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Earth and Environmental Science Division
EES-15, Environmental Science Group
Los Alamos, New Mexico 87545

SUBJECT: EXTERNAL REVIEW - GROUNDWATER SAMPLING PLAN FOR PAJARITO AND THREEMILE CANYONS

The subject plan was prepared in response to HRMB comments on the RFI Report for OU 1093. We have committed to provide the plan, along with additional comment responses, to HRMB by July 15, 1997.

Please review the enclosed plan, and if possible return review comments by July 9 to Merlin Wheeler. (Comment resolution forms attached). If you have any questions on this material please contact Merlin at 661-5224.

TEG/nr

Attachments: (1) Groundwater Sampling Plan
(2) Comment resolution forms

Distribution:
David Broxton, EES-1, MS D462 w/ Attachment 1 and 2
Pat Longmire, CST-7, MS J534 w/ Attachment 1 and 2
Brent Newman, EES-15, MS J495 w/ Attachment 1 and 2
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Merlin Wheeler, ICF Kaiser, MS M892 w/o Attachments
OU 1093 Project File w/ Attachment 1
RPF, MS M707 w/ Attachment 1
EES-15 File w/o Attachments

ATTACHMENT A

SAMPLING AND ANALYSIS PLAN-PAJARITO AND THREEMILE CANYONS GROUNDWATER INVESTIGATION

1.0 Problem Definition

RFI Phase 1 sampling at former OU 1093 indicated the presence of several potential contaminants in soils and groundwater, primarily volatile organic compounds (VOC) and high explosives (HE). Data on the observed concentrations are presented in Chapter 4 of the RFI Phase 1 report (LANL 1995, 1255). The only constituent detected at concentrations which exceeded groundwater quality standards was 1-2 dichloroethane (EDC), which was detected near three now-abandoned septic systems. Notable detections of these potential contaminants are shown in Figure 1-1.

The existing data indicate that groundwater up-gradient from TA-18 in Pajarito Canyon contains high explosive compounds and degradation products. However, samples were collected only once from the up-gradient wells, so there is no direct information on seasonal variability.

Samples were collected quarterly and analyzed for high explosives at a location within TA-18. The location may potentially be affected by HE contamination from a former firing site, but the sampling data (Table 1-1) provide some information on expected seasonal variability.

Table 1-1. Concentrations of HMX in Wells MW-1, -2,- 3, and -4 (µG/l)

Well	10/93	2/94	7/94	2/95
MW-1	3.1	4.3	3.4	NA
MW-2	2.3	3.3	3.2	NA
MW-3	0.3	3.8	2.7	4.5
MW-4	3.2 (dup. 3.5)	3.2	3.3 (dup 3.4)	3.4

The data for HMX show at least as much variability among the four wells for a particular sampling event as from event to event for a particular well. For these data, sampling and measurement variability appears to obscure any evidence of seasonal variability.

Additional data are required to establish:

- What is the magnitude and seasonal variability of potential contaminant concentrations in groundwater and surface water entering TA-18 from up-gradient locations?
- How does the magnitude and seasonal variability of potential contaminant concentrations vary within and down-gradient from TA-18?
- Is there evidence of potential contaminant sources within or down-gradient from TA-18 that are degrading water quality so as to exceed groundwater or surface water quality standards?

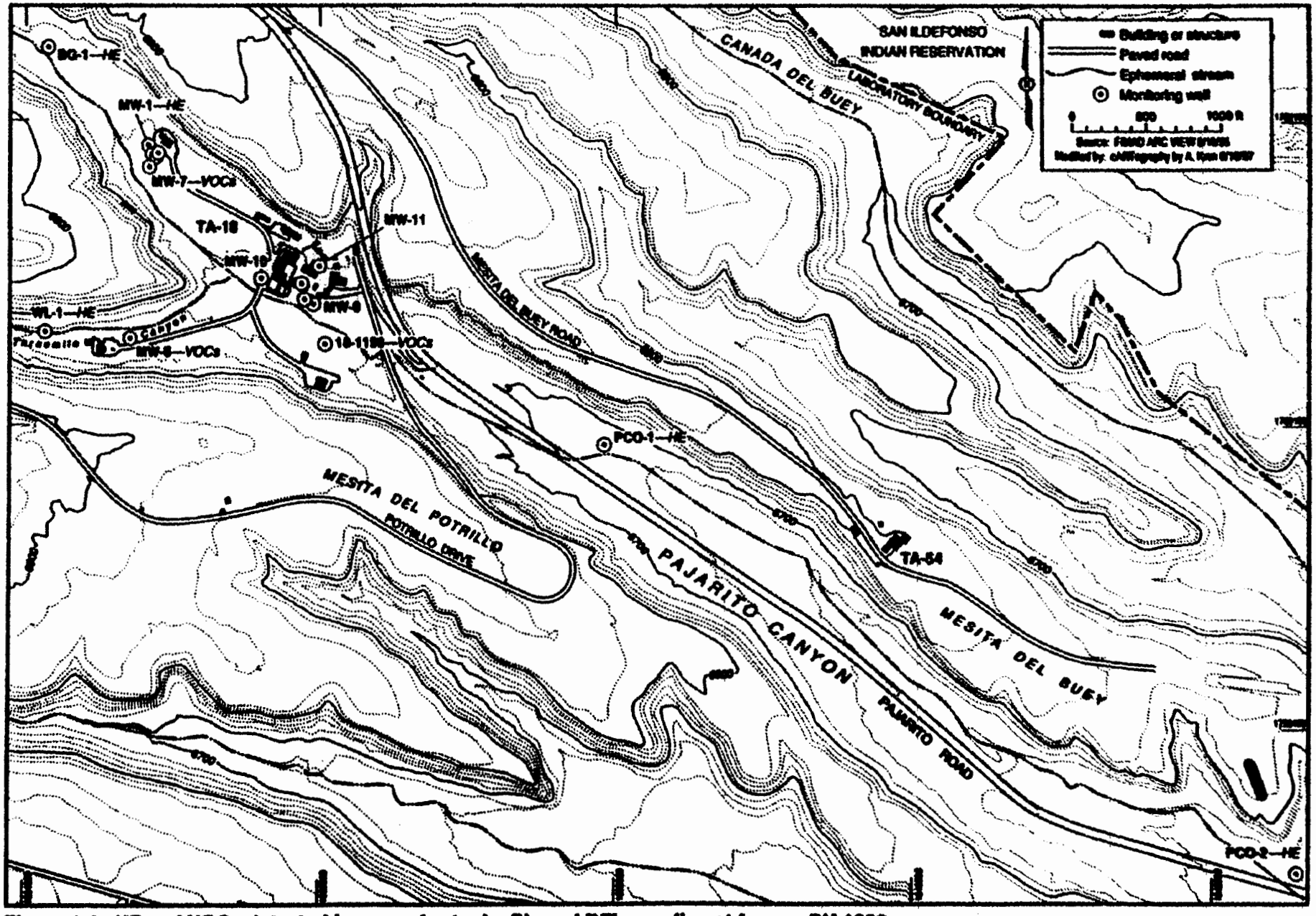


Figure 1-1. HE and VOCs detected in groundwater by Phase I RFI sampling at former OU 1093.

