50

ENTERED

RECEIVED
APR 2012
NMED Hazardous Waste Bureau

LA-UR-12-20320
Approved for public release; distribution is unlimited.

Title: The Vapor Plume at Material Disposal Are C in Relation to Pajarito Corridor Facilities

Author(s): Masse, William B.

Intended for: Report
Environmental Regulatory Documents

Los Alamos
NATIONAL LABORATORY
EST. 1943

Disclaimer:
Los Alamos National Laboratory, an affirmative action/equal opportunity employer,is operated by the Los Alamos National Security, LLC for the National NuclearSecurity Administration of the U.S. Department of Energy under contract DE-AC52-06NA25396. By approving this article, the publisher recognizes that the U.S. Government retains nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Departmentof Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

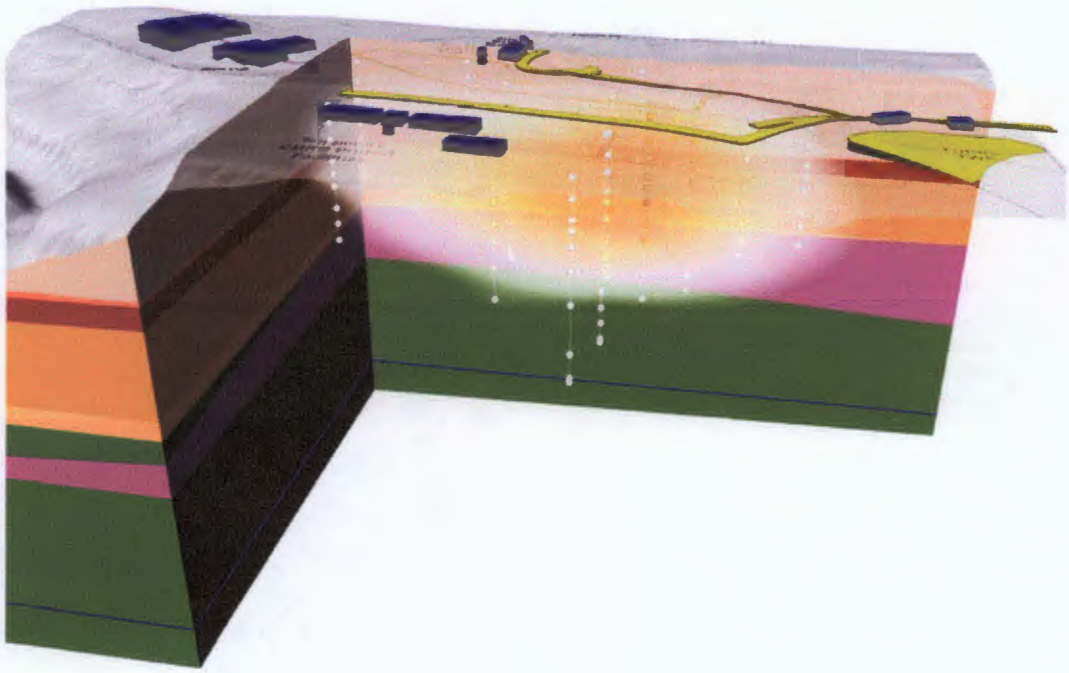
35155

LA-UR-12-XXXX
Approved for public release; distribution is unlimited.

March 2012

Title

The Vapor Plume at Material Disposal Area C in Relation to Pajarito Corridor Facilities



Los Alamos
NATIONAL LABORATORY
Los Alamos, New Mexico 87545

Prepared by:

W. Bruce Masse (ENV-ES)
Kay H. Birdsell (EES-16)
Charles J. English (REGS-DO)
Daniel M. Strobridge (Weston Solutions)

This report was prepared as an account of work sponsored by an agency of the U.S. Government. Neither Los Alamos National Security, LLC, the U.S. Government nor any agency thereof, nor any of their employees make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represent that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by Los Alamos National Security, LLC, the U.S. Government, or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of Los Alamos National Security, LLC, the U.S. Government, or any agency thereof. The Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

Contents

Executive Summary 1
1.0 Introduction 1
2.0 Worker Health and Safety 3
2.1 Comparison to Threshold Limit Values 3
2.2 Trichloroethylene 4
3.0 Material Disposal Area C and Pajarito Corridor Facilities 4
4.0 Distribution of the TCE Plume at MDA C and LANL Worker Safety 6
5.0 Conclusions Regarding the Health Risks of the TCE Vapor Plume at MDA C 11

List of Figures

Figure 1. The location of TA-50 at LANL 2
Figure 2. MDA C in relation to proposed and existing Pajarito Corridor facilities and roads. The transect path (A—A') is used for the profile view depicted in Figure 3 5
Figure 3. Profile view of the TCE vapor plume expressed as percent of the Threshold Limit Value (TLV) 7
Figure 4. Threshold Limit Value (TLV) percentages for the TCE vapor plume at MDA C in relation to those Pajarito Corridor construction activities with a maximum depth below surface of 5 feet 9
Figure 5. Threshold Limit Value (TLV) percentages for the TCE vapor plume at MDA C in relation to those Pajarito Corridor construction activities with a maximum depth below surface of 24 feet 10
Figure 6. An oblique slightly upward profile view of the trichloroethylene (TCE) vapor plume at MDA C, depicting the sampling locations for fifteen bore holes. The relative Threshold Limit Value (TLV) percentage of TCE for each sample is represented by the color gradient. White indicates a TLV of less than 10%, grading up through yellow and orange. The dark orange-brown sample location in the center of the plume represents a TLV greater than 100% 12

