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SEP 1999
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Date: September 28, 1999
Refer to: E/ER:99-279

Mr. John Kieling
NMED-HRMB
P.O. Box 26110
Santa Fe, NM 87502

SUBJECT: SUBMITTAL OF ADDENDUM TO CMS PLAN FOR PRS 16-021(c)

Dear Mr. Kieling:

Enclosed is the Addendum to the Corrective Measures Study (CMS) Plan for Potential Release Site (PRS) 16-021(c), the 260 Outfall. This addendum is being submitted as a result of several discussions with Mr. John Young of your staff.

If you have any questions or concerns please call Dave McInroy at (505) 667-0819 or Joe Mose at (505) 667-5808.

Sincerely,

Brad

Julie A. Canepa, Program Manager
Los Alamos National Laboratory
Environmental Restoration

Sincerely,

T.J.T.

Theodore J. Taylor, Program Manager
Department of Energy
Los Alamos Area Office

JC/TT/NR/dm

Enclosure: Addendum to CMS Plan for 16-021(c)

6190

HSWA LANL 3/1082/16/16-021(c)

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September 1999

Addendum to CMS Plan for Potential Release Site

16-021(c)

3/1082/16/16-021(c)

Environmental Restoration Project
A Department of Energy Environmental Cleanup Program
ER19990107

Los Alamos
NATIONAL LABORATORY
Los Alamos, NM 87545

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Produced by the Remedial Actions Focus Area

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Insert the new section below on p. 57 of CMS Plan (Environmental Restoration Project 1998, 62413.3) within Section 6.1, "Objectives and Scope".

6.1.7 Regional Groundwater Investigations

The principal goal of this investigation is to determine the extent of contamination in the deep perched and regional aquifers associated with constituent discharges at Technical Area (TA) –16 and possibly other nearby sites. Subsidiary goals include: (1) determining how fast is that contamination moving downgradient toward the Pajarito well field or other potential exposure points; and (2) investigating the directions of groundwater flow and the hydrologic gradients within the regional and deep perched saturated zones at TA-16. These investigations will be used to evaluate the effects of regional groundwater contamination on human health or ecological assessment endpoints. The risk assessment for the surface soils, alluvial system, and vadose zone that will be completed under the 260 CMS will be augmented to include information on deep groundwaters derived from the investigations outlined in this CMS addendum. Thus, these data will be used to determine the necessity and feasibility of implementing cleanup remedies within the contaminated deep perched and regional groundwater systems associated with high explosives (HE) and other constituent discharges at TA-16 and potentially other nearby sites.

Insert the new section below on p. 59 of CMS Plan (Environmental Restoration Project 1998, 62413.3) within Section 6.2, "Approach and Implementation".

6. Regional groundwater

   Additional deep boreholes that intersect the regional aquifer will be drilled near TA-16. These borehole investigations are directly associated with the TA-16-260 CMS, but will also provide data relevant to investigations of other potential HE sources at TA-16 (Fish Ladder Canyon, Martin Spring Canyon, 90s Line Pond) and at TA-9. Data from these wells will be closely integrated with data from regional wells planned to be drilled under the Hydrogeologic Workplan (LANL 1998, 59599.1). Data from all these wells will be used to (1) determine the presence or absence of contamination and the concentrations of HE and other constituents at locations in the vicinity of regional well R-25; (2) investigate the seasonal variations of contaminant concentrations at these locations; (3) better define the hydrologic gradients, flow directions, and hydrologic properties in both the deep perched and regional saturated zones in the TA-16 region; (4) support modeling efforts designed to predict the movement of the HE plume(s) at TA-16; (5) design a monitoring program for the deep perched and regional aquifers; and (6) help evaluate whether multiple plumes exist in the deep perched zone and regional aquifer.

   Hydrologic information will be obtained during drilling. Water level measurements, packer or slug tests, and hydrologic parameter analyses of core from the saturated zones will be completed. Core/cuttings will be used to

determine lithologies. Downhole geophysics will be carried out where feasible in each borehole.

Multiple-port wells compliant with HSWA Module VIII Permit will be installed within these boreholes. Following well development, water from each screened interval will be sampled and submitted for HE, metal, and anion analysis. These analyses will be performed quarterly until completion of the CMS/CMI for PRS 16-021(c). The wells will be instrumented with pressure transducers. Seasonal water level data may be used to investigate any connectivity between portions of the deep perched and regional saturated zones.

Insert the following sections on p. 80 of CMS Plan (Environmental Restoration Project 1998, 62413.3), just before Section 6.4, "Data Collection Procedures".

6.3.6 Regional Groundwater Investigations

6.3.6.1 Overview

Background and Conceptual Model

High explosives were detected in regional well R-25 during fiscal year 1999. R-25 is located approximately 1700 ft east of the TA-16-260 outfall, PRS 16-021(c) (Figure 6.3-8). A major perched saturated zone was present between 747 ft and 1132 ft (Figure 6.3-9), and the regional aquifer extended from 1286 ft to the total depth of the borehole at 1942 ft. A zone of numerous alternating saturated zones and dry rock separates the two major saturated zones. The nature and degree of connectivity between these two major zones is unknown. Both of the major saturated zones appeared to contain HE constituents, including RDX, TNT, HMX, and amino-DNTs. RDX is the most abundant constituent; RDX concentrations range from non detect to above 75 ug/L (Figure 6.3-9). The two highest HE concentrations were in the middle of the perched zone and near the top of the regional aquifer, although until a developed well is complete it is difficult to evaluate whether any leakage from the upper zone to the lower zone has occurred.

As noted in Section 2 of this plan, HE contamination of shallow alluvial groundwater in Cañon de Valle and in the TA-16 springs is ubiquitous. RDX and other HE constituents are present in these media at levels greater than those observed in R-25. HE constituents at low levels (< 10 ug/L RDX) have also been observed in springs at TA-9, in springs at TA-18, and in surface and alluvial waters within Pajarito Canyon. It is assumed that liquid discharges at the TA-16 surface constitute the primary historic source for the HE observed at R-25.