2.0 SAP Design

2.1 Overview

The Hydrogeologic Work Plan (LANL, 1378) proposed a number of shallow alluvial wells in Pajarito and Threemile Canyons. These wells will augment existing wells within and down-gradient from TA-18 to establish a relatively dense groundwater sampling network. In addition, flowing surface water and springs up-gradient and down-gradient from TA-18 will be sampled to determine influent and effluent water quality and potential contaminant concentrations. The sampling will be done in several stages, as follows:

Stage 1. Determine Potential Contaminants

- Collect water samples from flowing streams and springs in Threemile and Pajarito canyon up-gradient from TA-18 for a minimum of 3 quarters (9 months) to evaluate the magnitude and variability of potential contaminant contributions to groundwater from these sources.

- Collect groundwater samples from selected existing wells up-gradient from, within, and down-gradient from TA-18 to determine magnitude and variability of potential contaminant concentrations.

- Install one monitoring well in Threemile Canyon up-gradient from all potential contaminant sources within TA-18 to determine up-gradient water quality in Threemile Canyon.

- Record stream flow data and water level elevations in monitoring wells in the study area on a quarterly basis to obtain water balance information for the study area, and possibly establish some hydrologic parameters, such as transmissivity, for the shallow aquifer.

The data collected from this stage will be used to shorten the list of potential contaminants, and to better define the distribution of these potential contaminants in the study area. The number and locations of additional monitoring wells will be determined by noting areas within and down-gradient from TA-18 where additional groundwater data are needed to explain the observed water quality data. Hydrologic properties estimated during Stage 1 will be used to design, as needed, further hydrogeologic tests.

Stage 2. Construct and Sample Additional Wells.

Additional monitoring wells will be installed and added to the sampling network. The list of target analytes may be revised based on Stage 1 sampling results. The collected data will be used to establish the full nature and extent of potential contaminant concentrations within former OU 1093.

2.2 Target Analytes

Stage 1 sampling will encompass all analytical suites from which analytes were retained as COPCs by the screening assessment portions of the RFI report. Table 2.2-1 summarizes these COPCs by PRS. From the table, it is evident that constituents from all major analytical suites (inorganics, VOCs, SVOCs, HE, and radionuclides) were detected at one or more PRSs, and will need to be included in the proposed sampling. Results from the first phase of sampling will be used to refine the list, possibly reducing the number of suites analyzed at a particular location.

Table 2.2-1 Primary COPCs Retained by Screening Assessment

PRS	Description	Inorganics	VOCs	SVOCs	HE	Radionuclides
18-001(a)	Lagoons	NR	NR	NR	NR	Thorium
18-001(b)	Sewer Line	lead, barium	EDC	PAHs, bis-(2-ethylhexyl) phthalate	NR	
18-001(c)	Sump	NR	NR	NR	NR	NR
18-002(a)	Firing site	NR	NA	NR	NR	NR
18-002(a,b)	Firing Site	NR	NA	NR	No SAL	NR
27-002	Firing Site		NA		No SAL	NR
18-003(a,b)	Septic System	lead,	TCE, PCE, EDC	PAH,	NA	Pu, U
18-003(c)	Septic System	Hg,	EDC,	PAH, pentachloro-phenol	2-4 DNT, 2-6 DNT	U, Pu
18-003(d)	Septic System	NR	EDC, 1-1 dichloro-ethane	TCE, 1-1-2 trichloro-ethane		
18-003(e)	Septic System	NR	NR	TCE	NA	NR
18-003(f)	Septic System	NR	NR	PAH	NA	NR
18-003(g)	Septic System	NR	Benzene, 1-4 dichloro-benzene	bis-(2-ethylhexyl) phthalate, 4-methyl-phenol	NA	NR
18-003(h)	Septic System	NR	NR	phenols	NA	NR
18-004(a,b)	Collection tanks	NS	NS	NS	NS	NR
18-005(	Magazine	NR	NA	NA	NR	NR
18-006	Uranium Solution Storage Pipe	NS	NS	NS	NS	NS
18-008	UST	NA	NR	NR	NA	NA
18-010(b)	Storm Drain	NR	NA	NR	NA	NR
18-010(c)	Storm Drain	NR	NA	PAHs	NA	NR
18-010(d)	Storm Drain	NR	NA	PAHs	NA	NR
18-010(e)	Storm Drain	NR	NA	PAHs	NA	NR
18-010(f)	Storm Drain	NR	NA	NR	NA	NR
18-011	Soil Contamination	NR	NA	NA	NA	NA
18-012(a)	Drain and outfall	NR	NA	PAH	NA	NR
18-012(b)	Drain and outfall	antimony, copper, lead, mercury	NA	PAH	NA	NR
18-012(c)	Drain and outfall	NR	NA	NR	NA	NR
18-013	Waste tank	NR	NR	PAH	NA	NR

NR - No COPCs retained by screening assessment
NS - Not Sampled
NA - Not Analyzed

2.3 Sampling Locations

Plate 1 shows the location of PRSs where COPCs were retained by the screening assessment, and principal COPCs at those locations. The figure also indicates the locations of existing monitoring wells, and proposed sampling locations for Stage 1 of this investigation. Table 2.3-1 describes the purpose of sampling at each of these locations, and the suites for which analysis will be requested at each.

2.4 Measurements and Sampling Procedures

2.4.1 Well Development

All of the shallow monitoring wells within TA-18 (MW-1 through MW-16), well BG-1 up-gradient from TA-18, and Wells MW-17 and MW-18 down-gradient from TA-18, were constructed with 2-in. PVC perforated casing. Well development was commonly performed by pumping or bailing the well, and development was not sufficient to reduce turbidity to an acceptable level. All of the wells scheduled for Stage 1 sampling (Table 2.3-1) will be further developed using surge blocks or other methods in an attempt to reduce turbidity. In addition, all wells will be fitted with a low-volume bladder pump set approximately in the middle of the water column in the well. Experience with other sampling has shown that this results in minimal disturbance of the water in the very bottom of the well bore, where any sediments tend to settle. The goal of the additional well development and the use of bladder pumps is to obtain water samples with a turbidity less than 5 Nephlometric Turbidity Units (NTU), the sample acceptance criteria specified in ER-SOP-06.02. The PCO series wells are currently equipped with bladder pumps, and samples generally meet the turbidity acceptance criteria. After well development and bladder pump installation, all wells will be allowed to stabilize for at least two weeks before sampling.

