DRAFT FINAL

EXPOSURE CONTROL ACTION
ENGINEERING EVALUATION/COST ANALYSIS
FOR THE
FORMER FIRE TRAINING AREA
MARSHALL ARMY AIRFIELD
FORT RILEY, KANSAS

December 1997

Prepared for
United States Army Engineer District, Kansas City
CENWK-EP-EA
601 East 12th Street
Kansas City, Missouri 64106-2896

Prepared by
Louis Berger & Associates, Inc.
1819 H Street, N.W., Suite 900
Washington, D.C. 20006

FFTA_3_4_001

LOUIS BERGER & ASSOCIATES, INC.

Engineers • Economists • Planners
1819 H Street, NW • Washington, D.C. 20006
Telephone: (202) 331-7775

December 12, 1997

Mr. Glen Shonkwiler
U.S. Army Engineer District, Kansas City
ATTN: CENWK-EP-EA
601 East 12th Street
Kansas City, Missouri 64106-2896

RE: Draft Final Exposure Control EE/CA
MAAF/FFTA, Fort Riley, Kansas
(Contract No. DACA41-92-D-0001)

Dear Mr. Shonkwiler:

The above referenced Draft Final report is enclosed (4 copies). Copies are also being forwarded to Mike Greene, Fort Riley DES, US Army Environmental Center, EPA, KDHE, USACHPPM, and ATSDR; as identified below.

The subject EE/CA Draft Final document has been quality control reviewed and coordinated by Berger prior to this submittal.

Please do not hesitate to call Barry Millman of Berger at (202) 331-7775 if questions arise.

Sincerely,
LOUIS BERGER & ASSOCIATES, INC.

CMcKinley / for

Susan E. Knauf
Project Director

Enclosure

c: Kyle Kirchner, Dynamac/Fort Riley DES (14 copies)
Joe King, AEC (2 copies)
Larry Tannebaum, CHPPM (5 copies)
Mike Greene, CENWK-FM-RI (1 copy)
Bob Koke, EPA Region VII (2 copies)
Randy Carlson, KDHE (2 copies)
Ed Gregory, ATSDR (1 copy)
Barry Millman, LBA (1 copy)
Charles McKinley, LBA (1 copy)
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EXECUTIVE SUMMARY

The purpose of this EE/CA is to evaluate exposure control alternatives for impacted private wells located downgradient (north) of the FFTA-MAAF that contain concentrations of chlorinated organic compounds -- trichloroethylene (TCE) and tetrachloroethylene (PCE) -- above the allowable drinking water concentrations (Maximum Contaminant Levels - MCLs) established under the Safe Drinking Water Act. Specifically, this EE/CA evaluates alternatives for providing water at concentrations below the MCLs to the users of private wells north of FFTA-MAAF. This EE/CA does not address cleanup of groundwater; groundwater cleanup alternatives are being evaluated under a separate remedial investigation/feasibility study (RI/FS) for the FFTA-MAAF. This EE/CA does, however, take into consideration the potential impacts (if any) that different exposure control alternatives could have on groundwater quality and cleanup alternatives.

E.1 Background Information

Fort Riley is located north of Junction City in northeast Kansas. Fort Riley contains over 100,000 acres in portions of Riley, Geary and Clay Counties. The Republican and Kansas Rivers are located at the southern portion of Fort Riley, in places forming the installation boundary. One cantonment area of Fort Riley, Marshall Field, is located south of the Kansas River. Due to a meander in the Kansas River, the river forms the western boundary to Marshall Field (MAAF).

The FFTA is located along the northern boundary of MAAF. Private properties are located to the north of MAAF, including residences, agricultural land and an automobile racetrack. The FFTA-MAAF overlies an alluvial aquifer of sands and gravels that is present along the Kansas River plain. The alluvial aquifer is highly productive and is used as the primary source of drinking water by Fort Riley and nearby towns. Beneath the FFTA, the alluvial aquifer extends to depths of 60 to 70 feet beneath the ground surface.

Initial investigations of the FFTA-MAAF beginning in September 1993 identified releases of volatile organic compounds and petroleum hydrocarbons from the FFTA to shallow groundwater. In addition, sampling of monitor wells and private wells downgradient of the FFTA have detected concentrations of 1,2-dichloroethylene (DCE), TCE, and PCE. Periodic groundwater monitoring has been conducted since the initial investigations and confirm the presence of DCE, TCE and PCE in private wells downgradient of the FFTA-MAAF. Specifically, two wells at the racetrack (identified as R-1 and R-2) and one well servicing a trailer home (identified as M-1) contain concentrations of DCE, TCE and/or PCE. Detected concentrations exceed MCLs for PCE and TCE at R-1 and R-2, but do not exceed MCLs at M-1. Wells R-1 and R-2 service the racetrack which is only used approximately two nights per week during the months of May through September. Well R-2 is used only for wetting and grooming of the track, and R-1 services the concession stand and restrooms. The use of R-1 for drinking water at the concession stand has been curtailed since the evidence of contamination above MCLs has become available. Well M-1 is the only source of water for the residents of the trailer, and also services an adjacent workshop.

E.2 Exposure Control Objectives

The National Contingency Plan (NCP), EPA's regulations for implementing authorities under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) states that removal actions (including exposure control actions) are warranted at sites where the following conditions exist (Section 300.415(b)(2)(i)-(viii)):

- Prevention or abatement of actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants; and
- Prevention or abatement of actual or potential contamination of drinking water supplies or sensitive ecosystems.

The implementation of exposure control actions at the site under CERCLA is independent of, yet consistent with, other long-term investigations and remediations that may need to be conducted to fulfill final cleanup requirements for the site under CERCLA. At the FFTA-MAAF, an RI/FS is underway to address the need for long-term cleanup of groundwater in the alluvial aquifer.

Removal actions are categorized by EPA as either emergency, time-critical, or non-time critical. Emergency and time-critical removal actions respond to releases requiring action within six months; non-time critical removal actions respond to releases requiring action that can start later than six months after the determination that a response is necessary. Based on the assessment that potential risks due to current uses of groundwater with concentrations exceeding the MCLs are within EPA acceptable values and can be managed, this removal action is considered non-time critical. The process for conducting non-time critical removal actions is outlined in Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA, EPA's Office of Solid Waste and Emergency Response, EPA540-R-93-057, August 1993.

Once the need for a non-time critical removal action has been identified, an EE/CA is prepared which serves to evaluate and document the selection of an alternative to be implemented. The objective of this EE/CA is to evaluate alternatives to control exposures of humans to contaminated groundwater. The next step in developing an exposure control action plan is to identify the applicable considerations related to the site. These considerations must be identified to ensure that the proposed removal action is in substantive compliance with applicable or relevant and appropriate requirements (ARARs) to the extent possible.

Although ARARs must only be complied with to the extent practicable, several were identified as potentially pertinent at the FFTA-MAAF. These ARARs are as follows:

- Safe Drinking Water Act (SDWA);
- National Primary Drinking Water Regulations (NPDWR);
- Clean Air Act/National Emissions Standards for Hazardous Air Pollutants (NESHAPs);
- State of Kansas Ambient Air Quality Standards and Air Pollution Control Regulations;
- U.S. Department of Transportation (DOT) Rules for Transportation of Hazardous Materials;
- State of Kansas Water Well Construction and Abandonment Requirements; and
- State of Kansas Public Water Supply and Water Rights Regulations.

Each of these regulations provides substantive requirements that were considered and incorporated into the exposure control alternatives to the extent that they are applicable, or relevant and appropriate.

E.3 Identification of Removal Action Objectives

An initial list of promising technologies and categories of potential exposure control alternatives was identified which would address providing water to users of R-1 and R-2 (and potentially M-1) at concentrations below MCLs. From this list, a set of specific exposure control alternatives was developed. Then, a screening of these alternatives was performed to select those alternatives which are anticipated to be effective, implementable and cost-effective. The alternatives selected through the alternative screening process are then evaluated in greater detail for effectiveness, implementability and cost.

Identification of Alternatives

Appropriate exposure control alternatives were identified in three categories using conventional water supply and/or treatment technologies:

- Extending Public and/or Community Water Supply Service;
- Installation of New Wells; and
- Performing Wellhead Treatment.

Five water supply systems were identified in and around the FFTA-MAAF, including the Fort Riley, Morris County, Ogden, Junction City and Grandview Plaza systems. All of these systems have the capacity to service the area north of the FFTA-MAAF. Extension of any of these systems to the users of R-1 and R-2 (and potentially M-1) would be effective in providing water at concentrations below MCLs. However, there are significant cost differences due to their proximity to the FFTA-MAAF. The two closest systems are the Fort Riley and Morris County systems. Since each system has different factors affecting implementability, both were retained as part of the screening process for more detailed evaluation.

Three alternatives were identified for installing new wells: (1) installing a new common well on Fort Riley property outside the area of contamination and extending service lines to R-1 and R-2 (and potentially M-1); (2) installing deeper wells adjacent to existing wells; and (3) installing a single well on the racetrack property outside of the area of contamination to replace the R-1 and R-2 supplies (and potentially installing a second well on the property with the trailer to replace M-1). The first alternative in this category was eliminated during the screening process because of the implementability issues and initial costs of implementing a new water supply, running the service lines and continued operation and maintenance costs and responsibilities for Fort Riley. The second alternative in this category was eliminated during the screening process because of the concern that wells adjacent to R-1 and/or R-2 may not provide concentrations of water below MCLs or may not provide sufficient volume. The alluvial materials do not have any continuous low permeability layers separating the zones of contamination with the deeper, uncontaminated zones of the alluvial aquifer; therefore, the capture zone of a well in the deep alluvial materials near R-1 and/or R-2 would intersect with the area of contamination above MCLs. The bedrock materials underlying the alluvial materials are used as water supply wells in the area, but typically have low yields. A discharge rate of greater than 100 gallons per minute (the currently discharge rate of R-2) is not expected from bedrock wells in the area. The third alternative is considered effective in that a well to replace R-1 and R-2 can be placed on the racetrack property in the alluvial aquifer such that the capture zone for the well during pumping does not intersect with the area of groundwater contamination. This third alternative was retained as a result of the screening process for more detailed evaluation.

Four wellhead treatment technologies applicable to removal of volatile organic compounds (VOCs) from groundwater were identified as follows: carbon adsorption, air stripping, ultra-violet (UV) oxidation, and steam stripping. Carbon adsorption is a well known technology and effective in reducing VOCs to concentrations below MCLs. Air stripping is difficult to operate and maintain under conditions where there is intermittent flow due to clogging and fouling of the system. UV oxidation is effective in reducing VOCs to concentrations below MCLs, but is costly relative to both carbon adsorption and air stripping. Steam stripping is effective in removing VOCs at high concentrations in groundwater but is not cost-effective for reducing the VOCs at concentrations in the low parts per billion range (which are the concentrations present in R-1 and R-2). Based on these considerations, carbon adsorption was retained as a result of the screening process for more detailed evaluation.

In accordance with EPA requirements for the EE/CA, each alternative is evaluated in detail for effectiveness, implementability, and cost.

Effectiveness is evaluated against the alternatives ability to protect human health and the environment, with emphasis in this case on exposures to groundwater that exceed drinking water standards (MCLs).

Implementability evaluates the ease or difficulty associated with the removal action, including approval processes, demonstration of substantive compliance with regulatory requirements, community acceptance and overall complexity of the removal action.

Cost evaluations include initial capital costs as well as on-going operations and maintenance costs. Each alternative was evaluated on the basis of providing exposure control to Wells R-1 and R-2 (Phase 1) during a five year period. Additional cost evaluations were completed for the contingency of providing exposure control to Well M-1 over a five year period, and for O&M costs for both phases over a thirty year period.

For the alternatives of extending a municipal water system and wellhead treatment, a preliminary evaluation of alternatives for effectiveness, implementability and cost was performed as an initial screening of alternatives. Then, the alternative that was determined to perform best against the effectiveness, implementability and cost criteria was selected for more detailed evaluation against the other types of alternatives.

Detailed Evaluation of Alternatives

A brief description of each of the alternatives retained for more detailed evaluation is as follows:

- *Alternative 1. Extend Fort Riley/MAAF water supply*: This exposure control alternative would involve extending a new supply line from the end of Ray Street at MAAF. The new line would traverse approximately 1,700 feet and involve crossing beneath the existing Marshall Army Airfield levee. One-inch service connections from the main to each user would also be provided.

  Effectiveness - This alternative would achieve the exposure control objectives by eliminating exposure to the groundwater contamination. The level of exposure control expected is 100 percent. The effectiveness and permanence of this alternative makes it a viable long-term solution.

  Implementability - Construction for this alternative would likely be accomplished using cut and cover pipeline with the exception of passing beneath the MAAF levee where jacking techniques will likely be required.

  Costs -

Phase 1 (5 yrs):	$305,300
Phase 1+Contingency (5 yrs):	$308,000
Phase 1 (30 yrs):	$311,200
Phase 1+Contingency (30 yrs):	$316,200

- *Alternative 2. Extend Morris County Rural Water District:* This exposure control alternative would involve extending approximately 10,000 feet of new supply line from a main line in the Morris County Rural Water District (RWD). The new line would be constructed within the right-of-way of Whiskey Lake Road and Racetrack Road. One-inch service connections to each user would also be provided.

  Effectiveness - This alternative would achieve the exposure control objectives by eliminating exposure to the groundwater contamination. The level of exposure control expected is 100 percent. The effectiveness and permanence of this alternative makes it a viable long-term solution.

  Implementability - There are no unusual construction and/or operational considerations with this alternative. There are no major roadways or natural resources over which to cross. Construction for this alternative would be accomplished using cut and cover pipeline.

  Costs -

Phase 1 (5 yrs):	\$606,600
Phase 1+Contingency (5 yrs):	\$610,200
Phase 1 (30 yrs):	\$612,400
Phase 1+Contingency (30 yrs):	\$618,300

- *Alternative 3. Install New Common Well for R-1 and R-2 On-Site and a Replacement Well for M-1 (if necessary)*: This alternative involves providing new groundwater well supplies on the subject properties, in a manner that would remove potential exposure to contaminants. Wells R-1 and R-2 would be replaced with a new 8-inch well serving both users, located in the southwest corner of the subject property. New service connections to the users would be provided, including placement of the R-2 service line under the existing racetrack. Well M-1 would be replaced with a 5-inch alluvial aquifer well 800 feet to the west of the existing well. A new service connection would be provided to the point of use.

  Effectiveness - This alternative provides a water supply that would have the ability to achieve the exposure control objectives and eliminate exposure to the pollutant parameters in the short term. Over time, a minimal potential exists for contamination of this alternate water source by migration of pollutants into the well's zone of influence.

  Implementability - Construction for this alternative would involve drilling two new wells and laying cut and cover pipe to all current supply points. No specialized equipment or personnel are required to implement this alternative; therefore, normal availability of personnel and equipment is expected during the typical construction season.

Costs -

Phase 1 (5 yrs):	$ 98,400
Phase 1+Contingency (5 yrs):	$131,200
Phase 1 (30 yrs):	$ 93,400
Phase 1+Contingency (30 yrs):	$148,000

A second option was identified for this alternative to reduce both costs and ARAR issues, which consists of providing a bottled water source of supply to R-1. The construction of new water service lines and facilities would be reduced. The costs for this option are as follows:

Costs -

Phase 1 (5 yrs):	$ 70,193
Phase 1+Contingency (5 yrs):	$102,991
Phase 1 (30 yrs):	$ 70,193
Phase 1+Contingency (30 yrs):	$140,381

- *Alternative 4. Perform Wellhead Treatment at Existing Wells via Carbon Adsorption*: This alternative involves the continued use of the existing wells, with provision of wellhead treatment prior to use of the water. Treatment would consist of VOC removal using granular activated carbon (GAC).

  Effectiveness - This GAC treatment would be designed and tested to remove the target contaminant(s) from the water to a concentration significantly below the respective MCL(s) and, attempt to reach concentrations that cannot be detected utilizing required analytical methods and instrumentation.

  Implementability - There are no unusual construction considerations with this alternative. Construction for this alternative will be restricted to appropriate sites at or adjacent to the existing wells, involving the installation of above-ground wellhead treatment equipment and a weather-proof enclosure. Long term O&M of these units by Fort Riley is an implementability issue which is also reflected in the long term costs.

  Costs -

Phase 1 (5 yrs):	$ 62,000
Phase 1+Contingency (5 yrs):	$ 84,000
Phase 1 (30 yrs):	$124,000
Phase 1+Contingency (30 yrs):	$177,000

E.4 Comparative Ranking of Alternatives

In order to adequately address the CERCLA requirements at the site, the nine evaluation criteria developed by EPA were applied to the four exposure control alternatives. These first seven criteria are:

1. Overall protection of human health and the environment
2. Compliance with ARARs
3. Long-term effectiveness
4. Control of exposure to contaminants
5. Short-term effectiveness
6. Implementability
7. Cost

There are two additional criteria that are considered in final selection in the Action Memorandum:

8. State acceptance
9. Community acceptance

A competitive and quantitative comparison was performed to facilitate ranking the four alternatives which were subjected to the detailed analysis. Each alternative was given a ranking based on how it rated compared to the other three alternatives; with equal rankings if it was not possible to significantly differentiate performance for a given criteria. The most favorable alternative(s) were given a 1, and so on, with a 10 being the least favorable ranking. This ranking method was employed for each of the evaluation criteria. Performance and ranking under each criterion is based on addressing control of exposure to groundwater contamination.

□ *Overall Protection of Human Health and the Environment*:

Alternatives 1 and 2 are protective of human health and the environment because an alternate source of water supply with unrestricted use would be provided, and the alternative is fully protective of the environment. Alternative 3 is protective in the short term, however, the potential exists for migration of the contamination to the new wells at some date in the future. Alternative 4 is protective, assuming that the treatment units are properly operated and maintained.

□ *Compliance With ARARs*:

All of the alternatives would substantively comply with ARARs. Alternatives 1 and 2 would fully comply with ARARs for drinking water, as appropriate for an extension of a public water supply system. Permitting requirements for the implementation of these alternatives would be moderate. Alternative 3 would comply with drinking water MCLs according to calculations of the potential contaminant migration. Alternative 4 would be in compliance with drinking water MCLs, assuming that the systems are properly operated and maintained.

□ *Long-Term Effectiveness and Permanence*:

Alternatives 1 and 2 provide the greatest level of long-term effectiveness and permanence of exposure control. The use of these alternatives could continue into any date in the future, or be discontinued if appropriate in the short term, providing flexibility in their implementation.

Alternative 3 provides a reasonable level of exposure control in the long term, however, less than all other alternatives due to the unlikely potential for future contamination occurring in the new wells.

Alternative 4 provides a high level of long term effectiveness, based on the conservative nature of the system design and configuration and provision of O&M needs by a vendor.

Based on available data and current projections, all four alternatives will likely be permanent and effective in the long-term, but Alternative 3 is the only alternative which lacks the inherent ability to adjust exposure control in the event that currently unforeseen changes in environmental conditions arise.

□ *Control of Exposure To Contaminants:*

Alternatives 1, 2 and 3 provide a high level of protection; any potential for exposure is preventable by future land use controls governing excavation in contaminated soils.

Alternative 4 could include similar future land use controls regarding excavation, and would also require proper handling of spent (contaminated) carbon media by the vendor.

□ *Short-Term Effectiveness:*

All of the alternatives will meet 100 percent of the exposure control goals in the short-term (within one year). Alternatives 1 and 2 will have longer construction periods, and Alternative 3 will have a longer initial permitting period. Protection of workers will be a moderate concern during construction of all of the alternatives, and more so for Alternative 4 which will involve treatment of contaminated groundwater.

□ *Implementability:*

There are no technical implementability concerns associated with any of the alternatives because well-documented technologies are used, with materials and services available in the region.

Alternative 2 is less implementable than the other alternatives due to the relatively long distance to connect to the Morris County system.

Alternative 1 has modest O&M costs, however, it would be an administrative burden for Fort Riley. Alternative 2 has similar O&M costs to Alternative 1, without the need for administration by Fort Riley. Alternative 3 only has O&M costs associated with periodic monitoring, and Alternative 4 has the highest O&M costs for periodic removal and replacement of the carbon media.

- ☐ *Cost:*

The order-of-magnitude cost estimates for each alternative shown above were used for comparison purposes and alternative ranking.

Table ES-1 is a summary of the four exposure control alternatives that were evaluated in greater detail and the relative ranking of the evaluation criteria for each alternative.

Although no statistical inferences can be made from the overall comparison based on the criteria-specific rankings for each alternative, a summation of the rankings is nonetheless useful. For these four alternatives, the ranking score illustrates that Alternative 3 (New Replacement Wells) ranks higher than the other alternatives. The strengths/weaknesses and costs/benefits associated with Alternatives 1 and 2 balance out in various ways so that there is no identifiable second best alternative. Alternative 4 is clearly the least desirable alternative.

E.5 Recommended Alternative

Based on the rankings provided in Table ES-1, installing a new replacement common well for R-1 and R-2 (with the potential option of using bottled water at R-1), and a new alluvial well for Well M-1 if needed, is the recommended exposure control action alternative (Alternative 3). This alternative best satisfies the evaluation criteria based on a comparative analysis.

Wells R-1 and R-2 would be replaced with a new 8-inch well serving both uses, located in the southeast corner of the subject property. In order to produce the required flow demand of 100 to 105 gpm, this well would have to be screened in the unconsolidated aquifer. This location is approximately 400 feet from the edge of the contaminant plume, however, the cone of influence from the well is estimated to be less than 275 feet. New service connections to the uses would be provided, including assumed jacking of the R-2 service replacement under the existing racetrack. In the event that ARARs relating to the R-1 public water supply permit become an issue, bottled water may be supplied to the R-1 concession.

A replacement well for Well M-1, if needed, would be a 5-inch diameter alluvial aquifer well 800 feet to the west of the existing well. A new service connection would be provided to the point of use.

