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Certified Mail

September 10, 2008
In reply refer to SHEA-107745

Mr. Gerard Abrams
Northern California Permitting and Corrective Action Branch
Hazardous Waste Management Program
Department of Toxic Substances Control
8800 Cal Center Drive
Sacramento, CA 95826-3200

Subject: Air Dispersion Modeling Report for the Area I Burn Pit
Santa Susana Field Laboratory, Ventura County, California

Dear Mr. Abrams:

Enclosed for your review is the *Air Dispersion Modeling Report for the Area I Burn Pit (AIBP)*, at the Santa Susana Field Laboratory (SSFL). The air dispersion modeling has been performed in response to a request from the California Department of Toxic Substances Control. The purpose of the modeling was to evaluate the potential spatial distribution of chemical constituent impacts to soil from historical open burn and open detonation (OBOD) events at the AIBP, and assist in the selection of soil sampling locations.

The results of the air modeling evaluation indicate that the greatest deposition from the former OBOD activities occurred within 500 meters (m) of the AIBP. Based on prevailing onsite wind directions, deposition is predicted to occur primarily in the northwest and east-southeast directions from the source (the latter is adjusted to account for topography near the AIBP).

These results are generally consistent with the findings of the air modeling previously performed for the AIBP and published in the *RCRA Facility Investigation Work Plan, Area I Burn Pit – Solid Waste Management Unit (SWMU) 4.8,* which predicted maximum deposition at a distance of 200 to 400 m from the source.

Based on these previous findings, surface soil sampling was proposed at distances of 200, 400, and 600 meters from the approximate center of the AIBP. In addition to alignment of sampling locations in the directions of prevailing wind direction (northwest and southeast), sampling was also proposed in the northeast and southwest directions for geographic coverage purposes.

Given the results of the current air modeling event is comparable to the previous event, no substantive changes to the proposed sampling program described above are proposed. To account for the effect of localized topography around the AIBP on prevailing wind directions, sampling originally proposed in the southeast direction from the AIBP is proposed to be adjusted to an east-southeast orientation. The revised locations for the proposed soil samples are illustrated in Figure 1 attached to this letter.

If you have any questions regarding the enclosed materials, please contact me at 818-466-8795.

