Spatz disease (Bondy, 2010).

While exposure to aluminum has been associated with increased cancer mortality, these investigations are confounded by concurrent exposures to other potent carcinogens. IARC concluded that aluminum production (the activity of working with aluminum) is carcinogenic to humans and that pitch volatiles (the polycyclic aromatic hydrocarbons (“tar”) associated with production) have fairly consistently been suggested in epidemiologic studies as being possible causative agents. The DHHS and EPA have not evaluated human carcinogenic potential of aluminum (ATSDR, 2008a).

	<u>MRL for Aluminum Exposure</u>
Inhalation	No MRL developed
Oral	1 mg/kg/day for intermediate exposure (lasting 15-364 days) and chronic exposure (365 days or longer)

### **Perchlorates**

Perchlorates ( $R-ClO_4$ ) are salts derived from the reaction of perchloric acid ( $HClO_4$ ) with a cation (i.e., ammonia ( $NH_4^+$ )) (Srinivasan and Viraraghavan, 2009). Perchlorate salts occur both naturally and through manufacturing. Perchlorates can form naturally in the atmosphere, leading to trace levels of perchlorates in precipitation. Perchlorate salts have a variety of industrial uses. Five perchlorates are manufactured in large amounts: magnesium perchlorate ( $MgClO_4$ ), potassium perchlorate ( $KClO_4$ ), ammonium perchlorate ( $NH_4ClO_4$ ), sodium perchlorate ( $NaClO_4$ ), and lithium perchlorate ( $LiClO_4$ ). Perchlorates are industrially used as a component in solid rocket fuels, temporary adhesives, electrolysis baths, batteries, charges for air bag deployment, drying agents, etching agents, cleaning agents and bleach, and oxygen generating systems (ATSDR, 2008c).

Perchlorates are found in the environment in two forms, either as a solid or dissolved in water. If no water is present (e.g., on top of dry ground), perchlorate will exist as a solid. If water is present, perchlorate quickly dissolves into the positive charged cation (e.g.,  $Mg^+$ ,  $K^+$ ,  $NH_4^+$ ,  $Na^+$ ,  $Li^+$ , etc.) and the negative charged perchloric anion ( $ClO_4^-$ ) (ATSDR, 2011). Perchlorates have a low vapor pressure and do not volatilize under ambient conditions, and when dissolved the perchlorate anions that do not tend to transition from aqueous to gas phase. This soluble, non-complexing nature makes perchlorates highly mobile in the aqueous environment and does not allow sorption. (ATSDR, 2008c; AWWA, 2011; Srinivasan and Viraraghavan, 2009). Under normal atmospheric conditions, perchlorate may be biologically degraded by indigenous microorganisms present in water under anaerobic conditions. Terrestrial and aquatic plants can take up perchlorate and accumulate or degrade it in various plant tissues (Srinivasan and Viraraghavan, 2009). Under normal environmental conditions, perchlorates may last in the environment for several years (ATSDR, 2008c).

The primary route of human exposure to perchlorates is via ingestion of perchlorate-contaminated water and food. Perchlorates have been found in food, milk, and some plants,

especially leafy green vegetables. As of 2008, 4% of over 3,800 community water systems sampled throughout the United States had measurable levels of perchlorate (ATSDR, 2008c). Ingested perchlorate is readily and completely absorbed from the gastrointestinal tract. Perchlorate concentrates in the thyroid, with levels peaking within four to six hours after exposure. Perchlorate is excreted rapidly via the urine. The biological half-time is about eight to twenty hours (approximately 95% is eliminated within 60 hours) after exposure. Skin absorption and inhalation of perchlorate can be considered negligible exposure pathways (ATSDR, 2008c; Srinivasan and Viraraghavan, 2009; Wolff, 1998).

The concern for perchlorate toxicity is its interference with the primary functions of the thyroid. The thyroid produces thyroid hormones (e.g., triiodothyronine (T<sub>3</sub>) and thyroxine (T<sub>4</sub>)). Iodine is used in production of these hormones. Ingested perchlorate can lead to inhibition of uptake of iodine (as iodide) into the thyroid tissues. The perchlorate ion blocks the protein that normally acts as an iodide pump in the thyroid tissues. As a result of this process, production of important thyroid hormones drop, which in turn leads to hypothyroidism (Braverman et al., 2005; EPA, 2005a; Srinivasan and Viraraghavan, 2009; Wolff, 1998). Studies indicate that only chronic, high-level exposures lead to deleterious thyroid outcomes; chronic low-level exposures, intermittent exposures, and infrequent high-level exposures to perchlorate do not appear to induce hypothyroidism (Braverman et al., 2005).

Hypothyroidism is a treatable condition that occurs when the thyroid gland does not make enough thyroid hormone. Symptoms include changes in sensory and mental states, changes in the health of the integumentary system, and reduction in the size of the thyroid gland. Prolonged hypothyroidism can lead to severe heart disease, dementia, and death (Boeleart and Franklin, 2005). Maternal hypothyroidism, particularly early in pregnancy, may have an adverse effect on the development of the fetal nervous system (Boeleart and Franklin, 2005; Crump and Gibbs, 2005). In the early stages of pregnancy, when the fetal thyroid is not yet functional, maternal thyroid hormones are critical for normal development of the fetus, particularly the neurological system and intelligence (Crump and Gibbs, 2005).

EPA does not consider perchlorate likely to pose a risk for cancer, particularly thyroid cancer (ATSDR, 2008c; EPA, 2005a). Perchlorates have not been classified as cancer causing by DHHS or IARC. However, hypothyroidism may result in the development of thyroid and other types of cancer (Boeleart and Franklin, 2005).

In 1998, EPA added perchlorate to the drinking water contaminant candidate list based on its presence in drinking water supplies in the southwestern United States. In 2005, EPA established an oral RfD of 0.7 µg/kg/day and a drinking water equivalent level (DWEL) of 24.5 µg/L. This RfD is ten times lower than the NOAEL. In January 2009, EPA issued an Interim Drinking Water Health Advisory for perchlorate exposures at 15 µg/L in water. While EPA continues to work toward implementing a final regulatory determination for perchlorate, various states within the United States have implemented guidelines or goals ranging from 1 µg/L to 18 µg/L for

perchlorate in drinking water (ATSDR, 2008c; Crump and Gibbs, 2005; EPA, 2005a; EPA, 2011a; Srinivasan and Viraraghavan, 2009).

Testing for human perchlorate exposure is not routinely available; however, perchlorate can be measured in the urine. Because perchlorate leaves the body fairly rapidly (in a matter of hours) perchlorate in the urine can only indicate very recent exposure. Testing the levels of thyroid hormones in the blood is routinely available. Medical tests are available to measure the thyroid functions of iodine uptake and production of thyroid hormones (ATSDR, 2008c).

<u>Minimum Risk Level (MRL) for Perchlorate Exposure</u>	
Inhalation	No MRL developed
Oral	0.0007 mg/kg/day = 0.7 µg/kg/day

## DATA LIMITATIONS

A number of limitations and uncertainties exist with regard to the data evaluated in this PHA. Due to the prevailing meteorological conditions during the DM-3 SRM test on September 8, 2011, air sampling did not successfully collect data on the plume of rocket exhaust. This lack of useable data prevents the EEP from providing an evaluation of potential exposure to airborne contaminants contained within the exhaust plumes generated by the DM-2 and DM-3 tests. While pre-test modeling data was utilized to identify potential contaminants of concern, health effects could not be directly assessed due to the lack of sampling data. At this time, the EEP is not aware of any future SRM tests planned for the ATK Promontory facility that would allow the collection of air monitoring data.

The caustic compounds calcium oxide and calcium hydroxide are typically very short lived in the environment, quickly reacting with water and carbon dioxide, respectively, to ultimately form calcium carbonate. Sampling of test-fire fallout material identified calcium oxide at the test site, which suggests that it may be responsible for the reported skin, eye, and throat irritation following the DM-2 test. However, given their short half-lives, the EEP cannot determine if calcium oxide and/or calcium hydroxide migrated to the surrounding communities.

The test-fire plume fallout material sample contained a level of phosphorus that exceeded the screening value for white phosphorus. However, there are many different forms of phosphorus and the soils at the ATK test site and surrounding areas have high levels of naturally occurring phosphorus, largely in the mineral apatite and salt forms. While it is highly dangerous and caustic, white phosphorus is never found free in nature due to its high reactivity and it is not a known byproduct of SRM combustion. The presence of white phosphorus, and any potential health hazard it represents, cannot be evaluated as the analytical methodology used to assess metals in the fallout material sample (EPA method SW-6010) determines only the gross phosphorus content and does not characterize which form(s) are present. It would be informative to analyze any future fallout material samples with EPA method 7580, which can quantify the

level of white phosphorus in soil, sediment, and water samples.

Although two well water samples showed quantifiable levels of arsenic, including one that suggests an elevated level, the remaining six samples did not contain detectable arsenic. Furthermore, USGS reports have indicated that the Cache Valley and Lower Bear River aquifers contain 1-10 µg/L of naturally occurring arsenic. While it is unlikely that SRM testing activity at the ATK Promontory facility makes a substantial contribution to arsenic in groundwater, the EEP cannot determine whether ingestion of arsenic from well water in this region could constitute a health hazard without further water sampling of the corresponding aquifers.

## **CHILDREN'S HEALTH CONSIDERATIONS**

The EEP and ATSDR recognize that the unique vulnerabilities of infants and children demand special emphasis in evaluating community environmental health risks. Children are at greater risk than adults from certain kinds of exposures to hazardous substances, particularly those that disrupt normal development. Children are more likely to be exposed because they spend more time interacting with their environment through play activities. Children are more likely to bring non-food items to their mouths and consume food items in a contaminated area. Children have a larger surface area-to-body-weight ratio making them more vulnerable to toxicants absorbed through the skin. Furthermore, the developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Finally, toxic exposures at a young age can result health problems later in life.

The EEP and ATSDR also recognize that pregnant women demand special emphasis in evaluating community environmental health risks. The developing fetus is undergoing rapid growth and development of organ systems. Some contaminants may affect the mother's health resulting in stress and poor nutrition that impacts the fetus. Other contaminants may cross the placenta and directly affect the fetus. Some contaminants can inhibit or interfere with the development of organ systems or biological functions resulting in negative health effects that may impact the child.

When sufficient knowledge exists, the health implications for children are discussed separately from adults. The CV and MRL values used to evaluate contaminants include uncertainty margins that make them protective for the most sensitive populations, particularly children.

## **COMMUNITY HEALTH CONCERNS**

The EEP collaborated with UDEQ to conduct a community needs assessment in Penrose and Thatcher to better understand the public health concerns associated with potential exposures to components of the DM-2 static rocket test. As part of the process, UDEQ staff conducted a site visit, attended town meetings, and administered a survey to residents. The results of these activities were shared with the EEP. The EEP also conducted a site visit. The goal of the needs assessment was to document and respond to community questions and concerns about the DM-2 static test.

The results of the community needs assessment have been compiled and are presented in this PHA as Appendix G. The community will have additional opportunities to express questions and concerns during any public health educational activities held in those communities as well as during the public comment period required for this PHAs approval process.

EPA and UDEQ hosted an informal public availability session at the Senior Center in Tremonton, Utah, February 23, 2011, in which residents were able to express their concerns. Most concerns were related to health effects from the frequent and visible smoke from the open burning activities at ATK. Residents asked questions regarding the effects of static test fallout on crops and cattle feed as well as physical distress on animals coming into contact with the fallout dust. Complaints regarding the corrosive effects of the static test fallout on properties, roof tops, fences, sheds, and car paint were also common.

## CONCLUSIONS

The EEP serves the public by using the best science available, taking responsive public health actions, and providing trusted health information in order that the public may make sound decisions about their individual health.

This PHA was conducted at the request of UDEQ in collaboration with EPA and in response to concerns expressed by citizens of communities that are near the ATK Promontory SRM test site. Citizens are concerned about airborne contamination resulting from static tests of solid fuel rocket booster motors at the site. Residents believe that these contaminants drifted into their homes and agricultural areas.

### *Air and Soil*

The EEP cannot conclude whether the DM-2 and DM-3 rocket motor tests at the ATK Promontory site could have harmed people's health. The reason for this is that no useful outdoor air data were collected to assess the air exposure pathway and perchlorate was not found in soil and ground water samples.

The EEP reviewed available soil and ground water sampling data that were taken shortly after the DM-2 static test, and test-fire fallout material taken from the DM-3 test. No useful air data were available from either SRM test. The EEP compared these available data with the dynamics of test operations and the natural hydrogeology and soil chemistry of the Blue Spring Hills and neighboring valleys.

As no air monitoring data were available for the DM-2 test, and the DM-3 sampling stations were not impacted by the SRM test, the EEP used pre-test modeling data to identify potential contaminants of concern. Health effects could not be directly evaluated because not enough information exists to properly assess them.

Analysis of the soil data did not identify a specific public health concern. Fallout pH indicated a potential for a transient irritation to humans and animals. Furthermore, without additional analysis of phosphorus composition and calcium oxide and calcium hydroxide life-cycles in the soil, it is difficult to determine the exact health impact of the fallout material on the surrounding communities.

A test-fire grab sample collected from the DM-3 fallout debris indicated the presence of caustic calcium oxide at the rocket test site. This would be expected considering the large calcite deposits at the SRM site and the temperatures generated by the SRM. Thus, the presence of an airborne caustic agent at the rocket test site strongly suggests this agent as the source of the public complaints regarding skin, eye, and throat irritation following the DM-2 test. Unfortunately, there is no way to verify whether or not caustic calcium oxide traveled to surrounding human populations because it is so short-lived in the environment.

### **Water**

Based upon the low arsenic values observed in the test-fire fallout material sample (6.84 ppm, Table 5, Appendix B), and the naturally occurring presence of arsenic in many ground water aquifers in Utah, it is very unlikely that debris from the ATK SRM tests makes a substantial contribution to the arsenic detected in the ground waters sampled in the region.

The EEP cannot conclude whether ingesting arsenic in water from wells connected to sampled groundwater aquifers could harm people's health.

Analysis of the ground water resulted in the identification of potentially elevated arsenic in one putative drinking water source. Arsenic is frequently found throughout Utah. Based on the available data, it is not possible to conclusively determine the contribution that ATK Promontory operations had on the ground water levels of arsenic.

## **RECOMMENDATIONS**

Based on the EEP's review of available DM-2 and DM-3 static test data, the EEP cannot conclusively determine that the test resulted in an increased public health risk for the communities near the test site. Some environmental risks were found, and the following recommendations are appropriate and will lead to improved health for those communities.

- § The EEP recommends that public drinking water systems work with the Bear River Health Department to confirm the presence of elevated levels of arsenic in the ground water used for public potable water sources.
- § The EEP recommends that private well owners test their well water for arsenic.
- § To produce a more complete assessment of the impact of SRM testing, further air and soil sampling should be considered. While the EEP did not determine whether or not the activities occurring at ATK Promontory resulted in adverse public health effects, the EEP recognizes that large industrial partners are a valuable resource to communities in

promoting public health in the neighboring communities. The EEP invites ATK Promontory to work with the Bear River Health Department (BRHD), UDEQ, and UDOH to explore how ATK Promontory can be an active participant and resource in promoting and protecting public health for the residents of its neighboring communities.

## **PUBLIC HEALTH ACTION PLAN**

The public health action plan for communities considered in this PHA contains a description of actions that have been or are proposed to be taken by EEP and other stakeholders associated with the ATK Promontory facility. The purpose of the public health action plan section of this PHA is to ensure that along with an assessment of public health hazards and risks, a plan of action is presented to mitigate or prevent harmful human health effects associated with those hazards or risks. Included is the commitment of the EEP to follow-up on this plan to promote implementation.

Public health actions that have been taken at the site include:

- § The creation by surrounding communities of an organized group to address air pollution concerns. It is recommended that this group be utilized to help public health distribute information and promote good health-based decisions.
- § The conducting by UDEQ and EPA of a public availability session, as well as one-on-one conversations, with concerned citizens to assess the needs and concerns of the communities. Additional work may need to occur to address some concerns.
- § The completion by EEP of this PHA following ATSDR protocols to document and evaluate potential environmental health concerns and adverse health effects resulting from exposure to environmental contaminants.

Public health actions that are ongoing or will be implemented at the site include:

- § The EEP tentatively participating in one or more public meetings with community residents from Bothwell, Howell, Penrose, and Thatcher, as well as other stakeholders. The purpose of these meetings will be to present the process and findings of this PHA. These meetings will be coordinated with BRHD.
- § A comprehensive cancer incidence study of the Bothwell, Howell, Penrose, and Thatcher communities was released in May of 2013 to provide a baseline of resident health in regards to cancer incidence.
- § Presentation of this PHA, when finalized, to BRHD. The EEP will make copies of the finalized PHA available through local libraries. The EEP will post the finalized PHA on the EEP website at <http://www.health.utah.gov/enviroepi/appletree/appleindex.htm>. Copies can also be obtained by calling the EEP offices at (801) 538-6191 or by email to [APPLETREE@utah.gov](mailto:APPLETREE@utah.gov). The EEP will be available to answer questions about this PHA.