2.4.2 Water Levels

Before each sampling event, the depth to water will be determined in each well. Previously surveyed elevations of the measurement point (typically top of casing) will be used to plot water level elevations for each well and develop water table contour maps. Stream channel segments in which surface flow is occurring will also be noted, and used as an aid to contouring. (The presence of a flowing stream indicates a potential for groundwater recharge or discharge, depending on the relative elevations of the stream channel and adjacent groundwater elevations.)

2.4.3 Stream Flow

Stream gauges are currently in place in Threemile and Pajarito Canyons (Figure 2.4.3-1) The gauge in Pajarito is equipped with a continuous recorder; the one in Threemile requires direct reading. The gauge in Threemile will be read on a periodic basis throughout the Stage 1 sampling period. The frequency will depend on antecedent and current runoff conditions, being more frequent when runoff rates vary greatly, such as during summer storm periods or spring snowmelt. A third stream gauge will be installed near the eastern (downstream) boundary of TA-18.

The stream flow data, coupled with groundwater elevation measurements, will be used to estimate water-balance relationships for the shallow aquifer.

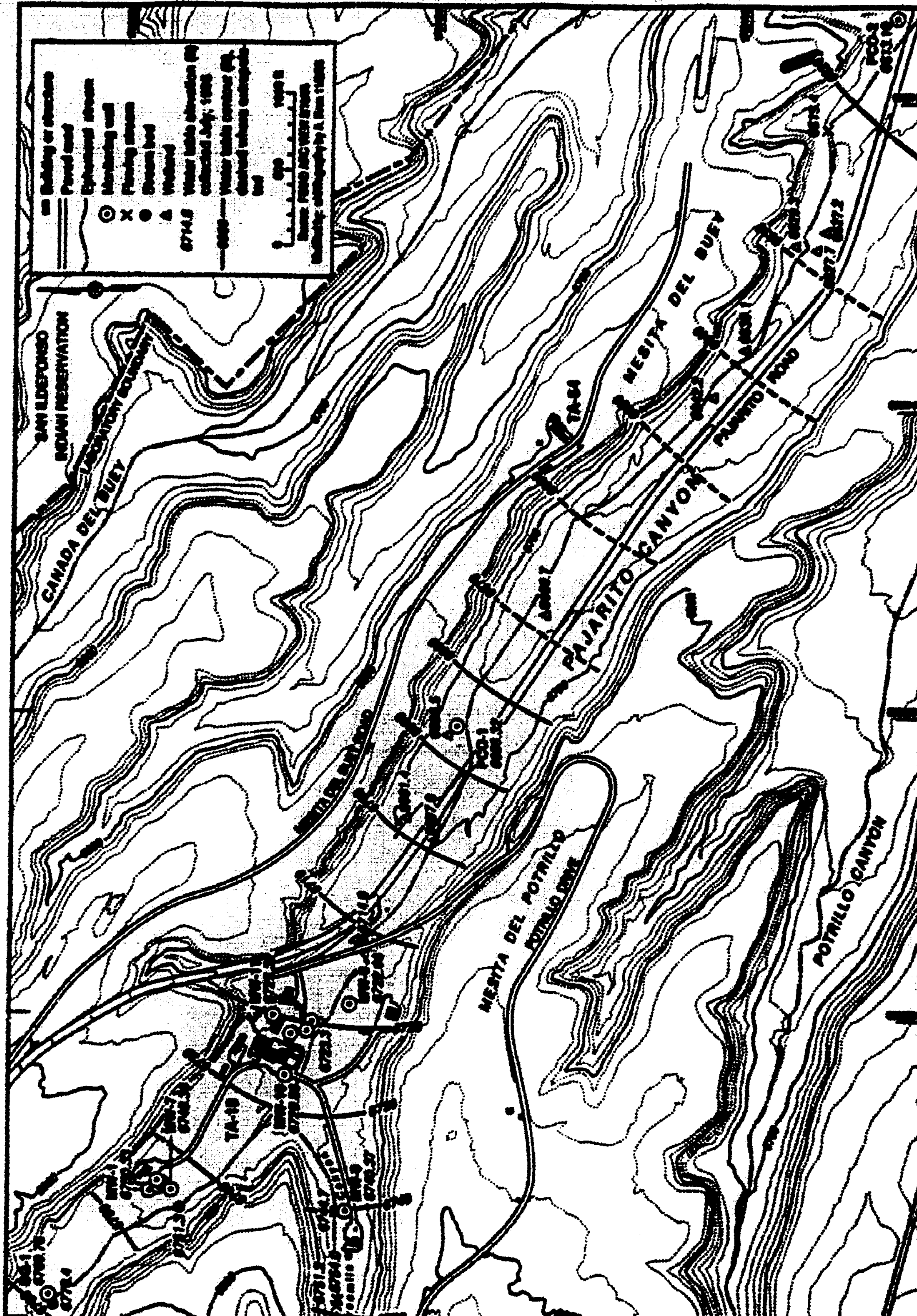


Figure B-2. Wetland, stream, streambed, and well-water elevations from wells BG-1 to PCO-2.

This figure will be replaced by a two-sheet plate showing all existing and proposed

Table 2.3.1-1 Sampling Design for Proposed Sampling Locations

Location Description	Location ID	Media	Purpose								
				MET	VOC	SVOC	HE	Major cations /anions	NO_3	Cl	H-3
Threemile Canyon Stream, near Threemile Spring A/B	18-00021	Surface Water	Determine water quality of ground water recharge source	X	X	X	X	X	X	X	
Pajarito Canyon Stream near TA-18 Boundary	18-10022	Surface Water	Determine water quality of ground water recharge source	X	X	X	X	X	X	X	
TA-18 Spring	18-10019	Surface Water	Determine relationship, if any, between spring and alluvial aquifer in Threemile Canyon	X	X	X	X	X	X	X	
BG-1, Background Well in Pajarito Canyon	18-1060	Ground Water	Determine influent water quality to TA-18 in Pajarito Canyon	X	X	X	X	X	X	X	X

Location Description	Location ID	Media	Purpose								
				MET	VOC	SVOC	HE	Major cations /anions	NO_3	Cl	H-3
BG-3-Background Well (New), in Threemile Canyon	18-10023 24	Ground Water	Determine influent water quality to TA-18 in Threemile Canyon	X	X	X	X	X	X	X	X
MW-4	18-2016	Ground Water	Measure COPCs from PRS 18-003(a,b)-verify HE data from BG-1	X	X	X	X	X			
MW-7	18-1135	Ground Water	Measure COPCs from PRS 18-003(a,b)	X	X	X	X	X			
MW-8	18-1166	Ground Water	Measure COPCs from PRS 18-003(c). Determine changes in HE resulting from PRS 18-002(b,c)	X	X	X	X	X			