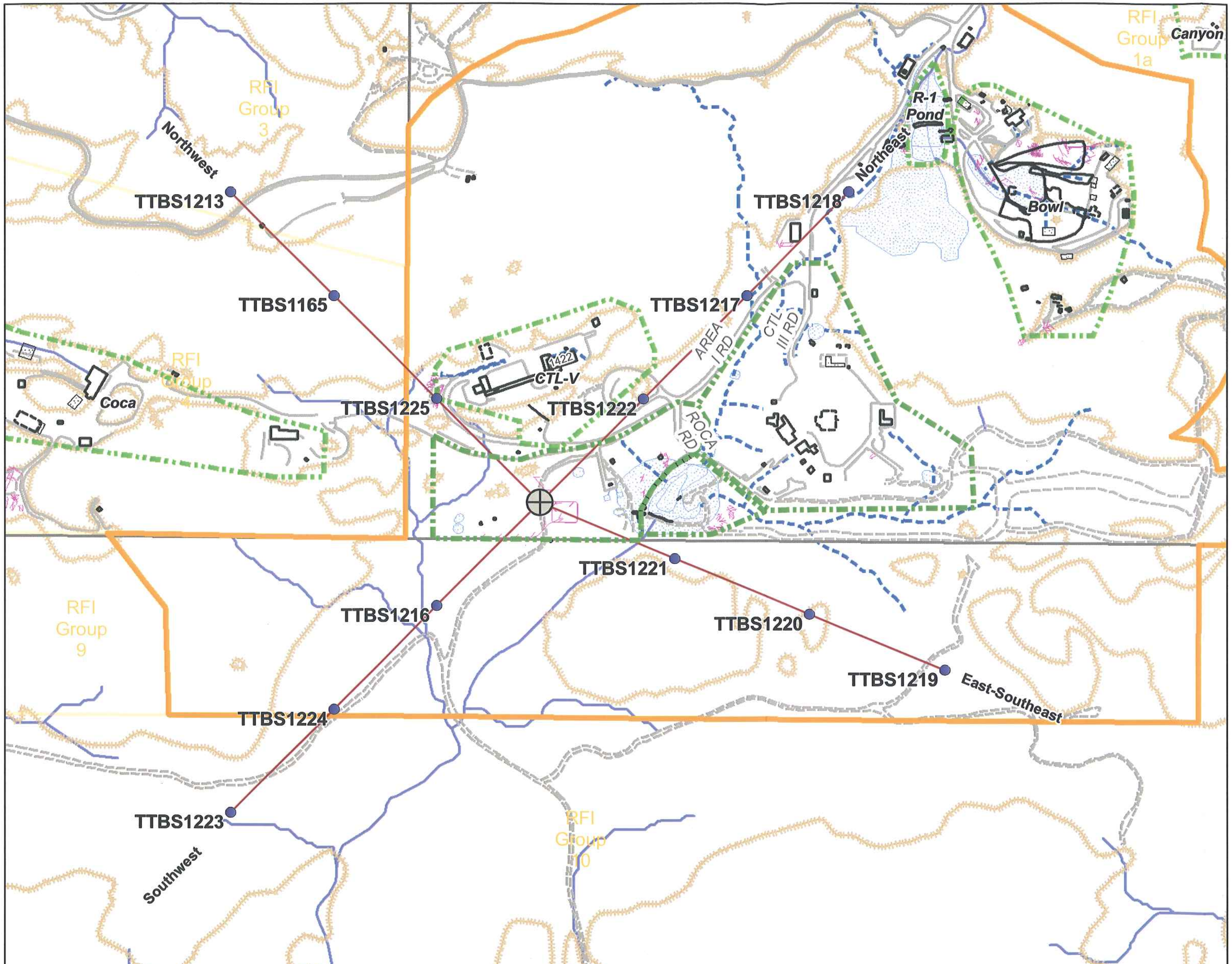
BOEING

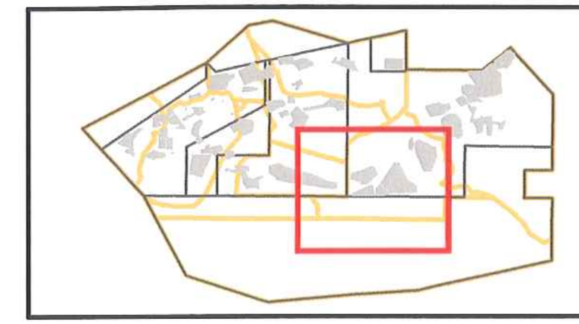
Sincerely,

Art Lenox
Environmental Remediation

AJL:bjc
Enclosure

cc:	Ms. Laura Rainey, DTSC	(w/1 enclosure)
	Mr. Lynn Baker, Calif. Air Resources Board	(w/1 enclosure)
	Mr. Doug Sheeks, DTSC	(w/1 enclosure)
	Mr. Norm Riley, DTSC	(w/o enclosure)
	Mr. Jim Pappas, DTSC	(w/o enclosure)





Basemap Legend

- Air Model Sample Locations
- Burn Pit Centroid
- Building - Existing
- Building - Removed
- Building - Not Yet Determined
- Excavation
- Road - Asphalt
- Roads - Dirt
- Rocks
- Waste Debris Area*
- RFI Site Boundary
- RFI Group Boundary
- Administrative Area
- Property Boundary
- Surface Drainage Divide
- Streams
- Pond

Proposed Air Deposition Surface Soil Sample Locations Area 1 Burn Pit Group 1B

1 inch equals 600 feet

0 600 1200 Feet

N

SANTA SUSANA FIELD LABORATORY

Figure 1

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Air Dispersion Modeling Report for the Area I Burn Pit, Santa Susana Field Laboratory

Prepared for

The Boeing Company

September 2008

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SCO/AIBP-AIR-MODEL-SSFL-DTSC-091008.DOC

Contents

Abbreviations and Acronyms

$\mu g/m^2$	micrograms per square meter
μm	micrometer
AIBP	Area I Burn Pit
AP	ammonium perchlorate-based solid rocket propellant
Cal/gram	calories per gram
D&D	diesel and dunnage
DTSC	California Department of Toxic Substances Control
ISCST3	Industrial Source Complex Short-Term Model
km	kilometer
lb/sec	pound per second
lb	pound
$Mg\text{-}NaNO_3$	magnesium-sodium nitrate propellant
MPRM	Meteorological Processor for Regulatory Models
OBOD	open burn and open detonation
OBODM	Open Burn/Open Detonation Model
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RFI	Resource Conservation and Recovery Act Facility Investigation
SCRAM	Support Center for Regulatory Air Models
SSFL	Santa Susana Field Laboratory
TSP	total suspended particulate
USEPA	United States Environmental Protection Agency

1.0 Introduction

The Santa Susana Field Laboratory (SSFL) Area I Burn Pit (AIBP), located in Ventura County, California, was historically used for the disposal of chemical fuels and solid rocket propellants by combustion and/or detonation. The greatest amounts of chemical fuels were burned at the AIBP during the period from approximately 1958 to 1971 (Haley & Aldrich, 2006).

To evaluate the potential migration of chemical constituents from the AIBP via air dispersion and deposition, soil sampling is planned to be performed as part of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) for the site. Pursuant to a request from the California Department of Toxic Substances Control (DTSC), air dispersion modeling has been performed to evaluate the potential spatial distribution of chemical constituent impacts to soil from open burn and open detonation (OBOD) events at the SSFL AIBP, and assist in the selection of locations for soil sampling. This document presents the methodology and results from the air dispersion evaluation of OBOD events at the AIBP.

1.1 Site Location

The SSFL is located 29 miles northwest of Los Angeles in the Simi Hills of Ventura County, California. The facility occupies roughly 2,850 acres (Haley & Aldrich, 2006).

1.2 Modeling Purpose and Objectives

The goal of the air dispersion modeling is to aid in the selection of sites for the soil sampling planned as a part of the site RFI. Because disposal occurred at AIBP between 37 and 50 years ago, there are uncertainties about the OBOD events.

This modeling report provides information on the air dispersion modeling used to determine the projected impacts from the OBOD events occurring at AIBP. These modeled impacts will reflect the potential spatial distribution to soil of chemical constituents from the AIBP via air dispersion and deposition. The resulting spatial distribution will be used to determine the likely pattern of deposition and will provide an indication of possible soil sample locations as part of the RFI and soil sampling plan.

1.3 Synopsis of Approach

Previous studies have evaluated the historical records of materials sent to the AIBP for burning or destruction and have identified the metals that are most appropriate to target in a soil sampling program (Sullivan, 2006). The metals identified are aluminum, magnesium, lithium, and zirconium (Sullivan, 2006).