- § The EEP will continue to provide support to UDEQ and EPA to interpret any additional data collected with respect to ATK Promontory operations.
- § ATK has provided public notification to neighboring communities regarding upcoming static tests of large solid rocket motors since 2005 in the form of approximately 500 postcards mailed to area residents. The postcards contain the planned day and time of the test as well as contact information for questions.
- § ATK has hosted an open house prior to every large rocket motor static test since February 2010. Typically, each open house includes representatives from ATK, UDEQ, and BRHD, as well as environmental researchers from the Utah State University. Neighboring residents receive invitations to the open house meetings by postcard.

## **AUTHORS**

### ***Report Prepared By:***

Craig J. Dietrich, Ph.D.  
Manager/Toxicologist  
Environmental Health Hazards Assessment Section  
Environmental Epidemiology Program  
Bureau of Epidemiology  
Utah Department of Health

McKell Drury, CHES  
Health Educator  
Environmental Health Hazards Assessment Section  
Environmental Epidemiology Program  
Bureau of Epidemiology  
Utah Department of Health

Sam LeFevre  
Program Manager  
Environmental Epidemiology Program  
Bureau of Epidemiology  
Utah Department of Health

Alexander Wu, MPH  
Epidemiologist  
Environmental Health Hazards Assessment Section  
Environmental Epidemiology Program  
Bureau of Epidemiology  
Utah Department of Health

Nathan LaCross, Ph.D., MPH  
Epidemiologist  
Environmental Health Hazards Assessment Section  
Environmental Epidemiology Program  
Bureau of Epidemiology  
Utah Department of Health

***Designated Reviewers:***

Scott Sudweeks, MS  
Regional Toxicologist  
Division of Community Health Investigations  
CDC/ATSDR Region 8

B. Gregory Williams, MPH  
Manager, Environmental Public Health Tracking  
Bureau of Epidemiology  
Environmental Epidemiology Program  
Utah Department of Health

***ATSDR Reviewers:***

Kai Elgethun, Ph.D., MPH  
Western Branch Associate Director for Science  
Division of Community Health Investigations  
ATSDR

Alan Yarbrough, MS  
Deputy Director (Acting)  
Division of Community Health Investigations  
ATSDR

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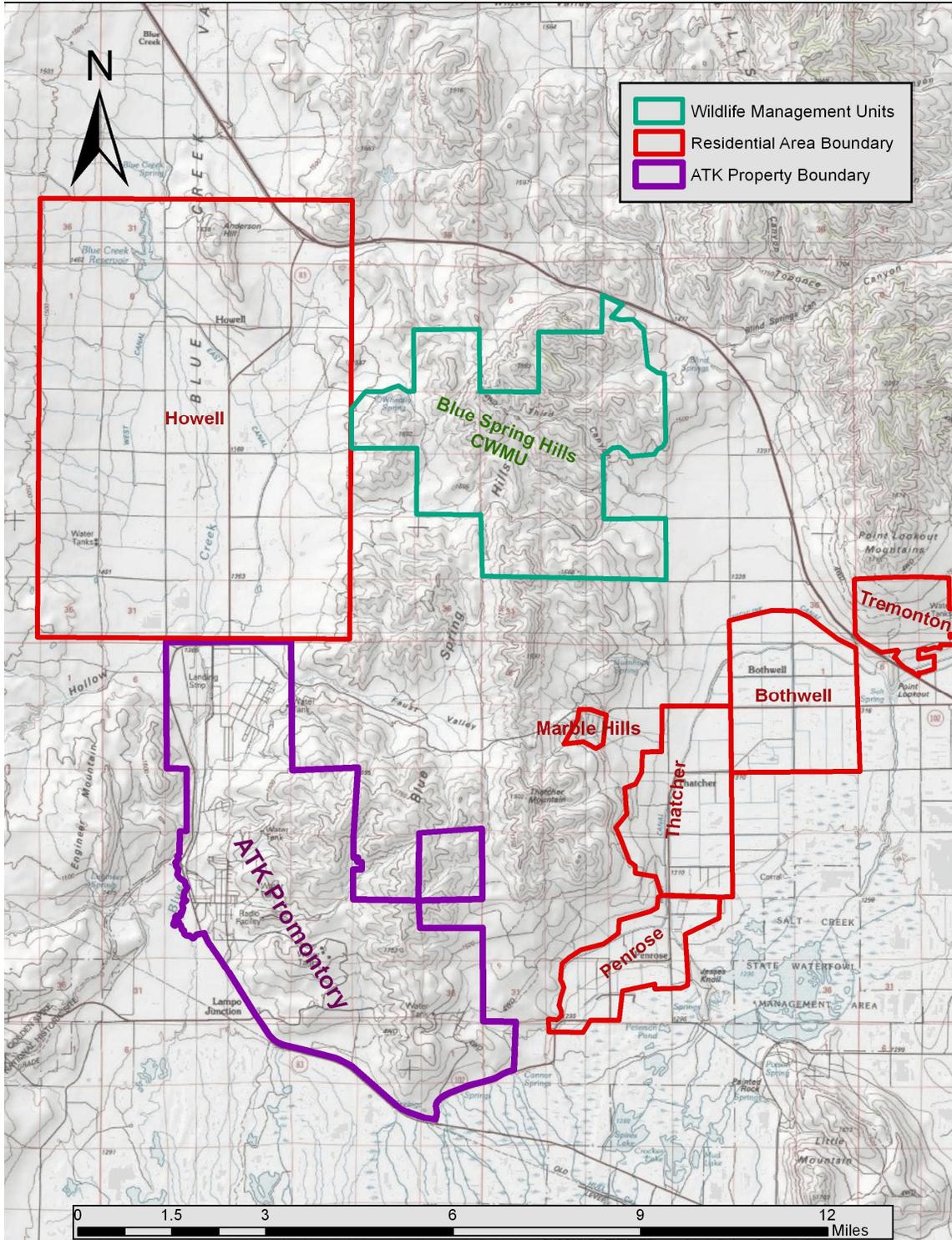
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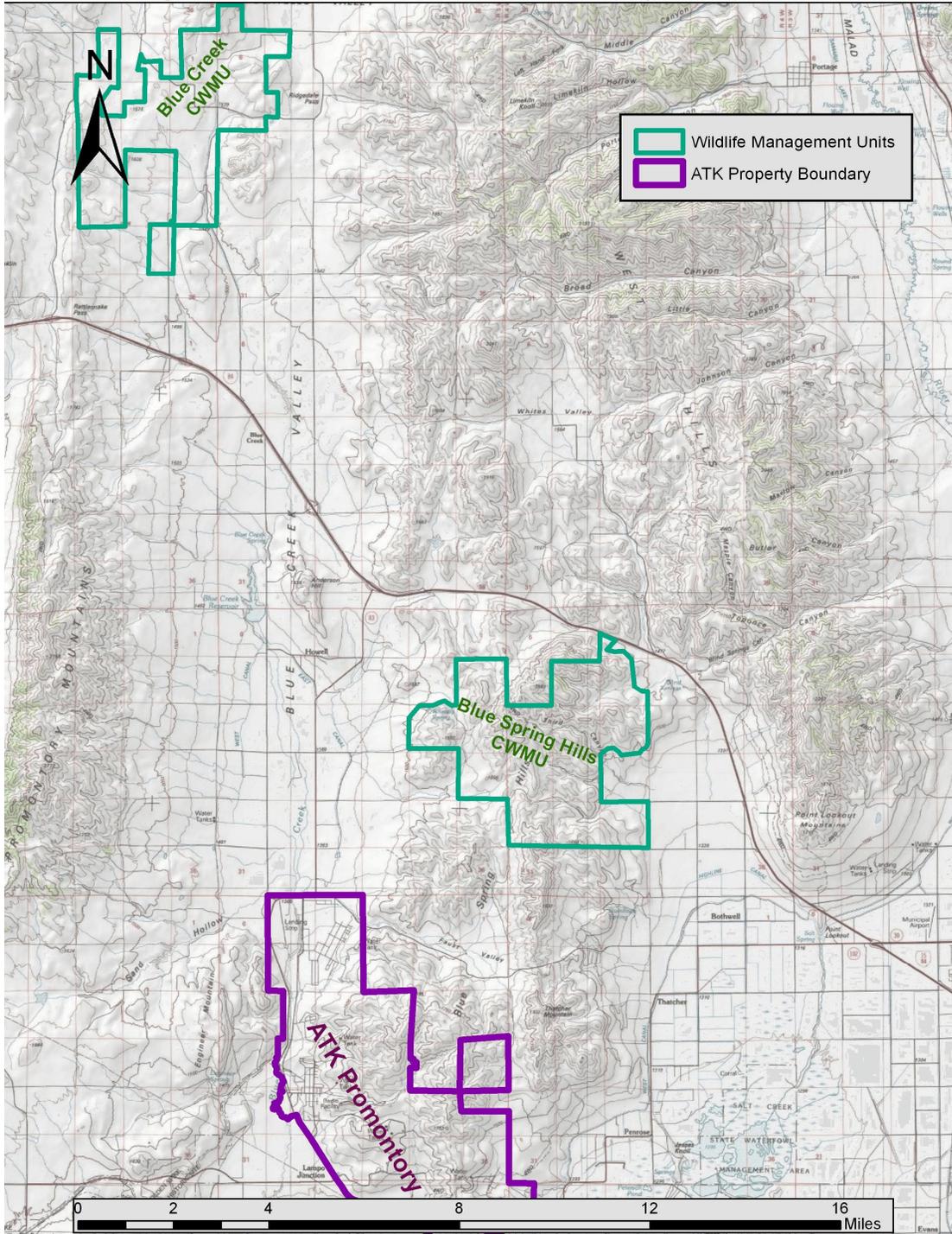
Welch, A.H., Westjohn, D.B., Helsel, D.R., and Wanty, R.B., 2000, Arsenic in ground water of the United States-- occurrence and geochemistry: *Ground Water* v.38 no.4, p.589-604.

**APPENDIX A: MAPS OF STUDY AREA**

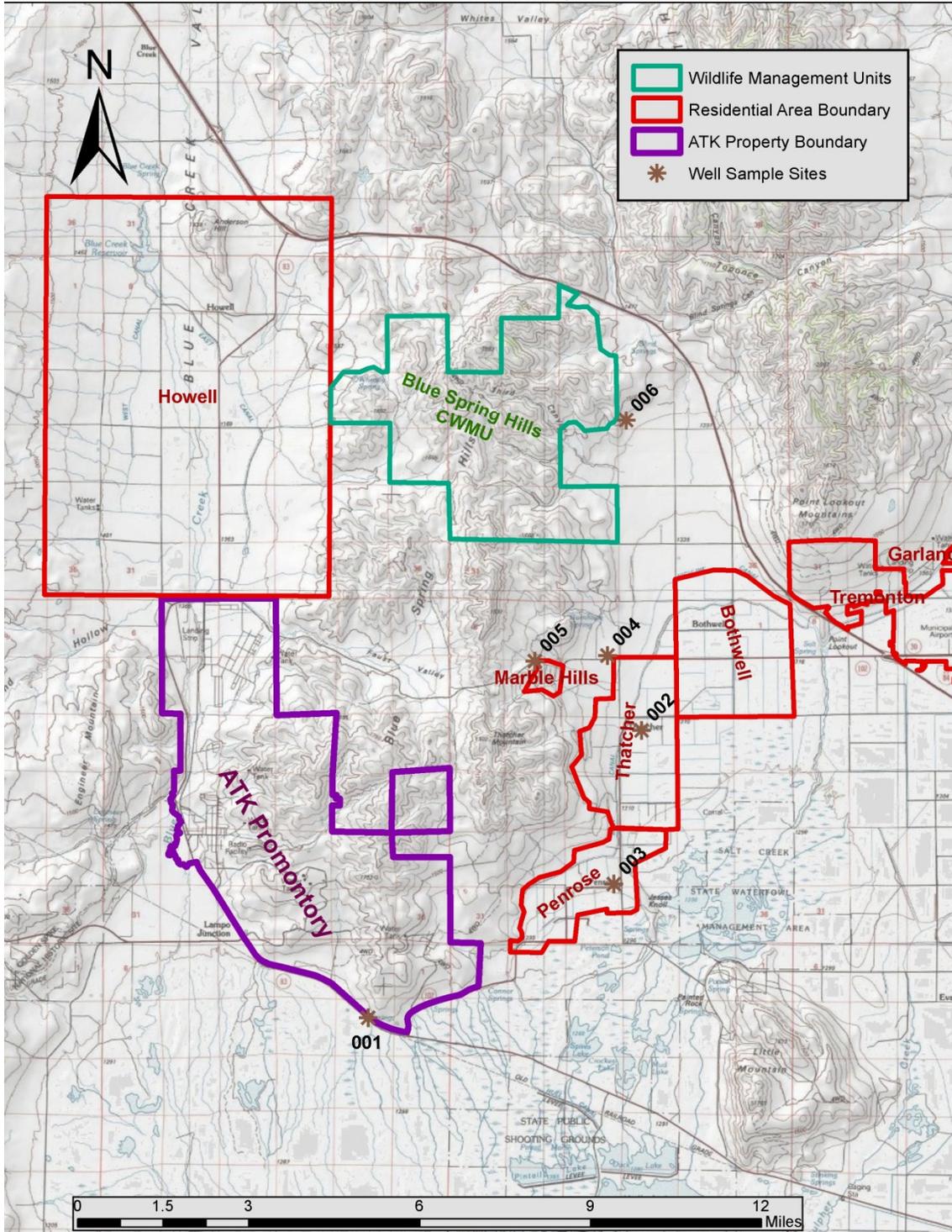
**Map 1.** Map of the ATK Promontory facility and surrounding communities in eastern Box Elder County, Utah (test site starred).



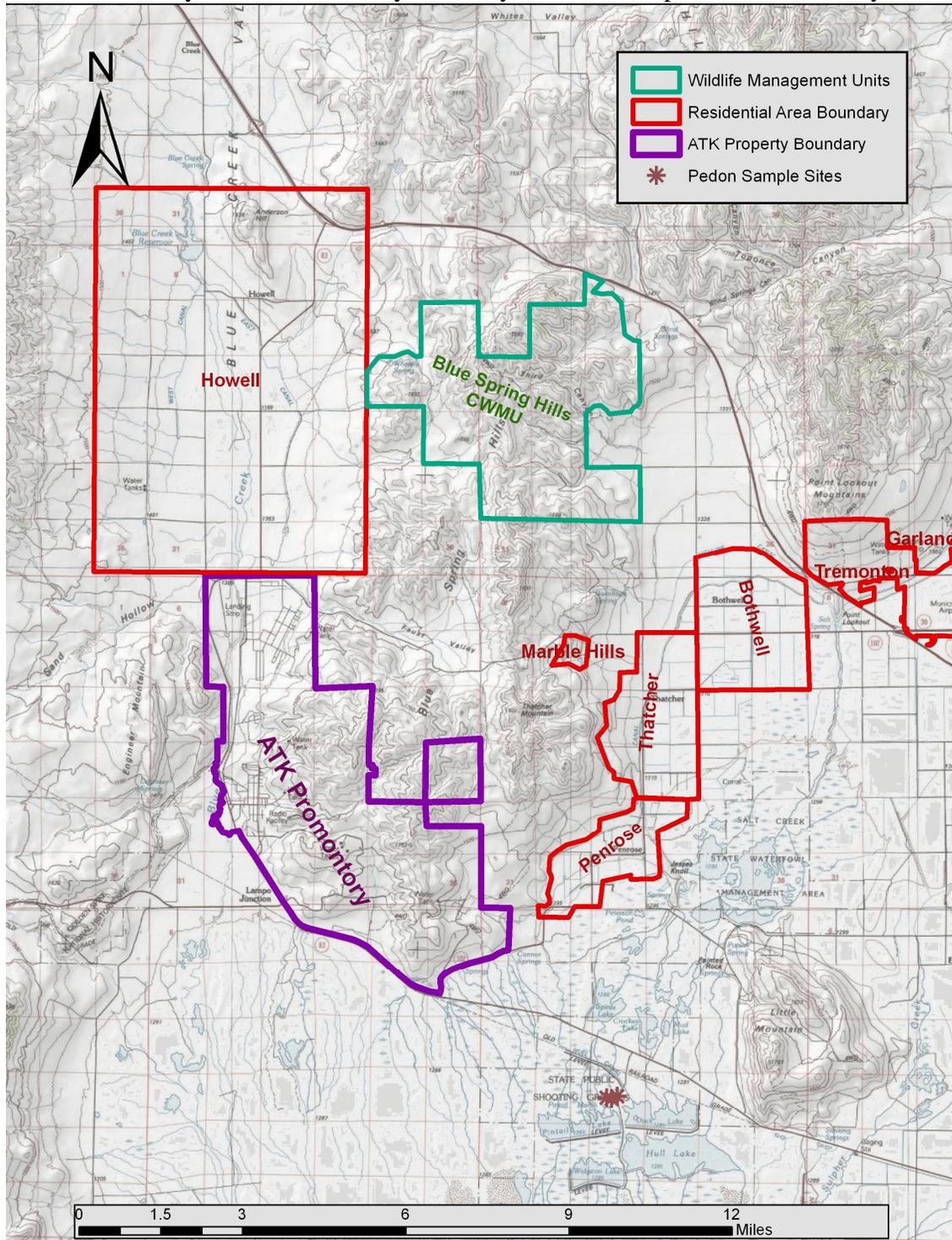
**Map 2.** Map of north of the ATK Promontory site showing the location of the Cooperative Wildlife Management Units (CWMU) in Box Elder County, Utah (test site starred).