Table ES-1
Summary of Alternative Screening

Criteria	**Alternative 1** Extend Ft. Riley System	**Alternative 2** Extend Morris System	**Alternative 3** New Wells	**Alternative 4** Wellhead GAC
Overall Protection	1	1	2	3
Compliance With ARARs	1	1	4	3
Long Term Effectiveness	1	1	4	4
Exposure Control	1	1	1	4
Short Term Effectiveness	2	2	1	2
Implementability	6	6	1	8
Cost	8	10	2	1
Total Ranking Score	20	22	15	25

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LIST OF ACRONYMS

AEHA	Army Environmental Health Agency (renamed to CHPMM)
ARARs	Applicable or Relevant and Appropriate Requirements
AWWA	American Water Works Association
CEMRK	Corps of Engineers, Missouri River Division, Kansas City District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended.
DCE	1,2-Dichloroethylene
DOD	Department of Defense
DOT	Department of Transportation
DWR	Division of Water Resources
EE/CA	Engineering Evaluation / Cost Analysis
EPA	United States Environmental Protection Agency
FFA	Federal Facility Agreement
FFTA	Former Fire Training Area
GAC	Granular Activated Carbon
gpd/ft	Gallons per day per foot
gpm	Gallons per minute
IAG	Interagency Agreement
KAR	Kansas Administrative Regulations
KDHE	Kansas Department of Health and Environment
KDWR	Kansas Division of Water Resources
KPL	Kansas Power & Light
KSA	Kansas State Article
L.F.	Linear Foot
MAAF	Marshall Army Airfield
MCLs	Maximum Contaminant Levels established by EPA under the Safe Drinking Water Act
MCLG	Maximum Contaminant Level Goal
MG	Million Gallons

MGD	Million Gallons per Day
NAAQS	National Ambient Air Quality Standards
NCP	National Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDWR	National Primary Drinking Water Regulations
O&M	Operations and Maintenance
PAC	Powdered Activated Carbon
PCE	Tetrachloroethylene or Perchloroethylene
PE	Polyethylene (pipe)
psi	Pounds per square inch
PVC	Polyvinyl Chloride (pipe)
PWSS	Public Water Supply System
QCSR	Quality Control Summary Report
RA	Removal Action
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RWD	Rural Water District
SARA	Superfund Amendments and Reauthorization Act
SCAPS	Site Characterization and Analysis Penetrometer System
SDWA	Safe Drinking Water Act
SI	Site Investigation
TBC	To Be Considered
TCE	Trichloroethylene or Trichloroethene
USGS	United States Geological Survey
UV	Ultra-violet
VOC	Volatile Organic Compound
mg/l	milligrams per liter (approximately equivalent to parts per million)
μg/l	micrograms per liter (approximately equivalent to parts per billion)

mg/kg	milligrams per kilogram (approximately equivalent to parts per million)
µg/kg	micrograms per kilogram (approximately equivalent to parts per billion)

1.0 OVERVIEW

Louis Berger & Associates, Inc. (Berger) has prepared this Engineering Evaluation/Cost Analysis to evaluate Exposure Control Alternatives for the Former Training Area - Marshall Army Airfield (FFTA-MAAF), Fort Riley, Kansas. Berger prepared this EE/CA for Fort Riley under contract to the U.S. Army Corps of Engineers, Kansas City District, Missouri River Division (CEMRK) (Contract No. DACA41-92-D-0001).

The U.S. Department of the Army - Fort Riley, the Kansas Department of Health and the Environment (KDHE) and the U.S. Environmental Protection Agency (EPA) entered into a Federal Facility Agreement (FFA) -- Docket No. VII-90-F-0015 -- to address environmental releases subject to the Comprehensive Environmental Response Compensation and Liability Action (CERCLA) and the Resource Conservation and Recovery Act (RCRA). The FFA is also referred to as the Interagency Agreement (IAG). Investigations and evaluations of an environmental release from the FFTA-MAAF are being conducted to fulfill requirements of the IAG.

An initial Site Investigation (SI) was conducted for FFTA-MAAF during the period of September 1993 through June 1994. The purpose of the SI was to collect data to confirm or deny that hazardous substances are present at the FFTA-MAAF. The results of the SI indicated that petroleum hydrocarbons and chlorinated solvents (including tetrachloroethylene, also known as perchloroethylene [PCE]) were present in the subsurface environment (soil and groundwater). Additionally, the same contaminants as those detected at the FFTA were detected in groundwater along the installation boundary and in private wells located at a speedway, approximately 1,000 feet north of the FFTA-MAAF.

Since June 1994, additional investigations and periodic groundwater monitoring have been conducted as an expansion to the SI. An overview of the key findings of these investigations are as follows:

- The FFTA-MAAF overlies an alluvial aquifer consisting predominantly of sand and gravel; the alluvial materials are underlain by bedrock at depths of approximately 60 to 70 feet beneath the ground surface in the area of the site.

- Depth to groundwater is approximately 15 to 20 feet beneath the ground surface; groundwater fluctuations of up to 8 feet have been observed due to high rainfalls and flooding.

- Direction of groundwater flow is predominantly to the north, with seasonal fluctuations due to changing hydrologic conditions to both the northeast and northwest.

- Groundwater monitor wells screened in the shallow alluvial materials (the upper 15 feet of the aquifer) and shallow private wells (screened intervals overlap with upper 15 feet of aquifer) have shown detections of 1,2-dichloroethylene (DCE), trichloroethylene (TCE) and PCE both in groundwater directly underlying the FFTA-MAAF and in wells up to 1,200 feet downgradient of the FFTA-MAAF.

- Detections of TCE and PCE in two private wells have exceeded Maximum Contaminant Levels (MCLs).

- Since 1993, the concentrations of DCE, TCE and PCE in groundwater underlying the FFTA-MAAF have decreased in all monitoring wells in that location.

- The highest concentrations of DCE, TCE and PCE in groundwater have consistently been present in the private wells downgradient of the FFTA-MAAF since October 1994.

- Initial investigations have been conducted on the water quality in the intermediate and deeper portions of the alluvial aquifer in the area at and immediately downgradient of FFTA-MAAF, and the results to date indicate that the contamination is limited to the shallow aquifer alluvial materials.

Investigations of groundwater quality in the area of FFTA-MAAF are ongoing. This EE/CA incorporates all groundwater quality data available for the site through August 1996.

1.1 Removal Action Process

CERCLA and the National Contingency Plan (NCP), EPA's regulations for implementing authority under CERCLA, define removal actions to include "the cleanup or removal of released hazardous substances from the environment ... or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare ... from a release or threat of release." The following are potential removal actions identified in Section 300.415(b)(2)(i)-(viii) of the NCP:

- Prevention or abatement of actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants; and

- Prevention or abatement of actual or potential contamination of drinking water supplies or sensitive ecosystems.

EPA has categorized removal actions in three ways based on the urgency of the release or potential release and the associated time frame in which the action must be initiated: emergency, time-critical, and non-time critical. Emergency and time-critical removal actions respond to releases requiring action within six months; non-time critical removal actions respond to releases requiring action that can start later than six months after the determination that a response is necessary.

Groundwater quality data show that two off-post, private wells on property immediately downgradient of the FFTA-MAAF have detected concentrations of TCE and PCE above MCLs. These wells are located at a property used as an automotive racetrack and is hereby referred to as the "racetrack property." The wells are identified as R-1 and R-2. Well R-1 serves the concession stand at the racetrack and was used intermittently for drinking water when the racetrack was in use, which is typically one or two nights per week for the months of May through September. According to users of the racetrack, water from well R-1 has not been used for drinking since evidence of contamination was found. Well R-2 is located in the center of the racetrack and water from it is used to spray on the track for grooming and dust control. Well R-2 remains in use. Other nearby private wells have either not shown contamination or do not have concentrations of contaminants above MCLs.

The mitigation and/or control of exposures to contaminated groundwater in private wells downgradient of the FFTA-MAAF meets the criteria for a removal action, as defined in the NCP. The removal action is considered a non-time critical removal action because the assessment has been made that potential risks due to current uses of groundwater with concentrations above MCLs for drinking water are within EPA acceptable values and can be managed. Therefore, the exposure control removal action can be initiated following six months from determining that a removal action is necessary without resulting in harmful exposures to contaminated drinking water. However, the removal action is warranted to ensure that future harmful exposures do not occur.

The process for conducting non-time critical removal actions is outlined in the following document: Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA, EPA's Office of Solid Waste and Emergency Response, EPA540-R-93-057, August 1993[1-1]. Once the need for a removal action has been identified, non-time critical removal actions require preparation of an EE/CA to identify the objectives of the removal action and to analyze the alternatives that may be used to satisfy these objectives for effectiveness, implementability and cost. Following the issuance of the EE/CA and a public comment period, the Action Memorandum is prepared which summarizes the EE/CA and documents the specific removal action to be implemented. The removal action is then implemented.

1.2 EE/CA Objectives

The overall objective of the EE/CA is to fulfill regulatory requirements for documenting the selection of a removal action activity to implement exposure controls for contaminated groundwater in private wells downgradient of the FFTA-MAAF. To fulfill regulatory requirements, this EE/CA adheres to EPA's 1993 guidance (cited above) for preparation of EE/CAs and documentation for non-time critical removal actions. The specific objectives of the EE/CA are as follows (and are discussed in more detail in Section 3.0 of this document):

- to identify the removal action goals;
- to identify potential alternatives for achieving the removal action goals;
- to evaluate each alternative for effectiveness, implementability and cost; and
- to select and recommend a removal action alternative.

1.3 Document Organization

This EE/CA is organized as follows:

Section 2.0 - FFTA Characterization: presents an overview of environmental conditions and geographic setting for the site, including a description of potential risks that are to be mitigated by the removal action;

Section 3.0 - Removal Action Objectives: describes the specific objectives of the EE/CA, establishing the criteria against which the alternatives will be evaluated for implementability, effectiveness and cost;

Section 4.0 - Identification and Screening of Exposure Control Alternatives: identifies three categories of alternatives and performs an alternative screening to select four specific alternatives to be considered; presents a description and conceptual model for each;

Section 5.0 - Evaluation of Exposure Control Alternatives: evaluates each alternative for effectiveness in meeting EE/CA objectives, implementability and cost; also presents a comparative analysis for each alternative based on these evaluation criteria;

Section 6.0 - Comparative Ranking of Exposure Control Alternatives: identifies the removal action that best satisfies the removal action evaluation criteria, summarizing the ranking process used to develop the proposed action;

Section 7.0 - Recommended Exposure Control Alternative: presents and describes the recommended alternative for exposure control based on the results of the EE/CA evaluation process.

Section 8.0 - References: provides a bibliography of reference material used in the EE/CA.

Tables and figures for each section appear at the end of each section; appendices are provided following Section 8.0.

2.0 FFTA CHARACTERIZATION

This section provides a description of FFTA history, the environmental and hydrogeologic setting for the area, and data pertaining to groundwater contamination at FFTA-MAAF and the nearby off-post properties. More detailed information on the site can be found in the following document:

- *Site Investigation for Former Fire Training Area - Marshall Army Airfield, Fort Riley, Kansas*[(2-1)].

2.1 FFTA Description

This section provides a description of the FFTA location, the surrounding land uses, topography and land features, and hydrogeology and groundwater uses.

2.1.1 FFTA Location

The Fort Riley Military Reservation is located just north of Junction City in northeast Kansas (Figure 2-1). Fort Riley contains 101,058 acres, including portions of Riley, Geary, and Clay Counties. Fort Riley is located approximately between latitudes 39° 02' and 39° 18' north and longitudes 96° 41' and 96° 58' west.

Fort Riley was founded near the confluence of the Republican and Smoky Hill Rivers that merge to form the Kansas River. The more widely developed areas of Fort Riley occur in the southern portion of the reservation in the areas along the Republican and Kansas Rivers. The developed areas are divided into six cantonment areas: Main Post, Camp Forsyth, Camp Funston, Camp Whitside, MAAF, and Custer Hill (Figure 2-2). [Custer Hill consists of the Custer Hill Troop Area to the north and Custer Hill Family Housing to the south.] Marshall Army Airfield is south of the Kansas River. Towns surrounding Fort Riley along the Kansas River include Ogden to the east, and Grandview Plaza and Junction City to the south.

The FFTA-MAAF is located along the northern boundary to Marshall Field, approximately 1,000 feet off the northeast end of the north-south runway. The Fort Riley installation boundary is located approximately 300 feet north of the former fire training pit. The general location of the FFTA-MAAF is shown in Figures 2-3 and 2-4.

2.1.2 Surrounding Land Uses

The area of the former fire training pit is within the boundaries of the airfield and is separated from the properties to the north by a levee and an 8-foot, continuous chain-link fence that surrounds the airfield. The nearest airfield building is over 2,000 feet to the southwest. No fire fighting training has been conducted at the FFTA since 1984. The FFTA-MAAF is used to harvest wild hay that grows at the airfield. In December 1994, a temporary fence was installed around the immediate area of the FFTA in conjunction with a pilot test study of soil remediation technologies. The area inside the fence is not currently used to harvest wild hay. Properties to the north are used for both private residences and farming. Private wells are located within approximately one-half mile to the north of the installation boundary at this location. Four properties with a total of eight private wells were initially identified -- two wells at two residences, three wells at the speedway, one at a trailer home adjacent to the speedway, and two on a farm. An irrigation well later went into service in the spring of 1994.

The property north of the FFTA-MAAF has been used as a racetrack for automobiles since the early 1980s. The speedway was used for racing standard and mini-sized automobiles. In addition to the two wells in use at the racetrack, there is an abandoned residence and potentially a former well located near the southeast corner of the racetrack. No information on the well has been located at this time. Also, an unidentified standpipe is located along the private road to the north of the racetrack, near the intersection with Racetrack Road.

2.1.3 Topography and Land Features

The topography of Fort Riley can be divided into upland areas with bluffs along alluvial valleys and lowland areas which consist of alluvial plains and associated terraces. Marshall Army Airfield and the FFTA-MAAF are located in the lowland areas where the land surface is relatively flat, with the following exceptions: 1) the levee surrounding MAAF represents a topographic high, and (2) the area within the interior of the racetrack is topographically lower than surrounding lands. The topography of the area is shown in Figure 2-5. The upland areas are located on either side of the river valley. To the east, the upland areas are located along Interstate 70 and Kansas Highway 18.

Whiskey Lake, as depicted on Figure 2-5, is an oxbow lake of Kansas River and has been routinely dry since at least the 1950s. However, when flooded, this area will retain water (as occurred in the March 1960 and July 1993 regional flooding). Regionally, the Kansas River flows east and south. The Kansas River, at its closest point, is located approximately 2,300 feet to the west of the FFTA-MAAF. Due to meanders in the river, the Kansas River flows to the north at its closest point to the FFTA-MAAF.

2.1.4 Hydrogeology and Groundwater Uses

This section provides an overview of the hydrogeologic setting, groundwater resources and users around Fort Riley.

The topographic lowlands along the Kansas River are underlain by a substantial thickness of alluvial deposits, consisting predominantly of sands and gravels, with occasional clay and silt layers. The alluvial deposits on Fort Riley are on the order of 100 feet in thickness near the river and thin out towards the bluffs. All of Marshall Field is located on alluvial deposits of the Kansas River. The FFTA-MAAF is located along the margin of the thick alluvial deposits. Four monitoring wells have been installed to bedrock in the immediate vicinity of the FFTA-MAAF; depth to bedrock ranged from approximately 60 to 70 feet. Bedrock was described as light gray, soft, weathered limestone with some shale. These borings to bedrock as well as other investigations of the area (including geophysical surveys and cone penetrometer testing) show that layers of silts and clays in the alluvial materials are relatively thin (on the order of a few feet in thickness) and are discontinuous.

Depth to groundwater at the FFTA varies from approximately 15 to 20 feet beneath the ground surface. Fluctuations in the groundwater elevations occur due to periods of high rainfall and drought; groundwater elevations rose to depths of 8 to 12 feet from the ground surface during the regional flooding in 1993. Measurements of groundwater elevations have been conducted periodically since October 1993. Since that time, the number of wells and piezometers used for collecting groundwater elevation data has increased. Three depictions of groundwater elevation measurements are provided as Figures 2-6 through 2-8. These figures show groundwater elevations measured approximately one year apart in September 1994, August 1995 and September 1996. These figures are presented as an overview of measured groundwater elevations; data from other measurement events are consistent with these figures.

- September 1994 (Figure 2-6) - The majority of measurement points are located at and immediately north of the FFTA-MAAF; one data point is located near the Kansas River (FP-94-12PZ). The predominant groundwater gradient is to the north; however, the data point at the Kansas River indicates that the gradient deflects to the northwest (towards the river) as the distance to the river decreases.

- August 1995 (Figure 2-7) - The measurement points are the same as in September 1994. The groundwater gradient is to the north-northeast.

- September 1996 (Figure 2-8) - The number of measurement points has increased, including additional data points between the FFTA and the Kansas River in the area downgradient of FFTA. The groundwater gradient is to the north-northeast.

Groundwater is the primary source of drinking water for Fort Riley and many of the surrounding communities. There is no use of surface water for drinking water within 15 miles downstream of the FFTA-MAAF.

Alluvial sand and gravel deposits in the lowland areas are excellent aquifers in the area. In the upland areas, limestone formations are tapped as sources of water. Uses of the alluvial aquifer and the limestone bedrock aquifers are identified below.

2.1.4.1 Alluvial Aquifer

Several alluvial aquifer tests were performed between 1974 and 1989 at three areas on and within the vicinity of Fort Riley. These tests were performed by contractors to the CEMRK for the purpose of constructing a water supply well system for Junction City, Kansas and the Army post at Fort Riley. Aquifer tests were also performed at MAAF for the purpose of potentially constructing a small groundwater production facility for use during airfield operations. An overview of test results is as follows:

- A 10-hour pump test was performed at the MAAF in March 1983. The test was comprised of pumping a test well at a rate of 1,000 gallons per minute (gpm) while monitoring four wells in the vicinity of the test well. The transmissivity values ranged from 203,894 to 367,304 gallons per day per foot (gpd/ft); the storativity values (which are unitless) ranged from 0.062 to 0.2[2-2].

- A 7-day pump test was performed in 1975 at test wells installed along a section of McCormick Avenue, west of Camp Forsyth. The test was comprised of pumping a test well at a rate of 1,250 gpm while monitoring numerous wells in the vicinity of the test well. Twelve piezometer holes were drilled in 1974, and 14 test holes were drilled in 1975. The transmissivity values ranged from 275,000 to 767,440 gpd/ft; the storativity values ranged from 0.23 to 0.45[2-3].

- Several pump tests were performed in the expansion well field east of the existing Main Post Well Fields (east of MP-1) within the town of Junction City, Kansas in 1984 and 1989. The pump rates varied from 1,000 to 1,056 gpm. The tests lasted from 300 to 660 minutes. Piezometers were drilled for monitoring groundwater around the pumped well. The transmissivity values ranged from 159,331 to 659,197 gpd/ft; the storativity values ranged from 0.000126 to 0.0143[2-4].

Fort Riley and the communities of Junction City and Ogden rely on groundwater withdrawn from alluvial materials for their municipal drinking water supplies. Fort Riley has eight active wells, Junction City has nine active wells, and Ogden has three active wells[2-5, 2-6, 2-7]. Ogden also provides water to a rural water district in Riley County.

- The nearest public water supply well is located at MAAF and is within 1 mile of the FFTA-MAAF. This well is located east of the airfield and south of the FFTA, near the Kansas River. The well at MAAF is only used to service the airfield in the event of an emergency affecting the Fort Riley water distribution system as a whole. There are no other private or public supply wells at MAAF.

- The producing well fields for Fort Riley include wells located west of Main Post along McCormick Road in the Camp Forsyth area. The supply system consists of six older wells (referred to as the Main Post wells brought on-line from 1928 to 1943) and two new wells located approximately 1,300 feet west of the Main Post wells (brought online in 1993). The Fort Riley drinking water wells are located approximately 3 miles from the FFTA.

- The wells for Junction City are located slightly greater than 4 miles west of the FFTA. Water from these wells also serves Grandview Plaza.

- The Morris County Rural Water District installed two wells along the Kansas River in 1994. These wells are approximately 2.5 miles northeast (downgradient) of the FFTA. The water district services the area to the south and southeast of the FFTA.

- The Town of Ogden is served by the Ogden Municipal Water District; their wells are located within the Ogden town limits, approximately 4.5 miles northeast of the FFTA. Although the Ogden wells are located in the downgradient direction, they are located on the opposite side of the Kansas River from the FFTA.

Private wells were identified on the properties downgradient of the FFTA-MAAF as follows:

- Three groundwater wells are located at the speedway, one northwest of the track near the grandstands (R-1), and two located within the interior of the track at each end of the track (R-2 to the west and R-3 to the east). The water from wells R-2 and R-3 is used for dust control and vehicle washing and is not used for consumption. R-3 is not currently in use and has not been used for several years. The water from well R-1 was formerly used to supply the concession stand and may have been used for washing and drinking. The KDHE sampled well R-1 on 4 April 1993[2-9]. The well was sampled because the owners applied for a well permit and the county routinely test wells before issuing a permit. The well is approximately 43 feet deep, is completed in unconsolidated sands, and has a screened interval from 33 to 43 feet. The results of that sampling indicated that chlorinated solvents were present as follows: PCE at 263 μg/l, DCE at 155 μg/l, TCE at 36.8 μg/l, benzene at 2.1 μg/l, and vinyl chloride at 0.5 μg/l [2-10].

- One residential drinking water well was identified immediately north of the racetrack: M-1 serves a machine shop and a house trailer (an investigation of M-1 in August 1996 determined that the well was 41 feet in depth and was screened from 23 to 32 feet).

- Other private wells serving residences and one irrigation well were also identified north of the racetrack; testing of these wells during the SI indicated that they are not contaminated and, thus, are not addressed in this EE/CA.

2.1.4.2 Bedrock Aquifer

Private residences in the upland areas, outside of town limits, use private wells. Some of these residences have access to water provided by rural water districts. Many of the rural residences surrounding Fort Riley are located in the uplands area, and their wells tap bedrock formations. In general, the limestone formations are sufficiently transmissive to yield reliable groundwater supplies. However, given the interbedded nature of the uplands area, many of the wells will be drawing water from different limestone horizons. One private well was identified in the area downgradient of the FFTA-MAAF (Township 11, Range 6) drawing from limestone. The exact location of the well was not field verified, but would be greater than 2 miles north of the FFTA-MAAF since data are available on residential wells within 2 miles of the FFTA-MAAF.

2.2 FFTA Background

2.2.1 Operational History

Fort Riley was established in 1853 and has been owned and operated by the U.S. Department of the Army since that time. The FFTA-MAAF was operated from the mid-1960s through 1984 to conduct fire training exercises [2-11, 2-12]. During the period of use, the site consisted of a crushed stone pad approximately 200 feet by 200 feet in size with no subsurface liner.