For this study, the previous studies and the historical record were reviewed to determine which OBOD scenarios could provide information that could aid in the selection of sampling sites for the soil sampling plan. The following three disposal scenarios were selected:

1. Deposition of aluminum (via aluminum oxide) and total particulate matter from the detonation of aluminized ammonium perchlorate-based solid rocket propellant (AP), used to represent the types of energetic materials containing aluminum that were disposed of at AIBP.
2. Deposition of magnesium (via magnesium oxide) from the burning of magnesium-sodium nitrate propellant, used to represent the types of energetic materials containing magnesium that were disposed of at AIBP.
3. Deposition of total particulate matter from the burning of "diesel and dunnage," or D&D. D&D is one of the standard source types from the Open Burn/Open Detonation Model (OBODM), which is described in Section 2. The D&D source is meant to provide information on a large range of "particle-bound" pollutants. Particle-bound pollutants bind to the particulate matter generated when petroleum-based fuels, such as diesel fuel, are burned.

The compounds from these three scenarios were chosen as representative of compounds that might have been deposited through OBOD operations at AIBP. The deposition results predicted by the air dispersion modeling are provided in the form of contour maps, presented in Appendix A. It is anticipated that the modeling results will assist in the selection of soil sampling locations.

2.0 Model Selection

The dynamics of OBOD treatments, especially the short-term, discrete nature of the events, require special air dispersion models to simulate the physics and to characterize the thermodynamics of OBOD operations. OBODM, developed at the Dugway Thermal Treatment Facility to evaluate the air quality impacts from the OBOD of obsolete munitions and propellants, is one such model (Bjorklund et al., 2001). It was specifically designed to predict the buoyant rise and dispersion of emissions from short-term quasi-continuous release.

OBODM uses cloud/plume rise, dispersion, and deposition algorithms from existing dispersion models for instantaneous and quasi-continuous sources, including Rocket Exhaust Effluent Dispersion Model, the Dugway Proving Ground Real-Time Volume Source Dispersion Model, and United States Environmental Protection Agency (USEPA) Industrial Source Complex Short-Term Model (ISCST3), to calculate downwind transport and dispersion of pollutants released by the combustion of solid propellants (Bjorklund et al., 2001).

OBODM uses emission source characteristic data, meteorological data, and receptor location to determine air concentrations and gravitational deposition. OBODM can calculate air concentrations and gravitational depositions for particulate pollutants in simple terrain, which is defined as terrain located below the source release height (Bjorklund et al., 2001).

The deposition of aluminum, magnesium, and particulate matter from OBOD events at AIBP were characterized using the most recent version of the OBODM (Bjorklund et al., 2001), available from the USEPA Support Center for Regulatory Air Models (SCRAM) website.

3.0 OBODM Input Parameters

3.1 Meteorological Data

OBODM can use sequential, hourly meteorological data, which are developed from observed surface and upper air data. Concentration and deposition values are calculated for the number of hours entered into the model. Six years of onsite meteorological data provided by Boeing, supplemented with data from the nearby upper air station, Miramar, California, were evaluated for used in this analysis. As specified in the modeling protocol and consistent with the Guideline on Air Quality Models (USEPA, 2005), the most complete 5 years of meteorological data were used for this modeling analysis. The meteorological data used for AIBP modeling include wind speed, wind direction, dry bulb temperature, and rural and urban mixing heights.

Onsite data were evaluated for completeness. According to USEPA regulatory guidance, meteorological data is complete when at least 90 percent of the data is accepted or present (Atkinson and Lee, 1992). Based on an initial screening, all 6 years of data were found to be complete by regulatory standards. As a result, an additional comparison was required to determine which 5 consecutive years of meteorological data provided would be most appropriate for use in the modeling analysis. The 6 years of onsite meteorological data were evaluated for the number of missing values for each meteorological parameter. Results of this analysis are included in Table 3-1.

TABLE 3-1
Number of Missing Meteorological Data From the Completeness Evaluation
Santa Susana Field Laboratory – Ventura County, California

Year	Wind Direction	Wind Speed	Temperature	Stability Class	Rural Mixing Height	Urban Mixing Height
2002	248	250	22	25	78	130
2003	536	536	161	161	1029	1096
2004	261	264	118	22	56	86
2005	772	801	349	348	349	353
2006	529	531	306	93	115	126
2007	555	578	418	418	505	521

Notes: Missing data classified as meteorological data listed as some variation of +/- 999 or 0.

To model with 5 consecutive years of meteorological data, data from either 2002 or 2007 had to be excluded. A comparison of the missing data for the years 2002 and 2007 was performed to determine which year would be excluded from modeling. Based on the results presented in Table 3-1, the year 2007 has more missing parameter values than the year 2002. As a result, the most applicable and complete data were found to be data for the years 2002 through 2006. Therefore, the OBODM modeling for the AIBP was performed using the onsite meteorological data for 2002 through 2006.

In addition to the onsite data, twice-daily mixing heights from the upper air station at Miramar, California, and stability calculated using the sigma/theta method were used for modeling emissions from OBOD events at AIBP. The 5 years selected for upper air data were the same as those selected for the onsite meteorological data. These meteorological data files were processed using the USEPA Meteorological Processor for Regulatory Models (MPRM) program, revised June 24, 1999 (USEPA, 1999).

3.2 Receptor Grid

A receptor grid network was used to locate the maximum deposition resulting from OBOD emissions. The receptor grid extends outward from the OBOD source a distance of 5 kilometers (km) with a spacing of 100 meters. As shown in the contour plots included in Appendix A, a 10-km-square receptor grid was sufficient to evaluate the potential deposition concentrations at and near the AIBP.

3.3 Land Use

OBODM requires the land use to be defined in the region of the source and the area of interest. The land use type determines the appropriate dispersion coefficients and surface roughness heights to be used in the dispersion analysis. Photos of the area surrounding AIBP indicate that the area is predominantly covered by vegetation (DTSC, 2008). Therefore, the area around SSFL is considered rural, and rural dispersion coefficients were used in the air dispersion modeling.