Multiple sources of high explosives contamination have been identified in soils at several technical areas in the western portion of the Laboratory through RCRA Facility Investigation (RFI) studies completed to date. Based on these RFI studies, the largest HE contaminant source term in soils appears to be at the TA-16-260 outfall (see Section 2 of this CMS plan). Other sites with significant (greater than a few hundred ug/g HE in soils)

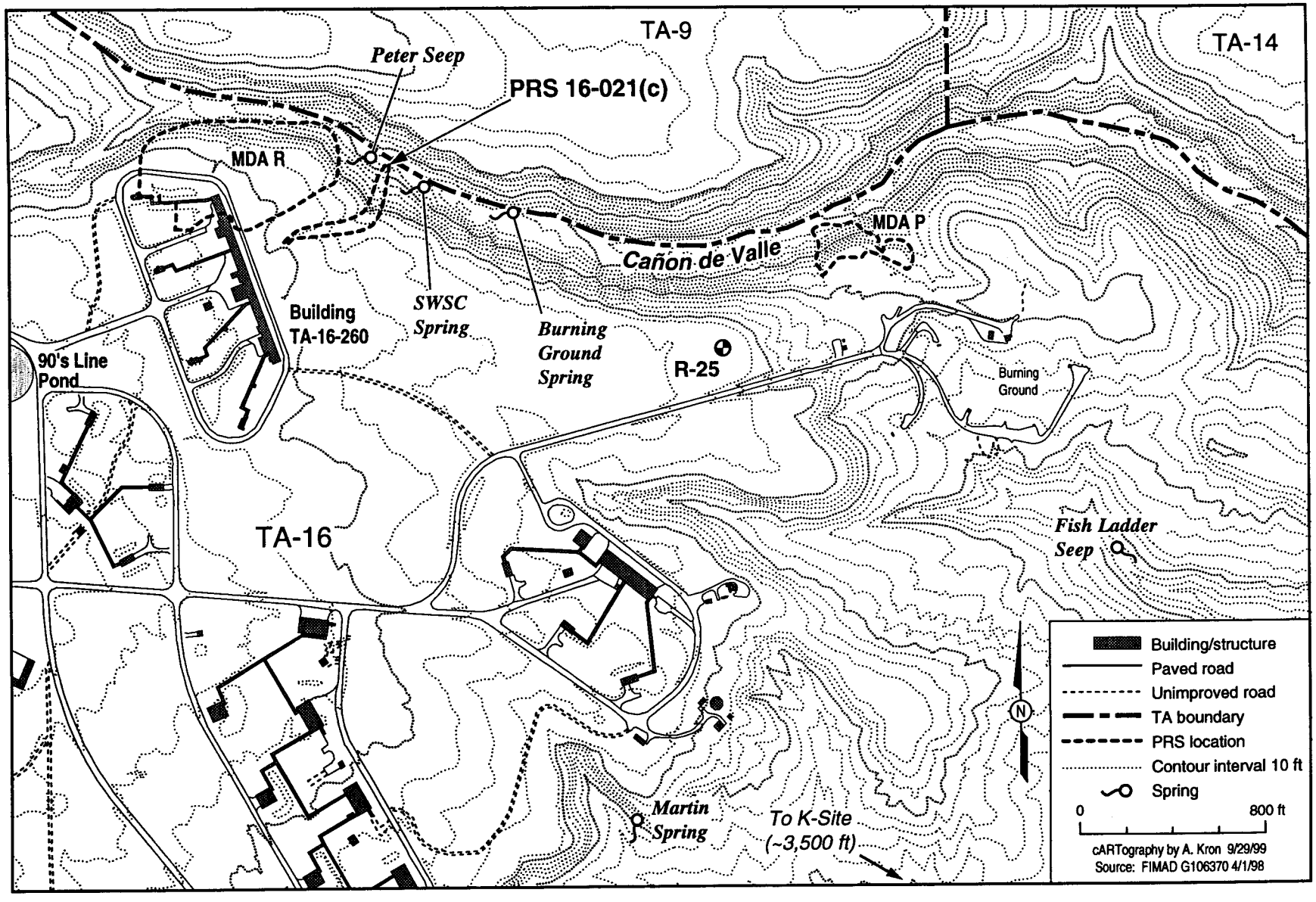

Figure 6.3-8. Location of PRS 16-021(c) and associated physical features

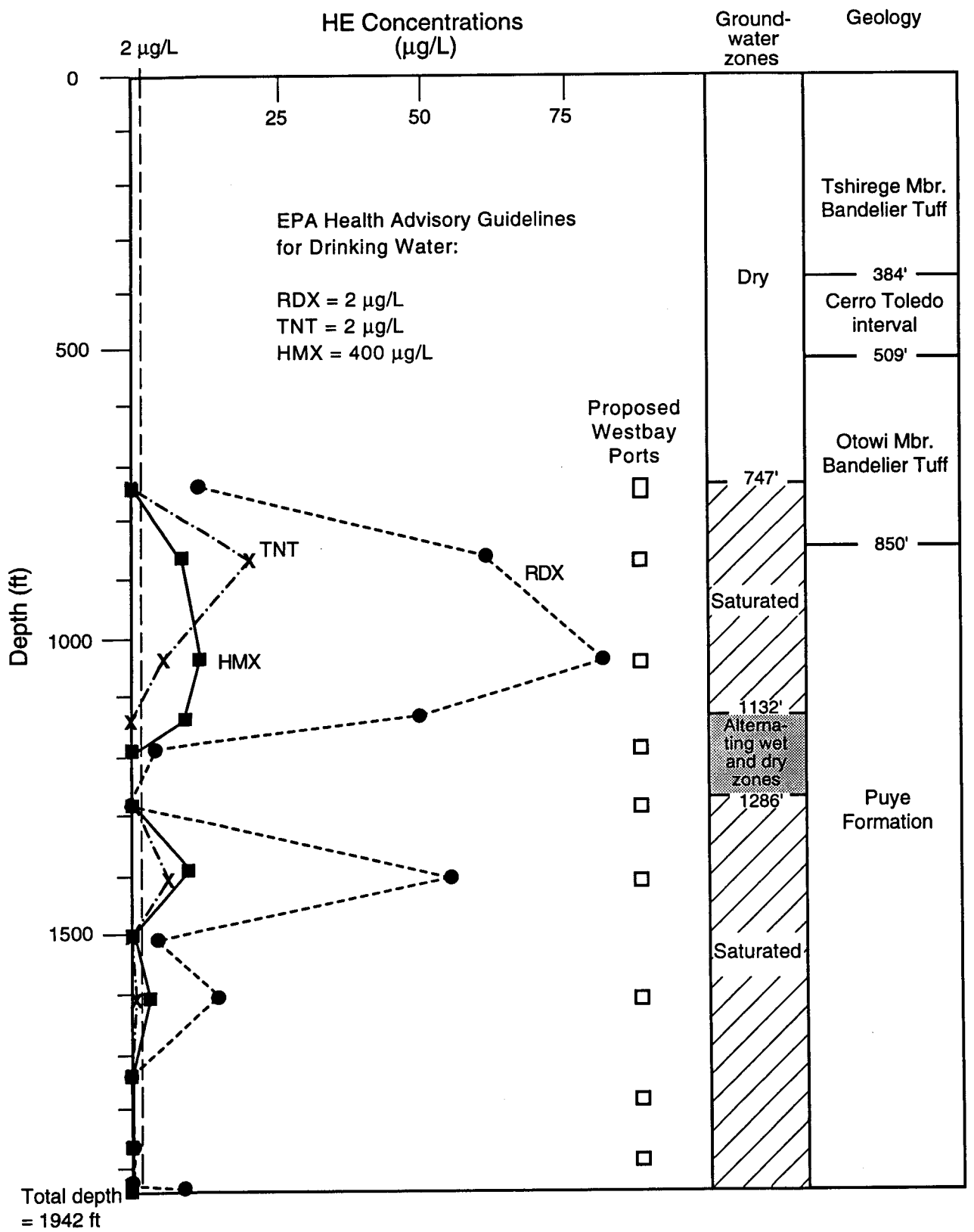

Figure 6.3-9. Distribution of HE compounds detected in deep groundwater at TA-16, borehore R-25