During its use, flammable liquids were dumped into the pit, ignited, then extinguished during fire training exercises. The predominant materials used for the fire training exercises were petroleum hydrocarbons, including JP-4, diesel, MOGAS (a generic term for motor gasoline often used to refer to gasolines with lead alkyls) and gasoline. Some flammable liquids were stored at the site in drums until the next training exercise was conducted. Aerial photographs from 1977 and 1984 indicate that these drums were stored to the immediate east and southeast of the bermed fire pit.

In August 1982, 55 gallons of PCE were inadvertently poured into the fire training pit. The next day it was pumped out of the pit prior to ignition. Hay was spread over the remaining liquid in the pit [2-13].

2.2.2 Overview of Previous Investigations

The chronology of field activities at the FFTA-MAAF can be divided into the following:

- Initial Site Investigation activities including sampling of soils and groundwater in the immediate vicinity of site as well as nearby private wells - field activities began in September 1993;

- Additional Site Investigation activities including more extensive sampling of groundwater in areas downgradient of the site - field activities began in June 1994;

- Pilot Test Study activities to evaluate methodologies for cleanup of soils at the site - field activities were conducted October 1994 through September 1995; and

- Periodic Groundwater Sampling and Elevation Measurements - ongoing from October 1993 through August 1996.

The following documents provide data that were generated during the environmental field activities at FFTA-MAAF:

- *Installation Wide Site Assessment for Fort Riley, Kansas,* 7 December 1992, as revised 16 February 1993 [2-14].

- *Sampling and Analysis Plan for Site Investigations of High Priority Sites at Fort Riley, Kansas*, 20 August 1993 [2-15]. (Modifications to this High Priority Sites Sampling and Analysis Plan were documented in Technical Memoranda, provided as Appendices to the SI report.)

- *Expanded Site Investigation Sampling and Analysis Plan for Former Fire Training Area, Marshall Army Airfield, Fort Riley, Kansas, and Nearby Off-Post Properties*, 24 May 1994 [2-16]. (Modifications to this Expanded Site Investigation Sampling and Analysis Plan were documented in Technical Memoranda #1 through #6 provided as Appendices to the SI report.)

- *Work Plan Pilot Test Study Soil Vapor Extraction and Bioventing Systems, Former Fire Training Area, Marshall Army Airfield, Fort Riley, Kansas*, August 1994 [2-17]. (Modifications to this Pilot Test Study Work Plan were documented in Technical Memoranda #2 provided as an Appendix to the SI report.)

- *Site Investigation for Former Fire Training Area - Marshall Army Airfield, Fort Riley, Kansas*, August 1995[2-1].

In addition, the laboratory analytical results of the SI and pilot study for the FFTA-MAAF have been compiled in *Quality Control Summary Reports* (QCSR). The QCSRs represent compilations of the raw chemical data along with the quality assurance reviews of the analytical findings. Summaries of the laboratory analyses and comparisons of results with previous findings are presented in the *Data Summary Reports* (DSRs). These reports are the following:

- *QCSR for Site Investigations of High Priority Sites at Fort Riley*, 17 December 1993 [2-18].

- *QCSR for Site Investigation of the High Priority Sites at Fort Riley*, 22 July 1994 [2-19].
- *QCSR for Pilot Test Study SVE and Bioventing Systems*, 9 September 1994 [2-20].
- *QCSR for Off-Post Soil and Groundwater Screening Samples at FFTA-MAAF*, 11 November 1994 [2-21].
- *QCSR for Periodic Groundwater Monitoring at FFTA-MAAF*, 11 November 1994 [2-22].
- *QCSR for Periodic Groundwater Monitoring at FFTA-MAAF*, 8 December 1994 [2-23].
- *QCSR for SCAPS Investigation for Deep Alluvial Well Siting for Groundwater Samples*, January 1995 [2-24].
- *QCSR for Periodic Groundwater Monitoring at FFTA-MAAF*, March 1995 [2-25].
- *QCSR Periodic Groundwater Monitoring Samples*, June 1995 [2-26].
- *QCSR Periodic Groundwater Monitoring Samples*, August 1995 [2-27].
- *QCSR Periodic Groundwater Monitoring Samples*, February 1996 [2-28].
- *Data Summary Reports*, 7 December 1994 [2-29] (Sections 1 through 10).

There have been no previous removal actions conducted at the site for purposes of preventing or abating exposures to users of groundwater downgradient of the FFTA.

2.3 Summary of Contaminant Distribution

The potential for groundwater contamination as a result of releases from the FFTA was evaluated by installing and sampling groundwater monitoring wells located in the vicinity of the FFTA. In addition, groundwater samples were collected and analyzed from nine private wells located in the areas downgradient of the FFTA. The number of monitor wells has increased since the initial SI in September 1993. At that time, seven monitor wells were installed and sampled. As of August 1996, 25 monitor wells were installed and sampled. The locations of the monitor wells sampled are shown in Figure 2-9, and this figure includes the four private wells immediately downgradient of the FFTA-MAAF. During each round of sampling, groundwater was analyzed for the following parameters:

- Volatile organic compounds using EPA Methods 8260 and 8270;
- Semi-volatile organic compounds using EPA Method 8270;

- Total petroleum hydrocarbons (both gasoline and diesel fractions) using EPA Method 8015 modified; and
- Priority pollutant metals using EPA Methods 6010 and 7000 Series.

Additional groundwater investigations have been conducted using field screening techniques. The results of the field screening techniques were used to guide the location and placement of monitor wells. Since monitor wells are currently located throughout the areas in which field screening of groundwater was conducted, the results of the groundwater sampling from the monitor wells will be used to summarize contamination at the site. The findings from the sampling of the monitor wells are consistent with the findings of the groundwater screening with respect to both magnitude of contamination as well as horizontal and vertical extent.

Groundwater sampling events were conducted on the following occasions:

- October 1993;
- July/August 1994;
- October 1994;
- January 1995;
- April 1995;
- August 1995;
- December 1995;
- May/June 1996; and
- August 1996.

Some of the private wells are periodically shutdown for the winter, preventing the collection of environmental samples. A summary of the sampling of private wells is provided in Table 2-2.

The positive detections in groundwater from October 1993 through August 1996 are presented in Appendix A. The detected concentrations are compared against the Maximum Contaminant Levels (MCLs) established by EPA under the Safe Drinking Water Act. Concentrations that exceed MCLs identify water that is not considered suitable for drinking. In general, the data show that the primary contaminants in shallow groundwater are 1,2-DCE, TCE and PCE. These three compounds have been regularly detected in monitoring wells both at and downgradient of the FFTA and in wells R-1 and R-2. Petroleum hydrocarbons have been detected in groundwater immediately underlying the FFTA (FP-93-04); however, petroleum hydrocarbons are not detected in downgradient monitor wells or in nearby private wells on a consistent basis, and constituents of petroleum (e.g., benzene, toluene, xylenes, naphthalene) have not been detected above MCLs in wells downgradient of the FFTA. In contrast, detections of 1,2-DCE, TCE and PCE have exceeded MCLs in R-1 and R-2 on a repeated basis. The May/June 1996 sampling includes data from intermediate and deep monitor wells installed at three locations beneath and downgradient of the FFTA. There were no detections of contaminants attributable to the FFTA in any of these monitor wells, indicating that the groundwater contamination is currently restricted to the shallow alluvial materials -- within the upper 20 feet of the saturated zone. Additional groundwater monitoring in August 1996 was conducted. Data from wells adjacent to R-1 and R-2 in the August 1996 sampling confirmed that MCLs are only exceeded at these locations in the shallow alluvial materials.

Isoconcentration maps for 1,2-DCE, TCE and PCE concentrations detected during the August 1996 sampling are presented in Figures 2-10 through 2-12. Key points of the patterns of detection are as follows:

- The area of highest concentrations of 1,2-DCE, TCE and PCE are centered around R-1 and R-2.

- The area of contamination appears to have become thinner along the direction of groundwater flow since August 1994. This "thinning" is attributed to the increased numbers of monitor wells that have been sampled since August 1994, allowing refinement in defining the boundaries of contamination. Conversely, this "thinning" is <u>not</u> attributed to actual changes in the extent of shallow contamination.

- The only private wells with detections attributable to FFTA through August 1995 were R-1 and R-2. The May/June 1996 sampling also indicated that 1,2-DCE was present in M-1.

2.4 Conditions Warranting Removal Action

The NCP identifies the following conditions under which a removal action is warranted (Section 300.415(b)(2)(i)-(viii)):

- Prevention or abatement of actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants; and

- Prevention or abatement of actual or potential contamination of drinking water supplies or sensitive ecosystems.

Groundwater data indicate that three private wells downgradient of the FFTA contain detectable concentrations of 1,2-DCE, TCE and/or PCE; these are R-1, R-2 and M-1. Each of these wells are used as follows:

- R-1 - Supplies the racetrack concession stand, which is an enclosed building - previously used for washing and potential drinking water uses. The racetrack concession stand is used intermittently; maximum use occurs approximately two nights a weekend during the months of May through September. The owner has been advised by KDHE not to use R-1 for human consumption.

- R-2 - Supplies water to a spigot that is approximately 15 feet off the ground surface. The supply is used by workers to fill water tankers and apply water to the track for grooming and to control dust. No other uses of the water are known or reported.

- M-1 - Supplies water to a machine shop and trailer home. The water is used for domestic purposes, including drinking, bathing, and sanitary sewer. The machine shop is currently active during the days, and the trailer home is currently occupied.

The types of actual or potential exposures that could result from use of each of these wells is discussed below. In addition, the potential magnitude of the exposures is presented. These data demonstrate that the detections of 1,2-DCE, TCE and/or PCE in wells M-1, R-1 and R-2 represent actual contamination of drinking water supplies and/or result in actual or potential exposures of humans to hazardous substances. These conditions meet the NCP requirements for conducting a removal action. Therefore, this EE/CA evaluates alternatives for prevention, abatement and/or mitigation of these potential or actual exposures.

2.4.1 Actual or Potential Exposures

This exposure assessment analysis focuses on actual or potential exposures at points of use that are currently known to be contaminated or have the potential to be contaminated in the near future. As described above, private wells R-1, R-2 and M-1 contain concentrations of 1,2-DCE, TCE and PCE. The other private wells in the area are outside the area of contamination and are not expected to be impacted by contaminant migration; thus, there are no potential or actual exposures at those locations.

The contaminants of concern -- 1,2-DCE, TCE and PCE -- are volatile organic compounds. That is, although present in groundwater, the compounds can form vapors when the groundwater is exposed to air. Therefore, the exposure assessment analysis considers exposures to the compounds in water as well as air. The matrix presented below identifies the potential routes of exposures that are applicable to each of the wells being evaluated:

		APPLICABLE ROUTES OF EXPOSURE		
WELL	**Frequency of Use**	**Ingestion**	**Dermal Contact**	**Inhalation**
M-1	Daily	✓	✓	✓
R-1	Intermittent	✓	✓	✓
R-2	Intermittent		✓	✓

The potential for human risk due to exposure to chemicals at the site from use of wells R-1, R-2, and M-1 was evaluated in detail in the FFTA RI/FS Workplan(2-30). Based on observed site conditions, it was concluded that chemical exposure is possible through contact with groundwater and vapors. The potential intake of the chemicals of potential concern was calculated using standard EPA exposure calculation equations for intake from ingestion, dermal contact, and inhalation of contaminants. The following risk assessment findings were made:

- Chemical concentrations under current conditions were assumed to be steady state. Since the modelling has shown that chemical concentrations in groundwater will not exceed current concentrations, risk potential is expected to decrease over time.

- The excess cancer risk values at the site were calculated for the racetrack worker, racetrack patron, and resident (child). Based on a comparison of the calculated risks to the EPA defined acceptable risk values, an excess cancer risk is not occurring at the site due to groundwater contamination. The racetrack worker has the highest cancer risk, calculated to be at the minimum end of the EPA range.

- Noncarcinogenic health hazard indices were evaluated for child residents which are the most sensitive receptors. The total hazard index for a child resident was calculated to be less than the acceptable EPA noncarcinogenic hazard indices.

In summary, both carcinogenic and noncarcinogenic risk values calculated for the site in the RI/FS Workplan were within EPA acceptable values for protection of human health.

2.4.2 Magnitude of Actual or Potential Exposures

The range of detections (minimum and maximum) from October 1993 through August 1996; and the most recent detections (August 1996) for 1,2-DCE, TCE and PCE in each of R-1, R-2 and M-1 are as follows:

CONCENTRATIONS IN GROUNDWATER (ug/l)						
WELLS	1,2-DCE MCL=70 ug/l		TCE MCL=5.0 ug/l		PCE MCL=5.0 ug/l	
	Range	Aug. 1996	Range	Aug. 1996	Range	Aug. 1996
M-1	<0.5-19	13	< 0.6	< 0.6	< 1.1	< 1.1
R-1	10-290	49	11-76	44	29-330	77
R-2	21-150	64	18-96	46	24-230	50

The data noted above show the potential concentrations that could be present in the groundwater supply source wells that are used for drinking water (ingestion), washing or bathing (dermal contact and inhalation), and racetrack maintenance (dermal contact and inhalation).

Table 2-1: Chronology of Field Activities Associated With the FFTA-MAAF

Date	Activity
September 1993	Initiated a Site Investigation (SI) for the High Priority Sites, which included the FFTA-MAAF.
	Collected SI Phase I and II samples at FFTA-MAAF including soil gas, groundwater screening, soil, and sediment samples.
October 1993	As part of the Phase III SI activities at FFTA-MAAF, seven monitor wells were installed within the installation boundary. Samples were collected from the seven monitor wells and six private wells, and laboratory analyzed.
January 1994	As part of SI activities, collected groundwater level measurements.
March 1994	As part of SI activities, collected groundwater level measurements.
April 1994	As part of SI activities, collected soil samples and field screened for polychlorinated biphenyls (PCBs).
June 1994	Initiated Phase I Expanded SI (ESI) activities.
	As part of Phase I ESI, collected Phase I expanded soil gas and groundwater screening samples, performed seismic reflection (on-post) and electrical resistivity surveys, and collected groundwater level measurements. Additionally, soil samples for PCBs were resampled and analyzed in the laboratory.
July 1994	As part of Phase I ESI, collected and analyzed groundwater samples for the first periodic sampling round, collected groundwater level measurements and installed piezometer adjacent to the Kansas River. Additionally, baseline soil samples for initiation of the soil vapor/ bioventing pilot test study were collected and analyzed.
August 1994	Initiated Phase II ESI activities.
	As part of Phase I ESI, collected monthly groundwater level measurements.
	As part of Phase II ESI, and collected and analyzed soil samples and expanded groundwater screening samples.
	As part of Phase II ESI, installed four monitor wells.
September 1994	As part of Phase I ESI, collected monthly groundwater level measurements.

Date	Activity
October 1994	As part of Phase I ESI, collected and analyzed second periodic groundwater samples and collected monthly groundwater level measurements.
October 1994 (continued)	As part of pilot test study, soil samples were collected and analyzed from borings at eight well locations.
December 1994	As part of Phase I ESI, collected monthly groundwater level measurements.
	As part of the ESI, additional geophysical data and deep groundwater screening samples were collected using the Site Characterization Analysis Penetrometer System (SCAPS) rig.
January 1995	As part of Phase I ESI, collected monthly groundwater level measurements and collected and analyzed third periodic groundwater samples.
February 1995	As part of Phase I ESI, collected monthly groundwater level measurements.
March 1995	As part of Phase I ESI, collected monthly groundwater level measurements.
April 1995	As part of Phase I ESI, collected monthly groundwater level measurements and collected and analyzed fourth periodic groundwater samples.
August 1995	Collected groundwater level measurements and collected and analyzed fifth periodic groundwater samples.
December 1995	Collected groundwater level measurements and collected and analyzed sixth periodic groundwater samples.
March 1996	As part of pilot test study and Pre-Remedial Investigations, collected and analyzed soil samples from borings at 52 locations.
April 1996	As part of Pre-Remedial Investigations, installed fourteen monitor wells and five piezometers. Collected soil samples for geotechnical analyses at selected wells.
May 1996	Collected monthly groundwater level measurements and collected and analyzed seventh periodic groundwater samples.
June 1996	Collected monthly groundwater level measurements and performed aquifer testing at eight wells.
July 1996	Collected monthly groundwater level measurements.

Date	Activity
August 1996	Collected monthly groundwater level measurements and collected and analyzed eighth periodic groundwater samples. Performed video survey of private well M-1.

Table 2-2: Summary of Private Well Samplings - North of FFTA-MAAF

Private Well ID	Groundwater Monitoring Events - Private Wells								
	October 1993	July/ August 1994	October 1994	January 1995	April 1995	August 1995	December 1995	May/ June 1996	August 1996
M-1	✓	✓	✓	✓	✓	✓	✓	✓	✓
R-1	✓	✓	✓	NS-W	✓	✓	NS-W	✓	✓
R-2	NS-F	✓	✓	NS-W	✓	✓	NS-W	✓	✓

NS-W: Not sampled due to winter shut down.
NS-F: Not sampled due to flooding.

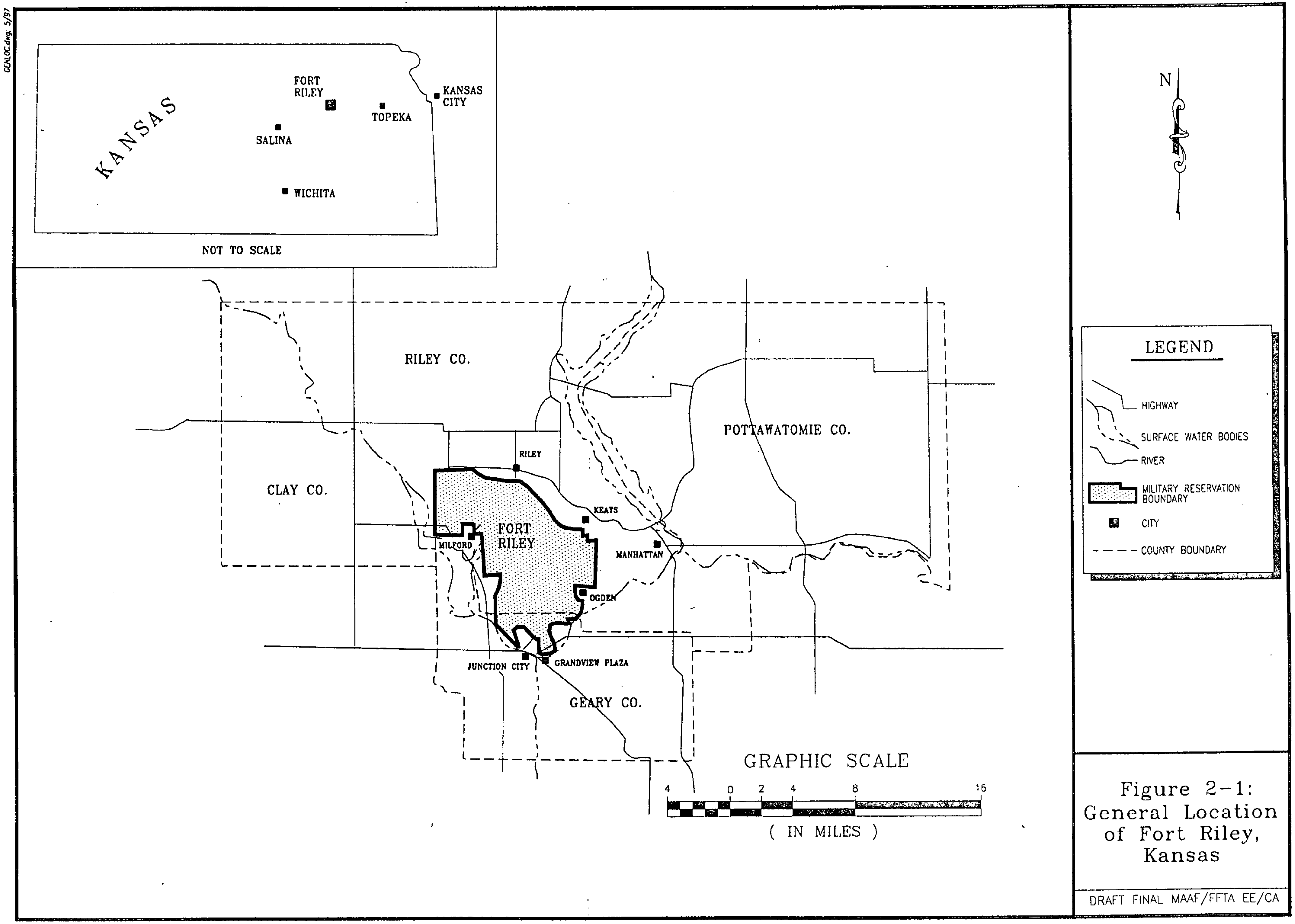
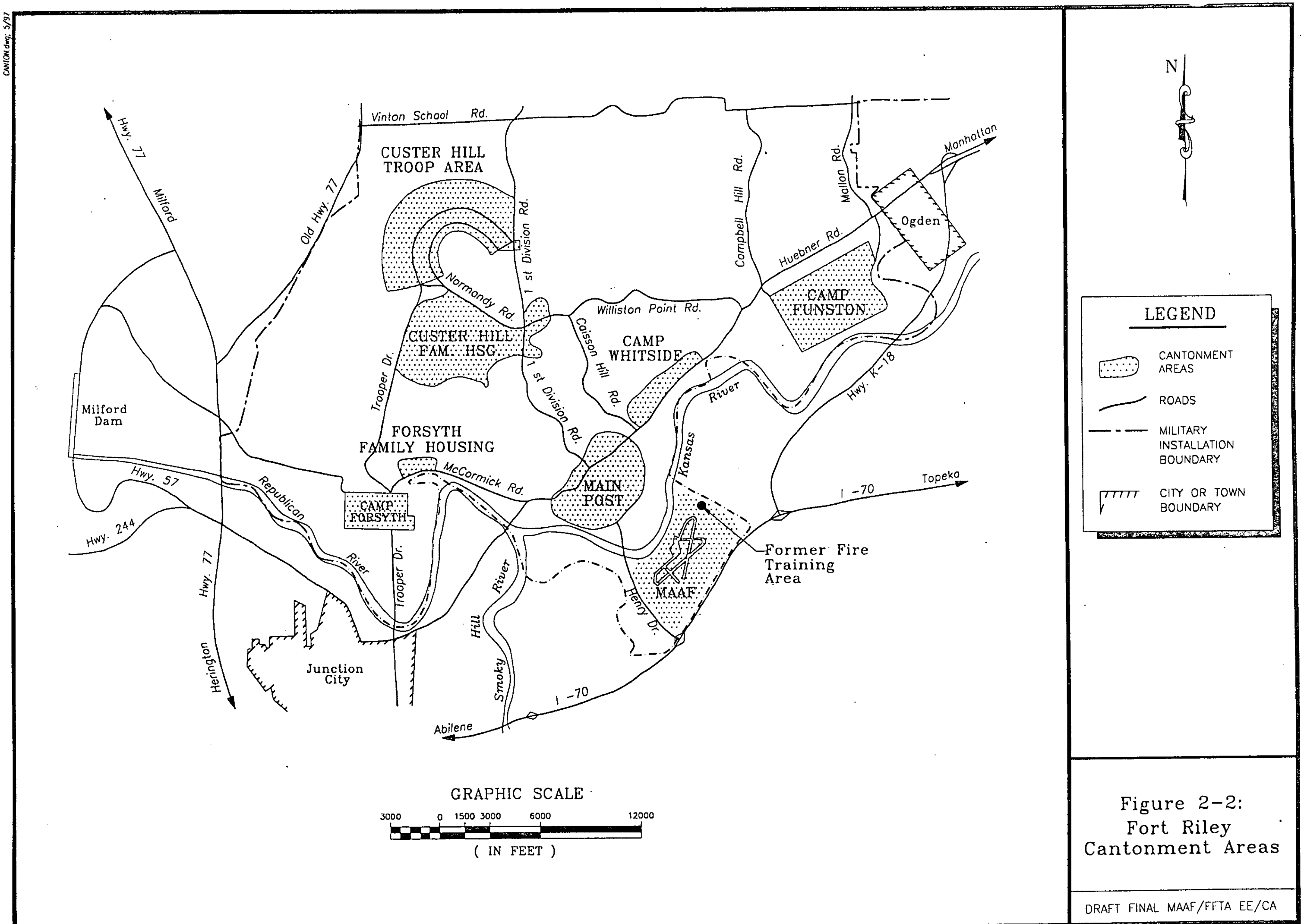