3.4 Terrain

Some of the terrain in the vicinity of AIBP could be considered complex because the height of the terrain is greater than the base elevation of the sources. OBODM cannot calculate particulate deposition values in complex terrain. Therefore, flat terrain was assumed to allow calculation of particulate deposition values by OBODM. The consequences of this assumption on the calculated deposition patterns are qualitatively discussed in Section 6.2.

3.5 Operational Requirements

Due to safety concerns, burning chemical wastes is typically limited to daylight hours. For this reason, the calculation of daylight hours (based on the latitude and longitude of the source location) is built into OBODM. Consequently, the modeling analysis assumed OBOD events at AIBP occurred only during daylight hours.

4.0 Source Characteristics

Available historical records were evaluated to determine the quantity and types of materials disposed at AIBP. Several disposal methods were used at AIBP, such as burning, detonation, and dilution. For this analysis, only the materials disposed of via thermal treatment (either burning or detonation) were considered. The data for the thermally treated materials were further sorted based on composition, allowing categorization based on potential emissions. Material types found to significantly contribute to the release of metals, including aluminum and magnesium, and total suspended particulates (TSP), were used for analysis.

4.1 Source Quantity and Type

Various amounts of materials were historically disposed at the AIBP (Haley & Aldrich, 2006). Table 4-1 shows the approximate total amounts treated for the three scenarios selected for air dispersion modeling, previously described in Section 1.

TABLE 4-1
Total Amounts Treated at Area I Burn Pit for Years 1958 - 1971
Santa Susana Field Laboratory – Ventura County, California

Item	Total Amount Treated a	Disposal Method
Ammonium perchlorate-based solid rocket propellant	2,197 lb	detonation
Magnesium-Sodium Nitrate [b]	26,605 lb [c]	burning
Diesel and Dunnage	124,566 gallons	burning

Notes:

a. Material Mass Disposed of per Event estimated from Table A-X, Area I Burn Pit Waste Disposal Summary (Haley & Aldrich, 2006)

b. Did not include the 1961 listing for magnesium of 820 gallons burned. This listing appeared to be an anomaly; the magnesium included in this amount is assumed to be mixed with some other fuel.

c. Historical tables list the mass of magnesium disposed of at AIBP. The total mass of magnesium-sodium nitrate (Mg-$NaNO_3$) propellant used for dispersion modeling was calculated assuming a stoichiometric mixture of magnesium and sodium nitrate.

The source characteristics and throughput levels that were used to model the OBOD events at AIBP are listed in Table 4-2. The burn rates for materials were estimated using historical data and material properties. Theoretical and experimental burning properties of diesel fuel pools were evaluated in *Metal Alkyls and Their Solutions* (Nobel, 2003). The burning properties of diesel were also evaluated in the *In Situ Burning of Oil Spills Workshop Proceedings* (Walton & Jason, 1998). These documents indicate that liquid fuel burn rates are a function of pool diameter until the diameter reaches about 1 meter. Burn rates are measured in terms of thickness per unit time. To determine a mass rate from reported burn rates, a surface area must be assumed. To calculate the mass burn rate for diesel, it was assumed that it was burned in 20-foot by 20-foot concrete ponds located at the AIBP.

Theoretical and experimental burning properties of magnesium-sodium nitrate (Mg-$NaNO_3$) were evaluated in *Temperature Sensitivity of Magnesium-Sodium Nitrate Propellants* (Singh and Rao, 1990). It was assumed that a stoichiometric mixture of magnesium and sodium nitrate would be representative of the magnesium-containing propellants disposed of at AIBP. The burn rate for Mg-$NaNO_3$ was calculated, assuming that the disposal event would occur at standard temperature and pressure and that the average size of the solid propellant disposed of was a cylinder approximately 8 inches in diameter and 16 inches long. The calculated burn rates for diesel and Mg-$NaNO_3$ are listed in Table 4-2.

TABLE 4-2
Source Characteristics to Model the OBOD events at AIBP
Santa Susana Field Laboratory – Ventura County, California

Item	Material Mass Disposed of per Event	Heat Content (Cal/gram)	Burn Rate (lb/sec) [a]
Ammonium perchlorate-based solid rocket propellant	225 lb	1,000b	Not Applicable – Detonation [c]
Magnesium-Sodium Nitrate	625 lb [d]	2,653	0.8
Diesel and Dunnage	2,359 gallons (16,702 lb)	1,000 [b]	4.6

Notes:

Cal/gram calories per gram
lb/sec pounds per second

a. Burn rate calculations assume: Liquid materials were disposed of in a 20-foot by 20-foot pond. Solid materials were approximately 8 inches in diameter and 16 inches long.

b. Source: OBODM built-in database (Bjorklund, J.R. et al. 1998).

c. For detonations, OBODM assumes a 15-second duration (Bjorklund, J.R. et al. 1998).

d. The total mass modeled per event for Mg-NaNO3 is assumed to be composed of many cylindrical igniters approximately 8 inches in diameter and 16 inches long.

4.2 Source Parameters

As discussed in Section 1, three disposal scenarios were used to represent the disposal of material via OBOD events at AIBP. Disposal of Mg-$NaNO_3$ and D&D were modeled as quasi-continuous burns, whereas the disposal of AP was modeled as a detonation.

General source parameters are listed in Table 4-3. These parameters were the same for all three types of sources modeled.