identified HE source terms include: the TA-16 Burning Ground and MDA P, MDA R, the TA-11 drop tower (K-Site), the 90s Line Pond, and TA-9-48 outfall at TA-9 (Figure 6.3-8). Although these, and other yet unidentified, sources may all be contributing HE to deep perched and regional saturated zones, the large contaminant mass at the TA-16-260 outfall and its location directly upgradient from regional well R-25 (Figure 6.3-8) suggest that it is the major source of HE in the deep perched and regional saturated zones in the TA-16 region.

The horizontal hydrologic gradient and flow directions in the regional aquifer are generally eastward from the mountain front of the Jemez Mountains, west of TA-16 (Purtymun 1995, 45344.1) (Figure 6.3-10). The gradient and flow directions in the TA-16 deep perched saturated zone are poorly defined. This deep perched saturated zone was found in seismic hazards borehole SHB-3. Water-level data from this borehole, coupled with that from R-25, suggest that the gradient in the deep perched zone is also from the west to east, perhaps with northerly and/or southerly components. Water-level data collected during the drilling of R-25 also suggest a vertical component to hydrologic gradients in the TA-16 area. There appears to be downward head gradients in both major saturated zones that might transport contamination to depth (Stone et al. 1999, 64010).

The principal recharge zone for the regional aquifer at TA-16 is hypothesized to lie to the west of TA-16, perhaps in association with the Pajarito Fault zone. Multiple recharge sources for the shallow perched zones at TA-16 were postulated [see Section 5 of the second TA-16-260 outfall RFI Report (Environmental Restoration Project 1998, 59891.3)]. These sources include the Cañon de Valle alluvial system and other surface saturated zones (90s Line Pond, steam plant drainage), diffuse surface recharge, recharge from TA-16 outfalls, and fracture-zone recharge. Inasmuch as the shallow saturated zones impact the deep perched zone and the regional aquifer, the deep perched zone and regional aquifer also must have multiple recharge zones. The ultimate surface discharge of the regional aquifer is in the White Rock Canyon springs and the Rio Grande.

Problems

The detection of HE in the deep perched and regional saturated zones at TA-16 raises questions concerning potential impacts on receptors. For the purpose of this CMS addendum, these two major saturated zones will be referred to as separate zones; however, whether they are distinct zones or both represent parts of the regional aquifer, is unknown. The principal question is whether there is a realistic pathway to exposure at concentrations above a threshold level of concern (or damage to a natural resource) from the HE found in deep groundwater underlying TA-16.

The primary initiative is to define the boundaries of any existing plumes, rather than (for instance) maximum concentrations within the plume (i.e., to determine the highest level of contamination at the present time). A key issue is whether HE constituents are likely to impact drinking water wells in the Pajarito well field that lies 7-8 km to the east of R-25 (Figure 6.3-10).

Four classes of data needs are identified. Each type of data bears on problems related to contaminant distribution, fate, and transport. Ultimately, the objective of collection of all of these data is to be able to accurately predict contaminant concentrations in the deep

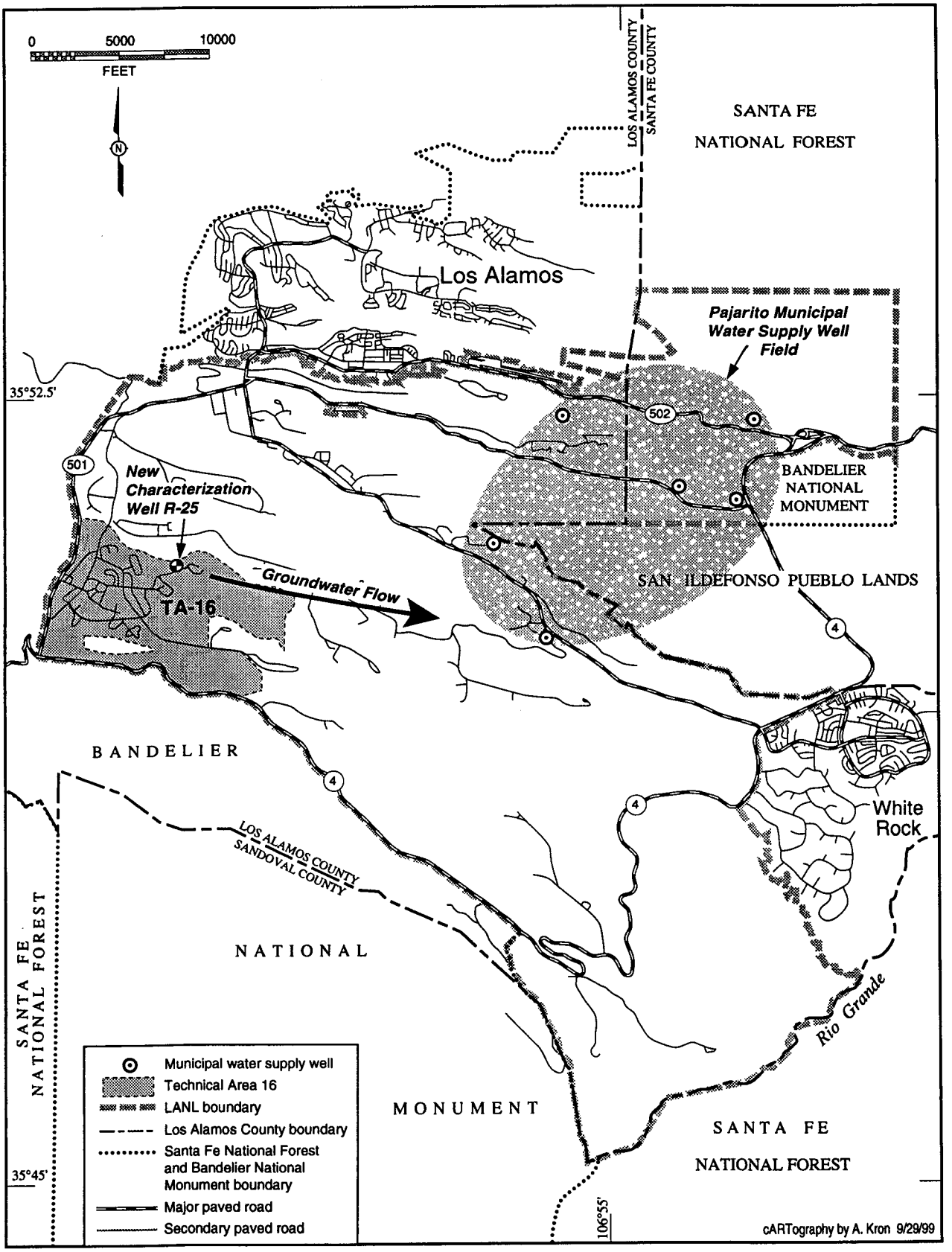

Figure 6.3-10. Location of Pajarito Municipal Water Supply Well Field relative to TA-16

perched and regional groundwater zones with a high degree of confidence. Such information on contaminant concentrations is needed to determine what type of remedy will be required for the deep perched and regional saturated zones.