Executive Summary

A vapor plume made up of volatile organic compounds is present beneath Material Disposal Area C (MDA C) at Los Alamos National Laboratory (LANL). The location and concentrations within the vapor plume are discussed in relation to existing and planned facilities and construction activities along Pajarito Road (the "Pajarito Corridor") and in terms of worker health and safety. This document provides information that indicates that the vapor plume does not pose a threat to the health of LANL workers nor will it pose a threat to workers during construction of proposed facilities along Pajarito Road.

1.0 Introduction

The Los Alamos National Laboratory (LANL or the Laboratory) monitors emissions, effluents, and environmental media to meet environmental compliance requirements, determine actions to protect the environment, and monitor the long-term health of the local environment. LANL also studies and characterizes "legacy" waste from past Laboratory operations to make informed decisions regarding eventual corrective actions and the disposition of that waste. Starting in 1969, these activities have been annually reported in the *LANL Environmental Report* (formerly Environmental Surveillance Report), and are detailed in publicly accessible technical reports meeting environmental compliance requirements.

Included among the legacy sites being investigated are several formerly used material disposition areas (MDAs) set aside by the Laboratory for the general on-site disposal of waste from mission-related activities. One such area is MDA C located in Technical Area 50 (TA-50), which was used for waste disposal between 1948 and 1974. The location of TA-50 is depicted in Figure 1.

On July 15, 2011 the *Phase III Investigation Report for Material Disposal Area C, Solid Waste Management Unit 50-009 at Technical Area 50 (EP2011-0223)* was submitted by LANL and the Los Alamos Site Office (LASO) of the Department of Energy to the New Mexico Environment Department (NMED). The report discussed the sampling performed to define a vapor plume made up of volatile organic compounds (VOCs) beneath MDA C. In particular, the concentration data for the most prevalent VOC, trichloroethylene (TCE), were modeled to illustrate the shape and extent of the vapor plume.

The Investigation Report examined the vapor plume with respect to its potential for impacting groundwater and found that the plume is situated about 700 ft above the regional aquifer. In addition, the results from groundwater monitoring at two down gradient regional aquifer monitoring wells, R-46 and R-60, were included in the report (Figure 2). The results of sampling performed at wells R-46 and R-60 indicate no release of contaminants from MDA C to the regional aquifer. Water-level data collected from R-60 during the Phase III investigation were used to update an evaluation of the groundwater-monitoring network for MDA C. This evaluation showed that wells R-46 and R-60 have a high efficiency for detecting potential releases from MDA C.