TABLE 4-3
General Source Parameters Required by OBODM
Santa Susana Field Laboratory – Ventura County, California

Input Parameter	Input Values	Source of Data	Notes
Source type (volume or line)	V	OBODM manual	"V" for volume
Hours of day during which source can be ignited	Daylight hours determined by model based on latitude and longitude of site	Calculated by OBODM	---
X, Y source coordinates (rectangular, polar)	R	---	"R" for rectangular (Cartesian)
X source coordinate	0		Model using generic coordinates---
Y source coordinate	0		Model using generic coordinates---
Z source base elevation	0		Complex terrain is not used when modeling particle impacts
Compound/species half life (hours)	0	OBODM Database	Sources modeled do not have half lives
Fraction of exhaust cloud constituting compound/species (fraction)	1	Values for each pollutant calculated from existing emission factors	Model results scaled based on pollutant-specific fraction of exhaust cloud

4.3 Particle-Size Distribution

To adequately model the particulate deposition, particle-size distribution is required. There are little data available regarding the particle-size distributions associated with OBOD activities.

An independent study, *Explosion Dust Particle Size Measurements*, evaluated particles from open and buried detonations. Their analysis was based upon four different detonation events of live projectile munitions. Despite differences in soil and munitions compositions, the particle distributions remained fairly constant. The data were bimodal and best fit two log-normal curves (Pinnick et. al., 1983). Due to the consistency in results, these data were used as the basis for the open detonation particle-size distribution.

In another series of studies, the so-called "BangBox" studies carried out at the U.S. Army Aberdeen Test Center, Aberdeen Proving Grounds, Maryland, data were collected from the disposal of energetic materials. These data do not include contamination by surface soils. BangBox data are accepted to be the most representative distribution for open burning of energetic materials.

Data from the BangBox studies and the Pinnick et al. (1983) data were reviewed by USEPA, the Alabama Department of Environmental Management, and the U.S. Army for the air dispersion modeling protocol for the recent RCRA Subpart X permit application for OBOD operations at Anniston Army Depot (U.S. Army, 2008). Table 4-4 shows the particle-size distributions that were agreed upon as being most representative for open burning (OB) and open detonation (OD) of energetic materials (URS, 2006). These particle-size distributions were used to model particle deposition from OB and OD events at the AIBP.

TABLE 4-4
Particle-Size Distribution
Santa Susana Field Laboratory – Ventura County, California

Open Burn Distribution		Open Detonation Distribution	
Diameter (micrometer)	**Number Fraction**	**Diameter (micrometer)**	**Number Fraction**
0.35	0.18	2.97	0.023
0.70	0.12	4.09	0.052
1.10	0.21	5.62	0.097
2.00	0.24	7.72	0.147
3.60	0.11	10.62	0.181
5.50	0.07	14.61	0.181
8.10	0.02	20.10	0.147
12.50	0.01	27.64	0.097
15.00	0.04	38.03	0.052
		52.31	0.023

5.0 Emission Factors

Emission characteristics of Mg-$NaNO_3$ propellant, ammonium perchlorate-based solid rocket propellant, and D&D, including composition, mass, heat content, and burn rate, were obtained for use with OBODM. Emission factors for the modeled wastes were based on the components that make up the waste burned. Emission factors for ammonium perchlorate-based solid rocket propellant and D&D come from the OBODM model's built-in database. The emission factor for Mg-$NaNO_3$ propellant was calculated using the POLU4WN combustion model (NAVSEA, 2003). This emission factor incorporates the magnesium-containing compounds released in the burning of Mg-$NaNO_3$ propellant, including magnesium oxide (MgO), magnesium, and magnesium nitride (Mg_3N_2). Using stoichiometry, MgO was determined to be 60.3 percent magnesium by weight and Mg_3N_2 was determined to be 72.25 percent magnesium by weight. These percentages were used in conjunction with the POLU4WN results to determine the total magnesium emission rate. Emission factors associated with the sources disposed of at AIBP are listed in Table 5-1.

TABLE 5-1
Emission Factors
Santa Susana Field Laboratory – Ventura County, California

	Pollutant Emission Rates (lb of species per lb of fuel)[a]		
Emission Source	**Aluminum**	**Magnesium**	**Total Suspended Particulate (TSP)** [b]
Ammonium perchlorate-based solid rocket propellant	0.011	--	0.42
Magnesium-Sodium Nitrate	--	0.40 [c]	--
Diesel and Dunnage	--	--	0.0054

Notes:

a. Unless otherwise noted, emission factors are from the OBODM database.

b. Default OBODM emission factors for particulate matter are used.

c. Calculated using POLU4WN Combustion Model.

6.0 Modeling Results

Air dispersion modeling with OBODM was performed to determine the cumulative deposition of metal and particulate contaminants resulting from OBOD events at the AIBP. The dispersion modeling objective was to determine the potential spatial distribution of chemical constituents from the AIBP via deposition. The resulting spatial distribution can be used to assist in the identification of soil sampling locations for the RFI sampling at the AIBP.

6.1 Specific Modeling Results

Each modeling scenario was performed for all days of years 2002 through 2006. Because OBOD activities are restricted to daylight hours, modeling was similarly restricted to daylight hours. The estimated total amount of material disposed at AIBP between 1958 and 1971 was used to produce deposition results that represent potential impacts from the operation of OBOD at the AIBP. This was done by scaling the annual results by the estimated number of events at AIBP, the total number of hours processed by OBODM, and the pollutant emission factor. The annual number of events was determined from the estimated amount of mass disposed per event and the estimated total amount treated at AIBP during its years of operation. The total number of hours processed by OBODM excludes nighttime operation and calm meteorological conditions. The emission factors, as discussed in Section 5, were applied for each pollutant.

It is important to note that because the total amounts of materials disposed, the number of events, and the amount of materials disposed per event are estimated, there is uncertainty in the deposition values calculated. Consequently, it is most appropriate to use the deposition values calculated as indicators of relative levels of deposition, rather than as specific amounts of deposition. Therefore, the deposition values given in Table 6-1 and in the contour plots should be used as indicators of relative levels of deposition.