1. The concentrations of HE and other anthropogenic constituents need to be determined at additional locations in the western portion of the Laboratory. The spatial boundaries of and contaminant distributions within the HE plume need to be defined for both major saturated zones. Based on the range of flow velocities calculated for the regional aquifer, the HE plume could extend as far as 7-8 km to the east of R-25.

   In addition, the constituent concentration data in additional wells are needed to define a monitoring baseline, to define trends in contaminant concentration both laterally and with depth, and to examine other aspects of the temporal and spatial variability of the contaminants in the deep perched and regional saturated zones. All of these data will be used both as input into models and for model validation.

   These concentration data will help determine: (1) whether contaminant concentrations decrease with distance from TA-16, or whether there is evidence for a high "pulse" of HE contamination associated with historic HE discharges; (2) if HE-degradation byproducts are present in the deep perched and regional aquifers, and whether information about this be used to investigate natural attenuation as a corrective action remedy; (3) to what degree the deep perched zone retards or enhances the flow of contaminants to the regional aquifer; (4) how water chemistry provides insight into the geochemical processes occurring in the deep perched and regional aquifers; and (5) how the mesatop HE sources and the Cañon de Valle and other alluvial systems may recharge the deeper saturated zones.

2. The hydrologic gradients (both vertical and lateral) need to be determined in both the regional and the deep perched saturated zones. Such data help define directions of groundwater flow and help optimize placement of monitoring and characterization wells. These data also provide key information for groundwater-modeling efforts.

   The gradient data will be used : (1) to determine whether contaminants enter the system at the top of the deep perched zone and if they are then transported by saturated flow through to the bottom of the zone; (2) to help identify fast pathways within the saturated zones; (3) to determine whether the significant downward vertical gradients identified in R-25 continue to the east or whether they are restricted to the west of the Laboratory near the Pajarito fault zone and the Jemez Mountain front.

3. The horizontal extent and geometry of the deep perched zone need to be determined. The deep perched zone was present in SHB-3 (1-2 km southwest of R-25) but is not found in the deep test wells that were drilled at TA-49 (4-6 km southeast of R-25) in the late 1950s and early 1960s.

   Information on saturated zones extent and geometry will be used to determine: (1) the eastward extent of the deep perched zone; and (2) whether the deep perched zone is a continuous unit that extends for several km from the mountain front eastward, or whether it is a "tongue" projecting eastward across TA-16. "Tongue" geometry

implies the existence of regions within the deep perched zone with northward and southward hydrologic gradients.

4. Hydrologic parameters within the two major saturated zones need to be defined in order to support groundwater-modeling efforts. The groundwater modeling efforts may provide better understanding of contaminant transport in the deep perched and regional saturated zones. Such information needs to be determined at additional points within potential contaminant flow paths downgradient from TA-16.

   Hydrologic parameter data will be used to determine: (1) whether the hydrologic properties of the Otowi and Puye formations in the western portions of the Laboratory are heterogeneous; (2) whether lateral variations in lithology are consistent with the current 3-D hydrogeologic model for the Laboratory; and (3) how that model can be refined.

6.3.6.2 Investigation Design

Data from deep wells within and downgradient from TA-16 will be used to address questions concerning HE sources, contaminant extent, transport and recharge pathways, contaminant concentration dynamics, and hydrologic gradients. The data will also support efforts to model the deep perched and regional saturated zones. These data will be derived from both the regional wells outlined within the Hydrogeologic Work Plan (LANL 1998, 59599.1) and the additional 260 CMS wells that are described below. Ultimately, these data will be used to support risk assessments that include the deep perched saturated zone and regional aquifers as pathways in the risk assessment.

The Hydrogeologic Work Plan includes plans to drill a series of regional aquifer wells, known as the 'R' wells (Figure 6.3-11). Five of these are approximately downgradient of TA-16: (1) regional well R-27, planned for the confluence of Cañon de Valle and Water Canyon, approximately 3-4 km southeast of R-25; (2) regional well R-19, planned for a mesatop location south of Threemile Canyon, approximately 4-5 km east of R-25; (3) regional well R-18, planned for a location in, or just south of, Pajarito Canyon, approximately 3-4 km northeast of R-25; (4) regional well R-28, planned for a location in Water Canyon, approximately 6-7 km southeast of R-25; and (5) regional well R-30, planned for a location at TA-49, approximately 4-5 km southeast of TA-16 (Figure 6.3-11).

Two regional wells, R-24 and R-26, are also planned for locations west of TA-16: these represent upgradient wells for the purposes of the TA-16 investigations (Figure 6.3-11). All of these regional wells will be characterized hydrogeologically. Water and core samples taken from them will be analyzed for a comprehensive suite of constituents, including HE, metals, water quality parameters, and radionuclides. Planning specifications for these Hydrogeologic Work Plan wells can be found in Table 6.3-6. Note that Laboratory-wide background values for groundwater are currently being developed by the ER project. Both these Laboratory-wide values, and data from the upgradient wells at TA-16, will be used to evaluate, in both the regional and 260 CMS wells, which anthropogenic constituents have been released to groundwater.