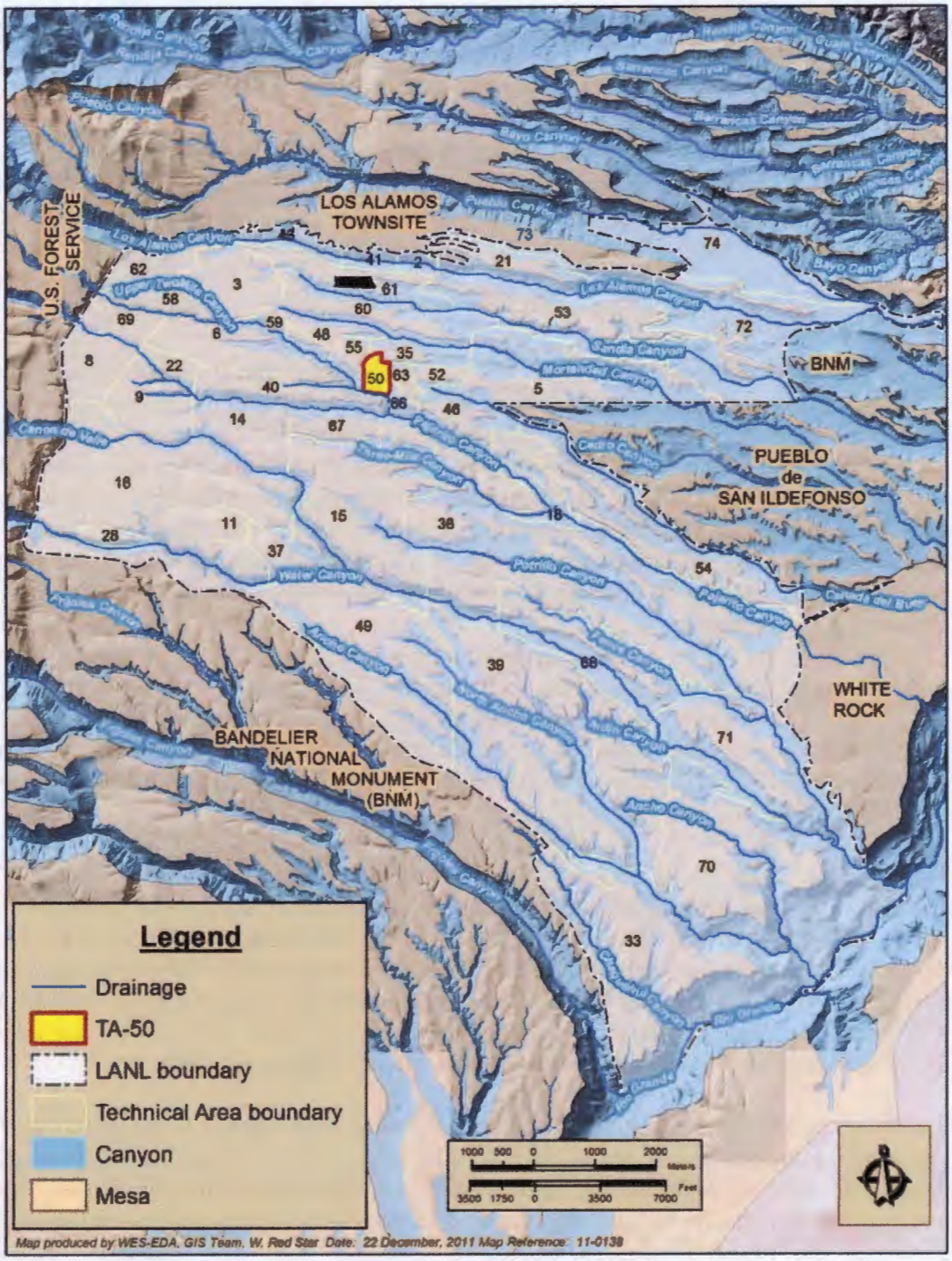


Figure 1. The location of TA-50 at LANL.

As is standard practice, the Phase III Investigation Report was made available to the public on the NMED website. Following the release of the report, questions regarding the vapor plume were raised during the July 2011 biannual public meeting for the LANL Chemistry and Metallurgy Research Replacement-Nuclear Facility (CMRR) Project, and the August 2011 public meeting for the Transuranic Waste storage facility (TWF) Project RCRA permit. Both of these projects, along with the Radioactive Liquid Waste Treatment Facility (RLWTF) Project, are scheduled to perform construction-related activities in the general vicinity of MDA C (Figure 2). On February 14, 2012 it was announced that the construction activities for the CMRR project will likely be delayed for at least five years.

The present paper uses a series of maps and cross sections to address the public concerns raised about the vapor plume at MDA C. As illustrated here, extensive sampling and data interpretation indicate that the vapor plume at MDA C does not pose a threat to the health of LANL workers nor will it pose a threat to workers during construction of the proposed facilities. The public cannot be directly exposed to the vapor plume beneath MDA C because Pajarito Road is closed to the public.

2.0 Worker Health and Safety

2.1 Comparison to Threshold Limit Values

The main concern with the MDA C vapor plume with respect to worker health and safety is that workers might experience health effects from breathing vapors emanating from MDA C at the ground surface, into nearby buildings, or during excavation and construction of proposed facilities. The subsurface vapor concentrations of all the constituents in the plume are compared to the time-weighted threshold limit values (TLVs) defined by the American Conference of Governmental Industrial Hygienists (ACGIH). The time-weighted average TLV represents the level to which it is believed a worker can be exposed daily during an entire career, based on an 8 hour work day and 40 hours worked each week, without adverse health effects. The TLVs are guidelines that the ACGIH considers to be either as protective as or more protective than the regulatory limits set by the Occupational Health and Safety Administration (OSHA).

A total of 28 VOCs have been detected in vapor plume beneath MDA C in the two years of quarterly monitoring data collected at the site. The maximum vapor-phase concentrations of these constituents were compared to their respective TLVs. Of these, only trichloroethylene (TCE) exceeds its TLV. The TLV for airborne TCE is 50 parts per million (ppm), a standard that is also accepted by OSHA. Based on two years of quarterly vapor monitoring, TCE concentrations at MDA C exceed the TLV at depths of 200 to 300 ft below ground surface (bgs), with a maximum of 118% of the TLV. However, TCE concentrations have been determined to be significantly lower than the TLV at the ground surface and at 20 feet below the surface (Figure 3).

2.2 Trichloroethylene

Trichloroethylene (TCE) is a nonflammable and noncorrosive colorless or blue liquid. At room temperature TCE has a sweet odor and a burning taste. It is used as an ingredient in adhesives, paint removers, typewriter correction fluids, and spot removers, with its primary purpose being that of a solvent to remove grease from metal parts.

TCE is not thought to occur naturally in the environment. At various locations throughout the United States it has been found in underground water sources and many surface waters as a result of the manufacture, use, and disposal of the chemical. It is slightly soluble in water, soluble in other solvents such as ethanol and acetone, and readily mixes with oil. It is relatively stable, but oxidizes slowly when exposed to sunlight in air. TCE is a volatile organic compound (VOC), meaning it evaporates quickly and easily into the air.