With this in mind, the modeling results indicate that the impacts from the detonation of AP were relatively the closest to the AIBP site. The calculated aluminum deposition rates did not exceed 100 micrograms per square meter ($\mu g/m^2$) outside a 1-km radius from the source. Deposition levels of TSP from AP detonation were higher and found further from the source, than aluminum from AP. However, the locations of TSP impacts from AP detonation are within 3 to 3.5 km in the northwest-southeast direction from the AIBP.

Modeling results indicate that the open burning of material is likely to result in impacts farther from the source than the open detonation of materials. In comparison to the open detonation results, higher levels of TSP from the open burning of D&D and levels of magnesium from the open burning of $Mg\text{-}NaNO_3$ were calculated to be as far as 5 km in the northwest-southeast directions from the source. It is likely that magnesium deposition levels would be higher than TSP since the ratio of magnesium to $Mg\text{-}NaNO_3$ is higher than the ratio of TSP to D&D. The maximum deposition values for each contaminant have been summarized in Table 6-1. Again, it is important to remember that these values should be used to make a relative comparison between the different modeling scenarios.

TABLE 6-1
Dispersion Modeling Deposition Results
Santa Susana Field Laboratory – Ventura County, California

	Aluminum	Magnesium	Total Suspended Particulate for D&D	Total Suspended Particulate for AP
Maximum Deposition				
Deposition Value (μg/m^2)	460	328,972	1,060	17,600
Distance from Source (m)	420	100	140	420
Direction of Impact from source	Southeast	South	Southwest	Southeast

Notes:
μg/m^2 micrograms per square meter
m meters

Based on the contour maps, the impacts are predicted to occur primarily along the northwest-southeast axis of the source. The contour maps indicating potential deposition patterns of aluminum, magnesium, and particulate matter as calculated by the OBOD modeling are provided in Appendix A.

In interpreting the contour plots, it is important to keep three things in mind:

1. The contour plots should be used as indicators of relative levels of deposition (as discussed previously).
2. The OBODM model does not adjust for terrain variances for deposition calculations.
3. There is significant terrain between the AIBP and the location at which the meteorological data were collected. This last consideration is discussed further in Section 6.2.

6.2 Implications of Separation of AIBP and Meteorological Data Site

The onsite meteorological data were collected in Area IV of SSFL, approximately 1.5 miles west-northwest of AIBP. The meteorological data collected at Area IV are dominated by winds from two directions: the northwest and the southeast. The elevations of AIBP and Area IV are equivalent; however, there is terrain between the two locations with elevations up to 300 feet greater. Because of this higher terrain, surface-level winds that occur at AIBP would be expected to differ slightly from those at Area IV.

The terrain to the northwest of AIBP would be expected to impact surface-level winds in two ways. First, the winds coming from the northwest at Area IV would likely be diverted around the terrain, and thus approach AIBP more from the west rather than from the northwest. Second, under very light wind conditions, terrain-driven upslope winds would be expected to occur during the day; downslope winds would occur at night.

Because of these expected differences in the surface-level winds between AIBP and Area IV, use of the meteorological data collected at Area IV for the dispersion of sources at AIBP might cause some distortion in the calculated deposition patterns. Dispersion results are likely to be less distorted when the plume rise exceeds the terrain height.

Results from the OBODM analysis indicate that the average plume rise from OD events most likely exceeded 300 feet, whereas the average plume rise from OB events was most likely less than 300 feet. Therefore, it is not likely that terrain had a significant effect on the location of impacts and deposition patterns from OD events. However, minor changes would be expected in the calculated deposition patterns associated with OB events.

Strong winds from the southeast measured in Area IV would generally be present in Area I. However, terrain impact to low-lying winds would cause them to lose momentum and decrease speed, which would result in greater levels of deposition nearer the source. Consequently, deposition levels from OB events would be concentrated closer to the source in the northwest direction than otherwise indicated by the OB deposition patterns. Wind from the northwest would be diverted by the terrain between Area IV and Area I, causing deposition impacts from OB events to be located more in the east-southeast direction than in the southeast direction as indicated by the OB deposition patterns.

6.3 Recommendations

As mentioned previously, available historical records were evaluated to determine the quantity and types of materials disposed at the AIBP. Consequently, assumptions have been made regarding the OBOD events, including the amount of material disposed, total amount of material treated, and the number of events per year. As such, this report provides information on the potential spatial patterns for deposition; however, the actual amounts of deposition will need to be evaluated by soil sampling.

Based on the contour maps (see Appendix A) and discussions in Sections 6.1 and 6.2, in all cases, deposition from contaminants are relatively much higher within 500 meters of the AIBP than at all other locations (that is, no separated hot spots are seen). Furthermore, higher levels of deposition are expected in the northwest and southeast directions, with the southeast direction likely rotated to east-southeast, as discussed in Section 6.2. Therefore, it is recommended that soil sampling locations be selected to investigate these areas.