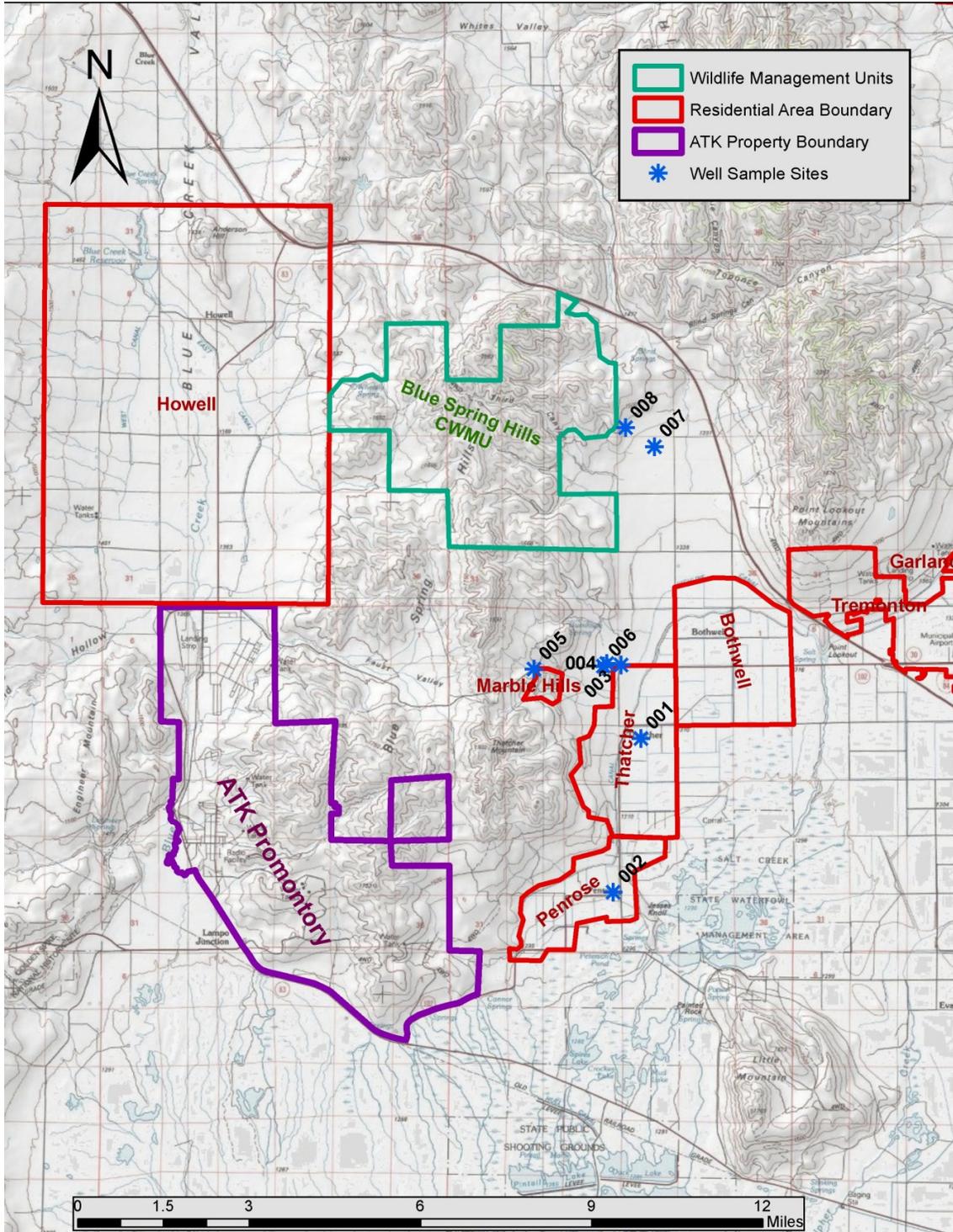
**Map 3.** Map of the location of soil samples collected by UDEQ during November 8-17, 2010 in the west side of Bear River Valley, Box Elder County, Utah.



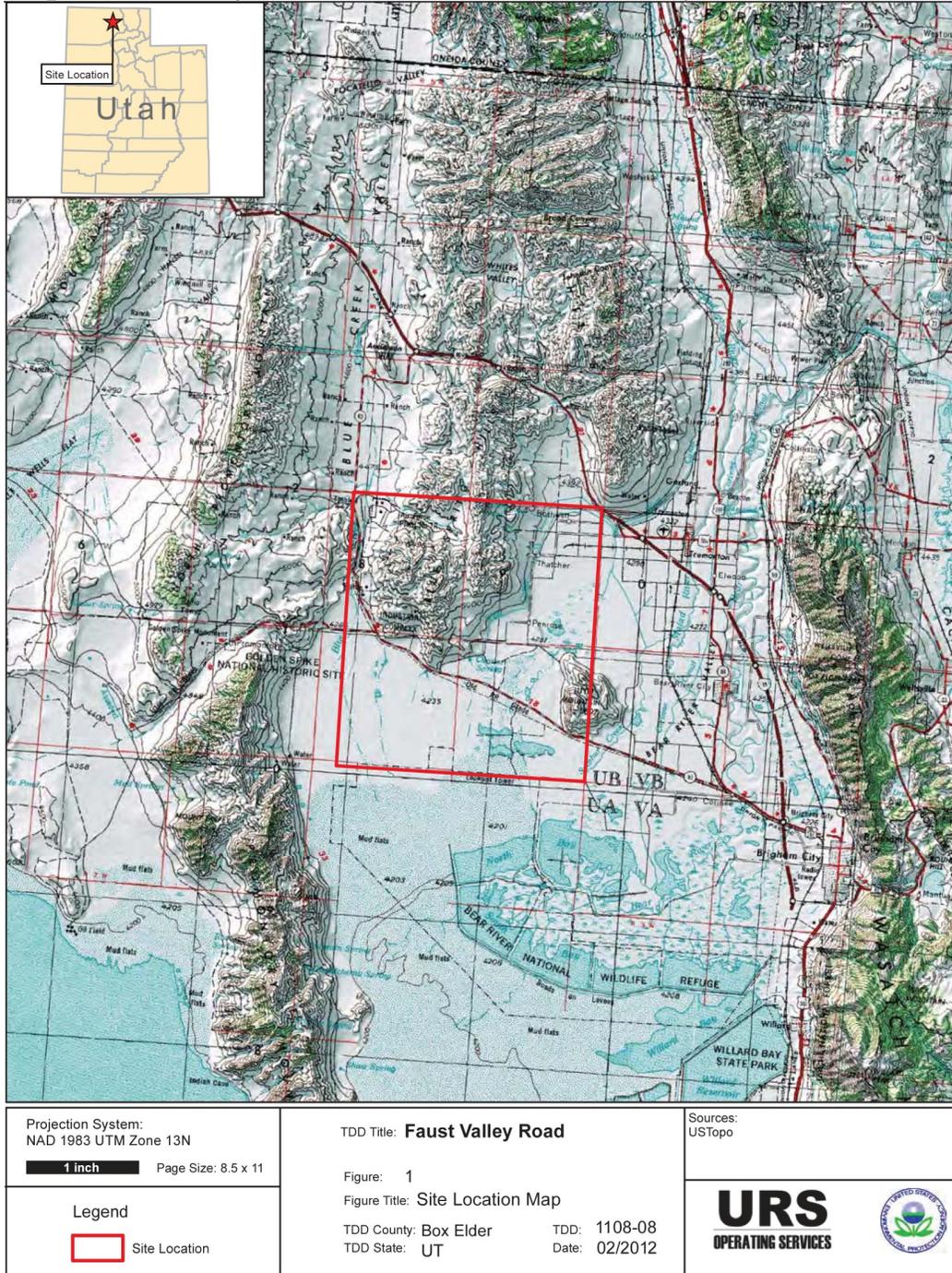
**Map 4.** Map of the location of pedon soil samples collected at the Public Shooting Grounds, Bear River Valley, Box Elder County, Utah, by National Cooperative Soil Survey in June 2000.



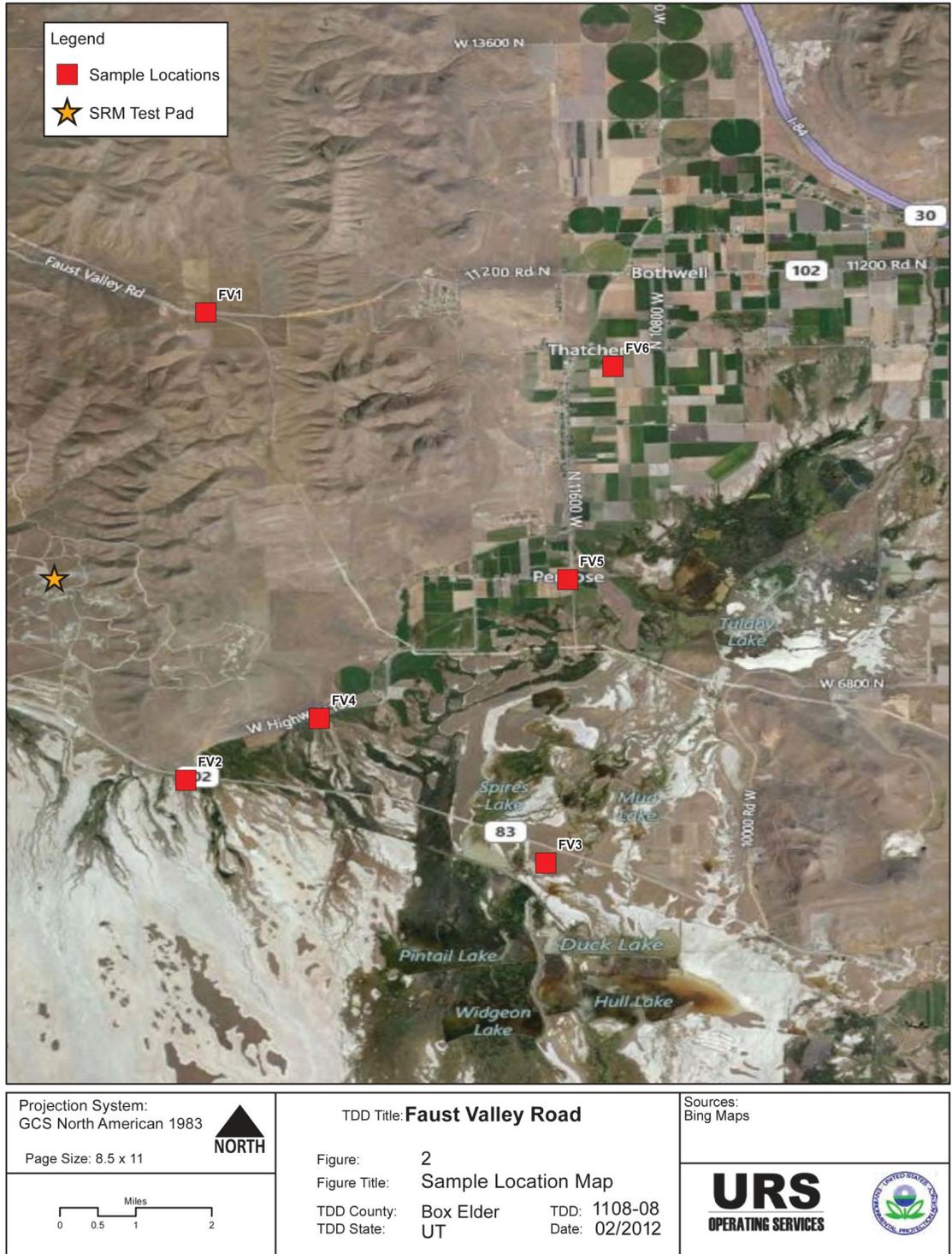
**Map 5.** Map of the location of well water samples collected by UDEQ during November 8-17, 2010 in the west side of Bear River Valley, Box Elder County, Utah.



**Map 6.** Faust Valley Road site location, Box Elder County, Utah.



**Map 7.** DM-3, 2011 air sampling locations. Faust Valley Road, sample and SRM locations, Box Elder County, Utah.



## **APPENDIX B: DATA TABLES**

**Table 1.** Analytical results of soil samples taken from sites along Faust Valley Road (see Map 3) in Box Elder County, Utah between November 8, 2010 and November 17, 2010. All values are given in milligrams of analyte per kilogram soil (mg/kg).

Analyte	CV	Sample 001		Sample 002		Sample 003		Sample 004		Sample 005		Sample 006	
Aluminum	50,000	7,060	v	17,300	v	8,830	v	14,200	v	7,550	v	13,000	v
Antimony	20.0	~ 2.2	v	~ 1.8	v	~ 2.0	v	~ 1.7	v	~ 1.7	v	~ 1.8	v
Arsenic	20.0	< 2.2	v	2.6	v	2.9	v	5.4	v	2.0	v	< 1.8	v
Barium	10,000	142	v	167	v	116	v	139	v	88.3	v	141	v
Beryllium	100.0	< 1.1	v	< 0.9	v	< 1.0	v	< 0.8	v	< 0.8	v	< 0.9	v
Boron	10,000	< 12	v	< 6.9	v	< 7.7	v	< 6.2	v	< 6.3	v	< 6.6	v
Cadmium	5.0	< 1.1	v	~ 1.4	v	< 1.0	v	< 0.8	v	< 0.8	v	~ 1.2	v
Calcium		40,300		9,580		47,600		5,370		4,750		8,160	
Chloride		288		427		442		430		416		435	
Chromium	50.0	10.4	v	21.6	v	11.9	v	17.4	v	11.9	v	17.2	v

< Analyte was undetected. The value reported is the detection limit based on the sample processing.

~ Reported value is estimated value.

R Rejected value because of laboratory quality control concerns.

v Reported value is below the comparison value.

^ Reported value is above the comparison value.

CV Comparison Value

**Table 1 (Continued).** Analytical results of soil samples taken from sites along Faust Valley Road (see Map 3) in Box Elder County, Utah between November 8, 2010 and November 17, 2010. All values are given in milligrams of analyte per kilogram soil (mg/kg).

Analyte	CV	Sample 001		Sample 002		Sample 003		Sample 004		Sample 005		Sample 006	
Cobalt	500	2.7	v	7.7	v	3.4	v	6.4	v	3.5	v	5.6	v
Copper	500	23.9	v	27.6	v	16.3	v	23.0	v	14.7	v	28.3	v
Fluoride	3100a	< 5.0		12.2		6.4		6.6		< 5.0		14.6	
Iron	55,000 <sup>a</sup>	6,770		18,000		8,020		13,100		6,880		12,460	
Lead	400.0	21.3	v	14.6	v	10.4	v	13.6	v	24.0	v	25.6	v
Magnesium		11,000		9,670		15,000		6,050		2,790		5,790	
Manganese	1,800 <sup>a</sup>	545		628		354		504		319		505	
Mercury	230 <sup>a</sup>	R 0.5		R 0.5		R 0.2		R 0.2		R 0.2		R 0.2	
Molybdenum	300.0	1.6	v	< 0.9	v	< 1.0	v	< 0.8	v	< 0.8	v	< 0.9	v

< Analyte was undetected. The value reported is the detection limit based on the sample processing.

~ Reported value is estimated value.

R Rejected value because of laboratory quality control concerns.

v Reported value is below the comparison value.

^ Reported value is above the comparison value.

a EPA=s Risk Based Screen Levels (RBSL) for Residential Soil

b EPA=s Superfund Chemical Data Matrix (SCDM) for non-cancer risk

CV Comparison Value

**Table 1 (Continued).** Analytical results of soil samples taken from sites along Faust Valley Road (see Map 3) in Box Elder County, Utah between November 8, 2010 and November 17, 2010. All values are given in milligrams of analyte per kilogram soil (mg/kg).

Analyte	CV	Sample 001		Sample 002		Sample 003		Sample 004		Sample 005		Sample 006	
Nickel	1,000	7.2	v	20.2	v	7.9	v	15.4	v	6.8	v	13.0	v
Nitrate	80,000	< 10.0	v	< 10.0	v	21.3	v	< 10.0	v	< 10.0	v	< 10.0	v
Nitrite	5,000	< 10.0	v										
Perchlorate	40.0	< 40.0	v										
Phosphate		494		572		671		554		201		525	
Potassium		~3,760		~8,550		~4,780		~5,400		~2,930		~5,100	
Selenium	300.0	< 2.2	v	< 1.8	v	3.0	v	< 1.7	v	< 1.7	v	< 1.8	v
Silver	300.0	< 2.2	v	< 1.8	v	< 2.0	v	< 1.7	v	< 1.7	v	< 1.8	v
Sodium		270		290		230		140		95		165	

< Analyte was undetected. The value reported is the detection limit based on the sample processing.

~ Reported value is estimated value.