The peak use of TCE as a solvent, including at LANL, was in the 1960s. As studies began to better define the toxic nature of TCE, its use was largely discontinued in favor of other solvents. Breathing small amounts of TCE can irritate the eyes and throat, cause headaches, dizziness and difficulty concentrating. Over the long term, it can cause nervous system, kidney and liver damage.

TCE is reasonably anticipated to be a human carcinogen based on limited evidence of carcinogenicity from studies in humans, sufficient evidence of carcinogenicity from studies in experimental animals, and information from studies on mechanisms of carcinogenesis. TCE is now considered to be "highly likely to produce cancer in humans" by the National Academy of Sciences, although its potency may be low.

The time-weighted TLV is set so that a worker does not experience these health effects even with daily exposure.

3.0 Material Disposal Area C and Pajarito Corridor Facilities

MDA C is located within the southern portion of TA-50 at the head of Ten Site Canyon (Figure 1). TA-50 is bounded on the north by Effluent and Mortandad Canyons, on the east by the upper reaches of Ten Site Canyon, on the south by Twomile Canyon, and on the west by TA-55.

MDA C is an inactive 11.8-acre landfill consisting of 7 disposal pits (trenches) and 108 shafts (Figure 2). Solid waste containing hazardous constituents as well as radioactive waste was disposed of in the landfill between 1948 and 1974. The depths of the 7 pits at MDA C range from 12 to 25 ft below the original ground surface, and the depths of the 108 shafts range from 10 to 25 ft below the original ground surface. The original ground surface is defined as the surface beneath the cover that was placed over the site in 1984. The topography of MDA C is relatively flat, although the slope descends to the north where the northeast corner of MDA C abuts the south wall of Ten Site Canyon.

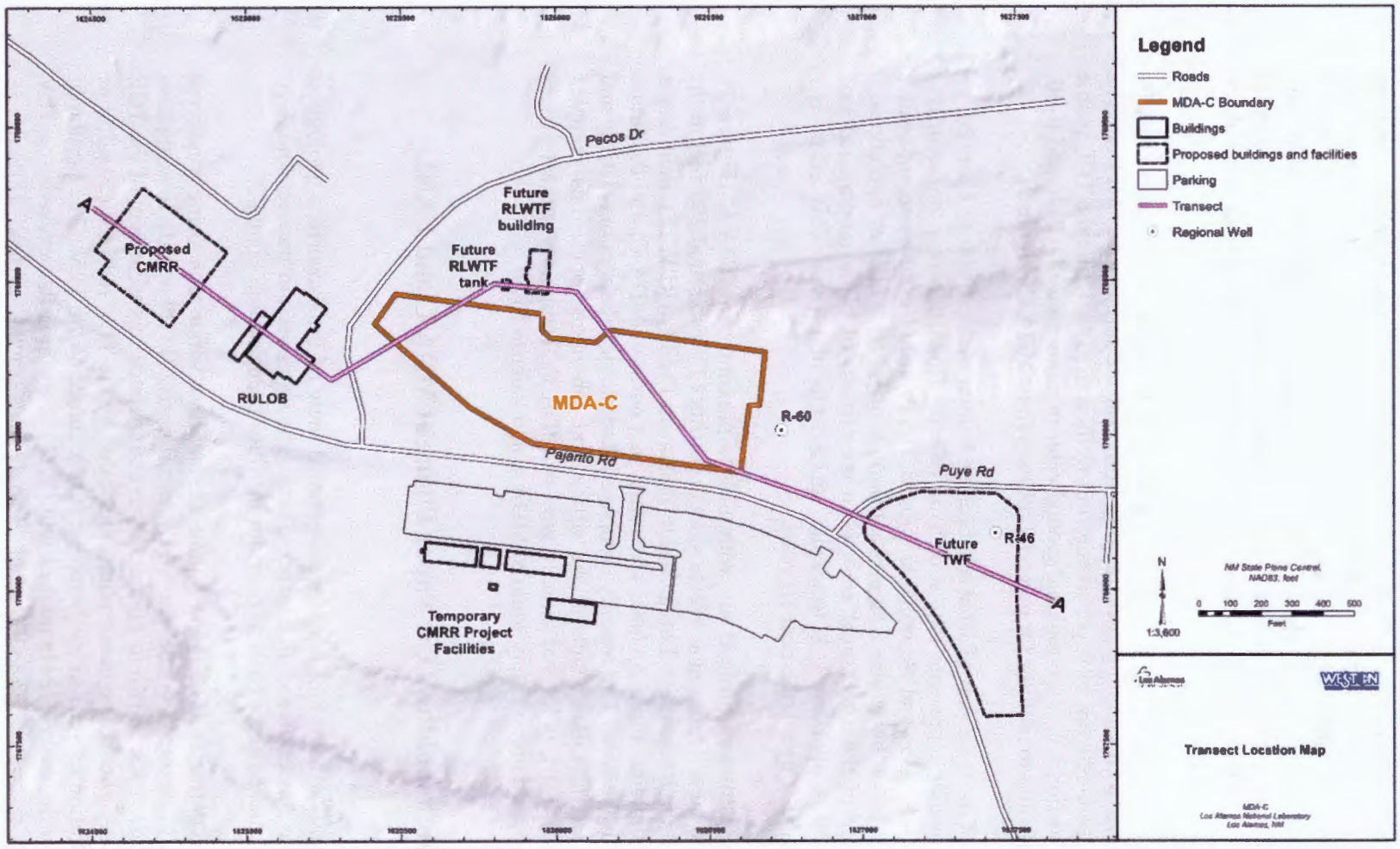


Figure 2. MDA C in relation to proposed and existing Pajarito Corridor facilities and roads. The transect path (A—A') is used for the profile view depicted in Figure 3.