7.0 References

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Appendix A
Contour Plots

FIGURE A-1. TOTAL DEPOSITION OF ALUMINUM FROM AMMONIUM PERCHLORATE

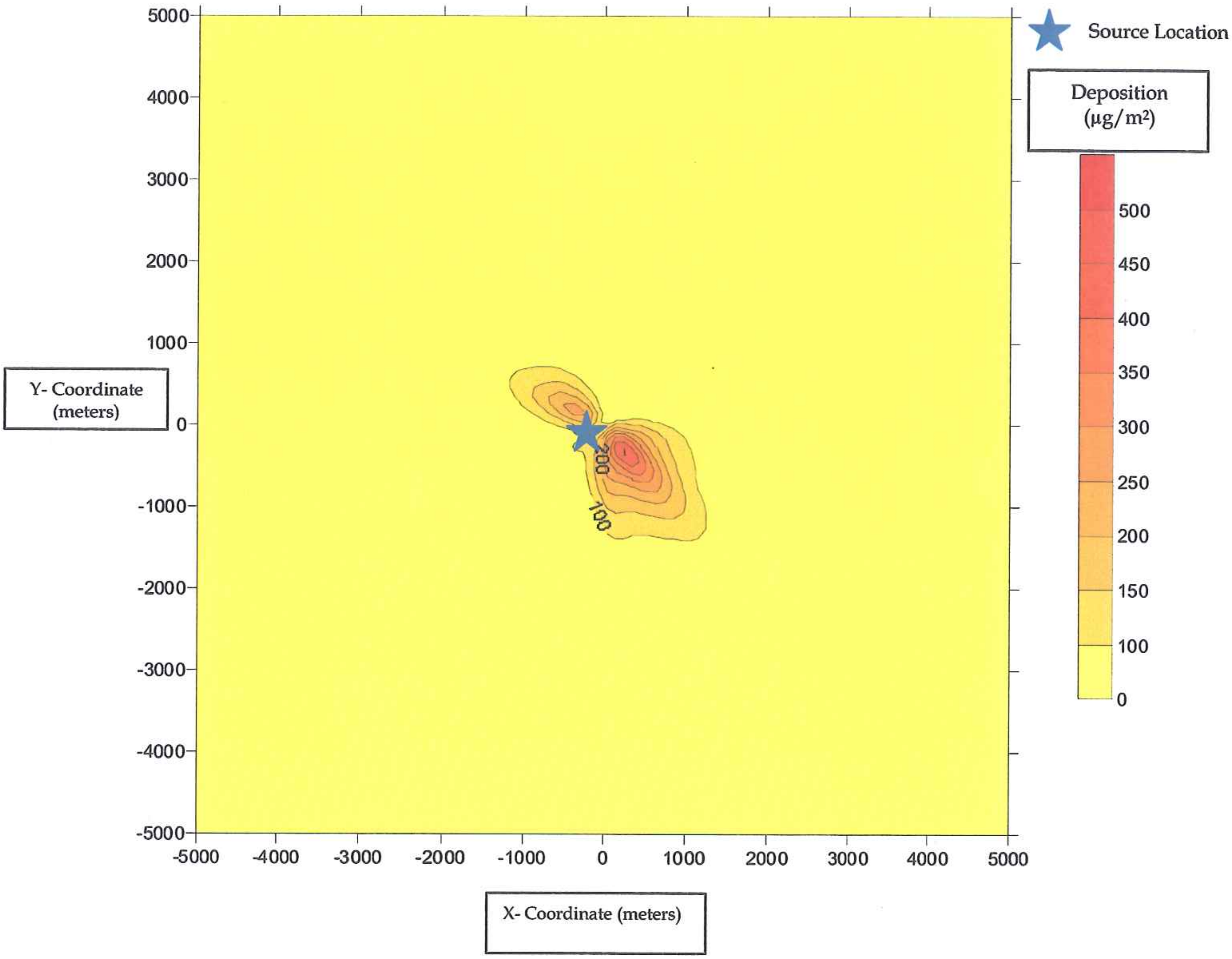

FIGURE A-2. TOTAL DEPOSITION OF MAGNESIUM FROM MAGNESIUM SODIUM NITRATE