R Rejected value because of laboratory quality control concerns.

v Reported value is below the comparison value.

^ Reported value is above the comparison value.

CV Comparison Value

**Table 1 (Continued).** Analytical results of soil samples taken from sites along Faust Valley Road (see Map 3) in Box Elder County, Utah between November 8, 2010 and November 17, 2010. All values are given in milligrams of analyte per kilogram soil (mg/kg).

Analyte	CV	Sample 001		Sample 002		Sample 003		Sample 004		Sample 005		Sample 006	
Sulfate		9,050		<2,000		<2,000		<2,000		<2,000		<2,000	
Sulfide		~ 10.0		35.4		~ 12.1		~ 50.7		< 10.0		~ 37.5	
Thallium	4.0	< 2.2	v	< 1.8	v	< 2.0	v	< 1.7	v	< 1.7	v	< 1.8	v
Vanadium	200.0	10.0	v	24.2	v	12.6	v	20.1	v	11.9	v	18.7	v
Zinc	20,000	93.7	v	91.2	v	51.1	v	58.1	v	41.0	v	84.4	v

< Analyte was undetected. The value reported is the detection limit based on the sample processing.

~ Reported value is estimated value.

R Rejected value because of laboratory quality control concerns.

v Reported value is below the comparison value.

CV Comparison Value

**Table 2.** Pedon soil survey data by the National Cooperative Soil Survey for the Public Shooting Grounds, eastern part Box Elder County, Utah pedon (02UT003003) sampled June 2000 (NCSS 2011) and background samples taken at the T-97 test stand site on ATK Promontory property (Map 4). All values are given in milligrams of analyte per kilogram soil (mg/kg).

Analyte	NCSS Pedon	ATK T-97 Test Stand			
		(1/2)	Center EP	North (1/3 Past)	South Fringe
Aluminum (Al)		13,600	22,400	23,300	19,300
Antimony (Sb)	0.04	< 2	< 2	< 2	< 2
Arsenic (As)	4.57	< 2	< 2	< 2	< 2
Barium (Ba)	212.64	104	62.4	70.9	68.1
Beryllium (Be)	0.96	0.703	0.381	0.373	0.460
Boron (B)		5	11	12	6
Cadmium (Cd)	0.26	< 0.1	< 0.1	< 0.1	< 0.1
Calcium (Ca)		77,100	111,000	121,000	92,100
Chromium (Cr)	25.97	11.9	11.6	12.2	10.2
Cobalt (Co)	4.83	3.49	1.59	1.34	1.86
Copper (Cu)	11.46	8.87	2.95	3.1	5.14
Iron (Fe)		8,900	5,160	4,310	5,150
Lead (Pb)	15.64	< 2	< 2	< 2	< 2

**Table 2 (Continued).** Pedon soil survey data by the National Cooperative Soil Survey for the Public Shooting Grounds, eastern part Box Elder County, Utah pedon (02UT003003) sampled June 2000 (NCSS 2011) and background samples taken at the T-97 test stand site on ATK Promontory property (Map 4). All values are given in milligrams of analyte per kilogram soil (mg/kg).

Analyte	NCSS Pedon	ATK T-97 Test Stand			
		(1/2)	Center EP	North (1/3 Past)	South Fringe
Magnesium (Mg)		7,280	5,320	6,110	5,570
Manganese (Mn)	335.93	225	114	88.3	151
Mercury (Hg)	--				
Molybdenum (Mo)	0.31	< 0.1	< 0.1	< 0.1	< 0.1
Nickel (Ni)	12.34	9.84	7.07	6.52	6.36
Phosphorus (P)	586.28	542	521	510	501
Potassium (K)		4,020	1,920	1,730	2,430
Selenium (Se)	365.78	< 3	< 3	< 3	< 3
Silver (Au)	0.05	< 0.1	< 0.1	< 0.1	< 0.1
Strontium (Sr)	637.73	201	298	355	250
Thallium (Tl)		< 1	< 1	< 1	< 1
Tin (Sn)	1.02	< 3	< 3	< 3	< 3

**Table 2 (Continued).** Pedon soil survey data by the National Cooperative Soil Survey for the Public Shooting Grounds, eastern part Box Elder County, Utah pedon (02UT003003) sampled June 2000 (NCSS 2011) and background samples taken at the T-97 test stand site on ATK Promontory property (Map 4). All values are given in milligrams of analyte per kilogram soil (mg/kg).

Analyte	NCSS Pedon	ATK T-97 Test Stand			
		(1/2)	Center EP	North (1/3 Past)	South Fringe
Titanium (Ti)		347	228	179	245
Tungsten (W)	0.02				
Vanadium (V)	32.77	27.6	21.1	19.9	18.9
Zinc (Zn)	43.70	29.2	16.7	16.6	17.2

**Table 3.** Analytical results of well water samples taken from sites along Faust Valley Road (see Map 5) in Box Elder County, Utah between November 8, 2010 and November 17, 2010. All values are given in micrograms of analyte per liter water ( $\mu\text{g/L}$ ).

Analyte	CV/MCL	Sample 001		Sample 002		Sample 003		Sample 004		Sample 005		Sample 006		Sample 007		Sample 008	
Aluminum	10,000/-	< 20	v														
Antimony	4/6	< 6.0	v														
Arsenic	3/10	< 2.0	v	~ 9.6	v	< 2.0	v	< 2.0	v	< 2.0	v	~ 3.4	v	< 2.0	v	< 2.0	v
Barium	2,000/2,000	< 100	v														
Beryllium	20/4	< 2.0	v														
Boron	2,000/-	~ 342	v	~286	v	~ 115	v	~142	v	~ 80.7	v	~ 152	v	69.3	v	69.4	v
Cadmium	1/5	< 0.2	v														
Calcium		~116,000		~78,900		~76,800		~66,100		~44,700		~42,000		~87,000		~73,300	
Chloride		147,000		325,000		417,000		257,000		68,900		190,000		286,000		242,000	
Chromium	100/100	< 4.0	v														

< Analyte was undetected. The value reported is the method detection limit based on the sample processing.

~ Reported value is estimated value.

R Rejected value because of laboratory quality control concerns.

v Reported value is below the comparison value.

^ Reported value is above the comparison value.

CV Comparison Value

MCL EPA's Maximum Contaminant Level

**Table 3 (Continued).** Analytical results of well water samples taken from sites along Faust Valley Road (see Map 5) in Box Elder County, Utah between November 8, 2010 and November 17, 2010. All values are given in micrograms of analyte per liter water ( $\mu\text{g/L}$ ).

Analyte	CV/MCL	Sample 001		Sample 002		Sample 003		Sample 004		Sample 005		Sample 006		Sample 007		Sample 008	
Cobalt	100/-	< 60.0	v														
Copper	100/1,300	~ 19.5	v	~ 21.4	v	~ 3.3	v	< 2.0	v	~ 3.2	v	< 2.0	v	9.5	v	5.7	v
Fluoride		244		458		378		561		315		543		228		237	
Iron		~ 122		< 20		< 20		~213		< 20		~ 93.3		21.6		274	
Lead	15/15	~ 1.7	v	~ 1.0	v	~ 0.7	v	~0.9	v	~ 1.3	v	~ 1.1	v	~ 1.2	v	~ 1.7	v
Magnesium		~66,900		~46,400		~42,500		~45,500		~17,400		~36,600		~41,900		~32,800	
Manganese	300/-	~ 11.1	v	~ 10.7	v	~ 12.9	v	< 10.0	v								
Mercury	2/2	R 0.2	v														
Molybdenum	50/-	< 2.0	v	~ 4.4	v	< 2.0	v	~ 4.8	v	~ 4.7	v	< 2.0	v	< 2.0	v	< 2.0	v

< Analyte was undetected. The value reported is the method detection limit based on the sample processing.

~ Reported value is estimated value.

R Rejected value because of laboratory quality control concerns.

v Reported value is below the comparison value.

^ Reported value is above the comparison value.

CV Comparison Value

MCL EPA's Maximum Contaminant Level

**Table 3 (Continued).** Analytical results of well water samples taken from sites along Faust Valley Road (see Map 5) in Box Elder County, Utah between November 8, 2010 and November 17, 2010. All values are given in micrograms of analyte per liter water ( $\mu\text{g/L}$ ).

Analyte	CV/MCL	Sample 001		Sample 002		Sample 003		Sample 004		Sample 005		Sample 006		Sample 007		Sample 008	
Nickel	100/-	< 10.0	v														
Nitrate	10,000/10,000	9,030	v	1,930	v	1,550	v	2,820	v	2,260	v	3,280	v	2,000	v	1,350	v
Nitrite	1,000/1,000	< 100	v														
Perchlorate	7/-	< 4.0	v														
Phosphate		52		50		< 20		< 20		< 20		< 20		< 20		< 20	
Potassium		~7,750		~16,700		~6,650		~10,500		~2,650		~14,400		~4,470		~3,410	
Selenium	50/50	~ 4.4	v	< 2.0	v	< 2.0	v	~ 2.8	v	< 2.0	v	< 2.0	v	< 2.0	v	~ 2.2	v
Silver	50/-	< 1.0	v														
Sodium		~188,000		~289,000		~228,000		~129,000		~63,700		~117,000		~137,000		~123,000	

< Analyte was undetected. The value reported is the method detection limit based on the sample processing.

~ Reported value is estimated value.

R Rejected value because of laboratory quality control concerns.

v Reported value is below the comparison value.

^ Reported value is above the comparison value.

CV Comparison Value

MCL EPA's Maximum Contaminant Level

**Table 3 (Continued).** Analytical results of well water samples taken from sites along Faust Valley Road (see Map 5) in Box Elder County, Utah between November 8, 2010 and November 17, 2010. All values are given in micrograms of analyte per liter water ( $\mu\text{g/L}$ ).

Analyte	CV/MCL	Sample 001	Sample 002	Sample 003	Sample 004	Sample 005	Sample 006	Sample 007	Sample 008
Sulfate		466,000	166,000	71,000	89,600	31,900	52,700	58,900	39,200
Sulfide		< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100
Thallium	2/2	< 0.2 v							
Vanadium	100/-	< 60 v							
Zinc	3,000/-	~ 78.7 v	~ 35.0 v	~ 20.2 v	~ 839 v	~ 44.5 v	< 20.0 v	< 20.0 v	< 20.0 v

< Analyte was undetected. The value reported is the method detection limit based on the sample processing.

~ Reported value is estimated value.

R Rejected value because of laboratory quality control concerns.

v Reported value is below the comparison value.

^ Reported value is above the comparison value.

CV Comparison Value

MCL EPA's Maximum Contaminant Level

**Table 4.** Analytical results for EPA SW-846 Method 8270 semivolatile organic compounds in test-fire soil in milligrams per kilogram (mg/kg).

Analyte	CAS No	Superfund Chemical Data Matrix (January 28, 2004)		EPA RSL		CV	Sample ID
		RDSC	CRSC	Residential Soil	Industrial Soil		
Pyridine	110-86-1	-	-	78	1,000	50	0.070 U
Phenol	108-95-2	-	-	18,000	180,000	2,000	0.062 U
Bis(2-chloroethyl)ether	111-44-4	-	-	0.21	1	2,000	0.063 U
2-Chlorophenol	95-57-8	-	-	390	5,100	300	0.064 U
1,3-Dichlorobenzene	541-73-1	-	-	-	-	1,000	0.061 U
1,4-Dichlorobenzene	106-46-7	-	-	2.4	12	4,000	0.060 U
Benzyl alcohol	100-51-6	-	-	6,100	62,000	6,100	0.110 U
1,2-Dichlorobenzene	95-50-1	-	-	1,900	9,800	5,000	0.064 U
2-Methylphenol	95-48-7	-	-	3,100	31,000	3,100	0.067 U
Bis(2-Chloroisopropyl)ether	108-60-1	-	-	4.6	22	4.6	0.067 U
4-Methylphenol	106-44-5	390	-	310	3,100	310	0.074 U
N-Nitrosodi-n-propylamine	621-64-7	-	-	0.069	0.25	0.1	0.073 U
Hexachloroethane	67-72-1	-	-	12	43	12	0.067 U
Nitrobenzene	98-95-3	-	-	4.8	24	4.8	0.060 U
Isophorone	78-59-1	-	-	510	1,800	510	0.062 U
2-Nitrophenol	88-75-5	-	-	-	-	-	0.060 U
2,4-Dimethylphenol	105-67-9	1600	-	1,200	12,000	1,200	0.062 U
Benzoic acid	65-85-0	-	-	240,000	2,400,000	200,000	0.390 U

**Table 4 (Continued).** Analytical results for EPA SW-846 Method 8270 semivolatile organic compounds in test-fire soil in milligrams per kilogram (mg/kg).

Analyte	CAS No	Superfund Chemical Data Matrix (January 28, 2004)		EPA RSL		CV	Sample ID FV9OP
		RDSC	CRSC	Residential Soil	Industrial Soil		
Bis(2-Chloroethoxy)methane	111-91-1	-	-	180	1,800	180	0.064 U
2,4-Dichlorophenol	120-83-2	230	-	180	1,800	200	0.064 U
1,2,4-Trichlorobenzene	120-82-1	-	-	22	99	500	0.061 U
Naphthalene	91-20-3	3100	-	3.6	18	1,000	0.060 U
4-Chloroaniline	106-47-8	-	-	2.4	8.6	200	0.088 U
Hexachloro-1,3-butadiene	87-68-3	16	8.2	6.2	22	9	0.077 U
4-Chloro-3-methylphenol	59-50-7	-	-	6,100	62,000	6,100	0.067 U
2-Methylnaphthalene	91-57-6	-	-	310	4,100	200	0.071 U
Hexachlorocyclopentadiene	77-47-4	-	-	370	3,700	300	0.160 U
2,4,6-Trichlorophenol	88-06-2	--	58	44	160	60	0.060 U
2,4,5-Trichlorophenol	95-95-4	-	-	6,100	62,000	5,000	0.070 U
2-Chloronaphthalene	91-58-7	-	-	6,300	82,000	4,000	0.072 U
2-Nitroaniline	88-74-4	-	-	610	6,000	610	0.065 U
Dimethyl phthalate	131-11-3	-	-	-	-	-	0.061 U
2,6-Dinitrotoluene	606-20-2	-	-	61	620	200	0.068 U
Acenaphthylene	208-96-8	-	-	-	-	-	0.062 U
3-Nitroaniline	99-09-2	-	-	-	-	-	0.096 U
Acenaphthene	83-32-9	4700	-	3,400	33,000	3,000	0.068 U

**Table 4 (Continued).** Analytical results for EPA SW-846 Method 8270 semivolatile organic compounds in test-fire soil in milligrams per kilogram (mg/kg).

Analyte	CAS No	Superfund Chemical Data Matrix (January 28, 2004)		EPA RSL		CV	Sample ID FV9OP
		RDSC	CRSC	Residential	Industrial		
				Soil	Soil		
2,4-Dinitrophenol	51-28-5	-	-	120	1,200	100	0.280 U
4-Nitrophenol	100-02-7	-	-	-	-	-	0.250 U
Dibenzofuran	132-64-9	310	-	78	1,000	78	0.062 U
2,4-Dinitrotoluene	121-14-2	-	-	1.6	5.5	100	0.065 U
Diethyl phthalate	84-66-2	63000	-	49,000	490,000	49,000	0.060 U
4-Chlorophenyl phenyl ether	7005-72-3	-	-	-	-	-	0.060 U
Fluorene	86-73-7	-	-	2,300	24,000	2,000	0.060 U
4-Nitroaniline	100-01-6	-	-	24	86	24	0.110 U
4,6-Dinitro-2-methylphenol	534-52-1	-	-	4.9	49	4.9	0.390 U
N-Nitrosodiphenylamine	86-30-6	-	130	99	350	100	0.064 U
4-Bromophenyl phenyl ether	101-55-3	-	-	-	-	-	0.077 U
Hexachlorobenzene	118-74-1	63	0.4	0.3	1.1	0.4	0.060 U
Pentachlorophenol	87-86-5	2300	5.3	0.89	2.7	2	0.370 U
Phenanthrene	85-01-8	-	-	-	-	-	0.073 U
Anthracene	120-12-7	23000	-	170,000	1,700,000	20,000	0.082 U
Carbazole	86-74-8	-	32	-	-	32	0.070 U
Di-n-butylphthalate	84-74-2	7800	-	6,100	62,000	5,000	0.080 U
Fluoranthene	206-44-0	3100	-	2,300	22,000	2,000	0.060 U

**Table 4 (Continued).** Analytical results for EPA SW-846 Method 8270 semivolatile organic compounds in test-fire soil in milligrams per kilogram (mg/kg).