MDA C was the primary disposal site at the Laboratory before waste disposal operations began at TA-54. Although information on the waste inventory at MDA C is limited, the wastes received at the site likely included waste solvents as well as solid wastes with incidental solvent contamination. The amount of TCE disposed at MDA C is unknown; however, the total mass of TCE currently in the subsurface environment is calculated to be equivalent to around 30 gallons based on the vapor concentrations measured at the site.

The vapor-monitoring network at MDA C is made up of 14 vapor monitoring wells with 129 sampling ports with sampling ports ranging from near the surface to 697 ft bgs. The data from this dense network of vapor monitoring wells is used to define the TCE plume as described in section 4.0. Two regional groundwater-monitoring wells, R-46 and R-60, are placed specifically to monitor for potential releases from MDA C (Figure 2).

The facilities at TA-50 are part of what has become known as the "Pajarito Corridor." The Pajarito Corridor represents that stretch of Pajarito Road between the security checkpoints east of TA-59 and west of White Rock. The Pajarito Corridor encompasses several technical areas that house a significant portion of LANL's nuclear operations. The infrastructure of these technical areas is in the process of being modernized to ensure continuous support of U.S. stockpile stewardship objectives. This effort is expected to continue through the next 10 years.

Three major infrastructure projects are within close proximity to MDA C (Figure 2). These include the new Transuranic Waste storage facility (TWF) around 500 feet to the east; upgrades to the Radioactive Liquid Waste Treatment Facility (RLWTF), including a new operations building and associated water tank just north of MDA C; and the future CMRR facility to the west. The recently completed Radiological Laboratory, Utility and Office Building (RLUOB), which is the office and laboratory operations complex associated with CMMR, is located directly west of MDA C. Temporary project offices for CMRR are located immediately south of MDA C and Pajarito Road.

4.0 Distribution of the TCE Vapor Plume at MDA C and LANL Worker Safety

Figure 3 represents a 1600-foot-deep cross-sectional view of the subsurface geology at MDA C with the superimposed TCE vapor plume. The cross-section transect line A-A' through MDA C and adjacent Pajarito Corridor facilities is depicted in Figure 2.

The data used to define the TCE vapor plume are based on vapor monitoring conducted in 2010 and 2011 reported in the previously mentioned 2011 Phase III Investigation Report. The vapor plume shown in Figure 3 is an extrapolated representation of the TCE concentration data. The TCE concentrations are scaled by the TLV for TCE (50 ppm) so that the concentration contour intervals represent percentage of the TLV. The portion of the plume within the dashed circle marked with 100% is the area that exceeds the TLV for TCE; this occurs at 200-300 feet below the ground surface (Figure 3).