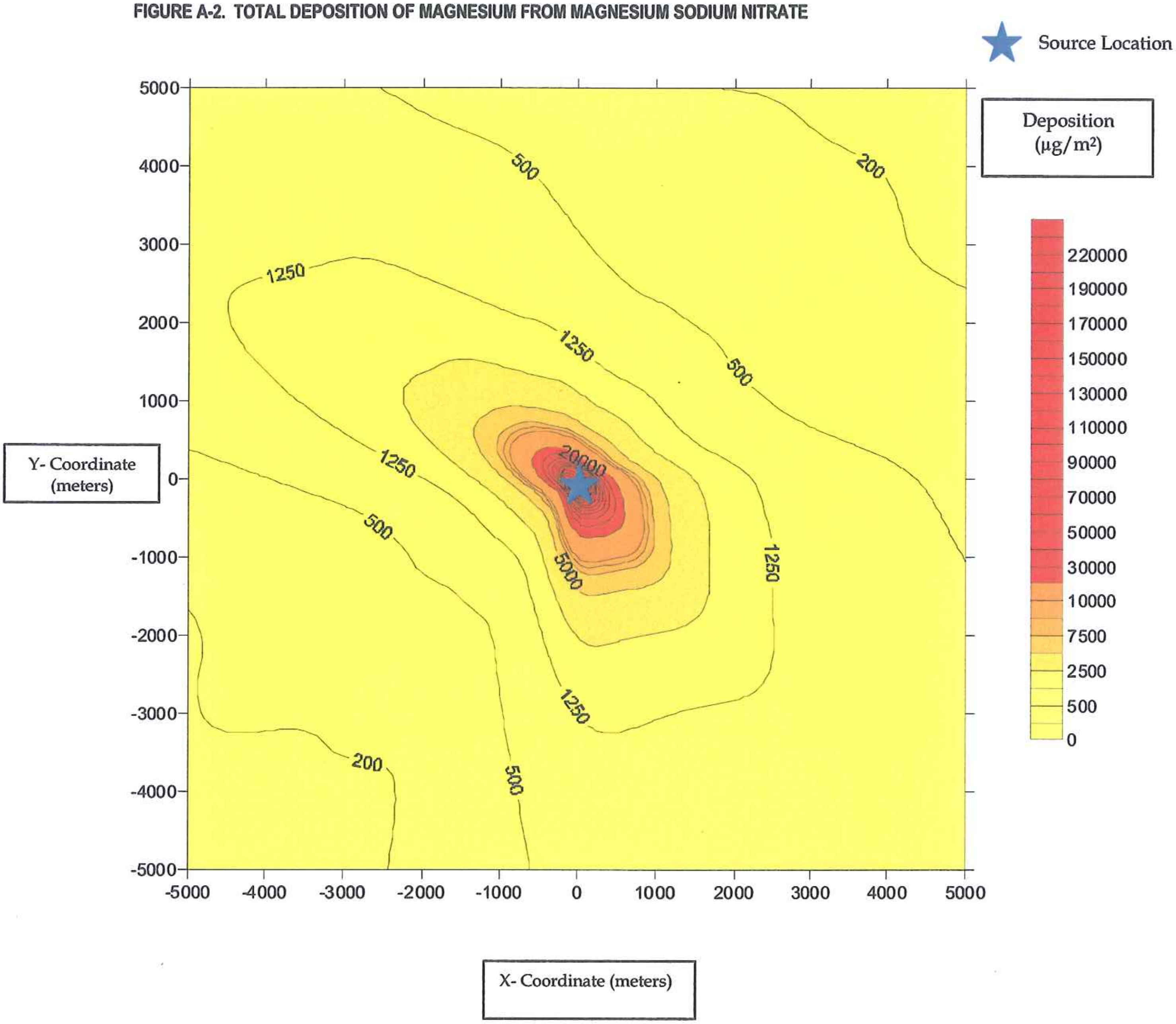

FIGURE A-3. TOTAL DEPOSITION OF TOTAL SUSPENDED PARTICULATE FROM DIESEL AND DUNNAGE

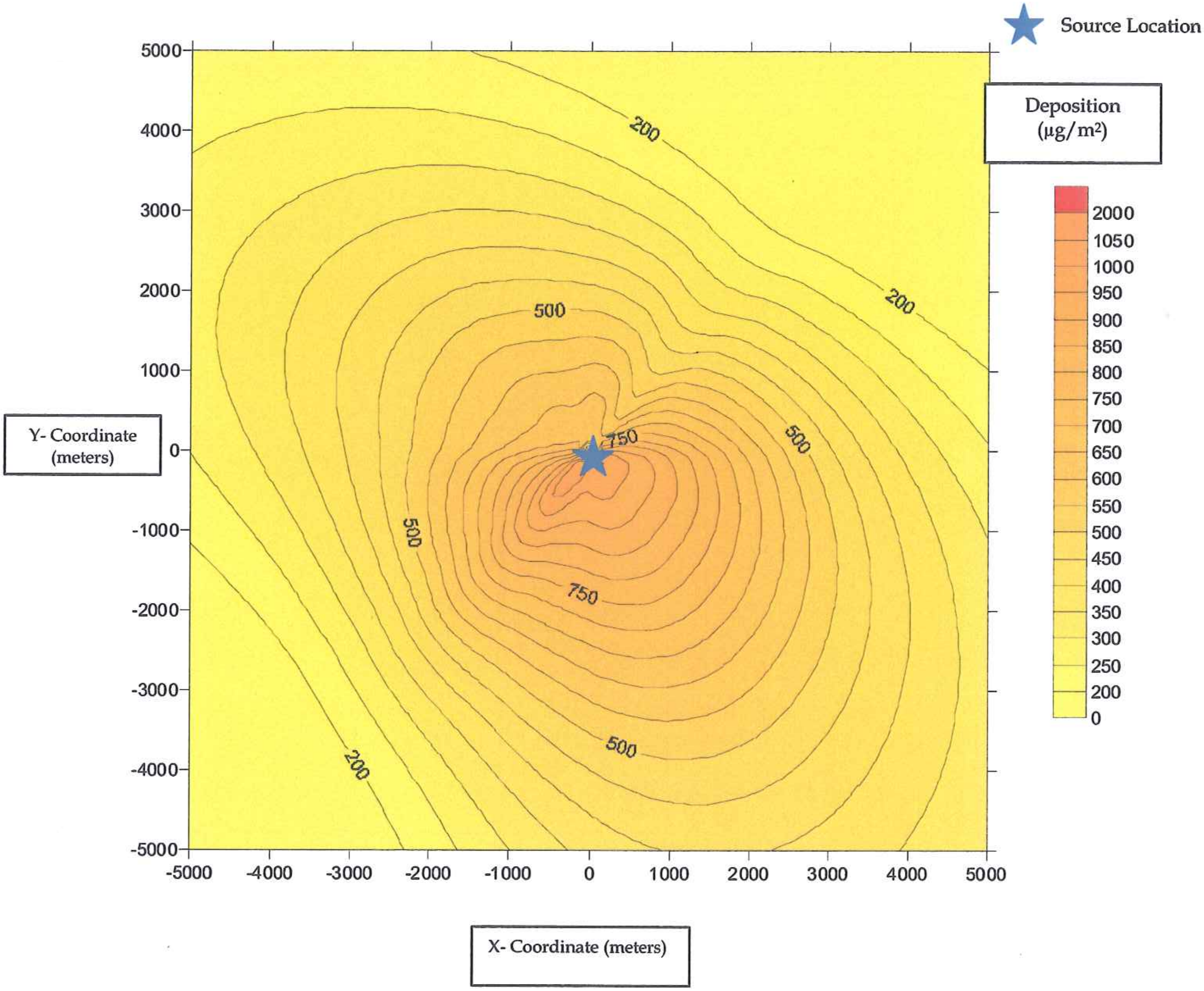

FIGURE A-4. TOTAL DEPOSITION OF TOTAL SUSPENDED PARTICULATE FROM AMMONIUM PERCHLORATE