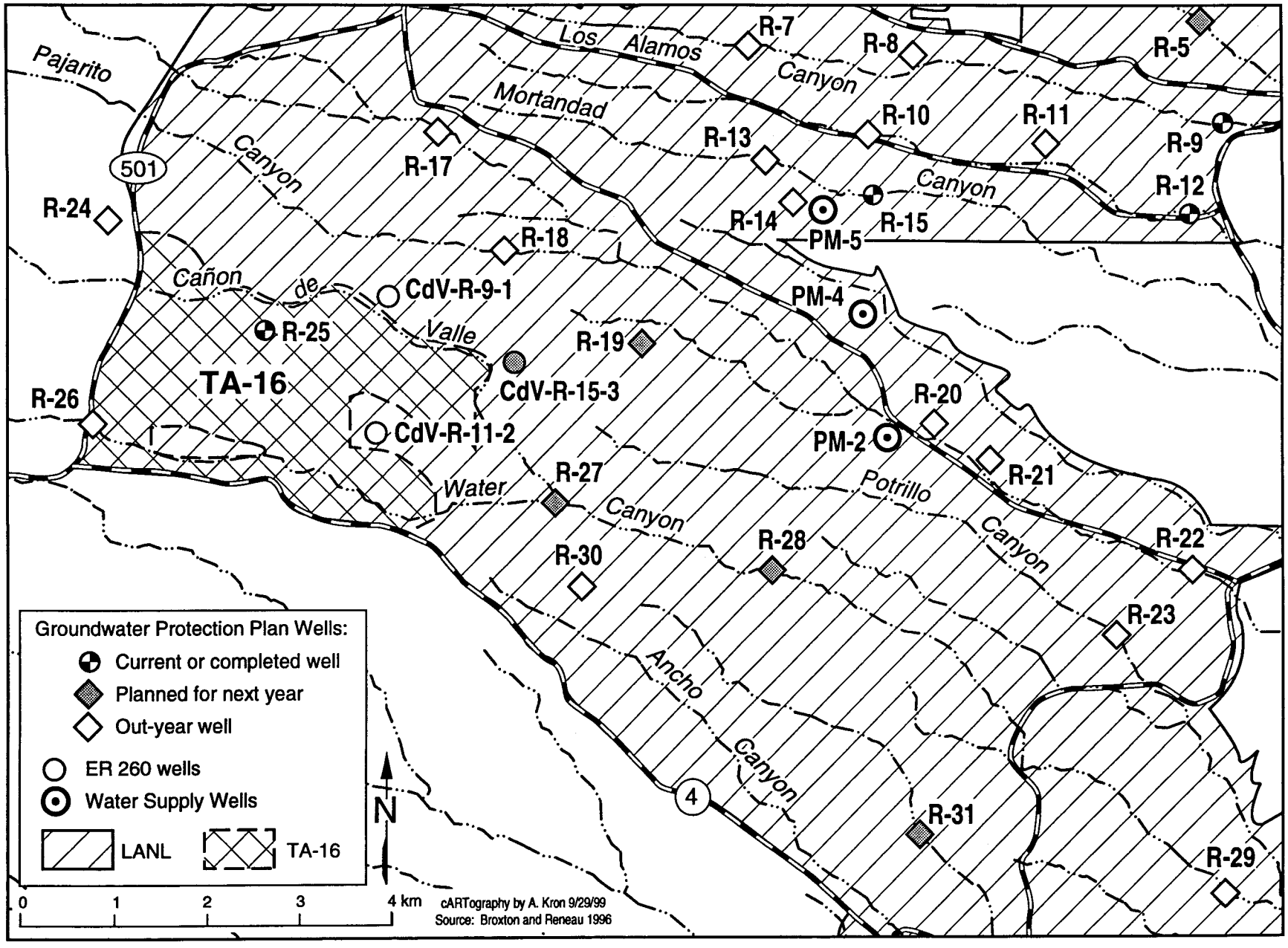

Figure 6.3-11. Proposed deep wells in the vicinity of TA-16

Table 6.3-6

Planning Specifications for Groundwater Protection Plan Wells That are Relevant to TA-16 Investigations

Regional Well Designation	Location	Estimated Depth (ft)	Well Completion Type	Current Estimated Start Date for Drilling
R-27	Water Canyon/Cañon de Valle confluence	1840	Multiple	FY 00
R-19	TA-15	1945	Multiple	FY 00
R-28	Water Canyon	4020	Multiple	FY 00
R-18	Pajarito Canyon	1945	Multiple	FY 01
R-30	TA-49	1580	Single	FY 05
R-24	West of TA-16	1476	Multiple	FY 05
R-26	West of TA-16	1280	Multiple	FY 05

Note: Specifications are based on the Hydrogeologic Work Plan.

The 260 CMS wells, as described below, will be used to augment the regional wells proposed under the Hydrogeologic Work Plan. The 260 CMS deep drilling program addresses the problem of contamination in the deep perched zone and regional aquifer. To focus on this problem most effectively, this CMS plan addendum minimizes, for the time being, consideration of the near-surface source term. This exclusion pertains not only to historic or ongoing surface releases, but also to any contamination that is presently in the vadose zone. However, data from both the Hydrogeologic Work Plan wells and the 260 CMS wells will provide crucial information on recharge sources and transport pathways within the near surface. Whereas assessment of sources (especially in the vadose zone) ultimately is crucial to resolving the "global" problem associated with TA-16 HE discharges, it is not the primary goal of the investigations outlined in this document. The near-surface source term and vadose zone in the vicinity of TA-16-260 are currently being addressed through the ongoing CMS process for PRS 16-021(c). Other sources will be investigated through the ongoing RFIs at TA-16 and other TAs in the western half of the Laboratory.

A minimum of three 260 CMS wells are proposed in this CMS Plan addendum. These three wells will be located to the east of TA-16-260 and R-25 at TA-15 (Well CdV-R-15-3), to the southeast of TA-16-260 and R-25 at TA-11 (Well CdV-R-11-2), and to the northeast of TA-16-260 at TA-9 (Well CdV-R-9-1) (Figure 6.3-11). The exact locations of these wells are not finalized. The Laboratory intends to continue to use the data quality objectives (DQO) process throughout the implementation of this CMS addendum. As

each well is installed, and after characterization data are acquired, the results from each well will be discussed with NMED personnel to reassess the 260 CMS deep groundwater characterization and the ongoing well installation project. At that time, locations of upcoming wells will be reviewed.

The siting of the initial three 260 CMS wells was based on the boreholes' ability to investigate key problems associated with the TA-16 groundwater investigations: (1) the nature, extent, and dynamics of HE contamination in the deep perched zone and regional aquifer; (2) the hydrologic gradients in the TA-16 area; (3) the extent and geometry of the deep perched zone; and (4) the hydrologic properties of subsurface geologic units in the deep perched and regional aquifers. Equally important siting criteria included the ability of the wells to complement the Hydrogeologic Work Plan wells and logistical issues. Key logistical issues that influenced decisions on well siting included whether a location can be accessed by a large drill rig, whether a location falls within the blast radius of an active firing site, and whether a location lies within the nesting area of a threatened and endangered species.

Table 6.3-7 outlines the rationale for drilling the three well locations. Based on those assessments, the first well that will be drilled is CdV-R-15-3, the TA-15 well; the second will be CdV-R-11-2, the TA-11 well; and the third will be CdV-R-9-1, the TA-9 well. Drilling at CdV-R-15-3 will be initiated during fiscal year 2000, the other two wells will be initiated as soon as funding allows, probably during fiscal year 2002.