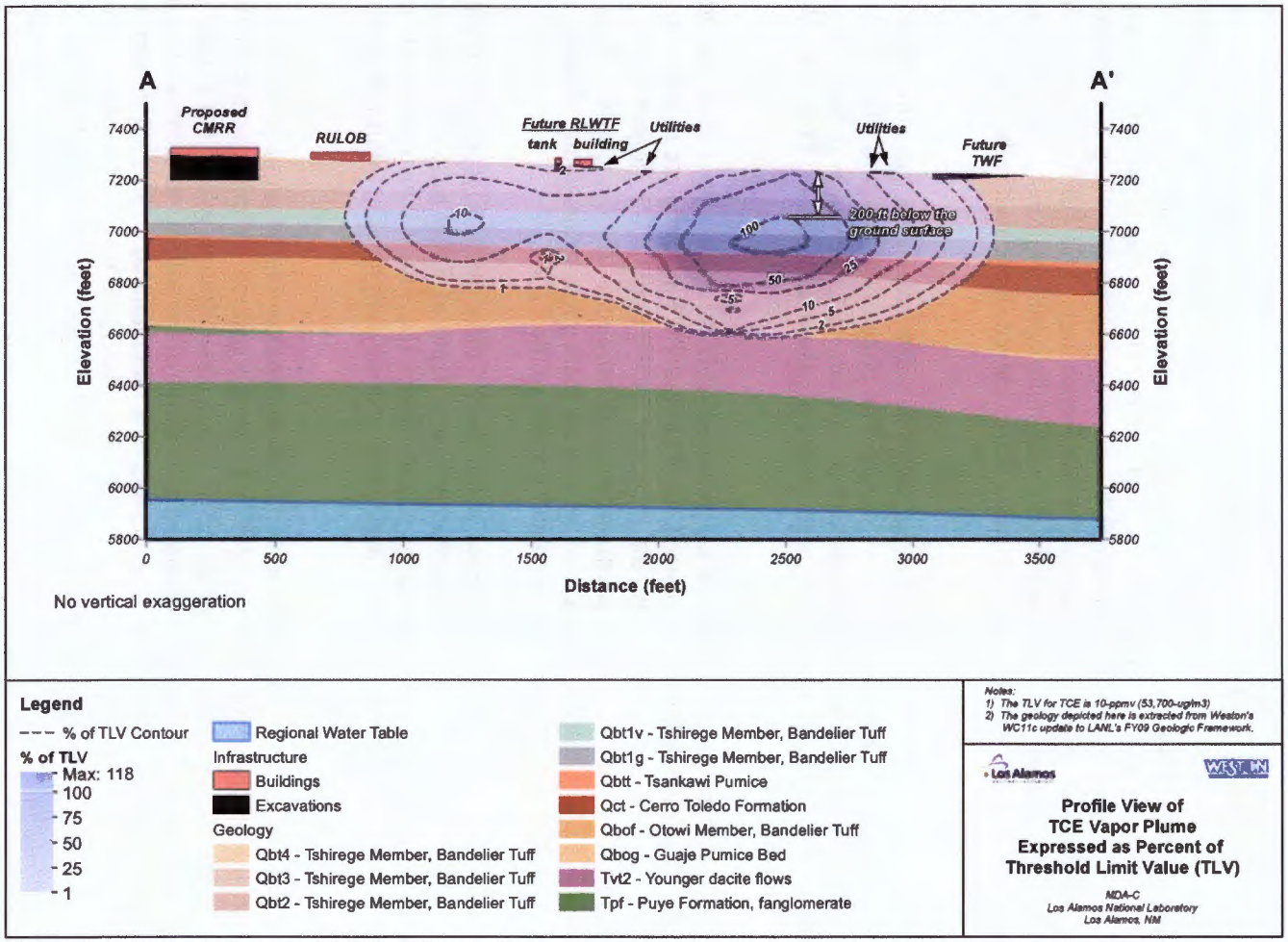


Figure 3. Profile view of the TCE vapor plume expressed as percent of the Threshold Limit Value (TLV).

The MDA C pits and shafts are dug into the mesa top to a depth of 25 ft bgs. Over the history of MDA C, TCE has migrated out of the original pits and shafts. The present TCE plume is a vapor-phase plume; there is currently no evidence of liquid-phase TCE in the subsurface at MDA C. Vapor-phase migration of TCE within the tuff units can be described by diffusive behavior that spreads the vapor in all directions along concentration gradients that diminish with increasing distance from the highest concentrations in the center of the plume. The steepest concentration gradients are upward toward the surface, which leads to preferential VOC transport toward the mesa top and yields releases to the atmosphere. TCE vapors are present near the pits and shafts, but their concentrations are not as high as in the deeper units. This configuration of the vapor plume, particularly the depth where the maximum concentrations occur, indicates the plume is predominantly related to releases that occurred in the past rather than from ongoing releases.

Based on two years of quarterly monitoring, the TCE vapor emanation from the site and its release to the atmosphere appears to be steady. The plume configuration suggests that the bulk of the VOCs present in the subsurface is from past releases with little or no contribution from ongoing releases from the waste disposed at MDA C. Therefore, the plume is considered to be stable.

Figure 3 indicates that the RLUOB and the proposed CMRR facilities are clearly outside of the modeled plume, while the proposed RLWTF and TWF projects are in areas with low TLV measurements. Specifically, the proposed RLWTF and TWF project facilities are in locations in which the measured surface concentrations of TCE are less than 5 percent of the TLV. Utility trenches associated with these three projects are likewise in locations with surface measurements around 5 percent of the TLV.

These relationships can also be visualized in "at depth" plan views. Figure 4 represents the TCE vapor plume that would be encountered at a depth of 5 feet bgs. This is useful for understanding how the vapor plume might impact the future construction of the RLWTF building and a series of utility trenches that cross the plume but will not exceed a depth of 5 feet.

The maximum TCE vapor concentration at the 5-foot depth would be about 30 percent of the TLV in the southeastern corner of MDA C. In the case of the construction of the RLTWF building, it is expected that the TCE vapor concentration would not exceed 2 percent of the TLV at the construction site. The bottoms of the utility line trenches would encounter a TCE vapor concentration estimated at a maximum of around 10 percent of the TLV, and typically much less. Figure 4 also illustrates that TCE vapor plume concentrations in the vicinity of the temporary CMRR project facilities south of Pajarito Road are anticipated to be minimal. The parking areas would be subject to a TCE vapor concentration less than 5% of the TLV, while the temporary office buildings would be less than 1%. The fact that the parking areas are paved greatly reduces the likelihood of detectable surface concentrations of TCE in the vicinity of the temporary facilities.