Figure 2-1: General Location of Fort Riley, Kansas

DRAFT FINAL MAAF/FFTA EE/CA



CANTON.dwg; 5/97

Figure 2-2:
Fort Riley
Cantonment Areas

PMLOC.dwg; 5/97

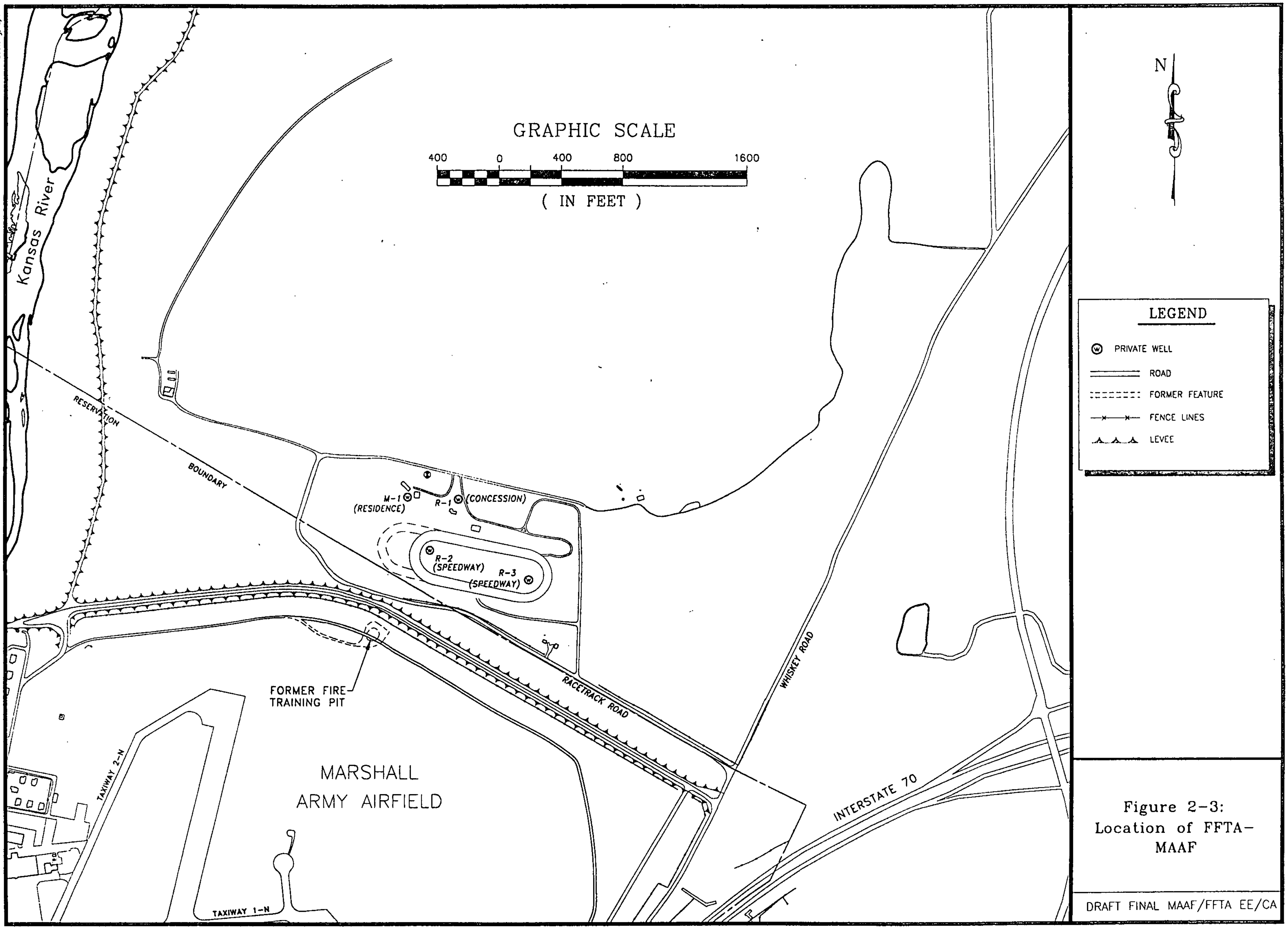
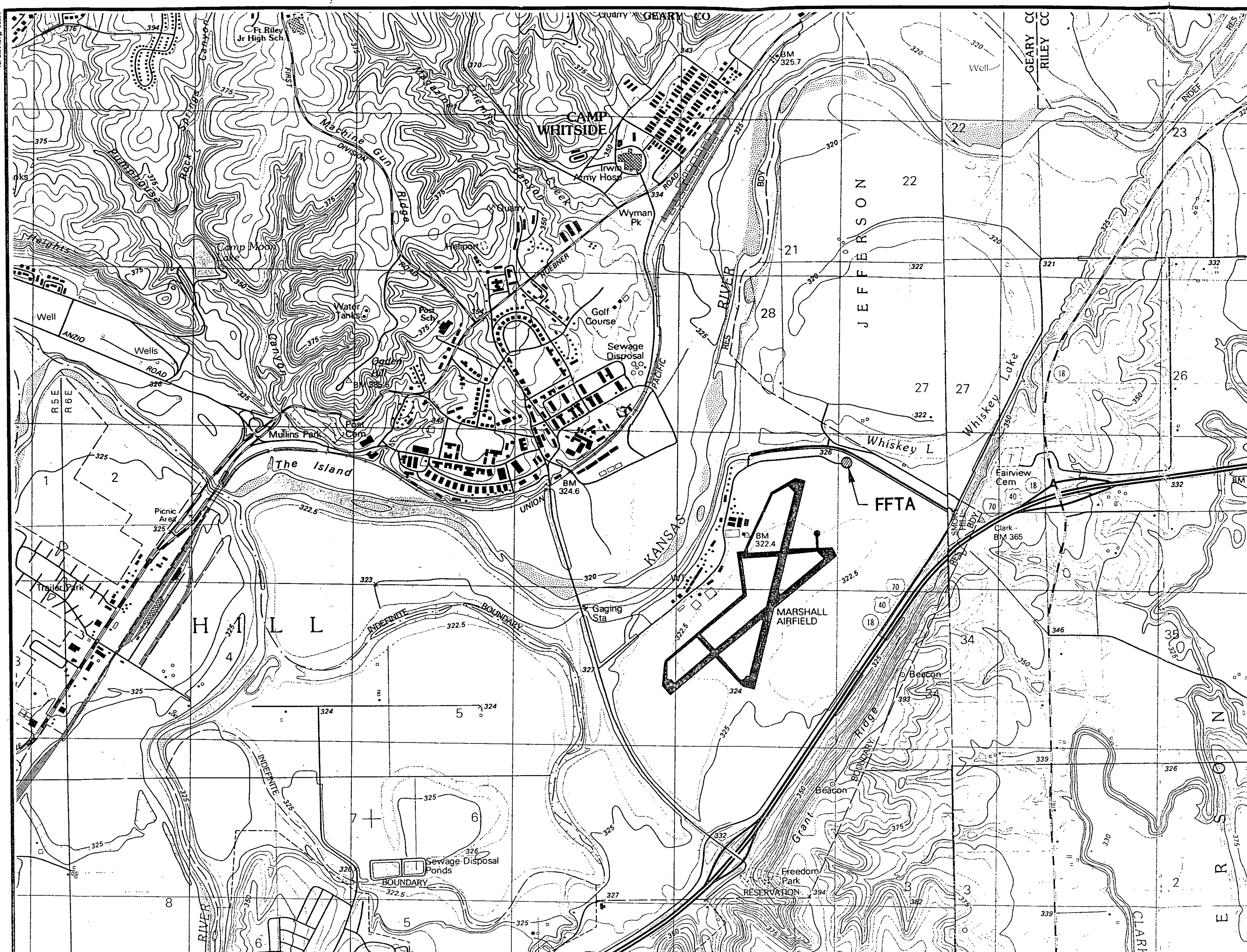


Figure 2-3: Location of FFTA-MAAF

Figure 2-4: Aerial Photograph of Former Fire Training Pit.

(15 November 1984)



N

GRAPHIC SCALE

0 1

(IN MILES)

Source: USGS, Ogden and Junction City 7.5 Minute Quadrangle

Figure 2–5: Topographic Map of FFTA–MAAF and Surrounding Areas

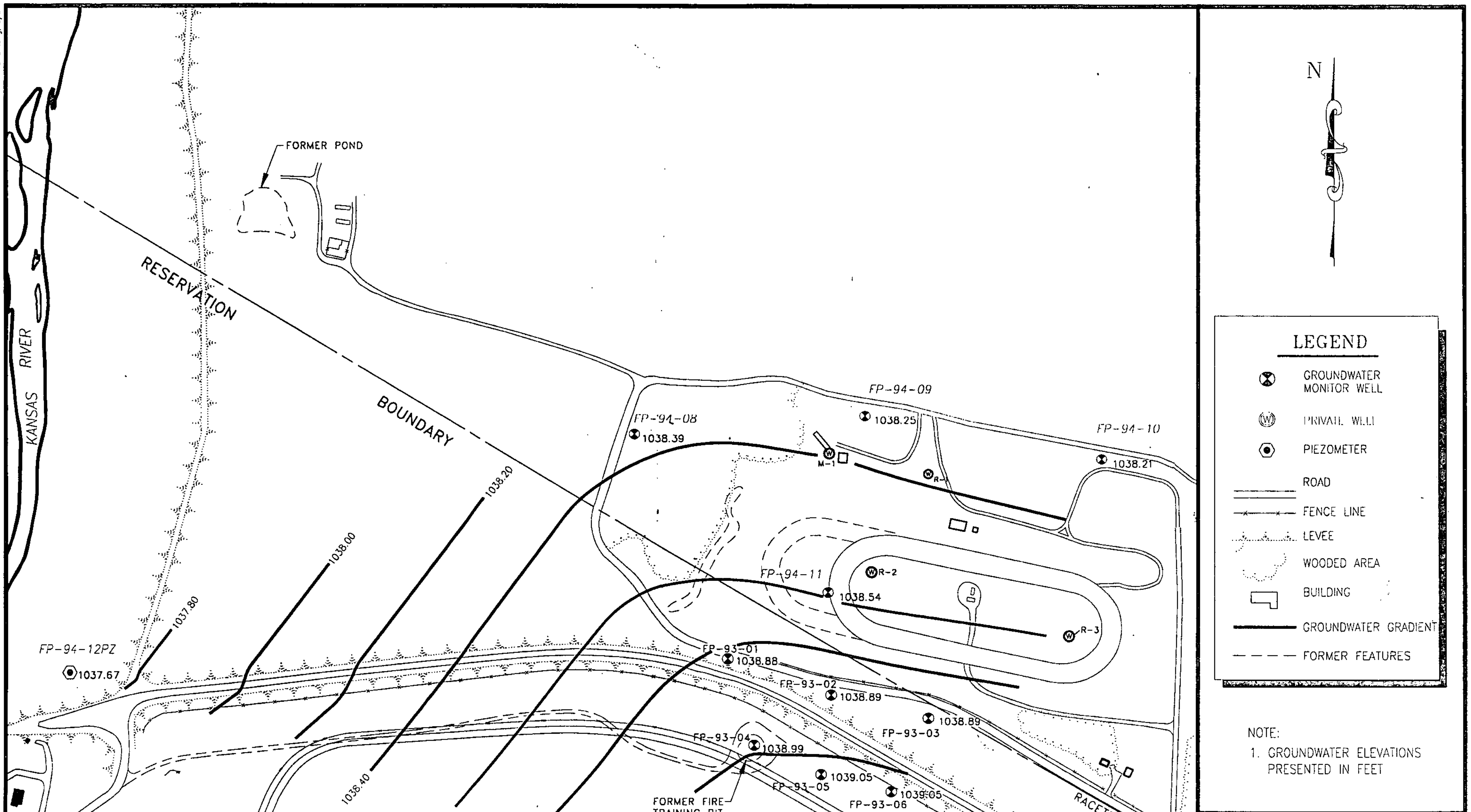


Figure 2-6: Groundwater Elevation Map (18 September 1994 Data)

DRAFT FINAL MAAF/FFTA EE/CA

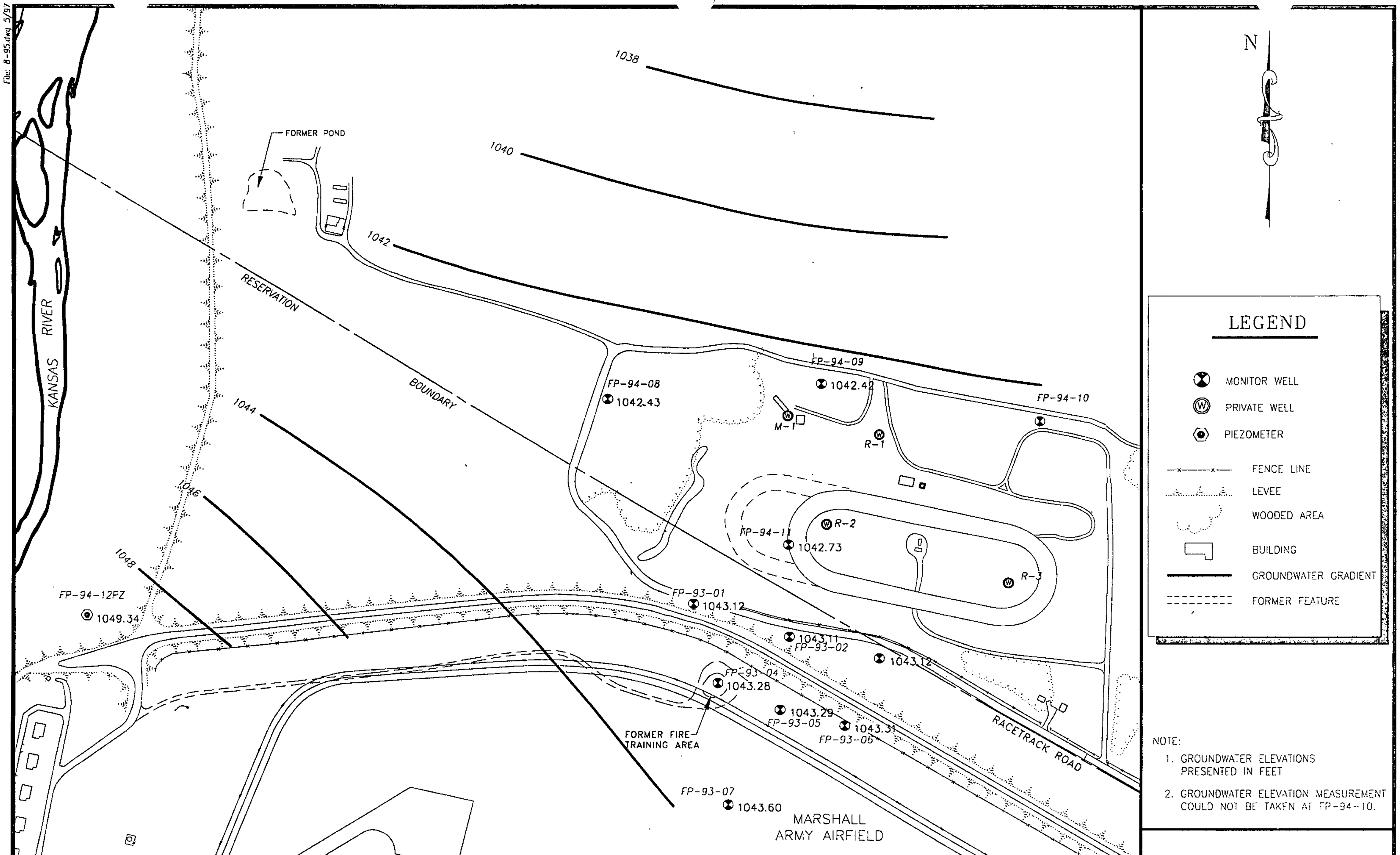
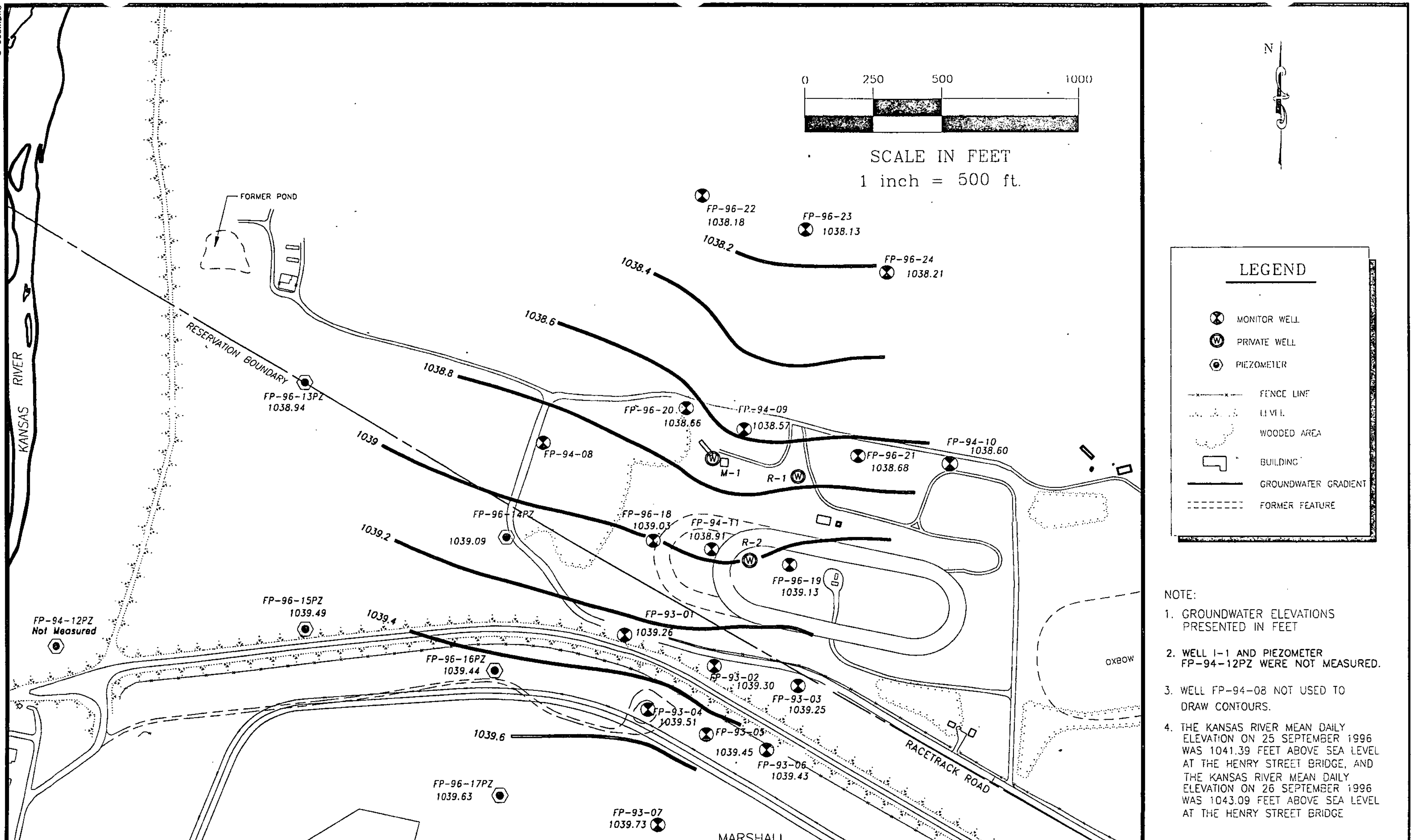


Figure 2-7: Groundwater Elevation Map (24 August 1995 Data)

DRAFT FINAL MAAF/FFTA EE/CA



NOTE:

1. GROUNDWATER ELEVATIONS PRESENTED IN FEET
2. WELL I-1 AND PIEZOMETER FP-94-12PZ WERE NOT MEASURED.
3. WELL FP-94-08 NOT USED TO DRAW CONTOURS.
4. THE KANSAS RIVER MEAN DAILY ELEVATION ON 25 SEPTEMBER 1996 WAS 1041.39 FEET ABOVE SEA LEVEL AT THE HENRY STREET BRIDGE, AND THE KANSAS RIVER MEAN DAILY ELEVATION ON 26 SEPTEMBER 1996 WAS 1043.09 FEET ABOVE SEA LEVEL AT THE HENRY STREET BRIDGE