Location Description	Location ID	Media	Purpose								
				MET	VOC	SVOC	HE	Major cations /anions	NO_3	Cl	H-3
MW-6	18-2024	Ground Water	Measure Combined effects of upgradient PRSs, 18-003(a,b,c,f), 18-002(a), and 18-002(b,c)	X	X	X	X	X	X	X	X
MW-10	18-1255	Ground Water	Measure Combined effects of upgradient PRSs, 18-003(a,b,c,f), 18-002(a), and 18-002(b,c)	X	X	X	X	X	X	X	
MW-12		Ground water	Measure COPCs from PRS 18-003(d); track changes in HE concentrations	X	X	X	X	X			

Location Description	Location ID	Media	Purpose								
				MET	VOC	SVOC	HE	Major cations /anions	NO_3	Cl	H-3
Pajarito Canyon Stream at down-stream end of TA-18	18-10025	Surface Water	Determine Surface water quality at exit from TA-18	X	X	X	X	X	X	X	
MW-17	18-01684	Ground water	Determine water quality downstream from TA-18, and upstream from PRS 27-002	X	X	X	X	X	X	X	X
PCO-1		Ground water	Determine water quality downstream from TA-18, and upstream from PRS 27-002	X	X	X	X	X	X	X	X
WL-5	36-2014	Sediment	Obtain sample in 0-6 in depth interval	X	X	X	X				
WL-6	36-2009	Sediment	Obtain sample in 0-6 in depth interval	X	X	X	X				

Location Description	Location ID	Media	Purpose								
				MET	VOC	SVOC	HE	Major cations /anions	NO3	Cl	H-3
WL-7	36-2004	Sediment	Obtain sample in 0-6 in depth interval	X	X	X	X				
WL-8	36-2001	Sediment	Obtain sample in 0-6 in depth interval	X	X	X	X				
MW-18	18-01685	Ground water	Determine Water Quality within influence of PRS 27-002	X			X	X			
PCO-2		Ground water	Determine water quality down-gradient from PRS 27-002 and all wetland areas	X	X	X	X	X	X	X	

Table 2.3-1. Sampling Design for Proposed Sampling Locations

2.4.4 Well Drilling and Water Sampling Protocols

2.4.4.1 Well Construction

All new wells for both Stage 1 and Stage 2 sampling will be constructed in conformance with ER SOPs 04.01, 04.04, 05.01 and 05.02. The typical design for wells MW-1 through MW-17 is illustrated in Figure 2.4.4.-1. The proposed design for new wells, as given in the Hydrogeologic Work Plan (LANL, 1378), is shown in Figure 2.4.4.-2. The new wells will penetrate the entire saturated thickness of the alluvial aquifer, which is underlain by unsaturated or partially saturated Bandelier tuff. The wells will be screened throughout the full saturated thickness, and, where possible screening will be extended above the saturated zone to allow for rises in the water table. However, a minimum of 5 ft is required between the surface and the bottom of the bentonite seal to ensure proper sealing of the well annulus.

2.4.4.2 Surface Water Sampling

Samples of stream flow and spring discharge will be collected in conformance with ER SOP 06.13. Samples will be collected with a peristaltic pump to minimize air contact during sampling. For purposes of comparison with various water quality standards, and for the intended data uses, aliquots for the various analyses will be either filtered, non-filtered, or both, as indicated in Table 2.4.4-1.

Table 2.4.4-1 Filtered and Non-filtered Surface Water Samples, by Analysis

Analysis	Filtered	Non-Filtered
TAL metals (except Hg)	X (livestock watering standards)	
Mercury		X (livestock watering, wildlife habitat standards)
Selenium		X (wildlife habitat standards)
VOC		X
SVOC		X
HE		X
Major cations/anions	X (water chemistry)	
NO_3		X
Cl		X

2.4.4.2 Groundwater Sampling

Groundwater samples will be collected in conformance with ER SOPs 06.01, 06.02, and 06.03. Well purging will be accomplished with the installed bladder pumps. Aliquots for major cations/anions will be filtered; aliquots for metals will be filtered and non-filtered; all other aliquots will be non-filtered. Field measurements of pH, turbidity, TDS, and temperature will be made.

2.4.4.3 Sediment Sampling

Sediment samples from the wetland areas will be collected with a hand auger, in conformance with ER SOP 06.10. Samples will be collected from a depth interval of 0-6 in. (See Comment 1.c.iv of this NOD Response.)