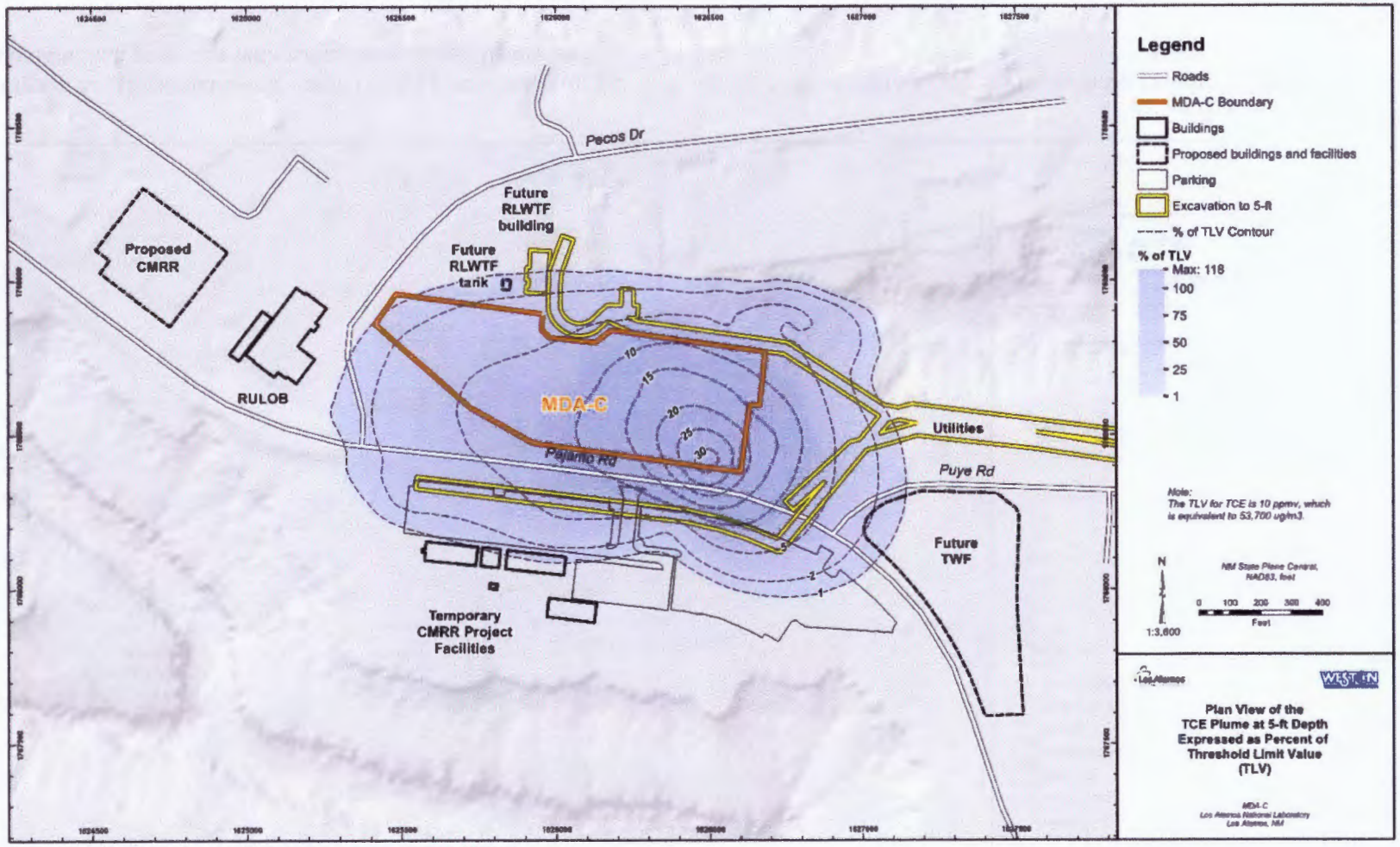


Figure 4. Threshold Limit Value (TLV) percentages for the TCE vapor plume at MDA C in relation to those Pajarito Corridor construction activities with a maximum depth below surface of 5 feet.