Analyte	CAS No	Superfund Chemical Data Matrix (January 28, 2004)		EPA RSL		CV	Sample ID
		RDSC	CRSC	Residential Soil	Industrial Soil		
Pyrene	129-00-0	2300	-	1,700	17,000	2,000	0.066 U
Butylbenzylphthalate	85-68-7	16000	-	260	910	10,000	0.069 U
3,3'-Dichlorobenzidine	91-94-1	-	-	1.1	3.8	2	0.011 U
Benzo(a)anthracene	56-55-3	-	0.88	0.15	2.1	0.15	0.065 U
Chrysene	218-01-9	-	88	15	210	15	0.063 U
Bis(2-ethylhexyl)phthalate	117-81-7	1600	46	35	120	35	0.074 J
Di-n-octylphthalate	117-84-0	1600	-	-	-	1600	0.082 U
Benzo(b)fluoranthene	205-99-2	-	-	0.15	2.1	0.15	0.063 U
Benzo(k)fluoranthene	207-08-9	-	8.8	1.5	21	1.5	0.061 U
Benzo(a)pyrene	50-32-8	-	0.088	0.015	0.21	0.1	0.068 U
Indeno(1,2,3-cd)pyrene	193-39-5	-	0.88	0.15	2.1	0.15	0.067 U
Dibenz(a,h)anthracene	53-70-3	-	0.088	0.015	0.21	0.1	0.080 U
Benzo(g,h,i)perylene	191-24-2	-	-	-	-	-	0.076 U

RSL Regional Screening Level  
 J Analyte was detected above the Method Detection Limit, but not above the Reporting Limit (RL)  
 U Analyte not detected above the MDL, listed as the associated numerical value  
 - No benchmark exists for the analyte  
 RDSC Reference Dose Screening Concentration  
 CRSC Cancer Risk Screening Concentration  
 CV Comparison Value

**Table 5.** Analytical results for EPA SW-846 Method 6010C metals in test-fire soil in milligrams per kilogram (mg/kg).

Analyte	CAS No	RDSC	CRSC	EPA Residential RSL	EPA Industrial RSL	CV	FV9OP
Antimony	7440-36-0	31	-	31	410	20	0.706 J
Barium	7440-39-3	5500	-	15,000	190,000	10,000	85.7
Beryllium	7440-41-7	160	-	160	2,000	100	0.440 J
Boron	7440-42-8	-	-	16,000	200,000	10,000	44.7
Cadmium	7440-43-9	39	-	70	800	5	0.140 U
Chromium	7440-47-3	230	-	-	-	-	26.2
Cobalt	7440-48-4	-	-	23	300	500	2.97
Copper	7440-50-8	-	-	3,100	41,000	500	8.08
Iron	7439-89-6	-	-	55,000	720,000	55,000	8,350
Magnesium	7439-95-4	-	-	-	-	-	6,110
Manganese	7439-96-5	11000	-	-	-	3,000	136
Molybdenum	7439-98-7	-	-	390	5,100	300	0.743 J
Nickel	7440-02-0	1600	-	1,500	20,000	1,000	13.4
Phosphorus	7723-14-0	-	-	1.6	20	<b>10</b>	<b>1,180</b>
Potassium	7440-009-7	-	-	-	-	-	3,760
Selenium	7782-49-2	390	-	390	5,100	300	2.39
Silver	7440-22-4	390	-	390	5,100	300	0.290 U
Sodium	7440-23-5	-	-	-	-	-	355

- RSL Regional Screening Level
- BOLD** Analytical result exceeds one or more benchmarks
- J Analyte was detected above the Method Detection Limit, but not above the Reporting Limit (RL)
- U Analyte not detected above the MDL, listed as the associated numerical value
- No benchmark exists for the analyte
- RDSC Reference Dose Screening Concentration
- CRSC Cancer Risk Screening Concentration
- CV Comparison Value

**Table 5 (Continued).** Analytical results for EPA SW-846 Method 6010C metals in test-fire soil in milligrams per kilogram (mg/kg).

Analyte	CAS No	RDSC	CRSC	EPA Residential RSL	EPA Industrial RSL	CV	FV9OP
Strontium	7440-24-6	47000	-	47,000	610,000	30,000	348
Thallium	7440-28-0	0	-	0.78	10	0.78	0.290 U
Tin	7440-31-5	-	-	47,000	610,000	20,000	1.51 J
Titanium	7440-32-6	-	-	-	-	-	392
Vanadium	7440-62-2	-	-	-	-	500	24.2
Zinc	7440-66-6	23000	-	23,000	310,000	20,000	148
Aluminum	7429-90-5	-	-	77,000	990,000	50,000	47,500
Arsenic	7440-38-2	23	0.43	0.39	1.6	20	6.84
Calcium	7440-70-2	-	-	-	-	-	171,000
Lead	7439-92-1	-	-	400	800	400	5.73
Lithium	7439-93-2	-	-	160	2,000	160	9.74

RSL Regional Screening Level

**BOLD** Analytical result exceeds one or more benchmarks

J Analyte was detected above the Method Detection Limit, but not above the Reporting Limit (RL)

U Analyte not detected above the MDL, listed as the associated numerical value

- No benchmark exists for the analyte

RDSC Reference Dose Screening Concentration

CRSC Cancer Risk Screening Concentration

CV Comparison Value

**Table 6.** Analytical results for EPA Method 6850 perchlorate in test-fire soil in milligrams per kilogram (mg/kg).

Analyte	CAS No	Superfund Chemical Data Matrix (January 28, 2004)		EPA RSL		CV	Sample ID
		RDSC	CRSC	Residential Soil	Industrial Soil		
Perchlorate	14797-73-0	-	-	55	720	40	0.0062 U

RSL Regional Screening Level  
 U Analyte not detected above the MDL, listed as the associated numerical value  
 - No benchmark exists for the analyte  
 RDSC Reference Dose Screening Concentration  
 CRSC Cancer Risk Screening Concentration  
 CV Comparison Value

**Table 7.** Analytical results for EPA Method 300.0 inorganic anions in test-fire soil in milligrams per kilogram (mg/kg).

Analyte	CAS No	Superfund Chemical Data Matrix (January 28, 2004)		EPA		CV	Sample ID
		RDSC	CRSC	Residential Soil	Industrial Soil		FV9OP
Nitrite Ion	14797-65-0	-	-	7,800	100,000	5,000	100 U
Nitrite-N	NA	-	-	-	-	-	31 U
Bromide	24959-67-9	-	-	-	-	-	10 U
Phosphate Ion	14265-44-2	-	-	-	-	-	100 U
Phosphate-P	NA	-	-	-	-	-	33 U
Fluoride	16984-48-8	-	-	3,100	41,000	3,100	29
Nitrate Ion	14797-55-8	-	-	130,000	1,600,000	80,00	49
Nitrate-N	NA	-	-	-	-	-	11
Sulfate	14808-79-8	-	-	-	-	-	330
Chloride	16887-00-6	-	-	-	-	-	45,000

RSL Regional Screening Level

U Analyte not detected above the MDL, listed as the associated numerical value

- No benchmark exists for the analyte

RDSC Reference Dose Screening Concentration

CRSC Cancer Risk Screening Concentration

CV Comparison Value

**Table 8.** Analytical results for EPA SW-846 Method 9045 pH in test-fire soil.

Analyte	CAS No	FV90P
pH	-	9.77

## **APPENDIX C: EXPOSURE DOSE EQUATIONS**

**EXPOSURE DOSE EQUATIONS**

The exposure dose (D) from ingestion of water is estimated using the following formula:

$$D = (C \times IR \times EF) / BW$$

Where:

D	= exposure dose mg/kg/day
C	= contaminant concentration mg/L
IR	= intake rate of contaminated water L/day
for children, IR	= 1 L/day
for adults, IR	= 2 L/day
EF	= an exposure factor
BW	= body weight kg
for children, BW	= 16 kg
for adults, BW	= 70 kg

The use of an exposure factor gives the dose averaged during the period of exposure. The exposure factor (EF) is calculated as:

$$EF = (F \times ED) / AT$$

Where:

EF	= exposure factor
F	= frequency of exposure days/year
F	= 365 days/year
ED	= exposure duration years
for children, ED	= 5 years (the exposure for young children 1-5)
for adults, ED	= 70 years (the average life time)
AT	= averaging time days and is calculated as (ED x 365 days/year)

## **APPENDIX D: ACRONYMS AND TERM DEFINITIONS**

**ACRONYMS AND TERM DEFINITIONS**

ACGIH	<b>American Conference of Governmental Industrial Hygienists.</b> A professional association organized in 1938, originally as the National Conference of Governmental Industrial Hygienists. The ACGIC is an occupational exposure standards setting organization. See: <a href="http://www.acgih.org">http://www.acgih.org</a> .
AIHA	<b>American Industrial Hygiene Association.</b> A professional association organized in 1939. The AIHA is an occupational exposure standards setting organization. See: <a href="http://www.aiha.org">http://www.aiha.org</a> .
ATSDR	<b>Agency for Toxic Substances and Disease Registry.</b> The ATSDR is a federal health agency with the Centers for Disease Control and Prevention that is responsible for conducting public health assessments of environmental hazards. The ATSDR publishes comprehensive toxicological profiles of hazardous materials developed from peer-reviewed literature. See <a href="http://www.atsdr.cdc.gov/">http://www.atsdr.cdc.gov/</a> .
CDC	<b>Centers for Disease Control and Prevention.</b> The CDC is a federal agency in the Department of Health and Human Services that is responsible for epidemiologic public health functions such as surveillance, investigation, data analysis, and developing programs to control or prevent disease. See <a href="http://www.cdc.gov/">http://www.cdc.gov/</a> .
CV	<b>Comparison value.</b> A CV is the calculated concentration of a chemical or substance in the air, water, food or soil that is unlikely to cause adverse (harmful) health effects in exposed people. The CV is a screening level and has built into its derivation certain margins of uncertainty. The CV is used by risk assessors to decide from laboratory results whether a particular chemical should be considered in the risk assessment process. See: <a href="http://www.atsdr.cdc.gov/hac/PHAManual/appf.html">http://www.atsdr.cdc.gov/hac/PHAManual/appf.html</a> . See EMEG.
EEP	<b>Environmental Epidemiology Program.</b> A program within the Utah Department of Health that has a cooperative agreement with ATSDR to conduct public health exposure and risk assessment activities. See: <a href="http://health.utah.gov/enviroepi/">http://health.utah.gov/enviroepi/</a> .
EHHAT	<b>Environmental Health Hazards Assessment Team.</b> The team within EEP that conducts public health assessments. This team includes a toxicologist, an environmental epidemiologist, and a

risk assessor. Within EEP, there are additional environmental epidemiologists, environmental scientists, and health educators that can assist the EHHAT.

EMEG

**Environmental Media Evaluation Guides.** EMEGs are media-specific comparison values used to select contaminants of interest at hazardous waste sites.

EPA

**The U. S. Environmental Protection Agency.** A federal agency responsible for environmental quality regulation, environmental protection and environmental improvement (clean-up) activities. The EPA is a federal partner to UDEQ. See: <http://www.epa.gov/>.

ERPG

**AIHA emergency response planning guidelines.** The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.

Exposure Dose

A measurement of exposure. At some sites, the existing conditions may result in exposures that differ from those used to derive CV such as the EMEG. In these situations, the health assessor may calculate site-specific exposures more accurately and precisely using exposure dose calculating methods. The exposure dose can then be compared to appropriate published toxicity values such as the MRL, RfC or RfD.

Exposure Pathway

A way in which humans can be exposed to an environmental contaminant. An exposure pathway is a description of the way a chemical moves from a source to where people can come into contact with it. An exposure pathway is investigated by considering five elements:

- [1] A source of contamination
- [2] Transportation of the chemical through an environmental media (air, water, food, or soil) from the source to the population
- [3] A place where people can become exposed
- [4] A route of exposure. Exposure routes are inspiration (breathing in), ingestion (eating or drinking) or transdermal (through the skin).

[5] An exposed population. People who actually were at the place of exposure at or after the transportation of the chemical occurred.

Exposure pathways can be completed, potential or eliminated. A **Completed Exposure Pathway** is one where all five elements are shown to have existed, now exist, or will exist in the future. A **Potential Exposure Pathway** is one where four of the five elements have existed in the past, or exist now, or may exist in the future. An **Eliminated Exposure Pathway** is where one of the elements can be shown to have never existed, does not exist now and will never exist.

FDA	U. S. <b>Food and Drug Administration</b> . A federal agency responsible for food safety and quality regulation. See <a href="http://www.fda.gov/">http://www.fda.gov/</a> .
IDLH	NIOSH <b>immediately dangerous to life or health limits</b> . The IDLH values are used as respirator selection criteria for response workers. See <a href="http://www.cdc.gov/niosh/idlh/">http://www.cdc.gov/niosh/idlh/</a> .
MRL	<b>Minimum Risk Level</b> . An MRL is defined as an estimate of daily human exposure to a chemical that is likely to be without appreciable risk of deleterious non-cancer health effects over a specified duration of exposure. Thus, an MRL provides a measure of the toxicity of a chemical.
NIOSH	The <b>National Institute for Occupational Safety and Health</b> . NIOSH is a part of the CDC that provides leadership to prevent workplace illnesses and injuries. NIOSH is an exposure standards setting agency. See <a href="http://www.cdc.gov/niosh/">http://www.cdc.gov/niosh/</a> .
OSHA	<b>Occupational Safety and Health Administration</b> . OSHA is a federal agency with the U. S. Department of Labor that has responsibility for protection worker safety and health. OSHA is an occupational health standards setting organization and sets exposure standards for occupational exposure to hazardous substances in the workplace.
PEL	OSHA <b>permissible exposure limits</b> . Is a legal and enforceable exposure limit for employees to a chemical or physical agent in the workplace. PELs are usually given as a time-weighted average (TWA), as a short-term exposure limit (STEL), or as a ceiling limit. A TWA is the average exposure over a specified period of

time, usually a normal 8-hour workday. An STEL is an average exposure over a 15-30 minute period of maximum exposure during a single work shift. A ceiling limit is the maximum allowable instantaneous exposure. The ceiling limit cannot legally be exceeded for any period of time.

RACC

**Risk Assessment Coordinating Committee.** The RACC is committee of Utah Department of Health and Utah Department of Environmental Quality representatives. The RACC's purpose is to coordinate risk assessment activities and environmental public health messages between the agencies. The RACC also provides oversight and peer-review for the PHA process.

RBSL

**Risk Based Screen Levels** for tap water.

REL

**NIOSH recommend exposure limits.** REL's are occupational exposure limits that have been recommended by NIOSH to OSHA for adoption as PEL. The REL is a level that NIOSH believes to be protective of worker safety and health over a working lifetime when all appropriate safety practices are in place.

RfC

**Reference Concentration.** An RfC is an EPA inhalation analog to the oral RfD. It is based on the assumption that thresholds exist for certain toxic effects such as cellular necrosis. The calculation of the RfC includes controls for uncertainty factors. RfCs are used as guides and are not used to predict adverse health effects. RfCs do not take into account carcinogenic effects, chemical interactions, or exposure through multiple routes.

RfD

**Reference Dose.** An RfD is an EPA estimate of the daily lifetime dose of a substance that is unlikely to cause harm in humans. The calculation of the RfD includes controls for uncertainty factors. RfDs are used as guides and are not used to predict adverse health effects. RfDs do not take into account carcinogenic effects, chemical interactions, or exposure through multiple routes.

RMEG

**Reference Dose Media Evaluation Guide.** An RMEG is a media-specific comparison value used to select a contaminant of interest at hazardous waste sites. RMEGs are derived from RfDs, developed by the US EPA and are an estimate of human exposure to a substance that is not expected to cause non-cancerous health effects at that level for a specified period of exposure. They are

intended to result in protective decisions for the most sensitive individuals (e.g., children) in the population at risk.

SCDM

**Superfund Chemical Data Matrix** screen concentrations for toxicological response.

UDEQ

**Utah Department of Environmental Quality.** A state agency in Utah responsible for environmental quality regulation and environmental protection activities. UDEQ is the state counterpart to EPA. See <http://www.deq.utah.gov/>.

UDOH

**Utah Department of Health.** A state agency in Utah responsible for public health activities. See: <http://health.utah.gov/>.

**UNITS OF MEASUREMENT**

ppb	Parts per billion. 1 to 1,000,000,000
ppm	Parts per million. 1 to 1,000,000
g	Gram. 0.0353 ounces or 0.00220 pounds
kg	Kilograms. 1,000 grams
mg	Milligrams. 0.001 grams
µg	Micrograms. 0.000,001 grams
ng	Nanograms. 0.000,000,001 grams
m <sup>3</sup>	Cubic meter. 1,000 liters, 35.3 cubic feet, 1.31 cubic yards
L	Liter. 1.06 quarts (U.S.), 0.26 gallons (U.S.)

## **APPENDIX F: SECOR MODELS**

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## ***SECOR***

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### **2 Models Used**

The dispersion models used are the latest versions obtained from the U.S. Environmental Protection Agency (EPA). The models are the recommended models as contained in the *Guideline on Air Quality Models*. The models are obtained by downloading computer files from the EPA SCRAM Bulletin Board System (BBS).

#### **2.1 INPUFF Dispersion Model**

INPUFF is a Gaussian INtegrated PUFF model. The Gaussian puff diffusion equation is used to compute the contribution to the concentration at each receptor from each puff at every time step. In the default mode, INPUFF assumes a homogeneous wind field. Three dispersion algorithms are utilized within INPUFF for dispersion downwind from the source. These include Pasquill's scheme as discussed by Turner (1970) and a dispersion algorithm discussed by Irwin (1983), which is a synthesis of Draxler's (1976) and Cramer's (1976) ideas. The third dispersion scheme is used for long travel times in which the puff growth rate is proportional to the square root of travel time.