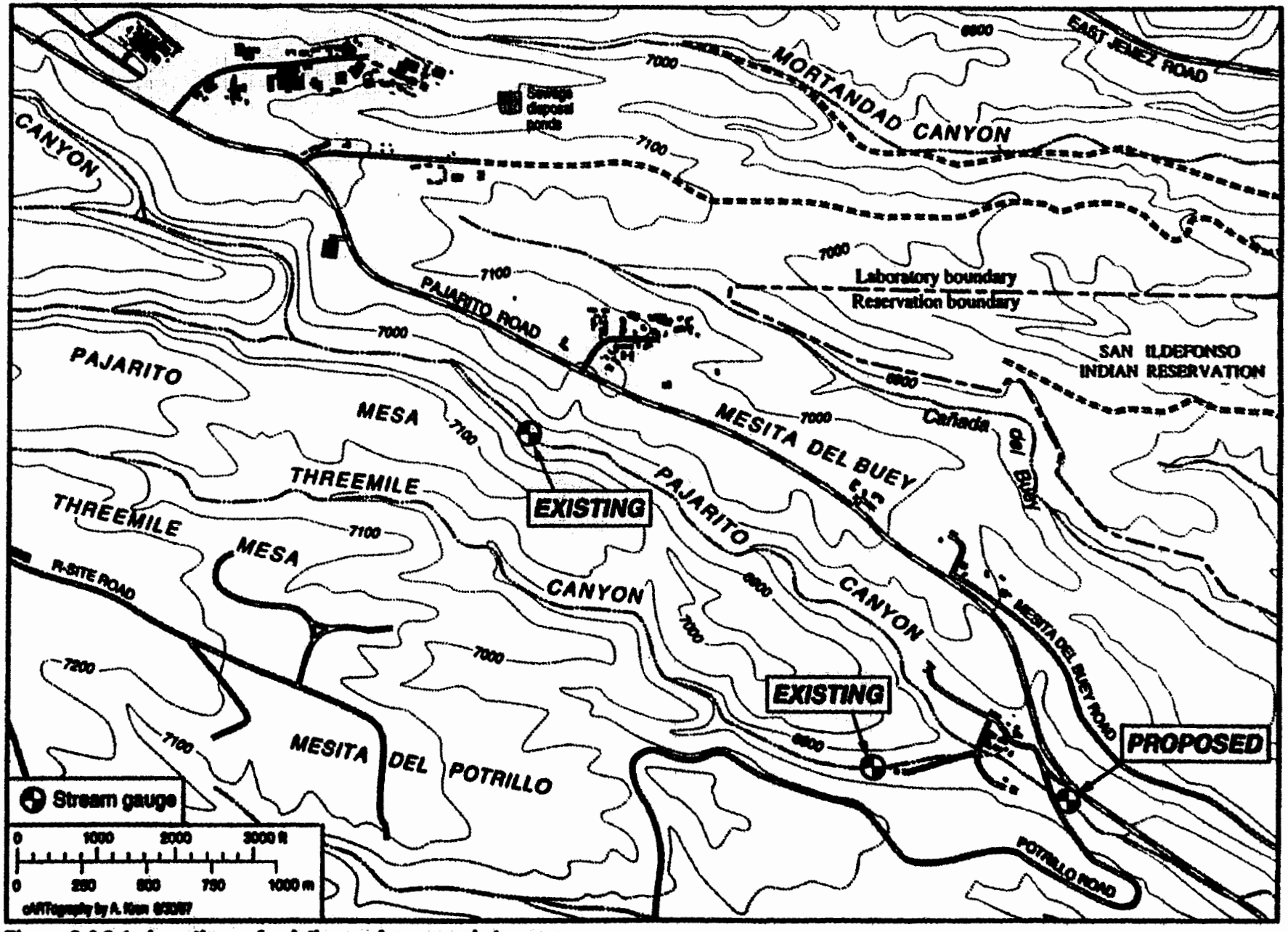


Figure 2.4.3-1. Locations of existing and proposed stream gauges.