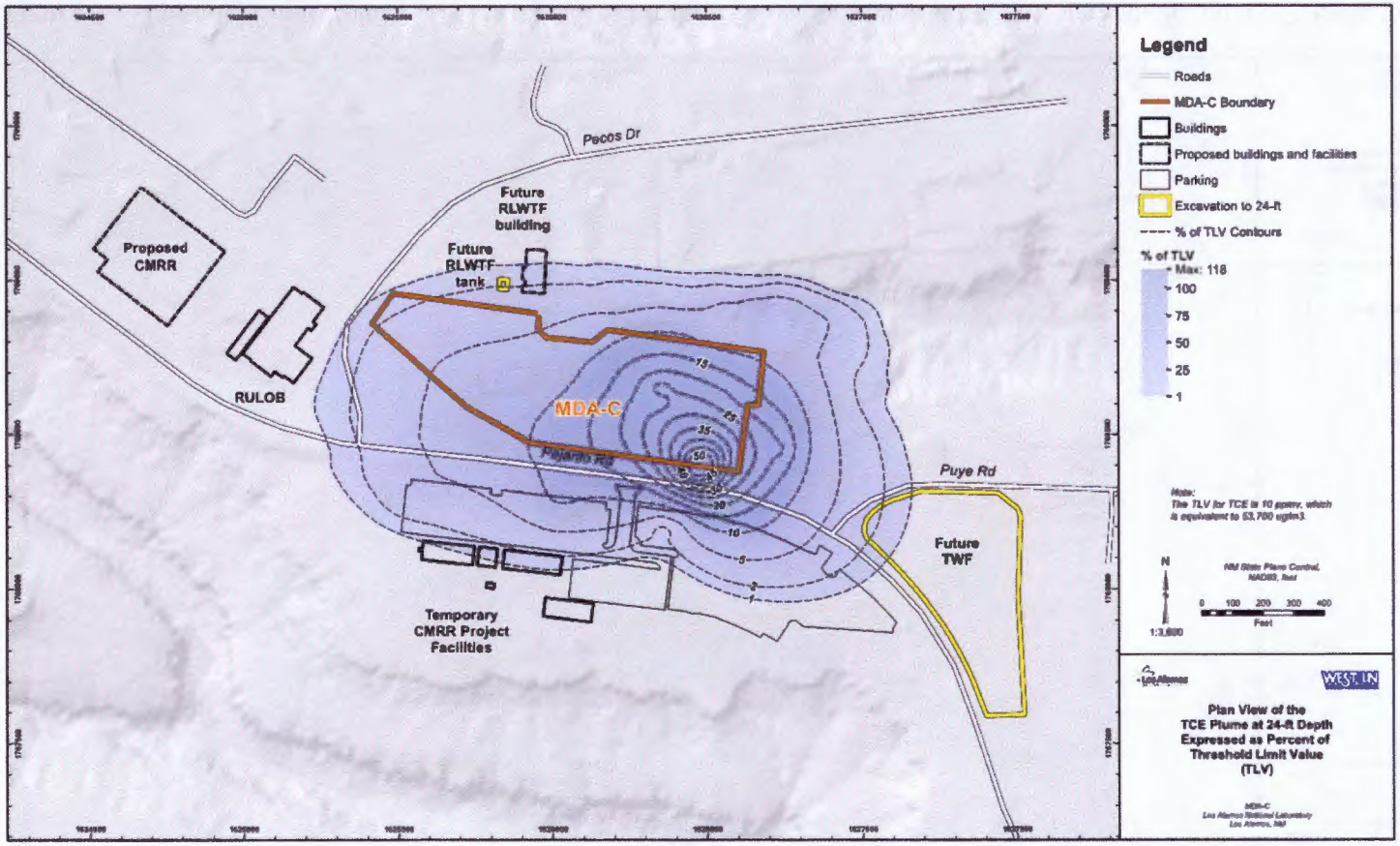


Figure 5. Threshold Limit Value (TLV) percentages for the TCE vapor plume at MDA C in relation to those Pajarito Corridor construction activities with a maximum depth below surface of 24 feet.

Figure 5 similarly depicts the modeled TCE vapor plume at a depth of 24 feet below the present ground surface. The modeled plume at this depth indicates that the highest concentration of TCE would be around 50% of the TLV in the southeastern corner of MDA C.

Construction of the TWF includes the leveling of the site to design grade, which will require the removal of fill to a depth of approximately 20 feet below the present surface in the northwestern upslope portion of the project area. The anticipated TCE vapor concentration at the bottom of the construction excavation would be less than 5% of the TLV. The construction of the foundation for the RLWTF water tower would encounter a TCE vapor concentration estimated at around 2% of the TLV.

Figure 6 depicts a three-dimensional view of the TCE vapor plume and pertinent sampling locations. The oblique slightly upward view shows the relationship between the sampled boreholes, relative TLV concentrations for the measured TCE values at sampling stations within each borehole, and surface facilities including the CMRR temporary project buildings, utility trenches, and the TWF project site. A similar downward view is depicted on the cover page for this paper.

5.0 Conclusions Regarding the Health Risks of the TCE Vapor Plume at MDA C

Investigations at MDA C have defined a vapor plume beneath the site. The maximum trichloroethylene (TCE) concentrations in the plume exceed the American Conference of Governmental Industrial Hygienists Threshold Limit Value (TLV) for adversely affecting human health at a subsurface depth of between 200 and 300 feet. On the surface the maximum is slightly more than 30% of the TLV in the southeastern corner of MDA C. These percentage values drop off below 10% of the TLV in all areas represented by present and planned Pajarito Corridor infrastructure projects. This document provides information that indicates that the vapor plume does not pose a threat to the health of LANL workers nor will it pose a threat to workers during construction of proposed facilities along Pajarito Road.

Figure 6. An oblique slightly upward profile view of the trichloroethylene (TCE) vapor plume at MDA C, depicting the sampling locations for fifteen bore holes. The relative Threshold Limit Value (TLV) percentage of TCE for each sample is represented by the color gradient. White indicates a TLV of less than 10%, grading up through yellow and orange. The dark orange-brown sample location in the center of the plume represents a TLV greater than 100%.