As originally used in the 1988 PSD permit, the INPUFF 2 model was used to predict near source concentrations from the SRM plume. The original modeling, performed in 1988, used INPUFF 2 for transport times up to one hour from initial firing of the SRM. This analysis uses a 12 hour transport time for all model runs. This longer transport time allows for analysis of impact under light winds. The modeling results are used for distances out to 30 kilometers. Since an analysis of longer transport distances is also required, the long range transport puff model, called CALPUFF, was used.

The INPUFF model uses short periods of meteorology (i.e., 2 minute averages) in sequence as part of its simulation. This treatment of short term meteorology allows for a temporally varying wind field. Since the INPUFF model does not incorporate the hourly wind direction meander component in its horizontal dispersion coefficients, explicit treatment of dispersion due to meander of wind direction must be handled by input of actual 2 minute average wind directions. Since the INPUFF model is being used in a screening mode, which assumes constant wind direction for the entire hour, hourly dispersion rates will be less than dispersion rates used in a continuous source model. Furthermore, use of worst case meteorological conditions for more than two hours produce conservative results.

#### **2.2 CALPUFF Dispersion Model**

The CALPUFF model is being used to predict concentrations from the SRM plume for transport distances from 30 kilometers to 200 kilometers. The CALPUFF model uses a full year of hourly averaged meteorological conditions measured on-site at the Thiokol facility.

CALPUFF is a multi-layer, gridded non-steady-state puff dispersion model that can simulate the effects of temporally and spatially varying meteorological conditions on pollutant transport, remove pollutants through dry and wet deposition processes, and transform pollutant species through

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**SECOR**

chemical reactions. This complexity requires a significant effort in creating the meteorological data file for CALPUFF. An option within CALPUFF is to use an ISCST3 meteorological data file generated with a preprocessor such as PCRAMMET. This greatly simplifies the input at the expense of temporal resolution in the modeling domain. This option was used in this analysis, where the meteorological data from the M-245 meteorological station was used as the primary meteorological inputs into CALPUFF. The M-245 station is located on a hill top near the T-97 test facility, and best represents the prevailing winds that occur near the facility. The hill top location also reduces the affect of local topographic influences and therefore is considered adequate for initializing the wind field used in CALPUFF.

### **2.3 ISCST3 Dispersion Model**

The Industrial Source Complex Short Term Version 3 (ISCST3, dated 00101) dispersion model was used to calculate ambient impacts due to all sources other than the SRM. The ISCST3 model was used as the preferred simple (receptor elevation below stack top), intermediate (receptor elevation between stack top and plume height), and complex (receptor elevation above plume height) terrain model.

The ISCST3 dispersion model is designed to use hourly meteorological data to calculate concentration or deposition values produced by emissions from continuous sources. Discrete or arbitrarily placed receptors are allowed. Average concentration or total deposition values are calculated for any averaging period. Average concentration or total deposition values are printed for source groups, where a source group consists of any combination of sources included in the model input data.

### **2.4 VISCREEN Visibility Model**

The VISCREEN model was used to evaluate visibility impacts inside the closest Class I area. The closest Class I area, Craters of the Moon National Monument, is located 204.5 kilometers from the T-97 test facility.

For purposes of this analysis, wind speeds from 3 meters per second and higher were analyzed. Wind speeds lower than 3 meters per second were not used because transport times would have to be greater than 24 hours to reach the Class I area.

### **2.5 Combining Model Estimates**

A method of combining the SRM model results with the other source impacts was developed to ensure that conservative estimates of PSD increment consumption and NAAQS contribution are achieved. Since the INPUFF generated modeling results from the SRM Test Facility are independent of direction, and the other source modeling results using CALPUFF and ISCST3 use actual spacial distributions, direct overlay of the two results could not be done. A conservative approach was used to add other source impacts to the INPUFF results. Adding other source impacts from ISCST3 to the

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***SECOR***

CALPUFF results were made on a receptor by receptor, and is very straight-forward.

The results from the INPUFF modeling analysis are in the form of impact versus distance from the source. These results can be combined by adding SRM impacts at a given distance to the maximum impact from other sources at that same distance. Repetitive combination of the two impacts at all distances is performed until cumulative impacts at all downwind distances and the maximum combined impact is found.

SECOR International, Inc. (SECOR). 1.4 million pound solid rocket motor static testing: PSD permit air quality impact analysis. Salt Lake City, Utah. October 2001. Pages 6-8

## **APPENDIX G: SITUATION ANALYSIS**



## Situation Analysis

### ATK Solid Rocket Motor Tests

#### Promontory, Utah



Developed by:

Utah Department of Health, Environmental Epidemiology Program

McKell Drury

**Contents**

I. Overview.....99

II. Public Health Issue.....99

III. Public Health Concern.....99

IV. Site History.....100

V. History of EEP Involvement.....100

VI. Demographics.....101

VII. Findings from Key Informant Interviews.....101

VIII. Recommendations.....110

IX. Appendix: Community Profile.....112

## I. Overview

In keeping with ATSDR's commitment to better respond to community concerns, a situational analysis was conducted for the ATK solid rocket motor test. A situation analysis defines and interprets the state of the environment of a population, or a community within a specific point in time. It identifies and analyzes a community's socio-economic problems, their assets, and their quality-of-life which are all essential steps in planning a thorough health program.

## II. Public Health Issue

The community surrounding Promontory, Utah generally does not have contact with fallout debris; however, during a solid rocket test on August 31, 2010 the prevailing winds shifted resulting in a layer of dust and debris contamination being blown over the small surrounding community. To investigate the potential impact to the health of the community, the following "pathways of exposure" have been studied.

Water: Present and future exposure

Soil: Present and future exposure

Air (indoor and outdoor): Present and future exposure

ATSDR has a mandate to prepare a public health assessment (PHA) to determine if the burn products and scour debris generated by the static motor test pose any health risks to residents and to define any follow-up activities needed to protect public health.

## III. Public Health Concern

Contaminates associated with the DM-2 rocket motor static testing consists of propellant burn products as well as ground materials scoured from the site and thrown into the atmosphere by the rocket burn. The primary contaminants of concern are:

***Ammonium Perchlorate:*** Perchlorates are colorless salts that have no odor. There are five perchlorate salts that are manufactured in large amounts: magnesium perchlorate, potassium perchlorate, ammonium perchlorate, sodium perchlorate, and lithium perchlorate. Perchlorate salts are solids that dissolve easily in water. The health effects of perchlorate salts are due to the perchlorate itself and not to the other component (i.e., magnesium, ammonium, potassium, etc.). Perchlorates are very reactive chemicals that are used mainly in explosives, fireworks, and rocket motors. The solid booster rocket of the space shuttle is almost 70% ammonium perchlorate. Perchlorates are also used for making other chemicals. Many years ago, perchlorate was used as a medication to treat an over-reactive thyroid gland.

***Aluminum Oxide:*** Aluminum is the most abundant metal in the earth's crust. It is always found combined with other elements such as oxygen, silicon, and fluorine. Aluminum

metal is obtained from aluminum-containing minerals. Small amounts of aluminum can be found dissolved in water. Aluminum metal is light in weight and silvery-white in appearance. Aluminum is used for beverage cans, pots and pans, airplanes, siding, roofing, and foil. Aluminum is often mixed with small amounts of other metals to form stronger and harder aluminum alloys. Aluminum compounds are used for a wide range of applications, from water-treatment to abrasives and furnace linings. They are also found in consumer products such as antacids, astringents, buffered aspirin, food additives, and antiperspirants. Upon combustion, the aluminum contained in the DM-2 solid fuel is converted to aluminum oxide ( $\text{Al}_2\text{O}_3$ ). Aluminum oxides and hydroxides (as well as other aluminum compounds) are found everywhere in nature. People can be exposed to aluminum oxide, also known as alumina or corundum, by breathing air containing these particles, by ingestion, or through dermal contact. Oral exposure to aluminum is usually not harmful as it is rapidly excreted (ATSDR, 2008).

**Hydrogen Chloride.** At room temperature, HCl is a colorless to slightly yellow, corrosive, nonflammable gas. It is heavier than air and has a strong irritating odor. On exposure to air, HCl forms dense white corrosive vapors. HCl has many uses, including cleaning, pickling, electroplating metals, tanning leather, refining, and producing a wide variety of products. HCl can be formed during the burning of many plastics. Upon contact with water, it forms hydrochloric acid. Both HCl and hydrochloric acid are corrosive (ATSDR, 2002).

#### IV. Site History / Background

The ATK Promontory facility is part of the ATK Aerospace Systems Division. The facility was originally developed as a rocket manufacturing and test facility by Thiokol Chemical Corporation in the 1950s. ATK is one of the largest aerospace and defense contractors for the U.S. Government. ATK was contracted to design, develop, manufacture, test and refurbish the Space Shuttle Solid Rocket Boosters. More recently, ATK's work includes the development, manufacturing and testing of solid rocket motor components for the Ares family of rocket systems. Static test firing is performed by igniting the solid rocket motor while it is anchored in a horizontal position. This lets ATK engineers monitor and evaluate the performance of the rocket motor's propellant, mechanical structure, and control systems.

#### V. History of EEP Involvement

The ATK fallout was brought to the attention of the EEP in the summer of 2010 through community concerns regarding short and long-term health effects associated with the static rocket motor test. The EEP was asked to evaluate data related to the fallout and potential acute and chronic health effects following exposure.

Most of the community concerns were health related:

- Cancer-related illnesses in the community
- Effects of static test fallout on crops and cattle feed as well as physical distress on animals coming into contact with the fallout dust.
- Safety of well water. They expressed a desire to have it tested for chemicals outside of the routine tests done by the health department or water master.
- Complaints regarding the corrosive effects of the static test fallout on properties, roof tops fences, sheds and car paint.

## VI. Demographics

There are limited demographic and socioeconomic data available for communities surrounding ATK. A general assessment, using Box Elder County data, is presented.

**Population:** The total population of Box Elder County is 49,975. Box Elder is 92% White. The total population of Utah is 2,763,885. Utah is 86% White, 13% Hispanic, 1% African-American, 1% American Indian, 2% Asian, and 3% other/ mixed race.

**Economic Status:** Median owner-occupied home values are lower in Box Elder (\$154,200) than across the state (\$208,100). The State of Utah has a higher percentage of renter-occupied housing (21%) than Box Elder County (10.7%).

**Education Level:** The percentage of residents with high school diplomas is consistent in Box Elder County with the state of Utah (90.5% v. 90.4%). The percentage of residents with a bachelor's degrees and higher is slightly lower in Box Elder County as compared to the rest of the State (21.7 v. 28.7%)<sup>1</sup>.

## VII. Finding from Key Informant Interviews

Interviews were conducted with a combination of community members and representatives of local business, industry, non-profit organizations, faith-based organizations and other community-based organizations.

### **Community perceptions, values and priorities**

EPA and UDEQ hosted an informal public availability session at the Senior Center in Tremonton, Utah February 23, 2011. The event was attended by 16 adults and one adolescent from Box Elder County between 3:00 pm and 7:30 pm. One citizen arrived late so EPA and UDEQ staff extended the input session at about 8:15 pm. Some citizens seemed uncomfortable about providing their names or writing them on the sign-in forms.

Attendees were from Thatcher (4), Bothwell (4), Penrose (2), Tremonton (3), West Corrine (2) and a subdivision NW of Thatcher known as Maple Hills (2). The event was not attended by media or elected officials, although one citizen was a former state legislator. Six of the citizens had previously worked for ATK and one is currently

employed at ATK. Other professions included teaching, nursing, conservation and ranching/ raising livestock (cows, sheep, etc.). Two representatives of the Bear River Health Department also listened to citizen comments.

Most of the concerns were health related regarding frequent and visible smoke from the open burning activities at ATK. Attendees also considered cancer-related illnesses in the community to be high. People had questions regarding the effects of static test fallout on crops and cattle feed as well as physical distress on animals coming into contact with the fallout dust. Complaints regarding the corrosive effects of the static test fallout on properties, roof tops, fences, sheds and car paint were also common. Many of the attendees also had concerns about the safety of their well water. They expressed a desire to have it tested for chemicals outside of the routine tests done by the health department or water master.

There were a handful of former ATK employees who feel recent cutbacks have compromised facility analysis of static tests and open burning practices. One couple said people who have lived in the area most of their life are used to the fallout and don't question the impacts as much as folks who are newer to area; the event was attended by five residents who have lived in the area for four years or less.

### **Notes from Community Meeting Participants**

Below are specific comments made by those who attended the community meeting.

#### Static Rocket Testing

- A citizen said you can tell the footprint of the fallout by looking at mailboxes in the area as they have been impacted by the corrosive material. This citizen has property concerns with this and said there are impacts to metal roofs, farm equipment, etc. Metal on the electric box had oxidized paint in a day or two from the soot that formed and that the soot looked like "grease" after a day or two. The citizen also said the day of the rocket testing that all AutoLiv (local airbag manufacturer) employees were given a free carwash and that kids in grade schools went under their desks during the fallout event as they thought there was an earthquake.
- A couple who both worked at ATK for many years said ATK has "been drained of lots of technical expertise" due to cutbacks. They said they had fallout at their home in Tremonton.
- Another couple voiced concerns about fallout from the rocket testing; said they had more than 1 inch of fallout on entire property that seemed "reactive" until shortly after it fell. Said the event was like "an eclipse from the sun." They said fallout caused pitting in their concrete and newly installed TREX (recycled plastic decking material); also appeared to prematurely age their 30-year shingles, causing them to "curl" and "look aged and crunchy." Said they were afraid to call

their insurance company. Had questions about drainage from contaminated soil on ATK's site and where rocket testing is conducted. Also said they heard ATK is hauling missiles to store on-site; said they suspect security with ATK plays a role in what they're told.

- A citizen said he thinks ATK needs to take the rocket test to the desert or blow into the mountain.
- A citizen said that they called ATK to report the fallout on her property and was told that someone would call her back. This person was also told that the material was not harmful. Rather than return the call, ATK sent a cleanup crew to the home. This person questions why they would conduct cleanup if the material is not harmful and doesn't trust them. The citizen said the cleanup crew told her they don't do roofs, yet later learned that some roofs were addressed. There is a concern that the property has been devalued.
- A citizen voiced concerns about the rocket testing and said their insurance company told them they have more than \$400,000 in damage.
- A current ATK employee attended the input session to find out if there are environmental concerns. This employee says the OSHA procedures are very much intact, even to the extent of becoming burdensome, but said that they have experienced open burn smoke blowing into an ATK crew driving through the area at times and wants to be as safe as possible. The citizen owns a home within four miles of the ATK facility and wants to know if there are health issues in the area. This person was concerned if ATK is shut down for any period of time they could lose business to Aerojet in California very quickly.

### Open Burning

All attendees said they are concerned with smoke from the open burning.

- A couple said the plume settles in the valley near their home in Bothwell between 2 and 4 times a year.
- A citizen who has been ranching in the area since 1952 voiced concerns with the open burning.
- A citizen said they happened to be in Howell Valley 2-16-11 when it was noticed that there was thick smoke just north of the church; it was so thick you couldn't see the mountains. This person stated a "stringy soot" fell at the cemetery on 11200 Street (near highway 102). Since they had worked at ATK this person was familiar with appropriate conditions for burning and said the pressures were wrong that day as there was a storm coming in so the smoke was just hanging in Howell Valley for most of the day.
- A couple who had worked at ATK for many years questioned why they haven't developed an incinerator. It was stated little regard is taken as to wind conditions and frequency of open burning and the smoke is carried onto nearby properties. They said they primarily see smoke events in the Whites Valley, Bothwell and Thatcher. The plume sometimes hits Tremonton. They said "nothing good comes from burning rocket propellant" as it puts asbestos, perchlorates and metals into

the air. They said this can't be good for farm crops and animals in contact with the smoke and groundwater, and that brain tumors, liver and pancreas cancer seemed to be high among co-workers. Said it was also mentioned that wastes from other companies are being transported to ATK for open burning; specifically mentioned waste from ATK subsidiary in Magna that does propellant casting (old Hercules operation) and asbestos from a company in Clearfield, Utah. They said more analysis of ATK methods and involvement is necessary to make the community feel safe. They added that they are loyal to the company but feel it has the expertise to develop better waste disposal methods and that the company needs to consider a growing community with concerns.

- A couple voiced concerns about the smoke from open burning and wanted to know why a risk assessment has not been completed. Asked why it is illegal for people to burn trash but not illegal for ATK to burn hazardous waste.
- Another citizen voiced concerns about open burning. This person stated that they had smoke at their ranch two times last spring and that the smoke is usually thick about 4 or 5 pm and that it usually goes NW or South. The citizen said "If I'd done business the way they done business, I'd be out of business."
- A citizen said they were told by a former ATK employee that the burning is supposed to be done in "trays" but that there are times when employees are told to "just get it done" and ignore safety steps and meteorological conditions. This citizen stated that they don't want to put ATK out of business but wants them to dispose of the waste safely.
- As mentioned above, under the static testing, an ATK employee said they have experienced open burn smoke blowing into and ATK crew driving through the area at times and wants to be as safe as possible.