Figure 2-8: Groundwater Elevation Map (25,26 September 1996)

DRAFT FINAL MAAF/FFTA EE/CA

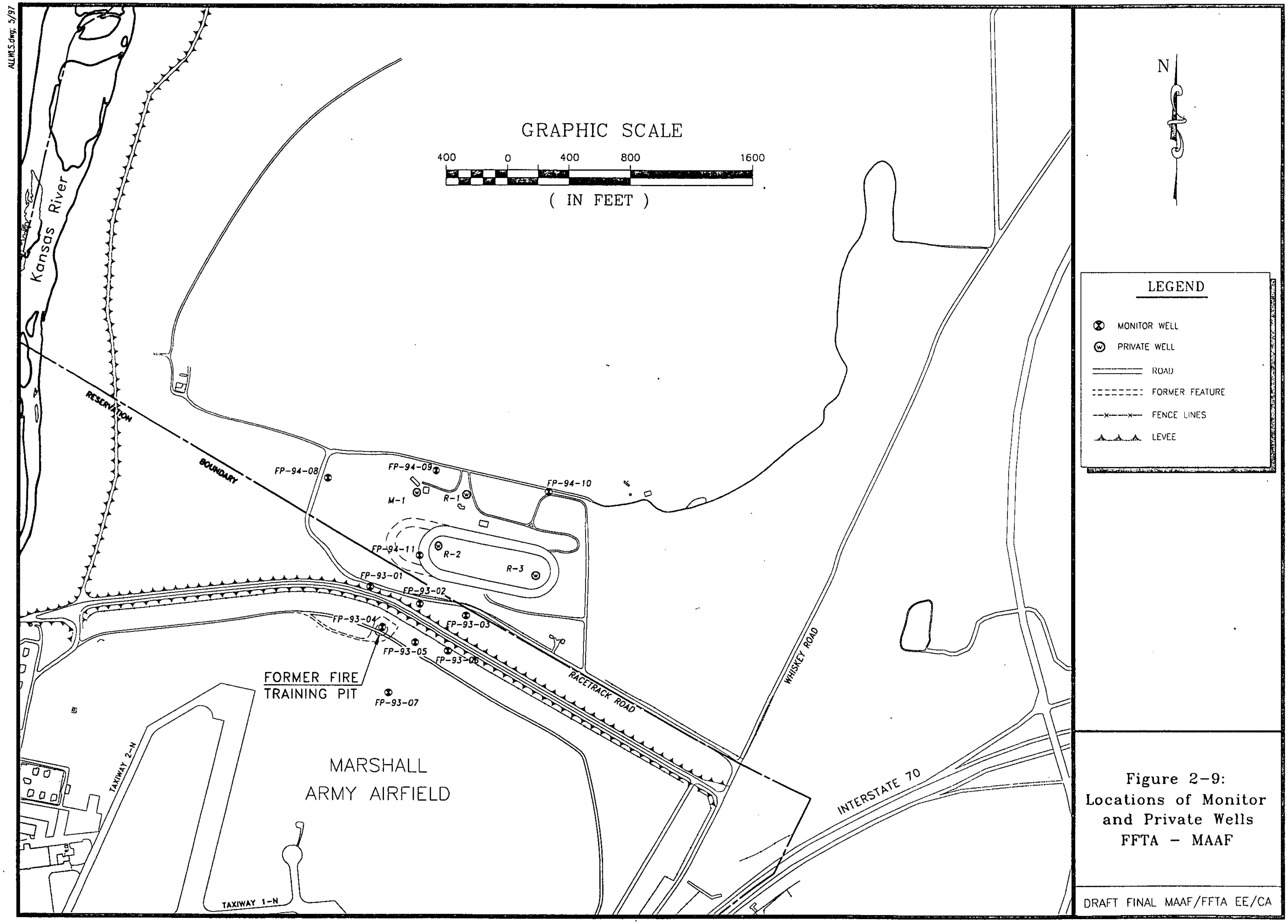


Figure 2-9:
Locations of Monitor and Private Wells
FFTA – MAAF

DRAFT FINAL MAAF/FFTA EE/CA

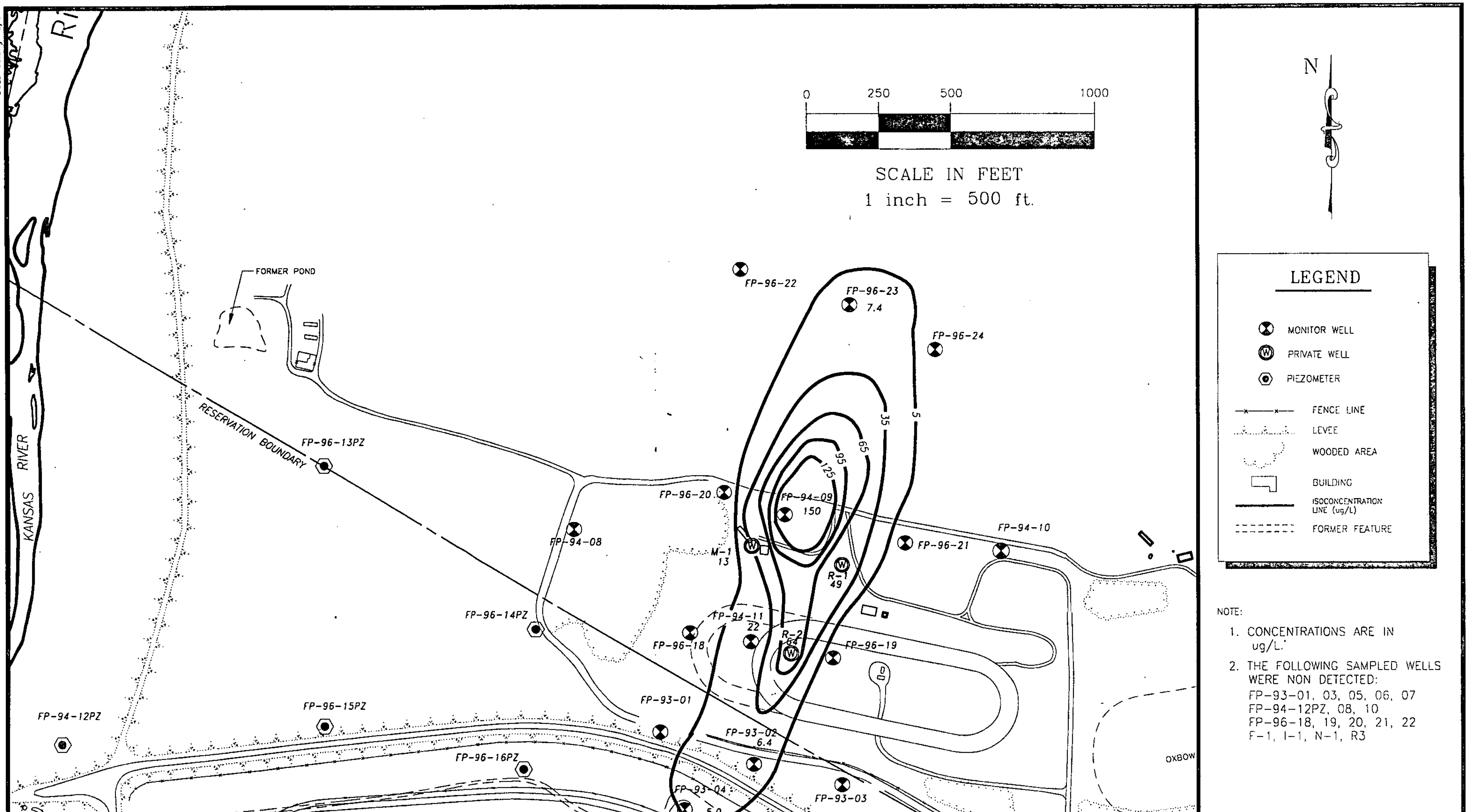


Figure 2-10: 1,2-Dichloroethylene (1,2-DCE) Concentrations in Shallow Groundwater (August 1996 Data)

DRAFT FINAL MAAF/FFTA EE/CA

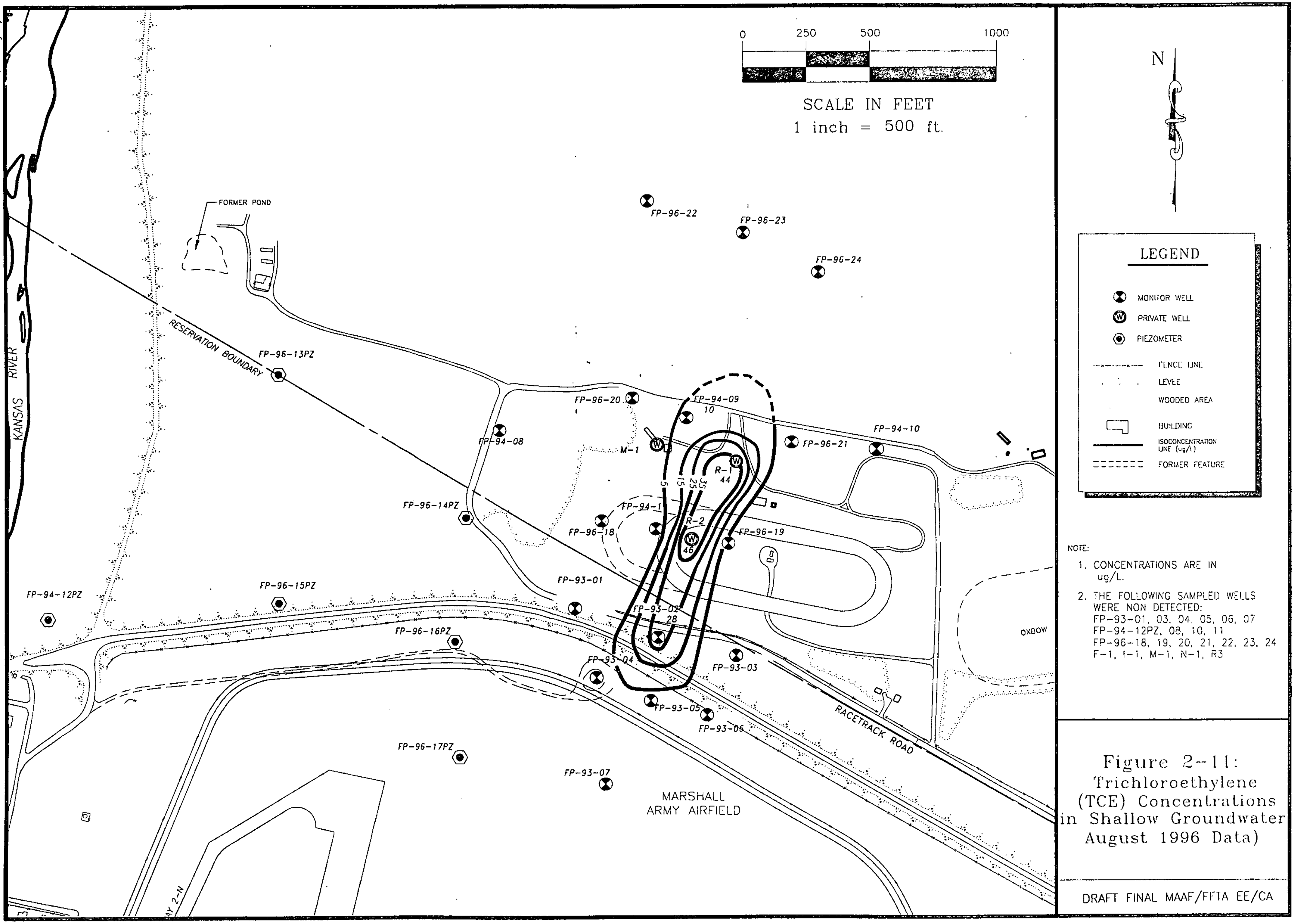
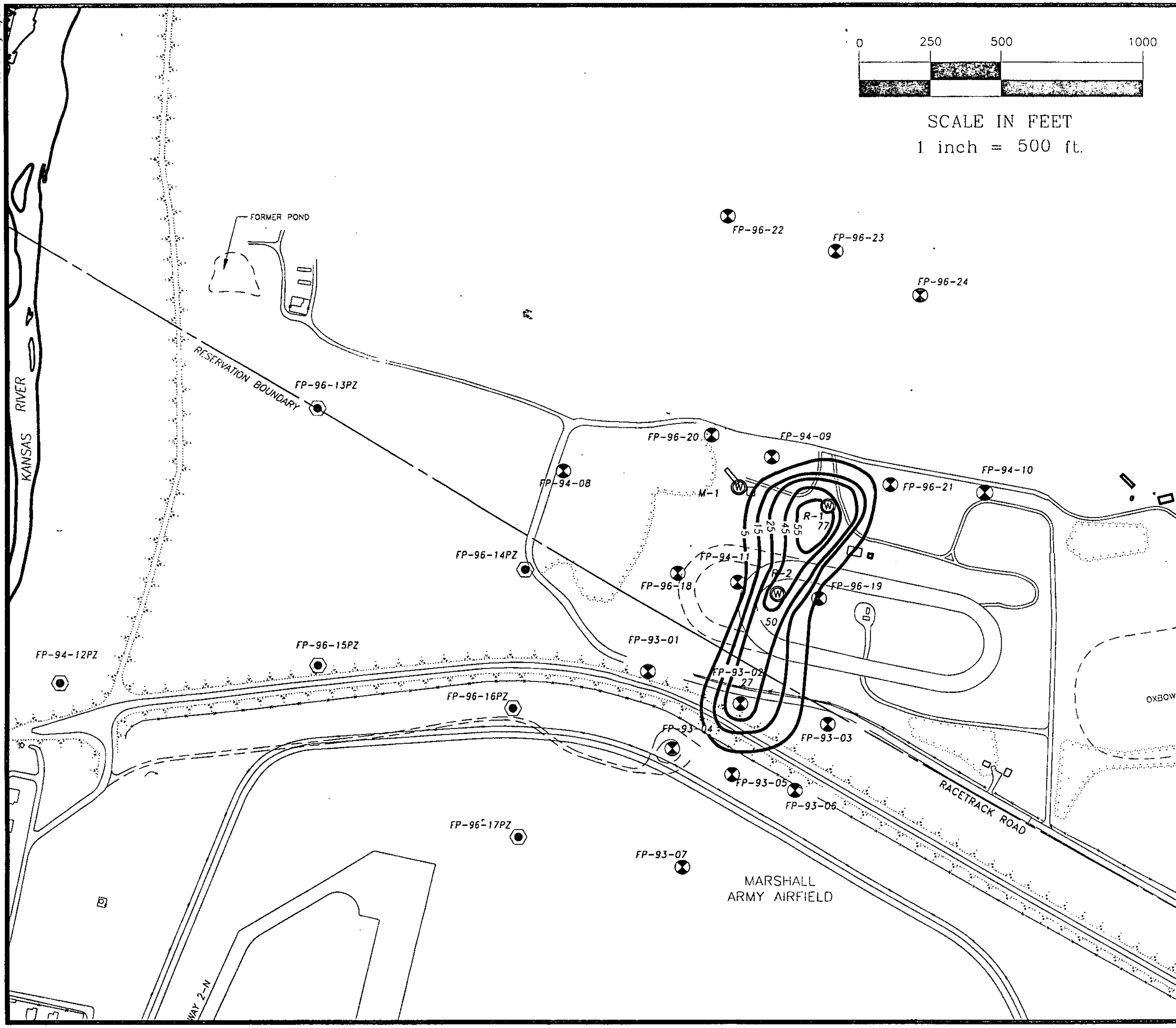


Figure 2-11:
Trichloroethylene (TCE) Concentrations in Shallow Groundwater August 1996 Data)

DRAFT FINAL MAAF/FFTA EE/CA



N

LEGEND

- MONITOR WELL
- PRIVATE WELL
- PIEZOMETER
- FENCE LINE
- LEVEE
- WOODED AREA
- BUILDING
- ISOCONCENTRATION LINE (ug/L)
- FORMER FEATURE

NOTE:

1. CONCENTRATIONS ARE IN ug/L.
2. THE FOLLOWING SAMPLED WELLS NON DETECTED:
   FP-93-01, 03, 04, 05, 06, 07
   FP-94-12PZ, 08, 09, 10, 11
   FP-96-18, 19, 20, 21, 22, 23, 24
   F-1, I-1, M-1, N-1, R3

Figure 2-12: Tetrachloroethylene (PCE) Concentrations in Shallow Groundwater (August 1996 Data)

DRAFT FINAL MAAF/FFTA EE/CA

3.0 REMOVAL ACTION OBJECTIVES

The Department of Defense (DOD) performs exposure control actions required by CERCLA through funding by the DOD Environmental Restoration Account. Therefore, the actions considered in this EE/CA are not subject to specific Superfund limitations on timing, duration, and maximum cost. The removal action schedule and cost will be developed as appropriate for the proposed removal action alternative, which will be implemented as soon as practicable following the completion of the public comment and regulatory review process.

3.1 Removal Action Scope

The overall objective of the exposure control action is to prevent harmful exposures to humans as a result of using water from private wells contaminated with hazardous substances. The cleanup of contaminated groundwater is currently being assessed by Fort Riley under a CERCLA remedial investigation/feasibility study. Therefore, cleanup of contaminated groundwater is not an objective of this exposure control action. Rather, the exposure control action will focus on the point-of-use exposure and alternatives for preventing or controlling the exposures that occur through use of contaminated wells.

As explained in Section 2.0, there are three private wells which contain hazardous substances that could result in actual or potential, harmful exposures. These are M-1, R-1 and R-2. Further, there are no other private wells in the area that are either contaminated or likely to be contaminated due to releases of contaminants present at the FFTA or the downgradient areas. Over approximately a three-year period from October 1993 through August 1996, the area of contamination has remained similar. Therefore, additional migration to other wells within the timeframe required to implement this removal action is not anticipated. The nearest private well downgradient of the area of contamination is I-1, which is used for irrigation of animal crops. Therefore, potential harmful exposures to humans are not anticipated due to the use of this well if it should become contaminated in the future. The next nearest downgradient drinking water wells are the Morris County Rural Water District wells, located approximately two miles to the northeast from the downgradient edge of the detected contamination. Also, in the past three years, there has been no evidence of residential development in the area downgradient of the FFTA-MAAF, and the presence of new users of groundwater in this area in the near future is not anticipated. Based on these data, the scope of this EE/CA is to evaluate exposure control alternatives for users of wells M-1, R-1 and R-2.

Additional refinement of the removal action scope is a follows:

- Concentrations in M-1 do not exceed MCLs through August 1996; therefore, this location is evaluated for a potential future action because of its proximity (fewer than 300 feet) to areas of contamination above MCLs. Additional monitoring data will be obtained for M-1, allowing Fort Riley to evaluate the need for exposure control during the implementation of the EE/CA removal actions. It is recognized that it would be more cost-effective to address exposure control at M-1, if needed, as part of other actions.

- Use of R-1 for drinking water purposes is associated with the racetrack food concession, therefore exposure control for R-1 is considered to mitigate potential ingestion as a public water supply source (greater than 25 users), and to prevent other potentially harmful exposure pathways.

- R-2 is not used for drinking water; however, water from R-2 exceeds MCLs and is sprayed over the area of the racetrack, exposing workers to dermal contact and inhalation risks. An exposure control for R-2 is considered to mitigate worker exposure.

The exposure control alternatives will be developed based on their ability to prevent harmful exposures to humans based on the following exposure pathway scenarios: water used for drinking and cooking (ingestion); water used for bathing and washing (dermal adsorption); incidental dermal contact; and inhalation of vapors emitted from water.

3.2 Applicable or Relevant and Appropriate Requirements (ARARs)

CERCLA and the NCP generally provide that remedial actions substantively meet all promulgated and substantive federal and state standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate requirements (ARARs). Due to the time-sensitive nature of removal actions, however, the EPA policy for removal actions is that ARARs will be identified and attained to the extent practicable.

Applicable requirements are those legal standards, criteria, protective requirements or limitations that are promulgated under federal or state law and that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site. Pursuent to CERCLA § 121(e)(1), 42 U.S.C. § 9621(e)(1) and the NCP, response actions conducted under CERCLA are exempt from the procedural requirements to obtain Federal, State, or local permits; however, the actions must meet the substantive Federal, State, and local requirements.

In the review of a potential ARAR, it is first determined whether that ARAR is applicable. If it is not legally applicable, it may still be binding as an ARAR if it is found to be relevant and appropriate. To consider whether a non-applicable requirement is relevant and appropriate, a comparison of a number of site-specific factors is performed. This comparison is done in light of standards, criteria, protective requirements or limitations that are promulgated under federal or state law which are not legally applicable, but address problems or situations that are sufficiently similar to those encountered at the site in question such that their use is well-suited to the given conditions.

ARARs may be categorized as chemical-specific, location-specific or action-specific, as follows:

- Chemical-specific ARARs are usually health- or risk-based numerical values which, when applied to site conditions, result in establishment of numerical action values. These values establish the acceptable amount or concentration of a chemical in a media or discharge stream. Potential chemical-specific ARARs are generally applied to contaminants in a specific media such as the soil, surface waters, sediments, and/or groundwater. Primary examples include the Safe Drinking Water Act MCLs, Federal Water Quality Criteria, and National Ambient Air Quality Standards.

- Location-specific ARARs are geographically determined requirements or limitations on potential remedial actions at the site because of the site's location. Federal and state location-specific ARARs include those established to protect endangered species, fish and wildlife, surface water quality, wetlands, water wells, floodplains and cultural resources and may include the following: RCRA location requirements, National Historic Preservation Act, Endangered Species Act, Wild and Scenic Rivers Act, and the Clean Water Act.

- Action-specific ARARs are technology- or activity-based requirements on limitations triggered by the proposed removal actions for the site. These ARARs are used to evaluate implementability of a proposed action rather than identify the need for a removal action. Examples include the following: RCRA Corrective Action requirements, Clean Air Act emissions requirements, and Clean Water Act discharge requirements.

3.2.1 Exposure Control Action ARARs

The ARARs included in this EE/CA are based on those ARARs that identify the need for an emergency removal action and that establish a level of protection against which the effectiveness of the exposure control alternatives can be evaluated. Additional action specific ARARs are reviewed for the site that are applicable to implementation of the various alternatives. The RI/FS being conducted for the FFTA-MAAF removal action will also address the need for long-term remedial actions.