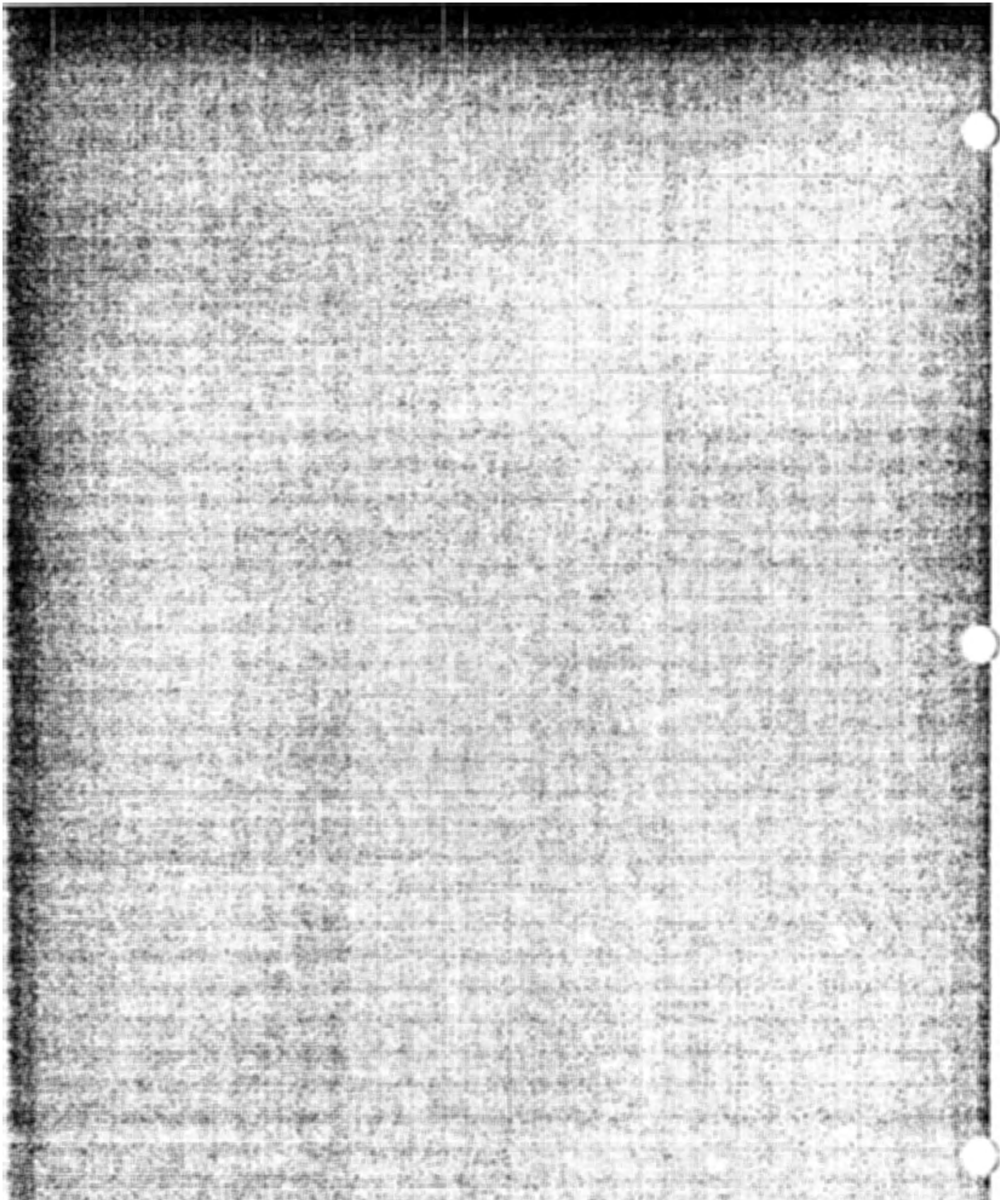
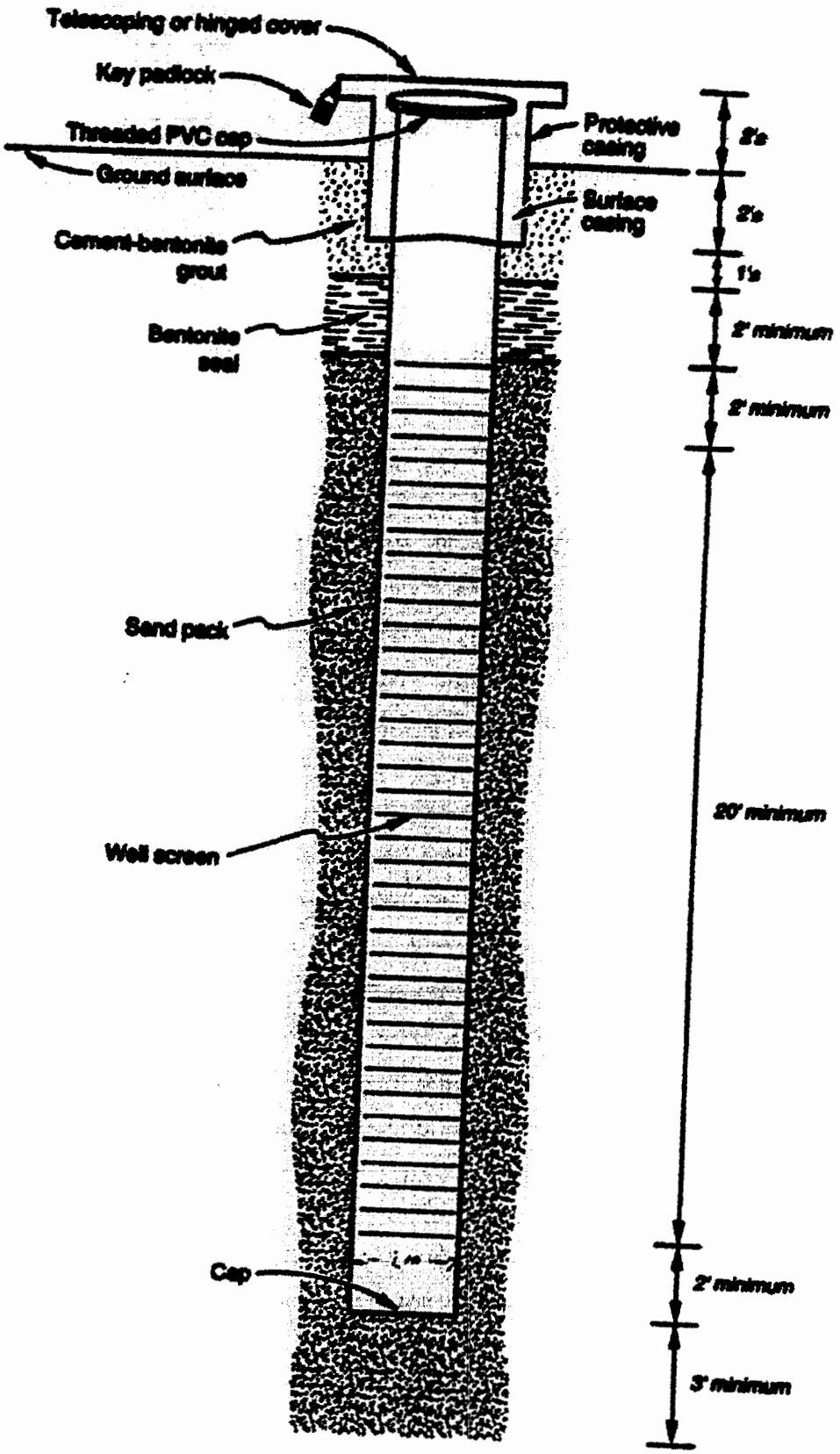