Table 6.3-7 Assessment of Well Sites Candidates

Location/ Well ID	PROS	CONS
TA-15/ CdV-R-15-3	• Could provide insight into TA-18 HE observations • Downgradient from TA-16-260, generally upgradient from supply wells • Downgradient from water-losing section of Cañon de Valle • Lies on east-west transect that includes TA-16-260, R-25, R-19 and PM-2/PM-4 • Could provide insight into geologic "basement structure"	• In concert with R-25 and SHB-3, not optimal for defining principal deep perched aquifer gradient
TA-11/ CdV-R-11-2	• Easy access • Area is not covered by planned "R" wells • Should define hydrologic gradient, and could help define the plumes' southern boundaries	• May not be directly downgradient from TA-16-260 in regional aquifer

Location/ Well ID	PROS	CONS
	• Should help in evaluation of other sources (Martin Spring Canyon) • Lies on transect between TA-16-260 and R-27 • Provides information on conditions near southern Laboratory boundary	
TA-9/ CdV-R-9-1	• Assesses flow to north of R-25 area • Ties to HE findings in Pajarito Canyon springs • Would help define gradients	• May not lie in direction of flow from TA-16-260 to water-supply wells • May reflect mixed sources

If the data from these 260 CMS wells and the Hydrogeologic Work Plan wells listed above suggest that the HE plumes within the deep perched zone and regional aquifer are not bounded, additional regional 260 CMS wells may be drilled. This strategy will be applied whether HE in perched and regional groundwater is derived solely from TA-16-260 or from multiple sources, including sources at TA-9. The locations of any additional wells will be developed in consultation with NMED personnel, as well as with members of the public and other stakeholders. Ongoing modeling efforts will also be used to optimize well location selection.

6.3.6.3 Sampling Activities

The Data Quality Objectives (DQOs) for data collection for these 260 CMS wells are similar, although reduced in scope, from those outlined in the Hydrogeologic Work Plan (LANL 1998, 59599.1). If relevant changes to the DQOs in the Hydrogeologic Work Plan are agreed upon with NMED, similar changes will be implemented for these 260 CMS wells. For the three wells, data needs are ranked as follows, in descending order of priority:

1. Contaminant profiles (for HE, metals, and anions) and water levels

2. General lithology (the zone that would be most beneficial to understand from a hydrogeologic perspective would be the layers between the two major saturated zones)

3. Various hydrogeologic parameters (e.g., saturated zone thicknesses, saturation levels, head gradients, permeability, and porosity)

One reason for the hydrogeologic parameters receiving the lowest priority is that, by the time the TA-15 well has been drilled, relevant information from other adjacent wells will be available. Another reason is that the primary use for these parameters is as input to models. Due to the heterogeneities of hydrologeologic parameters within lithologies on the Pajarito Plateau, modelers will have to compensate for poorly constrained data through the use of sensitivity analyses.

Borehole Advancement and Well Installation Specifications

The 260 CMS wells will be drilled and completed similarly to Type 2 wells, using the terminology of the Hydrogeologic Work Plan (LANL 1998, 59599.1). The following description of the proposed wells has been modified from the Hydrogeologic Work Plan, Section 4.1.1.2.

Each of the three wells will be a multiple-completion regional aquifer well. The boreholes for these wells will be drilled to an estimated depth of 1800 ft or at least 200 ft into the regional aquifer. A principal control on the depth of drilling will be whether the HE plume has been bounded in the vertical direction based on screening results. Approximately 5% of the borehole will be cored, with emphases on the deep perched groundwater zone, stratigraphic contacts within the saturated zones, and the top of the regional aquifer. The number and length of screened intervals will be finalized in the field, in consultation with NMED personnel based on site-specific findings. Screened zones will be installed in both the deep perched zone and regional aquifer. The selection of slot size for screens and the selection of filter pack materials will be made following sieve analysis of geologic cuttings in the zone to be screened.

Applicable borehole advancement/well installation specifications are as follows:

- A carbon steel surface casing, approximately 16 in. in diameter, will be set from the land surface to approximately 10 ft deep. In locations where alluvium is present, the surface casing will extend approximately 10 ft into the underlying competent layer and will be grouted in place.
- During borehole advancement, the drilling method will employ an outer temporary casing advanced to the total depth of the borehole. This is done to: 1) maintain borehole integrity, aid circulation of drilling fluids, and 2) minimize migration of fluids between the deep perched zone and the regional aquifer.
- The well will be constructed of 5.56 in. outer diameter mild carbon steel casing from land surface to the top of the stainless steel screen. A transitional coupling will be installed between the two casing types to minimize the potential for corrosion. An annulus ≥ 2 in. will be provided. Approximately 10 ft of blank casing with an end cap will be set at the base of the screen. Centralizers will be used at approximately 100-ft intervals.

- All backfill materials (grout, bentonite, sand) will be tremied/pressure grouted in place.
- A lockable steel protective cover will be cemented, in place, over the well casing and extending at least 2 ft below ground surface.
- The top of the well will be finished with a concrete pad 4 ft x 4 ft x 4 in. The well head will be surrounded by 8-ft chainlink fencing, topped with barbed wire, 15 ft on a side, with one side gated and padlocked.

Figure 6.3-12 is a general prototype drawing of Type 2 wells. Figure 6.3-13 is a depiction of the multiple-completion configuration.

HSWA Module VIII Requirements

LANL anticipates that these boreholes will be completed compliant with the HSWA Module VIII permit and that they will ultimately be used for long-term monitoring. Thus, they will fulfill all HSWA Module special permit conditions that concern the construction of monitoring wells. As cited in the Hydrogeologic Work Plan Section 4.1.2, the following permit language is relevant to the typical construction of the wells proposed in this CMS Plan addendum:

> "The monitoring wells installed under this and following sections of this permit shall be constructed using flush-joint, internal upset, threaded (or an equivalent method of joining without rivets, screws and glues) casing manufactured from inert materials. The boreholes for casings and screens shall be a minimum of six (6) inches greater in diameter than the well casing or screen outer diameter. Filter pack and screen slot openings shall be sized based on formation grain size and characteristics. Well screen lengths shall be no more than ten (10) feet in length. The filter pack shall extend no more than two (2) feet above the top of the screen and shall not cross any clay layers which may act as aquitards. If a bentonite seal is used, the bentonite shall be allowed to hydrate a minimum of twelve (12) hours before emplacement of grout. Grout shall be emplaced using a tremie pipe to ensure a consistent seal at depths greater than 5 feet, and grout shall be allowed to set a minimum of twelve hours before initiating development.
>
> Development procedures shall include purging of the well until contaminants introduced during drilling can be assured of being removed. Development shall also include surging with a surge plug, and either bailing or pumping until the nephelometric turbidity units (N.T.U.) can be consistently measured at five (5) or less, if possible. Well head construction shall include a well pad keyed into the well annulus and a system to secure the well from traffic and unauthorized access. Within thirty (30) days of construction and development of the last well required under this section, the Permittee shall submit to the Administrative Authority a report and map including:

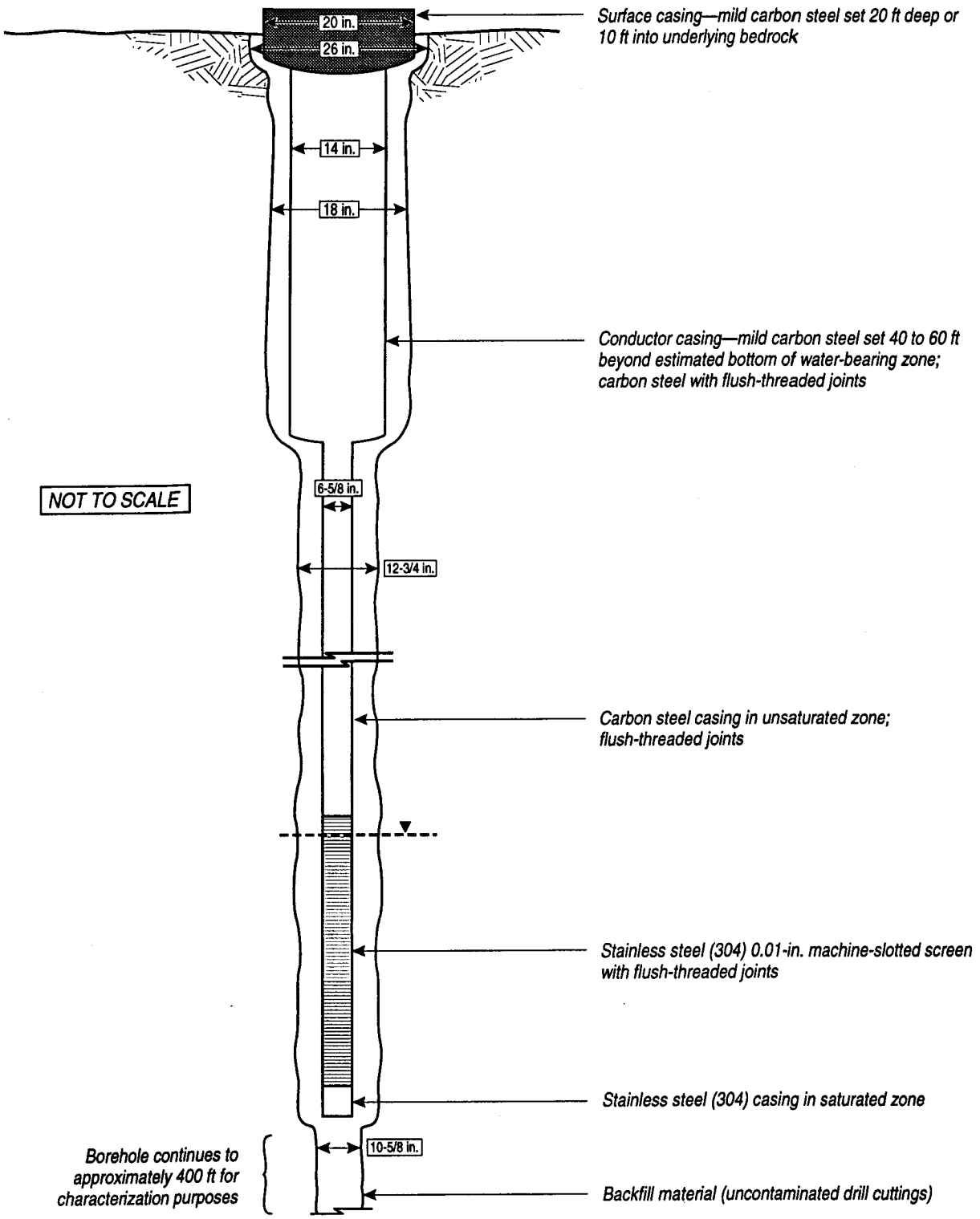

Figure 6.3-12. Schematic types 2 and 3 (regional) well design; all dimensions are approximate.