3.2.1.1 Chemical-Specific ARARs

The Safe Drinking Water Act is the federal statute which requires the regulation of public water supply systems, including the creation of enforcement powers and penalty provisions. The National

Primary Drinking Water Regulations (NPDWR) are the implementing regulations under the SDWA which apply to each public water system in each state. The NPDWR provides drinking water standards that apply to community water supply systems. This regulation also applies to non-transient systems.

The NPDWR establishes MCLs and Maximum Contaminant Level Goals (MCLGs) for many specific chemical constituents in drinking water. MCLGs are health-based goals set at a level at which no adverse health effects will arise. MCLs are set as close as feasible to MCLGs, but taking into consideration the best technology, treatment techniques, and other factors such as cost. The SDWA also establishes the requirement for setting Secondary MCLs and MCLGs, which generally regulate the odor or appearance of public drinking water, and are also deemed to be generally protective of the public welfare. MCLs are the legally enforceable standards under the SDWA as applied to the quality of drinking water "at the tap" and are considered to be an ARAR if it is determined to be relevant and appropriate. The MCLs are an ARAR for establishing drinking water supplies protective of public health for users of R-1, R-2 and M-1.

3.2.1.2 Location-Specific ARARs

- State of Kansas, Division of Water Resources, regulates ground water well withdrawal rates at specific locations through water rights permitting for public water supply and industrial uses.

3.2.1.3 Action-Specific ARARs

- Clean Air Act protects ambient air quality in the U.S. through pollutant source control. It defines National Ambient Air Quality Standards (NAAQS) for protection of public health. Also, it establishes National Emission Standards for Hazardous Air Pollutants (NESHAPs) released to the atmosphere. This act is a potentially applicable ARAR if the proposed response action involves emission of a constituent listed in NESHAPs. If applicable, the removal action would be operated in compliance with the restrictions to the extent practicable.

- State of Kansas, Ambient Air Quality Standards and Air Pollution Control Regulations provide state emission standards for listed hazardous air pollutants and state air quality standards to protect public health. This would be potentially applicable if the proposed response action involves emission of a listed constituent. If applicable, the response action would be operated in compliance with the restrictions to the extent practicable.

- Kansas Water Well Contractor's License; Water Well Construction and Abandonment regulations cover the construction, treatment, and plugging of water wells in State of Kansas aquifers; including contractor licensing and per well fee requirements. "Aquifer" is defined in the regulation as an underground formation that contains and is capable of transmitting groundwater. This regulation is potentially applicable to the extent that existing wells are abandoned and/or new wells are installed.

- Kansas Department of Health and Environment, Division of Environment, Bureau of Water, Public Water Supply Section requires a permit for actions involving the extension of public water main service in excess of one mile.

3.3 To Be Considered (TBC) Requirements

Other information that does not qualify as an ARAR may be needed during the development of remedies. TBCs are non-promulgated advisories, criteria, or guidance issued by Federal, state, or local governmental agencies that are not legally binding. While they do not carry the weight of ARARs in the determination of removal action goals, TBCs are considered in conjunction with ARARs during site risk assessment and they may be used as guidance in determining removal action goals and/or developing exposure control alternatives. TBC information generally falls within three categories:

- Health effects information with a high degree of credibility;
- Technical information on how to perform or evaluate site investigations or response actions; and
- Policy of administrative agencies.

The following sections identify the TBCs for alternatives that passed initial screening (Section 4) and are therefore to be considered during the design and implementation of the exposure control action.

3.3.1 State Regulations and Guidelines

- *Kansas Department of Health and Environment, "Policies, General Considerations and Design Requirements for Public Water Supply Systems in Kansas," 1995* - The purpose of this document is to identify KDHE policies and criteria for the design of Kansas Public Water Supply Systems (PWSSs). The policy statements are derived from state statutes and regulations which reflect KDHE's responsibilities to users of water produced in Kansas PWSSs. The design criteria consists mainly of principles and requirements which have been in use over a long period of time in water supplies found in Kansas. Their purpose is to provide guidelines and standards to those engaged in the design of new facilities and the upgrading of existing PWSSs.

  It is intended that designers using the criteria retain a maximum degree of design freedom since it is recognized that each water supply system is a unique entity and that certain changes to these criteria may be necessary to meet local conditions and unusual circumstances. Terms such as "should" or "recommended" indicate desirable guidelines with deviations subject to site-specific considerations. Terms such as "shall" and "must" are used where requirements or where safeguarding of the public health justifies definite action, although are not absolute terms in that KDHE may grant an exception to these requirements under certain circumstances.

- *Kansas Department of Transportation* - Guidelines and permits are available from the state transportation agency regarding proper procedures and guidelines during open cut trenching along state rights-of-way.

3.3.2 Industry Standards and Guidelines

- *"Recommended Standards For Water Works," (10 States Standards), Upper Mississippi River Board of State Public Health and Environmental Managers, 1987* - These standards, consisting of proven technology, are intended to serve as a guide in the design and preparation of plans and specifications for public water supply systems, to suggest limiting values for items upon which an evaluation of such plans and specifications may be made by the reviewing authority, and to establish, as far as practicable, uniformity of practice.

- *American Water Works Association Standards for applicable proposed water supply system elements, latest revisions* - AWWA standards describe minimum requirements and do not contain all of the engineering and administrative information normally contained in specifications. The AWWA standards usually contain options that must be evaluated by the user of the standard. The use of AWWA standards is entirely voluntary. AWWA standards are intended to represent a consensus of the water supply industry that the product described will provide satisfactory service.

- *U.S. Corps of Engineers, Guidebook: General Information for Sponsors of Flood Protection Projects Constructed by the Corps of Engineers* - All pipes, lines, and any other below ground structural features within the critical area should comply with special Corps requirements. This guide is furnished to assist the engineer in understanding what is important and why certain treatments are required. The guidebook covers specifically excavation and backfill; and pipelines over levees.

4.0 IDENTIFICATION AND SCREENING OF EXPOSURE CONTROL ALTERNATIVES

This section of the EE/CA addresses the following two main areas:

- Identification and description of technologies and exposure control options; and
- Development and screening of alternatives.

The approach utilized in developing this section of the EE/CA was to identify general categories of potentially applicable exposure control actions, and then develop specific alternative technologies within those categories. Alternatives are then screened based on effectiveness, implementability, and cost. During the screening process, alternatives are omitted from further consideration based on these criteria, and considering the specific site conditions.

Effectiveness is based upon how proven and reliable the exposure control option is with respect to the site-specific water supply needs and constituents of concern. Effectiveness also considers potential impacts to human health and the environment that may result from the implementation of the exposure control option, in terms of the degree of compliance with drinking water MCLs and other ARARs.

Implementability addresses the technical feasibility of installing and operating a technology option considering site-specific characteristics, and also considers the ability to substantively comply with regulatory provisions for the particular technology being considered. Those alternatives that are unworkable considering contaminant-specific conditions are eliminated from further consideration under this criterion.

Costs are evaluated based upon relative capital cost and operation and maintenance (O&M) cost in comparison with the other exposure control options presented for a specific technology type. The cost evaluation is based on quantitative cost calculations coupled with engineering judgement. A detailed evaluation of costs for those alternatives that pass the initial screening are presented in the detailed evaluation and analysis of alternatives (Section 4.3).

4.1 Technology Identification and Alternatives Development

Potentially applicable exposure control technologies were identified based upon likely effectiveness and consideration of the site characteristics and the exposure control objectives for the EE/CA. Promising exposure control technologies were then assembled, as appropriate, to develop general categories of exposure control alternatives to be developed and screened.

The categories of alternatives that were developed are the following:

- Extend Public/Community Water Supply Service;
- Install New Water Supply Wells; and
- Perform Wellhead Treatment at Existing Wells; or Tap Treatment At Points of Use.

The implementation of the exposure control alternatives has been developed to occur in a phased manner to first address the current exceedances of the drinking water MCLs at R-1 and R-2. The effectiveness, implementability, and cost of providing exposure control options for Well M-1 are also reviewed; however, these would occur as a contingency in a potential second phase since Well M-1 is not currently in violation of drinking water MCLs (although it is impacted by the groundwater contamination plume). The cost data presented in Section 4.3 show the costs of the separate implementation of the Well M-1 contingency options.

4.1.1 Extend Public/Community Water Supply Service

This category of alternatives assumes extension of water supply distribution from existing public/community systems to the site, to entirely replace the well water supply. Implementation includes abandonment of the existing wells. Alternatives included in this category involve construction costs of new facilities including utility easements along the pipe alignment, as well as annual system operation and maintenance costs (which are not presently borne by the water users).

Five public water systems were identified that operate within a feasible distance for connection of service to the site. The following sections include discussion of alternatives based on extending the service from each of the five systems.

Calculations for the sizing and conceptual design of appurtenances included in these alternatives are included in Appendix A.

4.1.1.1 Extend Fort Riley/MAAF Water Supply System

This alternative involves extension of the Ft. Riley/MAAF water supply to the site, accomplished by constructing a new 4-inch supply line from the existing 8-inch line at the end of Ray Street. The new line would traverse approximately 700 feet to Loop Road, and then another 1,000 feet along Loop Road before turning to cross beneath the existing Marshall Army Airfield levee (Figure 4-1). Once off Fort Riley property, the line would join the end of Racetrack Road and follow the private road along property easements, terminating adjacent to the furthest user to be supplied. One-inch and two-inch service connections from the main to each user would also be provided.

The water distribution system at Fort Riley consists of eight individual water systems which are integrated together to create one large water distribution system. These eight sub-systems consist of Custer Hill Troop Area, Custer Hill Family Housing, Colyer Manor, Camp Forsyth, Main Post, Marshall Field, Camp Funston, and Camp Whiteside.[4-5]

The maximum storage requirement to meet maximum daily flow and fire demand is 4.1 Million Gallons (MG). Existing storage capacity is 6.5 MG.[4-5] Marshall Army Airfield is served by two storage tanks of 0.5 and 0.25 million gallons capacity.[4-5] The smaller tank has not been in operation for several years due to a drop in water use. Due to a lack of demand from the larger tank, winter freezing within the tank has been noted.[4-5] Available pressure in the system is approximately 109 psi [4-5], which will require a pressure reducing valve to be installed in the main extension to the site. An overview of the components of this alternative is shown in Figure 4-2.

4.1.1.2 Extend Municipal or Rural Water District Lines

- Morris County Rural Water District (RWD)

This alternative would involve extending a new 4-inch supply line from the 10-inch main line of the Morris County RWD, with a connection made at the intersection of Route 114 and Whiskey Lake Road. The new line would be constructed within the right-of-way of Whiskey Lake Road and cross Route K-18 on an existing undercrossing. The proposed extension would follow Whiskey Lake Road, to a point just before reaching the MAAF levee, where it would turn west along Racetrack Road. At the end of Racetrack Road, the new line would enter a private road and follow this road to its termination point. One-inch and two-inch service connections to the users would also be provided. The alternative would require approximately 9,850 feet of new pipe installation along existing roadways, both public and private (Figure 4-3).

The Morris County RWD serves an area to the east of Marshall Army Air Field. The District serves over 400 customers, plus the towns of AltaVista and Dwight. Average daily water usage is 100,000 gpd.[4-6]

Water is provided through two wells located in the Clarks Creek Basin. Each pump has a capacity in excess of approximately 500 gpm, although pumping is limited to 300 gpm by the state Division of Water Resources.[4-7] The water is pumped to a 50,000 gallon storage tank through a 10-inch line.[4-7] The storage tank is located on Franks Hill, off of Kansas Route 57. [4-7] Pressure in the system transmission line at the proposed point of connection is approximately 150 psi [4-7], resulting in 85 to 90 psi at the point of use which requires a pressure reducing valve in the proposed extension to alleviate pressure transients (water hammer) in the proposed line. An overview of the components of this alternative is provided in Figure 4-4.

- Ogden Municipal Water District

This alternative would involve extending service from the Ogden Municipal Water District via a new 4-inch supply line from the existing 4-inch line at the intersection of Highway K-18 and South Walnut Street. The new supply line would follow within the right-of-way of Route K-18 to the intersection of Route K-18 and Whiskey Lake Road. Following Whiskey Lake Road, just before the MAAF levee, the new line would turn west along Racetrack Road. At the end of Racetrack Road, the new line would enter a private road and follow this road terminating adjacent to the users. This alternative would require approximately 3.7 miles of new pipe installation beneath existing roadways, both public and private. One-inch and two-inch service connections to the users would also be provided.

The Ogden Municipal Water District serves a city population of approximately 1,800 users and the Riley County Rural District population of approximately 1,200 users. The system was originally installed in the 1950's with upgrade and expansions occurring since that time.[4-8]

Water is provided from three groundwater wells. One well has the capacity of 250 gpm and the other two are rated at 300 gpm. At these pumping rates, the system capacity is 1.2 Million Gallons per Day (MGD). The most recent total average daily pumping rate recorded was 400,000 gpd. There are no booster pumps within the system.[4-8]

System pressure ranges between 35 psi and 90 psi. Pressure within the southern portion of the system, closer to MAAF, is on the higher end of the pressure range at approximately 80 psi.[4-8] Due to the distance of the main extension, a booster pump is included in this alternative to provide a minimum of 35 psi at the point of use.

- Junction City Water District

This alternative would involve extending a new service main from the Junction City district. The alternative would involved extending a 6-inch line from the existing 8-inch line beneath Reynolds Road in Junction City. The new line would be constructed east out of Junction City beneath the right-of-way of Route 40, extending to Flint Hills Boulevard and following this road until it connects with Whiskey Road. A booster pump would be included along Whiskey Road in order to maintain adequate in-line pressure. The new pipe construction includes jacking beneath Henry Road, to avoid interruption of traffic and a transverse trench pavement patch which could result in future roadway maintenance problems. Prior to the Henry Road crossing, the pipe would be reduced to a 4-inch diameter. The line would follow Whiskey Road to Race Track Road terminating adjacent to the users. This alternative would require approximately 7.2 miles of new pipe installation beneath existing roadways, both public and private. One-inch and two-inch service connections to the users would also be provided.

The Junction City Water District serves the population of Junction City and Grandview Plaza. Water is provided from 10 groundwater wells located next to the Republican River. The system is rated to provide a peak demand of 15 MGD. The average daily production and peak day production across all of the wells is 2.84 MGD and 6.35 MGD, respectively.[4-9]

The water supply system is divided into two pressure zones; a "low" system and a "high" system. The low system has a total storage capacity of 1.8 MG from three ground level storage tanks. At the time of this report, only two tanks are in use with a total combined storage capacity of 1.3 MG. Pressures within the low system range from 50 to 80 psi. The high system has a total storage capacity of 0.5 MG from a single elevated storage tank. Pressure within the high system is between 100 and 120 psi, and in the low system between 50 and 60 psi.[4-9] The proposed extension would occur on the low system.

- Grandview Plaza

This exposure control alternative would involve extending a new 6-inch supply line from the end of the existing system in Grandview Plaza. This alternative would extend the supply line just before the 6-inch line beneath Hudson Drive turns east and reduces to a 4-inch feeder to the motel. The new line would extend to Flint Hills Boulevard and follow this road until it connects with Whiskey Road. A booster pump would be included along Whiskey Road in order to maintain adequate in-line pressure. The new pipe would require jacking beneath Henry Road. The line would follow Whiskey Road to Race Track Road then onto the private road around to the residences. This alternative would require approximately 5.7 miles of new pipe installation beneath existing roadways, both public and private. One-inch and two-inch service connections to the users would also be provided.

An 8-inch line from Junction City provides all of the water to Grandview Plaza. The line from Junction City is considered an extension of Junction City's service. There are no pumps providing pressure from Junction City into Grandview Plaza. The pressure entering Grandview Plaza is approximately 75 psi.[4-10] Pressure within the system itself is adequate.

There are two aboveground storage tanks with a capacity of 50,000 and 100,000 gallons. Water enters the tanks under the existing pressure, although booster pumps are available.[4-10] The maximum amount of water available through the 8-inch water main entering Grandview Plaza is approximately 400 gpm.[4-10]

4.1.2 Install New Replacement Wells

Exposure control at the site may be achieved by installation of new water supply wells that would not pump contaminated groundwater. This can be achieved by intercepting the same unconsolidated aquifer at an alternate location that will not be influenced by the plume. The installation of replacement wells into bedrock formations beneath the alluvial aquifer was also considered. However, the local and state agencies (Geary County, KDHE, KDWR) do not have any information regarding bedrock wells completed in the valley location of the site, and no users of the bedrock units under the alluvial aquifer could be identified. Therefore, the quantity and quality of water available from the bedrock units could not be determined to be adequate to fulfill the objectives of the exposure control EE/CA.

4.1.2.1 Common Well and Distribution System Outside Area of Contamination

This alternative consists of completing a new water supply well on Fort Riley post property, outside of the zone of potential contamination, with a distribution line extending to the area to be serviced. This well would be located approximately 1,100 feet to the east of the plume area, completed in the unconsolidated alluvial aquifer. Installation would require a well house and fencing, extension of primary power to the site with a step-down transformer, and an access road extending from Racetrack Road.

This 8-inch well would be completed with a screen terminating at the bedrock interface, fully cased, and would include a grout seal for the full depth to a point 5-feet above the screen. A pitless adaptor system will be used, with valve access provided in the well house.

A 3-inch PVC main would extend from the well to a point adjacent to the users, where one-inch and two-inch services would be installed. Chlorination or other treatment of this source may be required to substantively comply with water supply provisions due to the potential for more than 25 users at the racetrack concession. A water rights permit (KDWR) would not be required for this well since the projected water withdrawal rate is well below the regulatory threshold.

4.1.2.2 Deeper Wells Adjacent to Existing Wells

Based on the assumption that the deeper alluvial materials at the site are uncontaminated, this alternative would include completion of new deep alluvial wells closely adjacent to the existing wells. These wells would be completed as standard 5-inch and 8-inch diameter residential wells, fully cased and screened with a grout seal. New service connections would be provided for each user.

4.1.2.3 Install New Common Well for R-1 and R-2, and New Well for M-1

This alternative considers the potential for providing new groundwater well supplies on the subject properties in a manner that would remove potential exposure to contaminants (Figure 4-5). Wells R-1 and R-2 would be replaced with a new 8-inch well serving both uses, located in the southeast corner of the subject property. In order to produce the required flow demand of 100 to 105 gpm, this well would have to be screened in the unconsolidated aquifer. A calculation for a well pumping 105 gpm in the alluvial materials yields a radius of influence of approximately 275 feet. [This calculation uses conservative values of 57,000 gallons per day per square foot for transmissivity (Section 2.1.4.1, as modified for aquifer thickness) and 30 feet for aquifer thickness]. The proposed location is approximately 400 feet from the edge of the contaminant plume. Hence, it is not anticipated that the new well would influence the dynamics of the contaminant plume to any measurable extent. Based on these findings, this well would not be subject to future contamination by the plume. New service connections to the users would be provided, including placement of the R-2 service replacement under the existing racetrack. The same KDHE permit provisions considered for the overall common well alternative (Section 4.1.2.1) would also apply to this R-1/R-2 common well.

To the extent that it is ever required, Well M-1 would be replaced with a 5-inch alluvial aquifer well approximately 800 feet to the west (near monitoring well FP-94-08) of the existing well. This well will be screened in the lower portion of the aquifer, extending to the bedrock. Based on an analysis of the aquifer characteristics, it is not anticipated that the new M-1 well will be able to affect the hydraulic gradients in the alluvial materials at the site to induce contaminant movement toward the new source. A new service connection would be provided to the point of use.

4.1.3 Perform Wellhead Treatment at Existing Wells or Tap Treatment At Point of Use

This alternative includes the continued use of the existing wells, with provision of wellhead treatment or tap treatment prior to use of the water (Figure 4-6). Treatment would be targeted for removal of VOCs.

Wellhead treatment facilities would include a secure heated structure to house equipment, and performance of scheduled maintenance and monitoring as required by each process. Well R-1 would use a unit rated for residential drinking water, and R-2 would use a commercial grade unit with higher flow capacity but fewer pre- and post-treatment processes that are needed for drinking water applications. In the event that contaminant levels ever exceed MCLs, Well M-1 would utilize a separate treatment unit similar to the R-1 unit.

Several treatment technologies are available and are discussed below. Byproducts from these groundwater treatment technologies may include gaseous elements that are discharged to the air, saturated or fouled treatment media which must be periodically disposed of and replaced, or waste solids/sludges that will require disposal. Potential disposal issues exist with each of the technologies, and treatability testing of the specific contaminants found in the groundwater is needed prior to implementation for many of the technologies.

Tap treatment would consist essentially of small scale versions of wellhead treatment technologies, such as activated carbon canisters installed at each sink, faucet, or other point of water use. Due to the difficulty in installing this type of technology on certain taps such as shower heads and exterior hose bibs, as well as the issue of potentially unreliable O&M within the private structures at each property, compromising the long term effectiveness of treatment. Therefore, tap treatment is not considered to be an implementable alternative.

Four wellhead treatment technologies applicable to removal of VOCs are carbon adsorption, air stripping, UV oxidation, and steam stripping. Other technologies identified but not applicable for VOCs are sedimentation (solids), filtration (solids), coagulation/flocculation (suspended solids), reverse osmosis (metallic salts), neutralization (acids/bases), chemical precipitation (metals), oxidation/reduction (cyanides, acids, and some organics), and activated sludge (non-chlorinated VOCs).

4.1.3.1 Carbon Adsorption

Activated carbon adsorption, commonly referred to as "charcoal treatment," is primarily used to remove trace organic compounds from aqueous or gaseous wastestreams. In this process, the dissolved contaminants adsorb to the carbon particles and stay adsorbed while the treated liquid is released. This process has proven effective in removing certain organic compounds and a few inorganic compounds from liquids.

Activated carbon is available in powdered (PAC) or granular (GAC) form. GAC is used in filter-adsorber units for taste and odor control, and for the removal of trace organics. Downflow contactors are typically used under pressure with multiple stages. The units are sized to be capable of meeting the maximum daily demand. Carbon material used will meet all applicable AWWA standards, and is periodically replaced when the adsorptive surfaces become saturated.

Batch testing or treatability testing of the groundwater at the site with this technology is necessary prior to implementation to determine the design parameters of the system.