#### Wells / Groundwater / Surface Water

- A citizen and former 20-year employee of ATK cited concerns about groundwater and has been told that ATK buried 50 gallon drums in an old Box Elder Landfill in the early 1970s, prior to regulations. This person said that the landfill closed 14 years ago and that the county conducts groundwater monitoring but that they don't know if the county tests for ATK-related contaminants. The citizen said the landfill is a former gravel pit and is not lined, and suggested we contact Gina Allen who is in charge of solid waste for the county. This person also stated most people in Tremonton are on city water but that Bothwell and Tremonton drinking water wells are located near the landfill.
- A citizen who had worked at ATK for many years voiced concern about water; said open burning plume goes to White's Valley in north Bothwell, the water source for the area. Also said their neighbors had their 150 foot well tested recently and that it passed by only 1 ppm for every contaminant that was checked.
- A couple said they had their well (between 90 and 120 feet) tested and it was high in nitrates and phosphates. They said they don't drink their groundwater but use

well for cooking, brushing teeth, garden and outdoor animals such as chickens, turkeys, etc.

- A couple asked if they should be concerned about their 60-foot domestic well which they and their children use for all home use. Said they were told testing for nitrates was normal; have filters for particles and rust, among other things.
- A citizen said they were informed by a UDEQ manager that there is perchlorate in the groundwater on their property when they were negotiating with ATK over cattle deaths on their ranch. This person also stated that they were told they would receive updates on ATK corrective action but hasn't seen any. This citizen shared that ATK is a big dumping ground for chemicals. Also said ATK had people watching what the citizen was doing during the lawsuit. Said they are on the culinary Thatcher-Penrose well and wants to know if they test for perchlorate. Stated that, according to ATK, the water and springs 1 mile west of the citizen's property is above standards but doesn't know for what contaminants or if the state collects their own data.
- A citizen asked questions about her soil and groundwater – had concerns about contamination. Also had questions about seasonal canal water she gets as it's used for her animals.
- A citizen with numerous concerns about groundwater suspects the perchlorate plume is migrating through fractures in the bedrock and percolating in shallow groundwater. He wants to know why more wells weren't sampled.

## Health

All attendees had questions and/or concerns about health.

- A former ATK employee and state legislator insisted that there are increased levels of cancer in his neighborhood and the surrounding areas closest to ATK operations. In Bothwell he and another attendee said they believe at least one person in each of the 150 homes has some form of cancer. He said his fellow ATK employees are plagued by cancer and health problems and he feels other maladies such as Multiple Sclerosis, Parkinson's and ALS in the community may be attributed to ATK activities. He said he worked in the production area with asbestos, toluene, and other chemicals. He said he once had to take silver nitrate to get his throat to stop bleeding from exposure to camloc 203 and 205 which bonds rubber to metal. He also said both of his parents lived in the area and died of brain tumors in the early 1990s within years of each other, and that his sister had breast cancer.
- A former ATK employee said he had lots of health problems. He said he developed a tumor on his right adrenal gland and that his doctors told him they suspect exposure to perchlorate caused the tumor. He also worked for Autoliv (airbag manufacturer that closed in recent years) and reportedly had Crohn's Disease while at this job. He believes that exposures while at ATK made his Crohn's Disease worse. He also said he knows of an ATK employee who died

unexpectedly at the age of 45; he said the man had worked at ATK for 20 years but that no one at ATK provided information as to the cause of his death.

- A couple attended the input session to inquire about health concerns regarding their daughters. They have three daughters between the ages of 8 and 17. Within the last year, all three have begun experiencing overactive thyroid problems. Thyroid conditions run in the mother's side of the family, however the mother said the girls' diagnosis is different from the mother's family members. The family's home is connected to West Corinne Water System. The family would like to find out if there are environmental reasons for their daughters' conditions and whether there are other families in the area experiencing the same thing.
- A couple expressed concerns about cancer and said that someone at every home around them has cancer. Have also heard that a person at every other house on Iowa Street in Tremonton has cancer. Said they also see a lot of Parkinson's disease. They asked about the credibility of a TV story several years ago that said ATK-related chemicals have been found in the milk of local cattle – should they be drinking local milk?
- A citizen voiced some health concerns; said his last son was born with an absent pulmonary valve (chamber with no separation) and he has wondered if there is a connection.
- A former nurse said she believes there are more cases of cancer in the area than where she previously lived. She said she also sees lots of liver and pancreas problems in area.
- Two women, a “mother” and “grandmother,” said all their family members began experiencing symptoms shortly after they returned from a trip in October. They said they didn't know a static test had been conducted until several days after they returned home, and that their two boys jumped on their trampoline multiple times, unaware that the material on the trampoline was ash from the rocket test. The mother recalls the children being covered in the stuff. None of their property was decontaminated. The boys aged 12 and 16, became ill not long after jumping on the trampoline. The mother described her boys as healthy their entire lives, with very little illness. Both have recently had CT tests done, at considerable expense to the family. The 12 year old is having gastro-intestinal issues. During the conversation, the mother stated that the child would soon undergo a colonoscopy for further diagnosis. The doctor told her the child could have Crohn's disease, something that does not run in either side of the child's family. The older child is experiencing blood in his urine. The prognosis is undetermined and the mother said there is an upcoming visit to a proctologist. The grandmother said she and her husband have both suffered from respiratory problems including bronchitis since October 2010. The grandmother has missed work and has been very ill during this time. Both got a flu shot in the fall of 2010. She said there are common symptoms among several members of the family, including the father, mother, grandmother and their two children. Symptoms are: headaches, joint pain and aches that have been experienced consistently since October of last year. There has been no experience of fever during the time these symptoms have been taking place. The grandmother said that the last time she noticed “fallout” was 20

years ago. She had been in her garden for several hours, and noticed a brown ash that began to fall. By the time she finished and went back inside, she had ash on the exposed surfaces of her body. She showered and immediately after broke out into welts. She described the welts as large and “coming out of nowhere.” She wonders if something in the ash reacted to the water in the shower and caused the welts. She has never experienced anything like that since. Both families get water from a shallow well on their properties and the mother said both her boys drink a lot of tap water, which draws from their shallow well. They have spoken to their water master about getting it tested. They want to know if the water they drink is safe. They have never had concerns about the testing that takes place at ATK and have been troubled very little with fallout. Their primary concern at this time is to get their children healthy and determine whether their well water, the fallout ash, or something else is responsible for the illness of the children and the symptoms of the parents and grandparents. They said they are aware of three people within a two-mile radius who have cancer -- two 50ish year old women with stomach cancer and a two year old boy with a type of leukemia of the lymph nodes. While at a local hospital, the mother was informed by a nurse who lives nearby that the area has a higher cancer rate.

### Worker Safety

- A former ATK employee said they worked in the ammonium perchlorate building #174 where perchlorate was ground from 200 mcg to smaller particles like powder (20 mcg). He said he was exposed to benzene, cyanide, perchlorate & aluminum and was frequently ill when working at ATK. Said building 174 was very dusty as they were dumping 5,000 lb tanks of perchlorate into a hopper to grind; he said workers only wore dust masks, smocks and cotton gloves/ no respiratory protection; he said the dust would get in his mouth, and go through his clothes, etc. He said that workers in a different building where they changed filters wore Tyvek suits and he wondered why this wasn't the case in building 174. He said he also worked in the area where waste was prepared for burning in “swing bags” filled with rocket fuel, Autoliv's waste, rags, perchlorate, aluminum, polymers, plastics, etc. He said there are rumors in the community that ATK has retained most of the local attorneys so they can't represent locals who are concerned about their health. He said a worker got cut while on the job and was afraid to tell anyone it happened at work
- As mentioned under the static test, a current ATK employee said the OSHA procedures are very much intact, even to the extent of becoming burdensome.
- A woman said she has two friends whose husbands both worked at ATK and recently died of cancer.
- A citizen said he worked at ATK in quality assurance years ago when he was young; someone squirted him with MEK and he got really sick.

### Animals

- A citizen said they previously had a number of cattle die and that they was initially told it was likely from Sego Lilies on the property – flowers that are poisonous to cattle. After a biologist walked the property and declared it free of the poisonous bulbs, blood work on the cattle indicated metals. Further investigation determined that cattle deaths were from molybdenum ingested via plants contaminated through ATK's open burning of Autoliv's waste. At this point he said the cattle are fine as long as they stay on a supplement that is high in copper to offset any molybdenum.
- A couple said they have had a number of their animals die while at their property in the past several years: 4 to 5 chickens and 3 turkeys.
- Another couple voiced concerns about their animals; said their chickens stopped laying eggs after the fallout – unsure if there is a connection.
- A citizen who raises sheep to sell (not to be confused with another concerned citizen who raises donkeys) said that since the rocket tests that many of the animal's eyes are different. The whites of the eyes are now red in the dogs, sheep and horses.
- A citizen who is relatively new to the area shared numerous concerns about their animals (eye problems, thyroid concerns in horses and other issues previously raised with UDEQ and EPA). This person also wonders why hummingbirds here walking on the concrete.

### **Historical Anecdotes**

ATK Launch Systems site in Promontory is located 30 miles northwest of Brigham City, Utah, in Box Elder County. ATK manufactures solid rocket motors for the Space Shuttle, Minuteman missiles, as well as commercial launch motors, pyrotechnics and flares. At the test site in Promontory, ATK conducts one test per calendar year, typically in the fall.

Promontory is well known as the site where the United States' first transcontinental railroad was completed in 1869. This route was used until a cutoff was built in 1904. In 1942 parts of the original line were removed for the war effort. The area had a shanty town during the railroad construction, but there has never been a permanent population.

ATK employees work at more than 60 facilities in 22 states, Puerto Rico and internationally. The company also has representatives in more than 50 countries throughout the world.

ATK was launched as an independent company in 1990, when Honeywell spun off its defense businesses to shareholders. The former Honeywell businesses had supplied defense products and systems to the U.S. and its allies for 50 years, including the first electronic autopilot that enabled B-17 aircraft to accomplish pinpoint bombing missions during World War II.

ATK expanded into the aerospace market with the acquisitions of Hercules Aerospace

Company in 1995 and Thiokol Propulsion in 2001, which transformed the company into the world's largest supplier of solid propellant rocket motors and a leading provider of high-performance composite structures.

A series of other acquisitions and key contract wins have continued to increase the company's presence in the aerospace, defense, and commercial ammunition markets:

- **2000**  
Selected to operate Lake City Army Ammunition Plant, the U.S. Government's only small-caliber ammunition manufacturing facility.
- **2001**  
Acquired the commercial ammunition businesses of Blount International, which made ATK the nation's largest manufacturer of ammunition.
- **2002**  
Acquired the ordnance business of Boeing, which brought together ATK's munitions portfolio with the products and capabilities of a leading military gun manufacturer.
- **2002**  
Acquired the assets of Science and Applied Technology, Inc., which added critical precision seeker, guidance, and system-level expertise.
- **2003**  
Acquired Composite Optics, Inc., which made ATK the world leader in composite space structures.
- **2003**  
Acquired GASL and Micro Craft, which added leading-edge propulsion and airframe technologies for highly demanding aerospace and defense applications.
- **2004**  
Acquired Mission Research Corporation, which enabled an advanced aerospace and defense technology pipeline spanning concept development to full-scale production.
- **2004**  
Acquired the PSI Group, which strengthened ATK's space systems portfolio and positioned the company to capture emerging opportunities in spacecraft integration and satellite technology.
- **2007**  
Acquired Swales Aerospace, adding enhanced systems engineering and engineering services to ATK's existing space launch, space exploration, small satellite, and spacecraft markets.
- **2009**  
Acquired Eagle Industries as a wholly-owned subsidiary, expanding position in the domestic and international accessories markets serving military and law enforcement customers.
- **2010**  
Acquired Blackhawk! Products Group, which added tactical, military and law

enforcement equipment expanding ATK's product base and market penetration in the growing security markets.

### **Community Assets**

The community assets include the presence of:

- Long-term residents
- Active community organizations
- Active faith-based organizations
- Historical knowledge about community
- Historical knowledge about past local industrial practices
- Historical knowledge about neighboring environmental sites

### **VIII. Recommendations**

Based on the analysis of the secondary data and interviews conducted, the EEP makes the following recommendations for the ATK Solid Rocket Motor Test Site; Promontory, UT:

- Finalize a Public Health Assessment (PHA): A PHA evaluates a site for hazardous substances, health outcomes (past, present and potential), and community concerns. A PHA also determines whether people could be harmed by coming into contact with site-related substances. PHAs are often the evaluation tool of choice when a site contains multiple contaminants and multiple, potential pathways of chemical exposure. ATSDR and other agencies use PHAs to identify whether a health study is appropriate or whether some other public health action is warranted, such as community health education. For every site that is on or is proposed for the National Priorities List, the Superfund law requires that ATSDR conduct a public health assessment. PHAs evaluate the following:
  - Levels (or concentrations) of hazardous substances
  - Whether people might be exposed to contamination and how they may come in contact with it (that is, through “exposure pathways” such as breathing, eating, or skin contact with contaminated air or soils)
  - What levels of a toxic substance might cause harm to people
  - Whether working or living near a hazardous waste site might affect people’s health
  - Other risks to people, such as unsafe buildings, abandoned mine shafts, or other physical hazards.
- Participate in a public meeting with other stakeholders and the community to explain the results of the PHA and address any community concerns.

- Make copies of the finalized PHA available to interested residents through various public buildings. Upon finalization, the document will also be able to be accessed electronically through the EEP website at <http://health.utah.gov/enviroepi>
- Provide continued health education (in the form of fact sheets, flyers and pamphlets) to the community on health effects from contaminant exposure and on ways to reduce or eliminate specific exposures.

## References

Agency for Toxic Substances and Disease Registry (ATSDR). 2008. *ToxFAQs for Aluminum*. Retrieved from: <http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=190&tid=34>

Agency for Toxic Substances and Disease Registry (ATSDR). 2002. *ToxFAQs for Hydrogen Chloride*. Retrieved from: <http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=759&tid=147>

## COMMUNITY PROFILE, 8/28/2011

### SECTION 1: SITE INFORMATION

**Site Name:** ATK Solid Rocket Motor Tests

**Address:** Promontory Utah and surrounding areas, Box Elder County, Utah

**Aliases:** Plant # 78; Thiokol

**EPA ID (CERCLA) Agency Number:** UT6570090013

**ATSDR Site Cost Recovery Number:**

**Other Affected Communities:** Thatcher, Bothwell, Penrose, Tremonton, West Corrine

#### History / Background of Site:

ATK Launch Systems site in Promontory is located 30 miles northwest of Brigham City, Utah, in Box Elder County. ATK manufactures solid rocket motors for the Space Shuttle Minuteman missiles, as well as commercial launch motors, pyrotechnics and flares. At the test site in Promontory, ATK conducts one test per calendar year, typically in the fall.

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ATK expanded into the aerospace market with the acquisitions of Hercules Aerospace Company in 1995 and Thiokol Propulsion in 2001, which transformed the company into the world's largest supplier of solid propellant rocket motors and a leading provider of high-performance composite structures ([www.atk.com/history](http://www.atk.com/history)).

A series of other acquisitions and key contract wins have continued to increase the company's presence in the aerospace, defense, and commercial ammunition markets:

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## **SECTION 2: ATSDR SITE INVOLVEMENT & FOCUS**

### **Site brought to ATSDR's attention by:**

The ATK fallout was brought to the attention of the EEP in the summer of 2010 through community concerns regarding short and long-term health effects associated with the static rocket booster test. EEP was asked to evaluate data related to the fallout and potential acute and chronic health effects following exposure.

Most of the concerns are health related:

- Cancer-related illnesses in the community
- Effects of static test fallout on crops and cattle feed as well as physical distress on animals coming into contact with the fallout dust.
- Complaints regarding the corrosive effects of the static test fallout on properties, roof tops, fences, sheds and car paint.
- Safety of well water. They expressed a desire to have it tested for chemicals outside of the routine tests done by the health department or water master.

### **What are the contaminants of concern and exposure pathways listed?**

The community generally does not have contact with the fallout debris, however, on this instance as the test was being performed the winds shifted and dust and debris was blown over the small surrounding community, leaving a layer of contamination on the community.

Water: Present and future exposure

Soil: Present and future exposure

Air (indoor and outdoor): Present and future exposure

### **Do people live, work, play or go to school on the site?**

Yes, ATK is located in a small town called Promontory, ATK Promontory currently employs approximately 1,500 people.

### **Do people live, work, play or go to school within ¼ mile of the site?**

Yes, ATK is located in a small town called Promontory, when the static test is performed, and weather conditions permit, the towns of Thatcher, Bothwell, Penrose, Tremonton, and West Corrine are also affected.