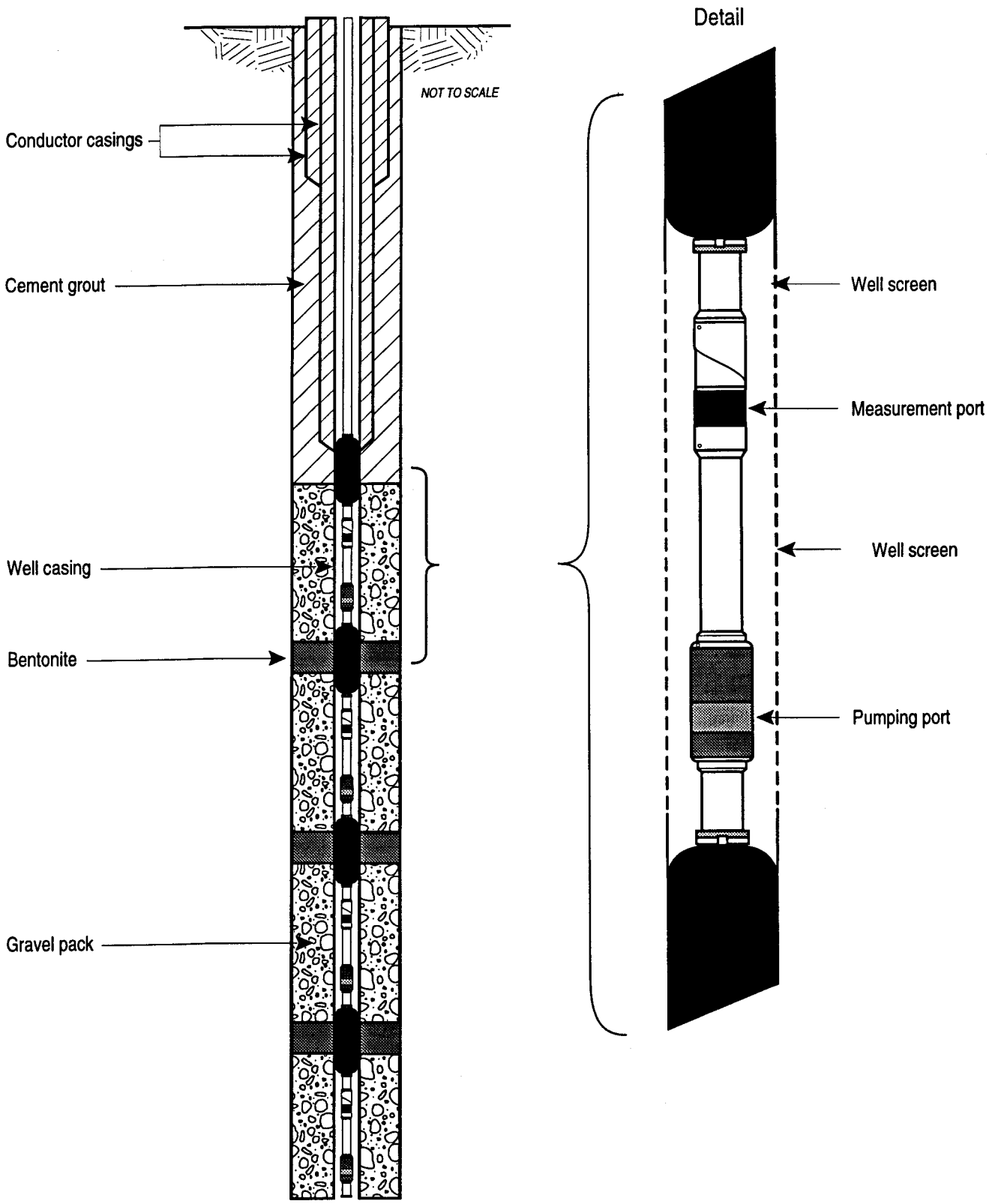

Figure 6.3-13. Westbay-type design for multi-level monitoring

1. Survey of location of each well;
2. Surveyed ground level, top of casting and top of well pad referenced to known elevation datum (NGVD, 1929);
3. Static water level, referenced to mean sea level;
4. Well construction data (including a diagram for each well, detailing total depth, screen placement, gravel pack, annular seal, borehole and casing size [all measured to within 0.1 foot], and well log data; and
5. Well development data.

Any saturated condition encountered will require grouting in a surface casing to prevent any downward migration of surface contamination along the wellbore. Any boring drilled into the main aquifer that encounters perched water shall set conductor pipe to the top of the main aquifer and hydraulically isolate the main aquifer from the deep perched aquifer. The annular space must be sealed with a bentonite grout or equivalent to prevent shrinkage cracking."

Renewal of the HSWA Module is currently being addressed with the NMED. The specifications of the 260 CMS wells as outlined in this CMS addendum will be modified to reflect changes in the new HSWA Module that are applicable to regional or monitoring wells.

Borehole and Groundwater Sampling

The well sampling specified for these three wells is a subset of that proposed for the regional wells specified in the Hydrogeologic Work Plan (LANL 1998, 59599.1). The key data needs are characterization of contaminant profiles, lithology, and hydrogeologic parameters. These needs will be met through sampling core and cuttings as well as groundwater, and through geophysical logging methods.

The following guidelines for sampling, which have been extracted from the Hydrogeologic Work Plan, apply to these 260 CMS wells:

- A comprehensive cased-hole geophysical logging suite will be run through the drill string immediately prior to completion of each well.
- Core and cutting samples will be field screened for HE using the spot test and D-Tech immunoassay methods. Field screening will be conducted at regular intervals during well advancement.
- Physical properties analyses will be conducted on five core samples per borehole. A list of hydraulic properties to be determined on core samples collected from saturated

zones includes: *in situ* water content, porosity, particle density, bulk density, saturated hydraulic conductivity, and water retention characteristics from 0 to 15300 cm suctions.

- Packer and slug tests will be completed at key geologic intervals as defined by the technical team hydrologist. These may be completed following well completion.
- Five samples of cuttings or core will be collected from saturated zones for petrographic, X-ray fluorescence (XRF), and X-ray diffraction (XRD) analyses.
- Following completion and development of the wells, groundwater samples will be collected on a quarterly basis from each screened interval or Westbay-type port and analyzed for the presence of HE, metals, and anions. One quarterly round of samples per year will be analyzed for volatile organic compounds, gross alpha beta, and a full suite of geochemical parameters as required for geochemical modeling.

Geophysical logging will be conducted on each of the wells. Two logging runs will be conducted for each borehole. The upper 300-500 ft of each borehole will be logged with open-hole logging tools if borehole stability is such that the borehole can be advanced without casing. After logging, casing will be set in this interval, and the borehole will be advanced to the nominal total depths identified above. Due to the unconsolidated nature of the subsurface strata and the use of air-rotary drilling, these boreholes will be cased prior to wireline logging. Cased-hole logging will be performed from land surface to total depth.

The following geophysical logs will be generated for all open-hole sections if possible:

- Caliper
- Electromagnetic induction
- Natural gamma
- Magnetic susceptibility
- Borehole color video (axial and sidescan)
- Fluid temperature (saturated zone only)
- Fluid resistivity (saturated zone only)
- Single point resistivity (saturated zone only)
- Spontaneous potential (saturated zone only)

The following geophysical logs may be generated for all cased-hole sections, if needed:

- Gamma-gamma density
- Natural gamma
- Thermal neutron

Insert the following revised table on p. 83 of CMS Plan (Environmental Restoration Project 1998, 62413.3), in Section 6.4, "Data Collection Procedures".

Table 6.4-3

Analyte Suites, Methods, and Protocols for Analysis of Soil and Water Samples

Analyte Suite	Analytical Method	Analytical Protocol*
HE	HPLC	SW-846, Method 8330
Metals	Inductively coupled plasma emission spectroscopy (ICPES) or Inductively coupled plasma mass spectroscopy (ICPMS)	SW-846, Methods 6010 and 6020
Anions (nitrate, sulfate)	Ion Chromatography	EPA Method 300
Fluoride	Ion Chromatography	EPA WW 340 series
Chloride	Ion Chromatography	EPA WW 325 series
Bromide	Ion Chromatography	EPA Method 300, EPA Method 320.1
HCO_3 (bicarbonate)	Titration	SW-846, Method 4500 – CO_2
Volatile organic compounds	Gas Chromatography Mass Spectrometry	SW-846, Method 8240
Gross alpha/beta	Gas Proportional or Liquid Scintillation Counting	Not available

* Or latest equivalent EPA method

Additional References

Environmental Restoration Project, September 1998. "CMS Plan for Potential Release Site 16-021(c)," Los Alamos National Laboratory Report LA-UR-98-3918, Los Alamos, New Mexico. **(Environmental Restoration Project 1998, 62413.3)**

Environmental Restoration Project, September 1998. "RFI Report for Potential Release Site 16-021(c)," Los Alamos National Laboratory Report LA-UR-98-4101, Los Alamos, New Mexico. **(Environmental Restoration Project 1998, 59891.3)**

LANL (Los Alamos National Laboratory), May, 1998. "Hydrogeologic Workplan," Los Alamos National Laboratory, Los Alamos, New Mexico. **(LANL 1998, 59599.1)**

Purtymun, W.D., 1995. "Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area," Los Alamos National Laboratory Report LA-12883-MS, Los Alamos, New Mexico. **(Purtymun 1995, 45344.1)**

Stone, W., D. Broxton, and D. Rogers, 1999. "Water Level Observations During Drilling and Vertical Head Distribution – Experience at R-25. A Deep Regional Borehole." Los Alamos National Laboratory, Unpublished Report, Los Alamos, New Mexico. **(Stone et al. 1999, 64010)**