Pretreatment requirements include removal of iron and manganese from the source using a water softener, as well as a 5μ particulate filter to remove solids, prior to the GAC unit to prevent premature clogging of the carbon media. Post treatment by UV disinfection to remove bacteria that may develop in the media is typically recommended for a drinking water application. NSF certification of the GAC system is also required for drinking water applications. The pre- and post-treatment units, and NSF certification, are not considered to be required for the racetrack dust control use (Well R-2).

4.1.3.2 Air Stripping

Air stripping is a process option in which the contaminated liquid and air are fed through a low-profile stripper design. Contaminated water flows over a distribution weir and along baffled aeration trays. Clean air is blown up through small holes in the aeration tray, forming a froth of bubbles with a large mass transfer surface area, which enables volatilization of the contaminants. Residuals from the process include a contaminated off-gas and a treated water. The contaminated off-gas can be treated through air pollution control equipment, if required. This method is effective in removing VOCs. Air stripping can also be associated with carbon adsorption where the carbon adsorption is used for polishing.

The KDHE has indicated that air stripping systems installed in the region for single residential or commercial users have operated poorly. Due to the high iron and hardness content of the groundwater, and intermittent flow through small systems, extensive fouling of the aeration media has typically occurred.

4.1.3.3 UV Oxidation

UV oxidation systems generally combine ultraviolet (UV) light with ozone and hydrogen peroxide to produce highly reactive hydroxyl radicals. The hydroxyl radicals react with and break down VOCs in the groundwater. Although highly effective, UV oxidation demands a high recycle rate of groundwater to achieve complete destruction of organics. Inorganics tend to oxidize and foul the UV light, causing operational concerns.

4.1.3.4 Steam Stripping

Steam stripping utilizes steam to extract organic constituents from a liquid. This process may be performed through direct contact in an air-stripping unit, or through indirect contact in a multiple-pass heat exchanger. In comparison to the other treatment types and process options for treating organic contamination in groundwater, this process is energy-intensive and not considered cost-effective.

4.2 Initial Screening of Alternatives

Section 4.1 has identified and summarized a comprehensive list of the general exposure control categories, and specific options which are considered to be potentially relevant and appropriate for the EE/CA as described below. The identified technologies and alternatives have been screened, with several being eliminated from further consideration on the basis of lack of technical implementability, effectiveness, or high costs. Factors that influenced the technology screening included the applicability of processes to control exposure to organic contaminants and the high cost to implement various technologically complex options. The rationale for screening out specific technologies and process options is summarized as follows:

4.2.1 Extend Fort Riley/MAAF Water Supply System

This alternative was deemed to be sufficiently implementable and cost-effective to retain it for further analysis.

4.2.2 Extend Municipal or Rural Water District Lines

The alternatives within this category were considered to have the same ranking for effectiveness because they require similar technologies to be implemented. Therefore, the group of specific options were screened separately for cost and implementability considerations to determine which extension alternative is retained for further evaluation. The implementability of the several potential water system extensions varies depending on length of pipe, number and complexity of major crossings such as highway bridges or waterways, and available water pressure. The results of an initial screening of the available water system extension alternatives are summarized in Table 4-1.

The Morris County system extension has the lowest cost and complexity due to shorter pipe lengths and no major crossings, and has adequate pressure and capacity to provide water supply to the site. Therefore, extension of the Morris County System has been selected as the municipal/rural system extension option that is retained for detailed analysis.

Table 4-1
Municipal/Rural Water System Extension Alternative Screening

Exposure Control Alternative	Length of Pipe (L.F.)	Major Crossings	Available Pressure @ 110 gpm (psi)
Morris County RWD	13,000 (4" diameter)	none	91
Ogden	27,460 (4" diameter)	- Former oxbow via Route K-18 bridge - Kansas River via Route K-18 bridge	35*
Junction City	12,890 (4" diameter) 14,500 (6" diameter)	- Kansas River via Route 40 bridge - Henry Drive via Pipe Jacking	35*
Grandview Plaza	7,150 (4" diameter) 12,890 (6" diameter)	- Henry Drive via Pipe Jacking	35*

Note: (*) In-line booster pump required to maintain minimum of 35 psi.

4.2.3 Install New Replacement Wells

The alternative consisting of a new common well on Fort Riley property includes the following factors that are not needed for the other replacement well options:

- Provision of an electrical transformer;
- Extension of electrical power, an access road, and water main 1,100 feet; and
- Long term O&M by the Army since the installation is on base property.

Therefore, this alternative would be more costly and less implementable than the other replacement well options, and has been screened from further consideration.

The installation of bedrock wells to replace existing wells is not feasible for Well R-2 due to the need for a 100 gpm capacity which is not believed to be achievable[4-11], and for Well M-1 involves unnecessary cost and effectiveness issues since contiguous property is available outside of the contamination plume where an alluvial replacement well could be completed. Therefore, this alternative has been screened from further consideration.

The option to install a new alluvial aquifer common well for Wells R-1/R-2, and a separate alluvial aquifer well for Well M-1 if required in the future, outside of the influence of the plume, has been retained for further analysis.

4.2.4 Perform Wellhead Treatment At Existing Wells

These technologies were screened as a group, to determine the most promising wellhead treatment alternative. Groundwater treatment technologies that are applicable only for high contaminant concentrations have not been retained. Alternatives that involve a complex process, or that generate byproducts requiring frequent management, have also not been retained.

The best available technologies for removal of all organic contaminants except vinyl chloride are air stripping and GAC adsorption. Air stripping for the removal of VOCs is a well-established technology, however, considerations of effectiveness for use in a high mineral water source with intermittent flows favor the use of GAC treatment. GAC processes involve the periodic disposal and replacement of spent media, which typically must be handled as a regulated waste.

4.2.5 Results of Initial Screening

A summary of the review of the categories of alternatives and the specific exposure control options is shown in Table 4-2. Based upon this initial screening, the specific alternatives that have been retained for further consideration are as follows:

- Extension of Fort Riley Water Supply System;
- Extension of Morris County Water Supply System;
- Installation of New Replacement Wells: Common Alluvial Well for R-1 and R-2; Alluvial Well for M-1 If Needed; and
- Provision of Wellhead Treatment: GAC Process.

In each alternative, provision of exposure control for Well M-1 would occur in a second contingency phase in the event that drinking water MCLs are exceeded in that source.

4.3 Analysis of Retained Exposure Control Alternatives

This section analyzes the alternatives that were retained for further consideration based upon the screening and discussions in previous sections. Each alternative is evaluated on its own merits for effectiveness, implementability and cost, and considers both short-term and long-term application. Conceptual design and preliminary cost estimates have been prepared for each alternative. Comparison between alternatives will be completed in Section 5.0.

Short term application assumes that the remedial action selection process will be completed within five years, after which time the exposure control actions would be discontinued in lieu of a selected remedial alternative other than mere continuation of exposure controls.

Long term application assumes that the exposure control actions that are implemented will be operated and maintained for a 30-year period (i.e., they become the selected long term remedial action identified in the Record Of Decision). This is a conservative estimate of the time required for the groundwater contamination to attenuate or be treated to a level which is protective of public health and the environment.

4.3.1 Description of Evaluation Criteria

The criteria used to evaluate the exposure control alternatives are discussed in the following sections. In accordance with the EE/CA guidance [1-1], these criteria include effectiveness, implementability and cost. The short-term and long-term aspects of these criteria must be assessed to direct the evaluation criteria as defined in the EE/CA guidance. Of substantial importance in this regard is each alternative's potential effect on the upcoming remedial action decision-making process, and whether or not it hinders or precludes otherwise promising remedial action alternatives.

4.3.1.1 Effectiveness

This criterion focuses on the two primary elements of protectiveness and ability to achieve exposure control objectives.

Protectiveness:

- The degree to which options reduce the public health and environmental hazards posed by the contamination at the site, including exposure of workers during implementation.
- Substantive compliance with ARARs.

Ability To Achieve Exposure Control Objectives:

- The degree to which an alternative controls the exposure of the property owners utilizing the water supply to the contaminants present in the alluvial groundwater aquifer.
- The type and quantity of byproducts that remain after contamination treatment processes.
- The reliability of each option to provide a safe source of water supply over the long term.

4.3.1.2 Implementability

Implementability relates to the technical feasibility of each option, the availability of the equipment and facilities needed, and the administrative feasibility of utilizing an alternative.

Technical Feasibility:

- Construction and operation considerations.
- Demonstrated performance and useful life.
- Adaptability to the site environmental conditions.
- Can be implemented within a one-year period.

Availability:

- Equipment and knowledgeable personnel to provide required construction and O&M services.
- Disposal capacity for byproducts.

Administrative Feasibility:

- Substantive compliance with required permitting.
- Easements or rights-of-way required.
- Impacts on adjoining properties.
- Ability to impose institutional controls on the O&M of facilities.

4.3.1.3 Cost

The cost evaluation considers capital costs (design, construction and testing) and operation and maintenance costs. Capital costs have been developed for installation of exposure control options during Phase 1 (measures to address Well R-1 and R-2); and the Contingency Phase (measures to address Well M-1). Operation and maintenance costs have been developed for options implemented during both phases. The procedures used in development of the alternative cost estimates are as follows:

- Phase 1 options are constructed during year zero of the project (1998), which is defined as the present worth year.
- Contingency Phase measures, if needed, are assumed to be installed two years after the Phase 1 measures (2000), and the associated Contingency Phase costs have been brought to a present worth value.
- A short term analysis has been completed, evaluating the total present worth costs of each alternative for a five year period. Hence, O&M costs for Phase 1 measures have been calculated over a five year period, and for Contingency Phase over a three year period.
- A long term analysis has been completed, evaluating the total present worth costs of each alternative for a thirty-year period. Hence, O&M costs for Phase 1 measures have been calculated over a thirty year period, and for Contingency Phase over a twenty-eight-year period.

Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at a greater cost, have been eliminated. A conceptual order of magnitude cost estimate associated with each alternative is provided in Tables 4-3 through 4-6.

4.3.2 Extend Fort Riley/MAAF Water Supply

4.3.2.1 Effectiveness

ARARs determined to be applicable to this alternative are the Safe Drinking Water Act, and the Kansas State laws KAR 28-15-11 through KAR 28-15-22. Guidelines to be considered consist of the KDHE Policies, General Considerations, and Design Requirements for Public Water Supply Systems in Kansas. The Fort Riley water supply system is already in compliance with the KAR and Federal drinking water requirements as a public water supplier.

Use of proper construction practices would ensure the protection of public health, environment, and workers during the implementation of this alternative.

This alternative would achieve the exposure control objectives by eliminating exposure to the groundwater contamination. The level of exposure control expected is 100 percent. The effectiveness and permanence of this alternative makes it a viable long-term solution.

4.3.2.2 Implementability

Construction for this alternative would likely be accomplished using cut and cover pipeline with the exception of passing beneath the levee where jacking techniques will likely be required. The trench depth would be not greater than five feet, and the majority of trenching will be on Fort Riley property. All structural and geotechnical concerns, hydraulic, mechanical, and hydrologic issues regarding the levee crossing would be coordinated with CEMRK. Permanent easements would be required to place the water main beneath the private roadway. There are no known obstructions to the construction of this alternative (e.g. sewer lines, power lines, telephone lines, gas lines, or other underground utilities). Full-width use of the private roadway would be limited for a short time period during construction.

Water pressure within the existing MAAF water supply system is more than adequate to provide service to the study area. A pressure reducing valve would be used to ensure that correct water pressure is provided to the proposed users.

As an extension of their current system, Fort Riley would be responsible for the operations and maintenance of this service line connection. This would likely involve annual cleaning and inspection of the line and associated valves as well as other activities performed in a similar manner on the existing MAAF water supply system. No user fees would be charged for the new connections.

This alternative would also have a positive impact on market values for adjoining properties, and can be implemented in less than one year.

4.3.2.3 Cost

The estimated design and construction cost for Phase 1 of this alternative is approximately $305,226 (Table 4-3). Annual operations and maintenance costs are estimated to be approximately $715. This O&M cost is based on an annual cleaning and inspection of the supply line by Fort Riley personnel. The Phase 1 present worth of the O&M costs, using a uniform series of payment over 5 years at seven percent discount rate, is $2,932. The capital costs for the Contingency Phase would be $2,599, with annual O&M costs of $285.

4.3.3 Extend Morris County Rural Water District Water Supply

4.3.3.1 Effectiveness

ARARs determined to impact this alternative are the Safe Drinking Water Act, Kansas state laws KAR 28-15-11 through KAR 28-15-22, and requirements of the Division of Water Resources. Guidelines to be considered consist of the KDHE Policies, General Considerations, and Design Requirements for Public Water Supply Systems in Kansas. The Morris County RWD system is already in compliance with the KAR and Federal drinking water requirements as a public water supplier.

Use of appropriate construction practices would ensure the protection of public health, environment, and workers during the implementation of this alternative.

This alternative would have the ability to achieve the removal objectives and eliminate exposure to the pollutants. The level of exposure control expected is 100 percent. The effectiveness of control from this alternative lends itself to be considered as a long-term solution.

4.3.3.2 Implementability

There are no unusual construction and/or operational considerations with this alternative. There are no major roadways or natural resources over which to cross. Construction for this alternative would be accomplished using cut and cover pipeline. The trench depth would not be greater than five feet, and the majority of trenching would be within state or county roadways.

No specialized equipment or personnel are required to implement this alternative; therefore, normal availability of personnel and equipment is expected during the typical construction season.

Permitting would be required to construct the water main within the right-of-way of existing state and or county roadways in addition to permits from the KDHE as required under KSA 65-163. This alternative would be considered a water main extension project; therefore, it is subject to fewer requirements of the permit process. A permanent easement would be required for construction beneath private roadways.

There are no known obstructions to the construction of this alternative (e.g. sewer lines, power lines, telephone lines, gas lines, or other underground utilities). Full-width use of the private roadway would be limited for a short time period during construction.

Pressure within the existing Morris County system is more than adequate to provide service to the study area. A pressure reducing valve would be used to ensure that excessive pressure is not realized by the proposed users.

The O&M of the main extension would be performed by the Morris County Rural Water District. This annualized cost for O&M is included in the base cost estimate. It is assumed that Fort Riley would pay for user fees for each connection for 30 years.

This alternative would have a positive impact on market values of adjoining properties and can be implemented in less than one year.

4.3.3.3 Cost

The estimated design and construction cost for Phase 1 of this alternative is approximately $606,599 (Table 4-4). Annual user fees are estimated to be approximately $696. This cost is based on the existing water usage fees set by the Morris County RWD [5-2]. The present worth of the user fee, using a uniform series of payment over 5 years at a seven percent discount rate, is $2,855. The capital costs for the Contingency Phase would be $3,580, with annual O&M costs of $278.

4.3.4 Installation of New Replacement Wells

4.3.4.1 Effectiveness

This alternative is considered a Domestic Water Source; therefore, applicable ARARs relate to the proper installation of the well and Safe Drinking Water Act MCLs for water quality requirements.

This alternative provides a water supply that would have the ability to achieve the exposure control objectives and eliminate exposure to the pollutant parameters in the short term. Over time, a minimal potential exists for contamination of this alternate water source by migration of pollutants into the well's zone of influence. The replacement well for Wells R-1 and R-2 would be sited outside of the plume of contamination and, using the assumed pumping rate, has been calculated to not draw contaminated groundwater from the plume. The replacement well for Well M-1 would be similarly located outside of the potential zone for contaminant migration.

Construction practices will ensure the protection of public health, environment, and workers during the implementation of this alternative.

There are no residual effects of concern for this alternative. The effectiveness of control from this alternative lends itself to be considered a long-term solution.

4.3.4.2 Implementability

Implementation would require compliance with the applicable requirements of KAR 28 for a water supply permit. Coordination with Kansas Power and Light (KPL) would also be required in order to receive electrical service.

It is noted that short-term effectiveness may be achieved by only replacing R-2 with a new well, and providing bottled water for the intermittent public use at the concession stand served by R-1. The permitting issues would be reduced; however, in the long-term (30 years), this option would cost approximately the same. Should water quality sampling of the water supply indicate that extensive pretreatment would be required to meet drinking water standards, the R-1 bottled water option may become more implementable.

There are no unusual construction and/or operational considerations associated with this alternative. There are no major roadways or natural resources over which to cross. Construction for this alternative would involve drilling two new wells and laying cut and cover pipe to all current supply points. The trench depth would not be greater than five feet, and would occur solely on private property.

No specialized equipment or personnel are required to implement this alternative; therefore, normal availability of personnel and equipment is expected during the typical construction season.

Operation and maintenance of the new wells would be the responsibility of the property owners since their water supply is being replaced with an in-kind system on their properties.

There are no known obstructions to the construction of this alternative (e.g. sewer lines, power lines, telephone lines, gas lines, or other underground utilities).

4.3.4.3 Cost

Fort Riley would be responsible for the construction of this alternative, although not for the facilities O&M costs since the property owners must currently operate similar wells to obtain water supply. Periodic monitoring of the groundwater quality has been included as an O&M cost which would be Fort Riley's responsibility. The estimated design and construction cost for Phase 1 of this alternative is approximately $98,393 (Table 4-5). Annual O&M costs due to monitoring are estimated to be approximately $1,400. The present worth of the O&M costs, using a uniform series of payment over 5 years at a seven percent discount rate, is $5,740. The capital costs for the Contingency Phase would be $32,798, with annual O&M (monitoring) costs of $600.

In the event that bottled water is used at R-1, the estimated design and construction cost for Phase 1 of this alternative is approximately $70,193 (Table 4-6). Annual O&M costs due to monitoring and purchase of the bottled water are estimated to be approximately $3,900. The present worth of the O&M costs, using a uniform series of payment over 5 years at a seven percent discount rate, is $15,991. The capital costs for the Contingency Phase would be $32,798, with annual O&M (monitoring) costs of $600.

4.3.5 Perform Wellhead Treatment at Existing Wells

4.3.5.1 Effectiveness

This GAC treatment would be designed and tested to remove the target contaminant(s) from the water to a concentration significantly below the respective MCLs and attempt to reach a level that cannot be detected utilizing required analytical methods and instrumentation. GAC units are placed in series to ensure effectiveness and provide protection from breakthrough of contaminants. Seasonal temperature variability may affect the performance of this treatment technology.

4.3.5.2 Implementability

There are no unusual construction considerations with this alternative. Construction for this alternative will be restricted to appropriate sites at or adjacent to the existing wells. The only construction would involve the installation of above-ground wellhead treatment equipment.

Operational considerations will be significant. Fort Riley personnel would have to continually maintain the treatment system in good working order. This would involve frequent visits to the site in order to perform scheduled maintenance, as well as provide for water quality sampling (assumed to be on a quarterly basis). Special permitting is not required, and no easement would be required for construction. There are no known obstructions to the construction of this alternative (e.g. sewer lines, power lines, telephone lines, gas lines, or other underground utilities).

A single above-ground structure would be required to house the treatment equipment at each wellhead. Resistance to installation of such a structure may be encountered from the homeowner and race track owner as well as adjoining property owners. This alternative can be implemented in less than one year. The GAC units would be provided by a vendor, which also provides for regularly scheduled removal and replacement of the media containers. Batch testing of the GAC unit would be performed prior to final installation to size the containers, verify the chemical compatibility of the media and groundwater, and develop a required regeneration period. All disposal, transportation and manifesting, and permitting issues would be the responsibility of the vendor and are included in the O&M costs discussed in the following section.

4.3.5.3 Cost

Fort Riley would be responsible for the construction and operations costs of this alternative. Users would not pay a water usage fee or meter fee. The estimated design and construction cost for Phase 1 of this alternative is approximately $61,989 (Table 4-7). Annual O&M costs due to monitoring are estimated to be approximately $7,200. The present worth of the O&M costs, using a uniform series of payment over 5 years at a seven percent discount rate, is $29,521. The capital costs for the Contingency Phase would be $21,706, with annual O&M costs of $3,600.

Table 4-2
Initial Alternative Screening

Category of Exposure Control Alternative	Options	Description	Screening Comments
1. Extend Public/ Community Water Supply Service	Fort Riley/MAAF	Construct a new 4-inch supply line from the existing 8-inch line at the end of Ray Street	Retained for further consideration.
	Morris County Rural Water District	Construct a new 4-inch supply line within the right-of-way of Whiskey Lake Road from the 10-inch Morris County RWD line.	Retained for further consideration.
	Ogden Municipal Water District	Construct a new 4-inch supply line from the existing 4-inch line at the intersection of K-18 Highway and South Walnut Street.	Not retained for consideration due to relatively high costs.
	Junction City Water District	Construct a new 6-inch supply line from the existing 8-inch line beneath Reynolds Road. At the intersection of Whiskey Lake Road and Henry Drive, the supply line will become 4-inches.	Not retained for consideration due to relatively high costs.
	Grandview Plaza	Construct a new 6-inch supply line off of the end of the existing system located behind the motels at Exit 300 off of Interstate 70.	Not retained for consideration due to relatively high costs.
2. Install New Wells	Common Well Outside Area of Contamination	Construct a new 8-inch water supply well on Fort Riley base property, outside of the zone of potential contamination, with a 3-inch PVC distribution line extending to the affected properties.	Not retained for consideration due to elevated costs and continued operations and maintenance considerations for the Army.
	Deeper Wells Adjacent to Existing Wells	Construct new deep alluvial or bedrock wells closely adjacent to the exiting wells.	Not retained for consideration due to insufficient capacity in bedrock units to meet 100 gpm requirement, and proximity of capture zone to contaminant plume in the alluvial aquifer.

Table 4-2 (continued)
Initial Alternative Screening

Category of Exposure Control Alternative	Options	Description	Screening Comments
	New M-1 Well on-site, New R1/R2 Common Well on-site	Replace Well M-1 with a 5-inch alluvial aquifer well west of the existing well. Replace Wells R1/R2 with a new 8-inch well located in the southwest corner of the subject property.	Retained for further consideration.
3. Perform Wellhead Treatment at Existing Wells	Carbon Adsorption	Treatment facilities would include a secure structure to house equipment. Activated carbon will be used to remove trace organic compounds from aqueous or gaseous wastestreams.	Retained for further consideration.
	Air Stripping	Treatment facilities would include a secure structure to house equipment. Water aerated in a packed column to promote transfer of VOCs to air.	Not retained for consideration as this technology is not applicable to intermittent flow situation nor effective as treatment with existing water hardness.
	UV Oxidation	Treatment facilities will include a secure structure to house equipment. Combines ultraviolet light with ozone and Hydrogen Peroxide.	Not retained for consideration in favor of more cost-effective options for treatment of organics.
	Steam Stripping	Treatment facilities will include a secure structure to house equipment. Uses steam to extract organics from effluent in a packed tower.	Not cost effective for low concentrations of contaminants.