**SECTION 3: COMMUNITY, STAKEHOLDER AND OTHER INTERESTED PARTIES****Federal Environmental Public Health and Federal Environmental Protection Agencies****ATSDR*****Regional Lead Assigned to Site:***Chris Poulet; [cpoulet@cdc.gov](mailto:cpoulet@cdc.gov)ATSDR - Region 8 Denver office, MS 8ATSDR. 1595 Wynkoop Street, Denver, CO 80202;  
(303) 312-7013***Other ATSDR Region 3 Staff:***Charisse Walcott, [cpw8@cdc.gov](mailto:cpw8@cdc.gov) (770) 488-3730Candice Mayweather, [hlb8@cdc.gov](mailto:hlb8@cdc.gov)***HPCIB Staff Assigned to Site:***Loretta Asbury, Health Communication Specialist, (770) 488-0718, [sia5@cdc.gov](mailto:sia5@cdc.gov)**EPA*****Community Involvement Coordinator***Jennifer Lane, [lane.jennifer@epa.gov](mailto:lane.jennifer@epa.gov) (800) 8917 ext 312-6813**State Health and Social Services Department**

Utah Department of Health

P.O. Box 142104/288 North 1460 West, Salt Lake City, Utah 84114-2104; (801) 538-6191,

<http://www.health.utah.gov>***State Lead Assigned to Site:***Sam LeFevre, APPLETREE PI, [slefevre@utah.gov](mailto:slefevre@utah.gov)

288 North 1460 West, Salt Lake City, Utah 84114 (p) (801) 538-6191

***Toxicologist:***Dr. Craig Dietrich, [dietrich@utah.gov](mailto:dietrich@utah.gov) (801) 538-6191***Health Educator Assigned to Site:***McKell Drury, Health Program Specialist, [mdrury@utah.gov](mailto:mdrury@utah.gov), (801) 538-6191**State Environmental Protection Department**

Utah Department of Environmental Quality

195 North 1950 West, Salt Lake City, UT 84114, (801) 536-4440, <http://www.deq.utah.gov>***Community Involvement:***Dave Allison, [dallison@utah.gov](mailto:dallison@utah.gov), (801) 536-4479

**Local Government Officials*****Name of Municipality:***

Bear River Health Department; 655 East 1300 North, Logan, UT 84341 (435) 792-6500

***Environmental Officer:***

Joel Hoyt; [jhoyt@utah.gov](mailto:jhoyt@utah.gov) Bear River Health Department; 655 East 1300 North, Logan, UT 84341 (435) 792-6500

***Public Information officer:***

Jill Parker; [jparker@utah.gov](mailto:jparker@utah.gov); (435) 792-6518

***County Website:***

<http://www.brhd.org/>

**Other County, State, and Federal Elected Officials*****Governor:***

Gary Herbert, 350 North Stat Street, Suite 200, Po Box 142220, Salt Lake City, UT 84114-2220, (801) 538-1000 <http://www.utah.gov/governor>

**Community Organizations*****Chamber of Commerce:***

<http://www.peachdays.org/>

***Senior Citizens Organizations:***

Bear River Valley Seniors Center, Tremonton, 435-257-2639

**Site's Responsible Party****ATK/Thiokol**

9160 N HWY 83

Promontory, UT 84316 (435) 863-3511

Solid rocket motors for space shuttle, military applications, mfg. commercial motors for satellite launches

**SECTION 4: COMMUNITY RESOURCES****Local Library**

[Brigham City Library](#) 26 East Forest Street, Brigham City, Utah 84302, Phone: 435-723-5850  
Box Elder County Bookmobile Library, 80 West 50 South, Willard, UT 84340; Phone: (435) 723-2261  
[Garland Public Library](#) 86 West Factory Rd, Garland, UT 84312; Phone: (435) 257-3117  
[Tremonton City Library](#) 210 North Tremont Street, Tremonton, UT 84337; Phone: (435) 257-2690

**EPA/DEP Field Office**

None Found. *Community Involvement Coordinator:* Jennifer Lane, (800)227-8917,  
[lane.jennifer@epa.gov](mailto:lane.jennifer@epa.gov)

**Local Religious Centers**

The Church of Jesus Christ of Latter Day Saints; <http://www.lds.org>

**Local Police**

County Sheriff's Department- SHERIFF J "Lynn" Yeates; 52 S 1000 W, P. O. Box 888; Brigham City, Utah 84302; <http://www.boxeldercounty.org/sheriff.htm>

**Local Post Offices**

- Garland, Utah (435) 257-5890
- 2425 North 4000 West, Corinne (435) 744-5191
- 97 S Main St, Brigham City (435) 723-9273
- Tremonton, Utah (435) 257-3748
- 15970 N 17400 W, Howell, UT 84316 (800) 275-8777

**Local Schools**

Box Elder School District, <http://www.besd.net>  
Garland Elementary, Garland, Utah  
North Park Elementary, Tremonton, UT

**Local Hospitals/Clinics**

**Brigham City Community Hospital;** 950 South Medical Drive, Brigham City, UT 84302 (435) 734-9471

**Bear River Valley Hospital;** 440 West 600 North, Tremonton, UT 84337 (435) 257-4385

**SECTION 5: COMMUNITY WORK-LIFE**

**Description of Major Local Industries**

The majority of community members work at ATK. The main industry in Box Elder County is agriculture. Much of the state's dry-land wheat is grown in the county. It is well-known for its Peaches and other fruits. Dairy, cattle, and sheep industries are also among the predominant parts of the economy for Box Elder County.

Other large employers include:

Walmart, Malt-o-Meal, Box Elder School District, Brigham City Community Hospital along with Local and State government.

**Transportation Mode(s) Available to Community**

The associated communities are all very small farm communities in which no public transportation is available.

**SECTION 6: COMMUNITY DEMOGRAPHICS AND SOCIOECONOMIC CHARACTERISTICS**

	<b>Box Elder County</b>	<b>State (Utah)</b>
<b>Population Size</b>		
Total Population	49,975	2,763,885
Males	51.1%	50.3%
Females	48.9%	49.7%
<b>Race/Ethnicity</b>		
White	91.8%	86.1%
Black/African-American	0.3%	1.1%
Asian	0.9%	2.0%
American Indian/Alaskan Native	0.8%	1.2%
Hispanic/Latino (Of Any Race)	8.3%	13.0%
Other Race/Two or More Races	2.2%	2.7%
<b>Age Distribution</b>		
Persons under 5 years old	9.8%	9.8%
Persons 18 years and over	33.4%	31.2%
Persons 65 years and over	10.8%	9.0%
<b>Languages Spoken in the Area*</b>		
English only		
Language other than English	8.4%	13.8%
Spanish		
Other Indo-European languages		
Asian/Pacific Island languages		
<b>Socioeconomic Characteristics</b>		

High school graduate or higher (25 years and over)	90.5%	90.4%
Bachelor's degree or higher (25 years and over)	21.7%	28.7%
In labor force (16 years or over)		
Families below the Poverty Level		
Individuals below the Poverty Level	9.6%	11.7%
Median household income	\$52,867	\$55,183
Per capita income	\$20,299	\$22,684
Median value, owner-occupied homes	\$154,200	\$208,100
Owner-occupied housing units	81.0%	72.0%
Renter-occupied housing units	10.7%	21.1%
Median monthly owner costs (with mortgage)		
Median monthly owner costs (no mortgage)		

\*Source: US Census: <http://factfinder.census.gov>

**SECTION 7: ADDITIONAL COMMUNITY RESOURCES**

**Community Media Resources**

**Local Print Media:**

The Herald Journal (435) 752-2121

Box Elder News Journal (435) 723-3471

**News Stories about the Site:**

<b>Date</b>	<b>Headline</b>	<b>Outlet</b>
9/1/2010	ATK Fallout	abc4.com
8/31/2010	NASA and ATK Successfully test...	<a href="http://www.nasa.gov">www.nasa.gov</a>

**Local Radio Station:**

KALL	700	Sports	North Salt Lake City, UT	Utah Radio Acquisition, Llc
KJMY	99.5	Alternative Rock	Bountiful, UT	Citicasters Licenses, L.p.
KNRS	570	News/Talk	Salt Lake City, UT	Citicasters Licenses, L.p.
KODJ	94.1	Oldies	Salt Lake City, UT	Citicasters Licenses, L.p.
KOSY-FM	106.5	Soft Adult Contemporary	Spanish Fork, UT	Citicasters Licenses, L.p.
KXRV	105.7	Rock Alternative	Centerville, UT	Citicasters Licenses, L.p.
KZHT	97.1	Contemporary Hits Radio	Salt Lake City, UT	Cc Licenses, LI

**Local TV Broadcast Stations:**

KSL-TV	5	Commercial (VHF)	NBC	Salt Lake City, UT	Bonneville Holding Company
KUTV	4	Commercial (VHF)	ABC	Salt Lake City, UT	Clear Channel Broadcasting Licenses, Inc.

**Community Medical & Academic Resources**

**Nearby Colleges/Universities:**

Utah State University Logan, Utah 84322 Phone: 435-797-1000

**Information Resources:**

*Additional websites with community information:*

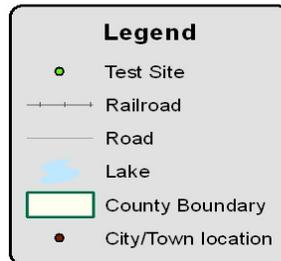
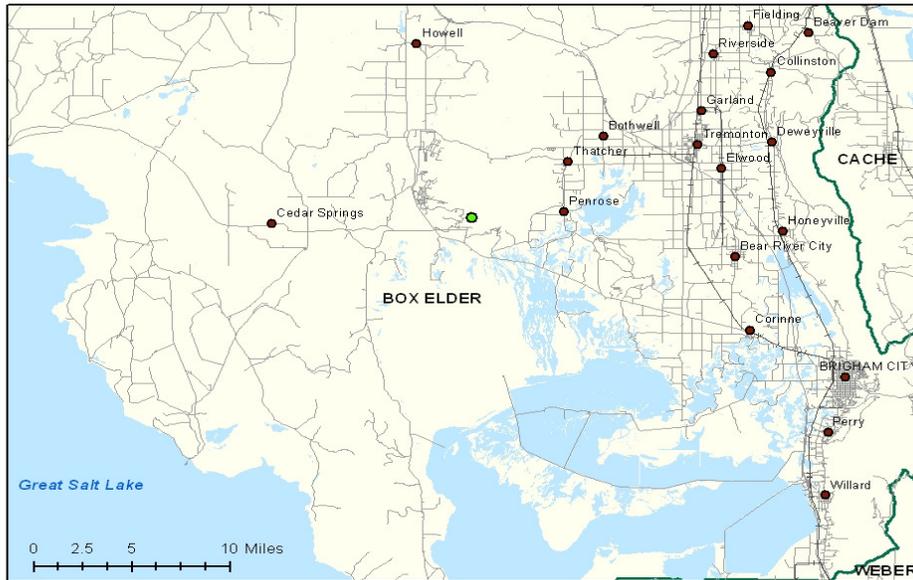
<http://boxeldercounty.org>

[http://pioneer.utah.gov/research/utah\\_counties/boxelder.html](http://pioneer.utah.gov/research/utah_counties/boxelder.html)

<http://www.peachdays.org/>

# Area Map

ATK Test Site and Surrounding Communities, Box Elder County, Utah



**Full length articles:**

PROMONTORY, Utah -- With a loud roar and mighty column of flame, NASA and ATK Aerospace Systems successfully completed a two-minute, full-scale test of the largest and most powerful solid rocket motor designed for flight. The motor is potentially transferable to future heavy-lift launch vehicle designs.

The stationary firing of the first-stage development solid rocket motor, dubbed DM-2, was the most heavily instrumented solid rocket motor test in NASA history. More than 760 instruments measured 53 test objectives.

Prior to the static test, the solid rocket motor was cooled to 40 degrees Fahrenheit to verify the performance of new materials and assess motor performance at low temperatures during the full-duration test. Initial test data showed the motor performance met all expectations.

"For every few degrees the temperature rises, solid propellant burns slightly faster and only through robust ground testing can we understand how material and motor performance is impacted by different operating conditions," said Alex Priskos, first stage manager for Ares Projects at NASA's Marshall Space Flight Center in Huntsville, Ala. "Ground-testing at temperature extremes pushes this system to its limits, which advances our understanding of five-segment solid rocket motor performance."

The first-stage solid rocket motor is designed to generate up to 3.6-million pounds of thrust at launch. Information collected from this test, together with data from the first development motor test last year, will be evaluated to better understand the performance and reliability of the design.

Although similar to the solid rocket boosters that help power the space shuttle to orbit, the five-segment development motor includes several upgrades and technology improvements implemented by NASA and ATK engineers. Motor upgrades from a shuttle booster include the addition of a fifth segment, a larger nozzle throat, and upgraded insulation and liner. The motor cases are flight-proven hardware used on shuttle launches for more than three decades. The cases used in this ground test have collectively launched 59 previous missions, the earliest being STS-3.

After more testing, the first-stage solid rocket motor will be certified to fly at temperature ranges between 40-90 degrees Fahrenheit. The solid rocket motor was built as an element of NASA's Constellation Program and is managed by the Ares Projects Office at Marshall. ATK Aerospace Systems, a division of Alliant Techsystems of Brigham City, Utah, is the prime contractor.

PROMONTORY Utah (ABC4 News) – There was fallout following ATK's latest rocket testing.

ATK Aerospace Systems performed their second ground test of the Arest solid rocket motor Tuesday and neighbors noticed.

"I looked out the window and saw my sidewalks covered in brown crud," said Gretchen Roberts who lives in nearby Thatcher.

Homes and property around the community of Thatcher was covered in dust like particles. Animals, barns, crops, homes and people felt the blanket of residue come over them. Jana Burdick's husband was working outside when the fallout covered him.

"It did burn him a little bit on his skin," she said. "There was ash covering everywhere."

ATK officials said unexpected winds sent the fallout to nearby homes. Mike Summers is worried about his crops and sheep which stood in the cloud of ash.

"Basically (I'm worried) if there's any toxins in the exhaust of the residue that might affect the sheep," Summers said.

ATK officials sent out crews to wash down properties that were smothered in particles.

"It's not toxic," said Trina Patterson, spokesperson for ATK. "And that's from the Utah Division of Air Quality and we do our own studies too."

ATK claimed the fallout is mainly dirt stirred up during the launch.

"There's a little chloride and aluminum found in the native soil (when it lands)," she said.

But she said they are minerals that are within allowable levels. ATK said the rocket's design has changed over the years but its propellant hasn't. That's why the state doesn't test the residue at every launch. State officials said the last time was in 2002 and their findings show its just dirt.

"You really don't want to be playing in it but at the same time it's really not hazardous or toxic," said DEQ spokesperson Donna Spangler.

Patterson said that prior to ever launch they hold an open house to explain the process and potential concerns to neighbors. She said prior to Tuesday's launch they sent out 800 invitations to the open house.

"No one showed up," Patterson said.

## **APPENDIX H: PUBLIC COMMENTS**

## **EEP Response to Public Comments on the ATK Solid Rocket Motor Static Tests PHA**

The EEP compiled all comments and questions received during the public comment period for the public comment version of this PHA (August 20, 2014 through September 26, 2014).

### **Comment**

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Page 26, Exposure Dose and Toxicological Evaluation, Phosphorus. There is a statement in this document that reads that without site specific information “. . . the EEP cannot determine that the phosphorus contained in the test-fire fallout debris represents a health hazard.” It is the opinion of the UDEQ/DERR that the phosphorus that was found in the sample likely came from the soil near the exhaust nozzle of the solid rocket booster, and likely existed as naturally occurring phosphate. As a result of the rocket blast the phosphate soil became entrained in the dust cloud and settled out with the test-fire fallout. It is unclear to us that any of the material was ever in the elemental phosphorus state, which if it were, would be oxidized very quickly and by the time that the material fell from the exhaust plume, it would be very unlikely to still be elemental phosphorus. The authors state that in future testing of the test-fire fallout, that an appropriate methodology to test soils for white phosphorus would be to use EPA method 7580. While this method is designed to identify concentrations of white phosphorus, sample preparation (the avoidance of any oxygen) would be extremely difficult in typical sampling situations and UDEQ/DERR would expect that the results would be of little value. Therefore, UDEQ/DERR would request that the authors include the limitations in using this method or remove the recommendation altogether.

### **Response**

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The EEP agrees with this comment. The section in question on page 26 has been modified to clarify the probable nature of phosphorus in the test fire fallout debris and the limitations of EPA method 7580.

**Comment**

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On page 41 of the Utah Department of Health report, *Public Health Assessment, ATK Promontory Solid Rocket Motor Static Tests*, a suggestion is made for ATK to form “a public notification plan to alert surrounding communities about potential smoke and dust plumes.” ATK has a public notification plan in place that has been utilized since 2005 to notify neighboring communities of upcoming static tests of large solid rocket motors. Historically, ATK provides notification in the form of approximately 500 postcards mailed to area residents. The postcards include the planned day and time of the static test and contact information for questions that may arise before or after the test.

Additionally, ATK has hosted a public open house prior to every large motor static test since February 2010. Typically each open house includes ATK representatives, Utah Department of Environmental Quality officials, environmental researchers from Utah State University, and local officials from Bear River Health Department. Neighboring residents receive invitations to the open house by postcard.

ATK welcomes the opportunity to collaborate with the EEP and Bear River Health Department on ways to enhance its public notification plan.

**Response**

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The sentence in question on page 41 recommending that ATK form a public notification plan has been removed. Sentences regarding ATK’s current SRM test notification plan and open house meetings have been added to the ongoing public health action plan.