Figure 2.4.3-1. Location of Existing and Proposed Stream Gauges Near TA-18



2.4.4-1

Figure 3E8. Monitoring well construction details (not to scale).

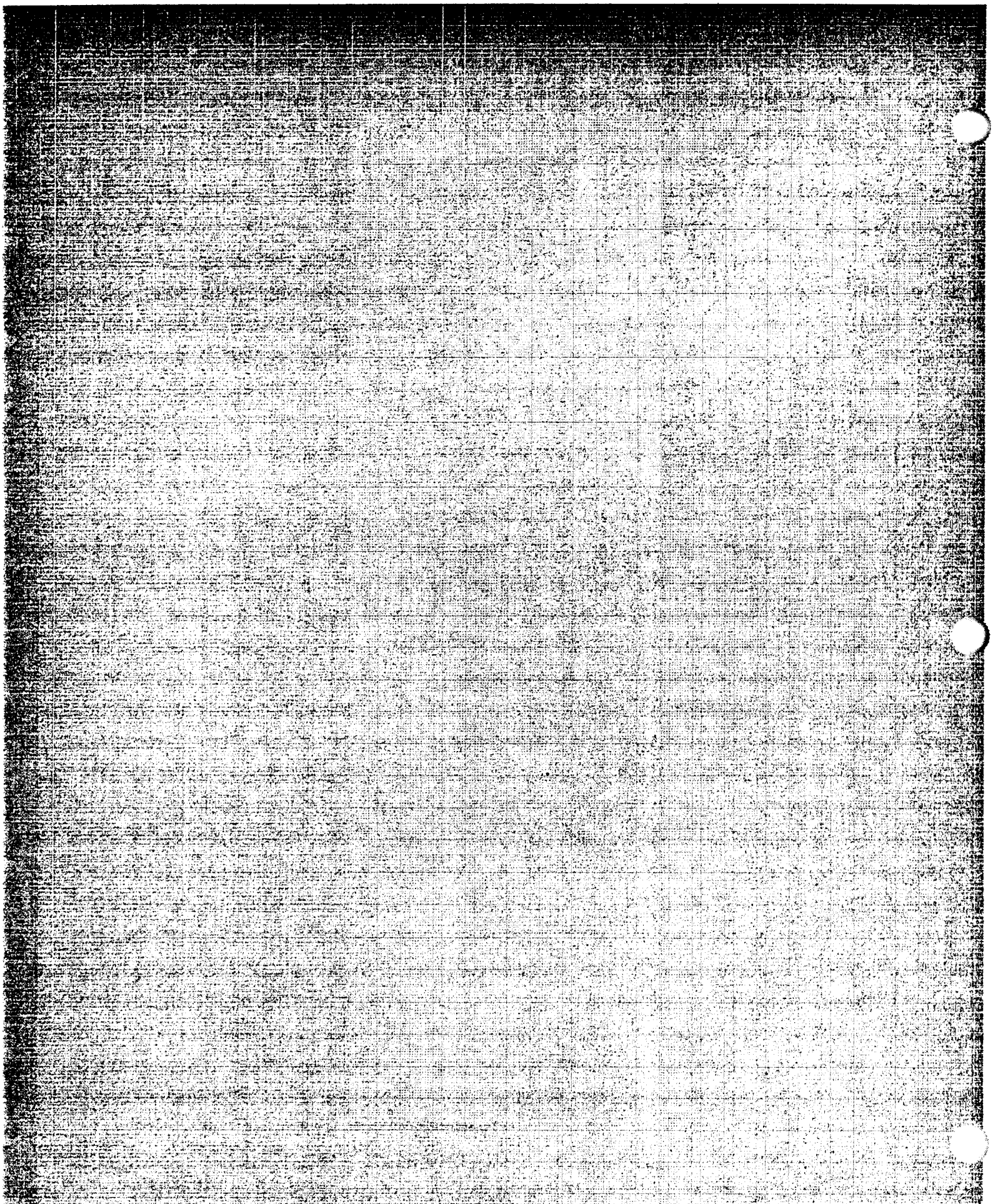


Figure 2.4.4-1. Design of Existing Monitoring Wells

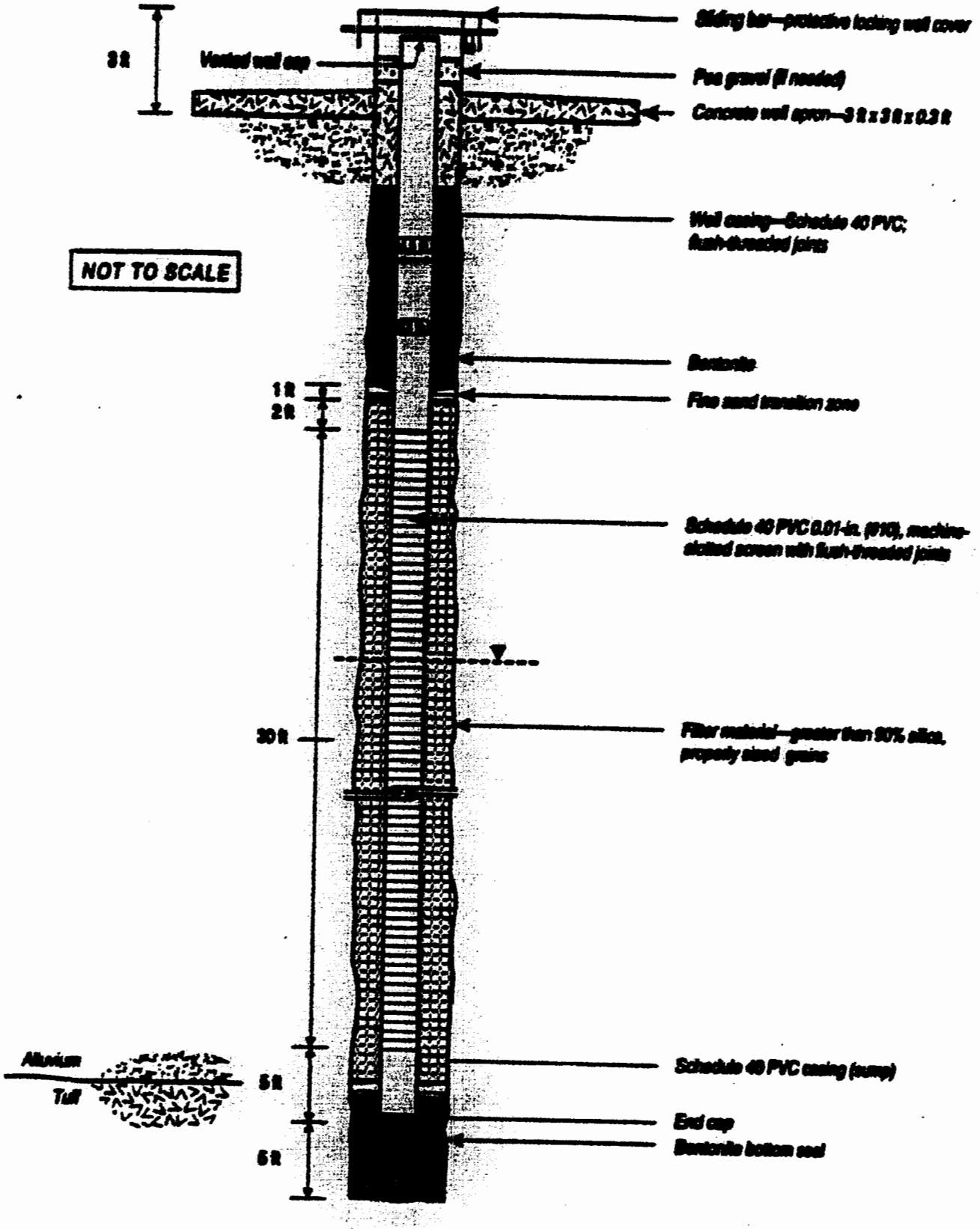


Figure 4-6: Type 1 (alluvial) well design.

2.4.4-2

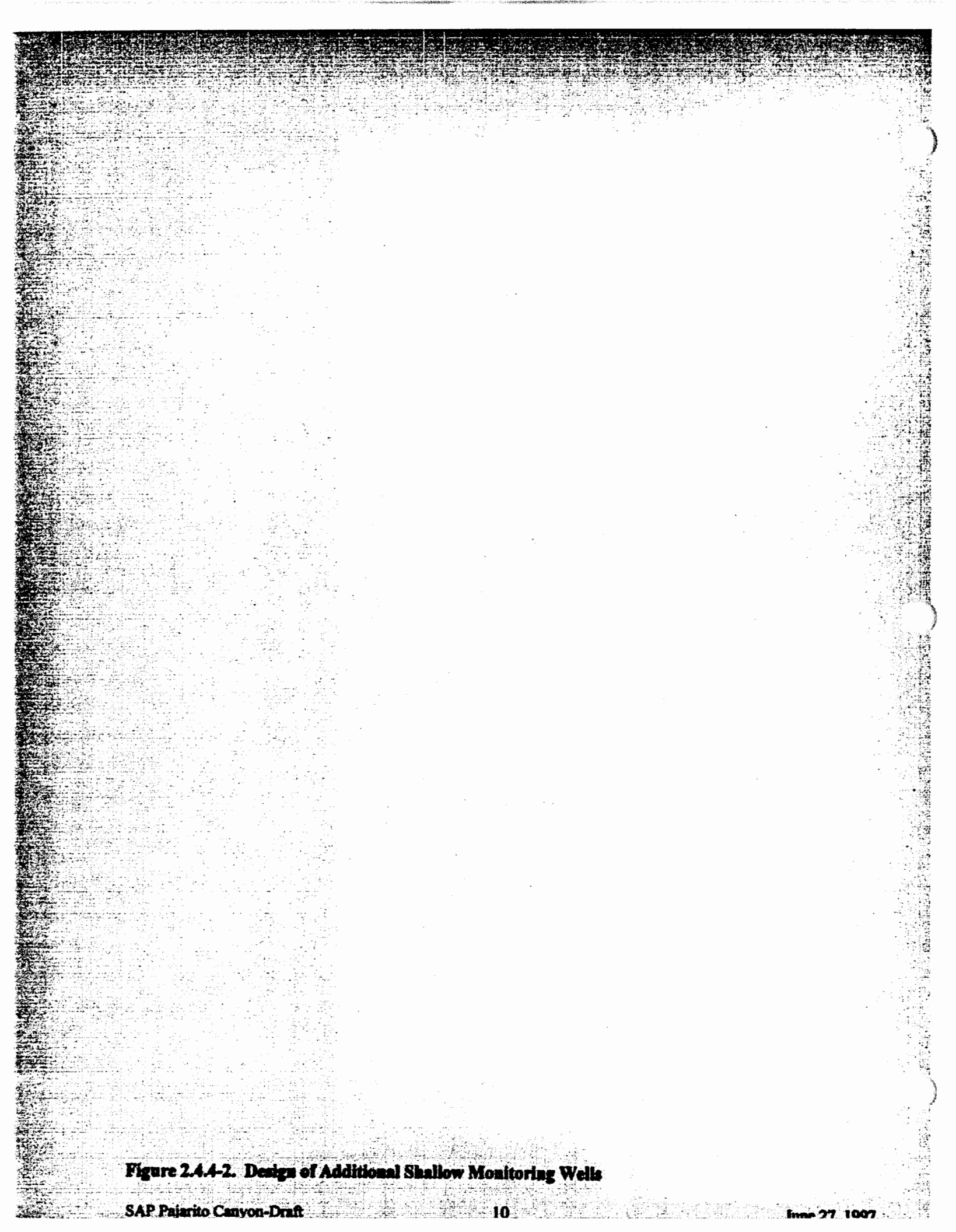


Figure 2.4.4-2. Design of Additional Shallow Monitoring Wells

2.4.4.4 Field QC Samples

The types, number, and purpose of field QC samples are shown in Table 2.4.4-2. Duplicates and PE samples will be submitted only for VOCs, SVOCs, and HE because VOCs and HE are the primary COPCs in the area under investigation. Residuals from high explosives, such as 2-4-6 trinitrotoluene, are reported by the SVOC analysis. Some constituents from these suites are expected to be present at concentrations near screening action levels or water quality standards. Confidence in the reported concentrations of VOCs, and of both HE and associated residuals, will add support to any conclusions regarding possible sources of observed VOC and HE concentrations.

Table 2.4.4.-2 Field QC Samples

Sample Type	Number	Purpose
Duplicates	3 samples for each quarter, analyzed for HE, VOCs, and SVOCs	Obtain variance estimates for the two primary COPCs (VOCs and HE constituents) previously observed in TA-18 groundwater samples.
Trip Blanks	1 per shipping container containing water samples for VOC analysis	Evaluate possible cross-contamination among sample containers.
Performance Evaluation Samples for HE, VOCs, and SVOCs (especially HE residuals)	2 samples for each quarter	Evaluate analytical laboratory performance.

2.4.4.5 Sample Analysis Methods

The methods proposed for sample analysis are given in Table 2.4.4.-3

Table 2.4.4-3 Analytical Methods

Analyte	Method
TAL metals	EPA 6010
Mercury	EPA 6010
Selenium	EPA 6010
VOCs	EPA 8260
SVOCs	EPA 8270
HE	EPA 8330 ????
Major cations/anions	Standard methods
Nitrates/Nitrates	EPA 300
Chloride	EPA 300
Tritium	????

3.0 Data Use and Interpretation

3.1 Stream Flow

Stream flow data will be used to establish the net surface water loss as the streams in Pajarito and Threemile Canyons cross TA-18. A significant portion of that flow loss results in groundwater recharge, although some fraction is lost to evapotranspiration. An estimate of the recharge in Pajarito and Threemile Canyons, coupled with water quality data for the up-gradient background wells, will be used to estimate a volume-weighted background water quality for groundwater entering the western boundary of TA-18. As now planned, the first three quarters of sampling and water level measurements will encompass the period from November through May, which correspond to the expected low and high elevations of both streamflow and water table.

3.2 Groundwater Elevations

Changes in groundwater elevations, in conjunction with estimates of the porosity and horizontal extent of the aquifer, will be used to estimate changes in the volume of groundwater in storage between measurement periods. The rate of change can also be used to estimate transmissivity for the aquifer. The change in groundwater storage will be compared with stream flow loss to refine water balance estimates for the aquifer.

3.3 Water Chemistry

Changes in concentrations of major cations and ions, as well as pH, will be used to evaluate the extent to which there may be contaminant sources within TA-18, particularly those associated with PRSs where COPCs were present above screening levels. Data presented in the RFI Report indicated little change in water quality within TA-18, but a persistent degradation with down-gradient distance east of TA-18. Seasonal changes in water quality, corresponding to the rise and fall of the water table, could indicate that some contaminant sources are seasonally encountered by the groundwater.

3.4 Concentrations of Potential Contaminants

3.4.1 Evaluation of Potential Contaminant Sources Within TA-18

The primary objective of the proposed sampling is to determine the extent to which concentrations of potential contaminants in groundwater change with down-gradient distance. Data from wells located in Threemile and Pajarito Canyon upstream from their confluence will be compared against the respective background wells in each canyon. As discussed in Section 3.1, for wells at and below the confluence, up-gradient wells will be used to determine a volume-weighted background water quality resulting from groundwater entering the western boundary of TA-18 through the two canyons. Observed concentrations of COPCs in wells within and down-gradient from TA-18 will initially be compared directly against the appropriate background concentration. In order to strengthen statistical comparisons of up-gradient and down-gradient data, At each of the upgradient (background) wells in Pajarito and Three-Mile Canyons, four sampling events will occur. This data will be considered our full amount of background water quality measurements for this site.

For downgradient wells affected by waters from only one of these canyons, comparisons will be made with only the four appropriate data sets. For those monitoring wells that are downgradient of both the Pajarito and Threemile Canyon background wells, comparison with all eight background samples may be

conducted if the data suggest that combining both background wells is appropriate. Data from the down-gradient wells will be compared to prediction intervals calculated from the background data, according to the theory put forth in Chapter 1 of Statistical Methods for Groundwater Monitoring by Robert D. Gibbons. An overall confidence level of 95% will be used for these tests. That is, the probability of a false positive reading for any of the simultaneous tests to be conducted (each analyte at each well) will be 5%.

Available data, as presented in Table 1-1, suggest that seasonal variability may not be detectable in the data. If so, steady-state background concentrations will be assumed. If the background concentrations vary significantly with time, an attempt will be made to develop a dynamic mixing model, using estimated groundwater flow rates. This will allow a more refined estimate of how the effects of changes in background water quality may be realized at any particular sampling location.

Qualitative and quantitative evaluation of the collected data will be used to assess whether PRSs within and down-gradient from TA-18 appear to be contributing contaminants to the groundwater. It is expected that HE constituents will be detected at most sampling locations; HE constituents have been previously detected up-gradient, within, and down-gradient from TA-18. The variability of HE concentrations across the study area will provide some indication of the effectiveness of the existing well network in characterizing the nature and extent of contamination in the shallow groundwater.

3.4.2 Stage 2 Sampling Design

The data from the Stage 1 sampling will be used, to the extent possible, to characterize the nature and extent of contamination. The need for additional monitoring wells will be assessed, and recommendations developed regarding the number and proposed locations of any additional wells or other sampling locations for Stage 2 sampling. The data from Stage 1 will also be used to refine the list of analytes for which data will be collected in the Stage 2 sampling.