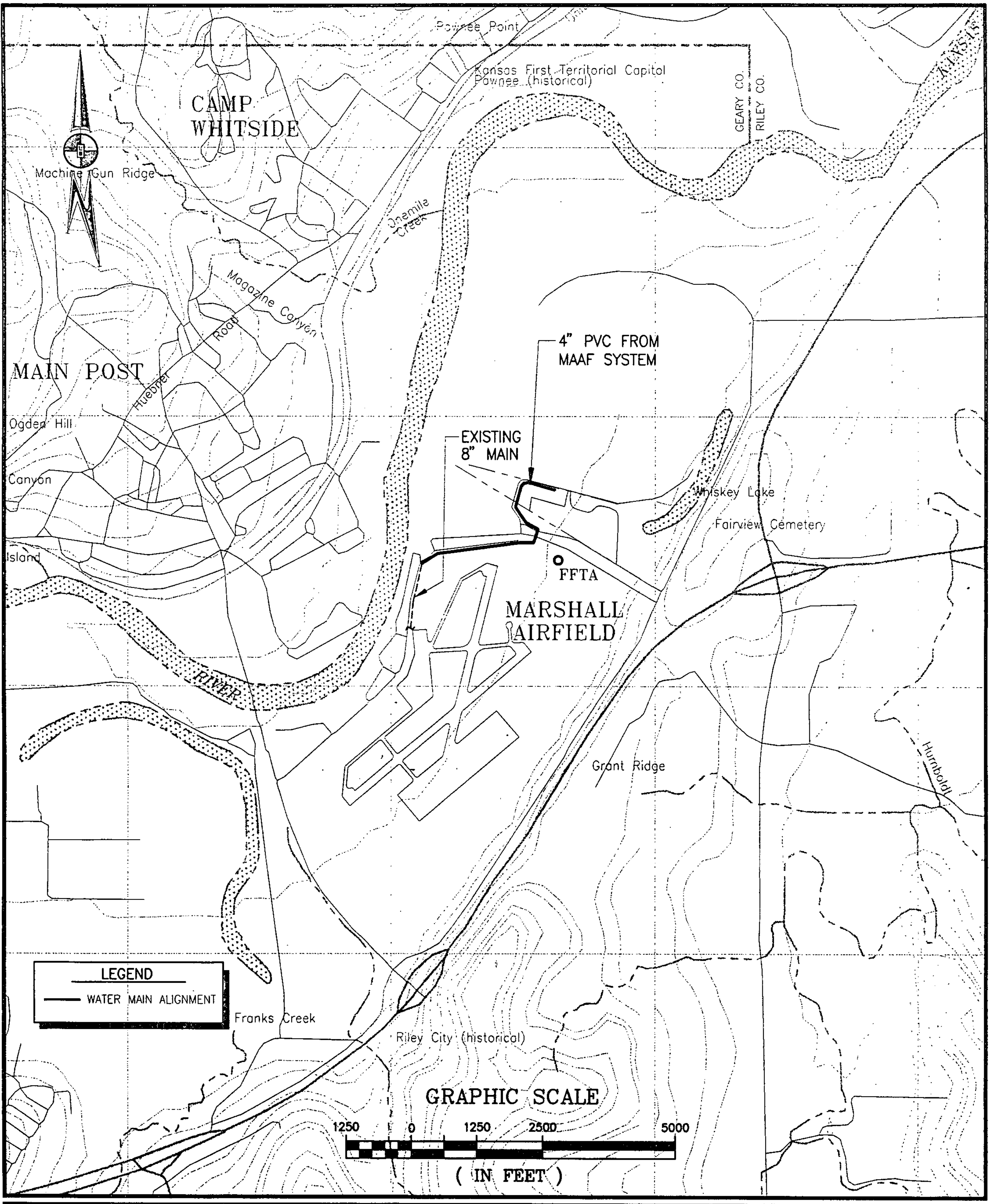


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Figure 4-1:
FORT RILEY SYSTEM EXTENSION
WATER MAIN ALIGNMENT

Scale: As Shown

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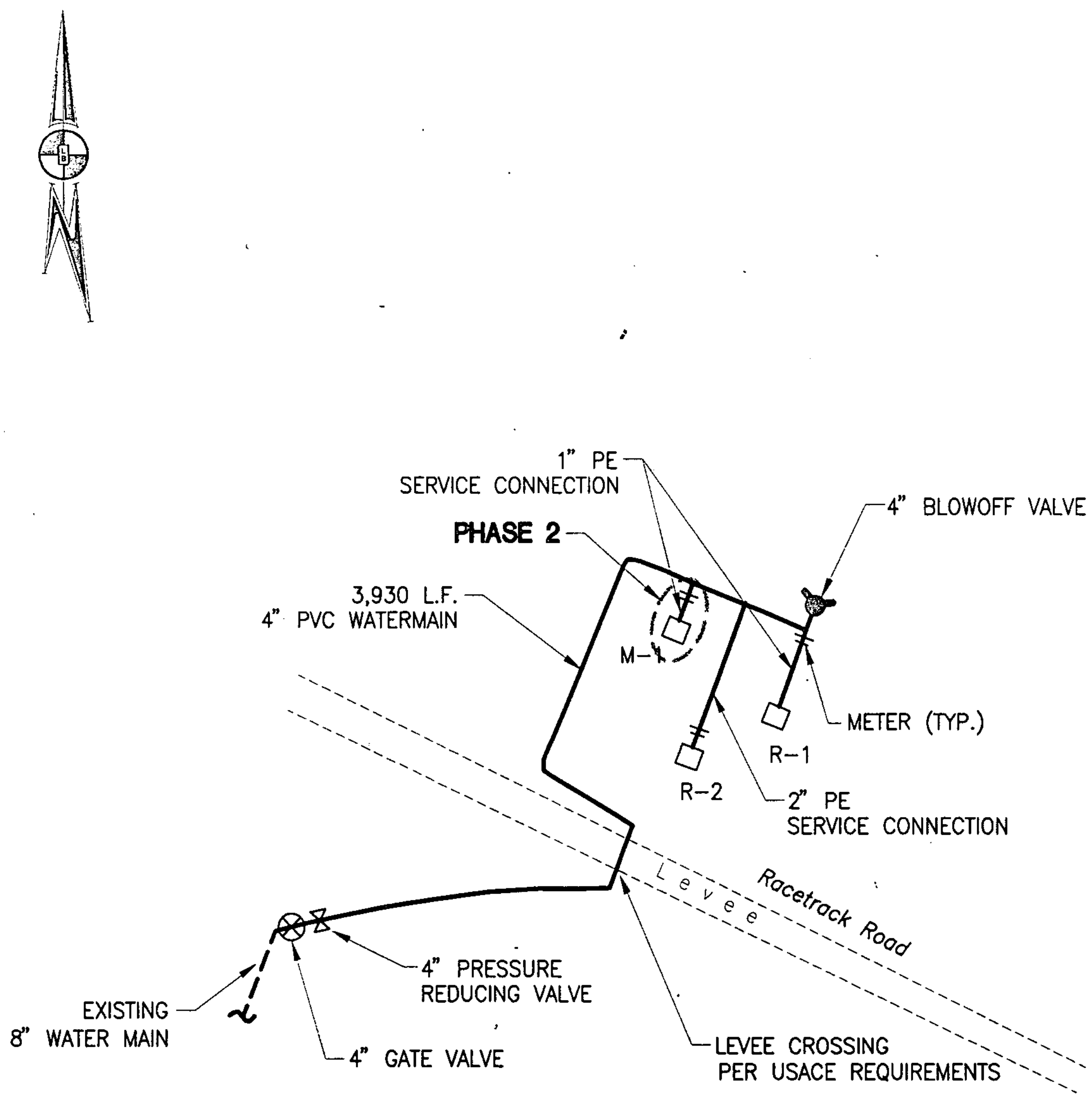

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Figure 4-2:

FORT RILEY SYSTEM EXTENSION ALTERNATIVE

Scale: Not to Scale

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Table 4-3
Engineering Evaluation/Cost Analysis
FFTA-MAAF
Exposure Control Alternative 1
Fort Riley Water Supply Extension

	ITEM	DESCRIPTION	UNIT	Phase 1 - Well R1&R2 ESTIMATED QUANTITY	UNIT COST	CONSTRUCTION COST	O&M	Contingency Phase - Well M-1 ESTIMATED QUANTITY	UNIT COST	CONSTRUCTION COST	O&M
A		*WATER MAIN*									
	1	Pipe, 4-inch, PVC, in place	LF	3,930	$ 30	$ 117,900					
	2	Pipe jacking under levee - Horizontal boring	LF	150	$ 550	$ 82,500					
	3	Pipe jacking under levee - Jacking pit	EA	2	$ 3,150	$ 6,300					
	4	8-inch to 4-inch connecting tee	EA	1	$ 270	$ 270					
	5	Pressure reducing valve, in place w/ vault	EA	1	$ 4,000	$ 4,000					
	6	Residential service connections, 1-inch PE pipe, in place	EA	2	$ 650	$ 1,300		1	$ 650	$ 650	
	7	Commercial service connections, 2-inch PE pipe, in place	EA	1	$ 1,000	$ 1,000					
	8	4-inch blowout valve	EA	1	$ 485	$ 485					
	9	4-inch gate valve, in-place w/ box	EA	1	$ 1,000	$ 1,000					
	10	4-inch 90 degree bends	EA	2	$ 125	$ 250					
	11	Thrust blocks	EA	5	$ 60	$ 300					
	12	2" Backflow preventor (R-2)	EA	1	$ 480	$ 480					
B		*SURFACE RESTORATION*									
	1	Gravel covering for road side trench	LF	1,700	$ 4	$ 6,137					
	2	Asphalt concrete pavement repair	LF								
	3	Abandon existing well	EA	2	$ 1,000	$ 2,000		1	$ 1,000	$ 1,000	
C					*SUBTOTAL*	$ 223,922				$ 1,650	
D		CONST. CONTINGENCY =	20%			$ 44,784				$ 330	
E					*CONSTRUCTION SUBTOTAL*	$ 268,706				$ 1,980	
F		ENGINEERING / CONSTRUCTION INSPECTION	10%			$ 22,392				$ 165	
G		ADMIN/LEGAL	5%			$ 11,196				$ 83	
H					*CONSTRUCTION TOTAL*	$ 302,295				$ 2,228	
I		ANNUAL OPERATIONS AND MAINTENANCE					$ 715				$ 285
J		PRESENT WORTH (O&M): P1 - 5 years; P2 - 3 years	7%				$ 2,932				$ 748
K		PRESENT WORTH (O&M): 25 years	7%				$ 8,872				$ 3,459
					PHASE 1 PROJECT	$ 305,226		***CONTINGENCY PROJECT***		$ 2,599	

SUMMARY

Phase-1 for 5 years:	**$**	**305,226**
Phase-1 and Contingency for 5 years :	**$**	**307,825**
Phase-1 for 30 years :	**$**	**311,167**
Phase-1 and Contingency for 30 years :	**$**	**316,134**

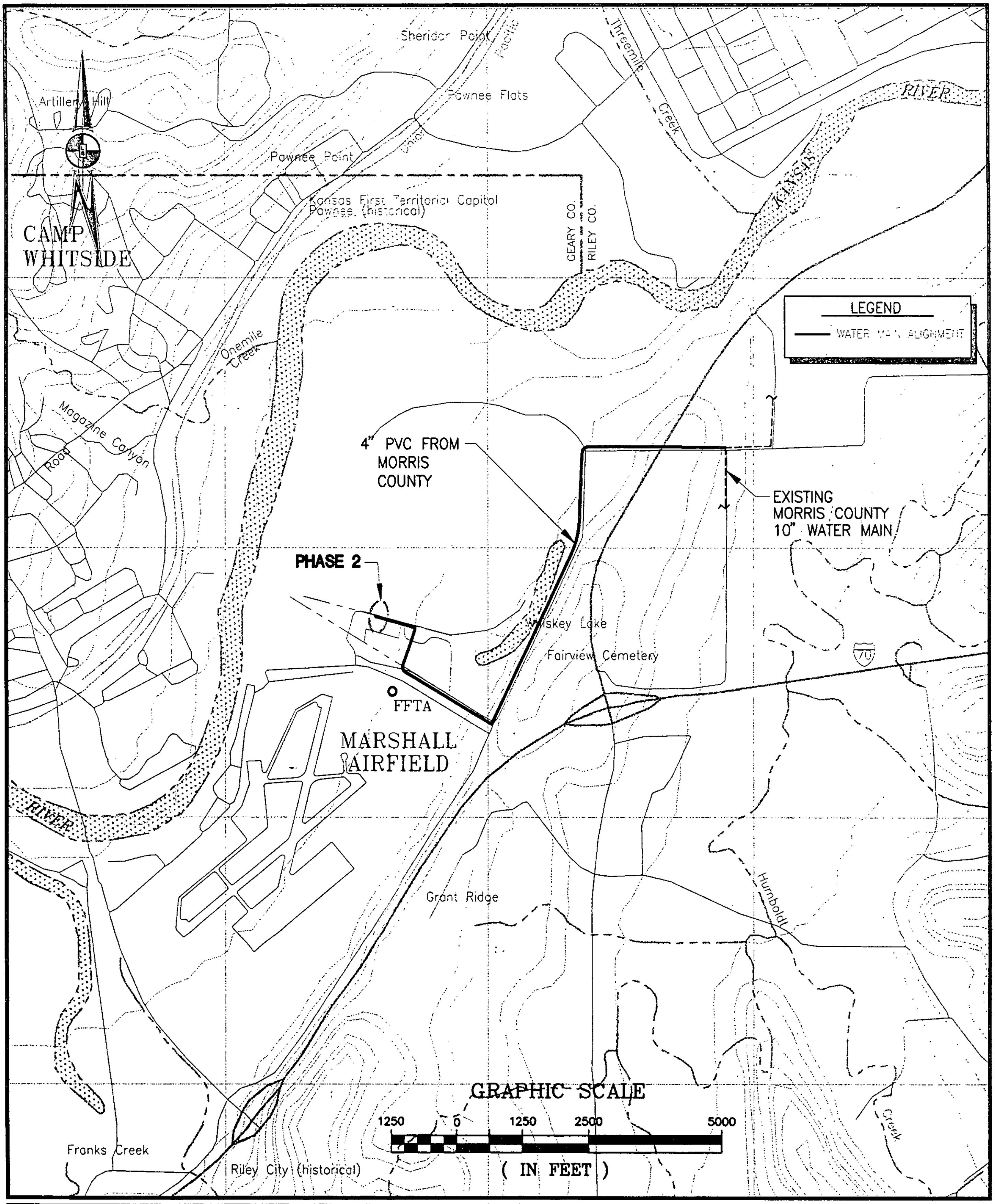

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Figure 4-3:
MORRIS COUNTY SYSTEM EXTENSION ALIGNMENT

Scale: As Shown

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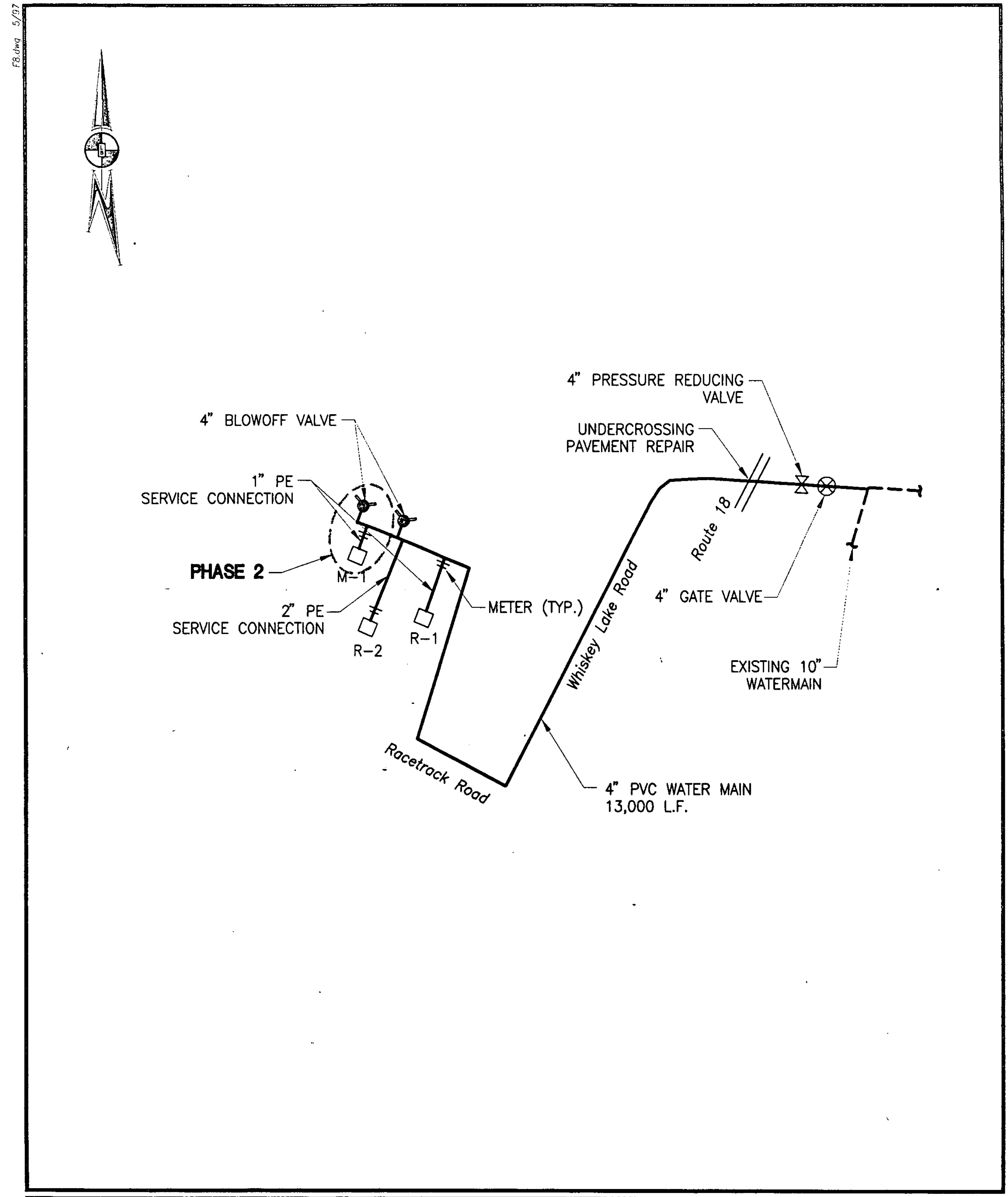

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Figure 4-4:
MORRIS COUNTY SYSTEM EXTENSION ALTERNATIVE

Scale: Not to Scale

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Tal 4-4
Engineering Evaluation/Cost Analysis
FFTA-MAAF
Exposure Control Alternative 2
Morris County Water Supply Extension

ITEM	DESCRIPTION	UNIT	Phase 1 - Well R1&R2 ESTIMATED QUANTITY	UNIT COST	CONSTRUCTION COST	O&M	Contingency Phase - Well M-1 ESTIMATED QUANTITY	UNIT COST	CONSTRUCTION COST	O&M
A	*WATER MAIN*									
1	Pipe, 4-inch, PVC, in place	LF	13,000	$ 30	$ 390,000					
2	10-inch to 4-inch connecting tee	EA	1	$ 280	$ 280					
3	Pressure reducing valve, in place w/ vault	EA	1	$ 4,000	$ 4,000					
4	Residential service connections, 1-inch PE pipe, in place	EA	1	$ 650	$ 650		1	$ 650	$ 650	
5	Commercial service connections, 2-inch PE pipe, in place	EA	1	$ 1,000	$ 1,000					
6	4-inch blowout valve	EA	1	$ 485	$ 485		1	$ 485	$ 485	
7	4-inch gate valve, in-place w/ bov	EA	1	$ 1,000	$ 1,000					
8	4-inch 90 degree bends	EA	4	$ 125	$ 500					
9	Thrust blocks	EA	5	$ 60	$ 300					
10	2" Backflow preventor (R-2)	EA	1	$ 480	$ 480					
B	*SURFACE RESTORATION*									
1	Gravel covering for road side trench	LF	12,800	$ 4	$ 46,259		100	$ 4	$ 361	
2	Asphalt concrete pavement	LF	100	$ 3	$ 263					
3	Abandon existing well	EA	2	$ 1,000	$ 2,000		1	$ 1,000	$ 1,000	
C				*SUBTOTAL*	$ 447,217				$ 2,496	
D	CONST. CONTINGENCY =	20%			$ 89,443				$ 499	
E				*CONSTRUCTION SUBTOTAL*	$ 536,661				$ 2,996	
F	INITIAL METER FEE	EA	2	$ 1,500		$ 3,000	1	$ 1,500		$ 1,500
G	ENGINEERING / CONSTRUCTION INSPECTION	10%			$ 44,722				$ 250	
H	ADMIN/LEGAL	5%			$ 22,361				$ 125	
I				*CONSTRUCTION TOTAL*	$ 603,743				$ 3,370	
J	PRESENT WORTH (Construction Total): 2 years (CAF,.05,2)	5%								
K	ANNUAL OPERATIONS AND MAINTENANCE					$ 696				$ 278
L	PRESENT WORTH (O&M): P1 - 5 years; P2 - 3 years	7%				$ 2,855				$ 728
M	PRESENT WORTH (O&M): P1-30 years;P2-28 years	7%				$ 8,642				$ 3,369
				PHASE 1 PROJECT	$ 606,599		***CONTINGENCY PROJECT***		$ 3,580	

Note: - Annual O&M assumes Monthly billing of $2.40/1000 gal. for first 5000 gal. + $1.60/1000 gal.+ $34.00
- Percent of Flow: M1-28.5%; R1-28.5%$; R2-43%

SUMMARY

Phase-1 for 5 years:	**$**	**606,599**
Phase-1 and Contingency for 5 years :	**$**	**610,178**
Phase-1 for 30 years :	**$**	**612,385**
Phase-1 and Contingency for 30 years :	**$**	**618,271**

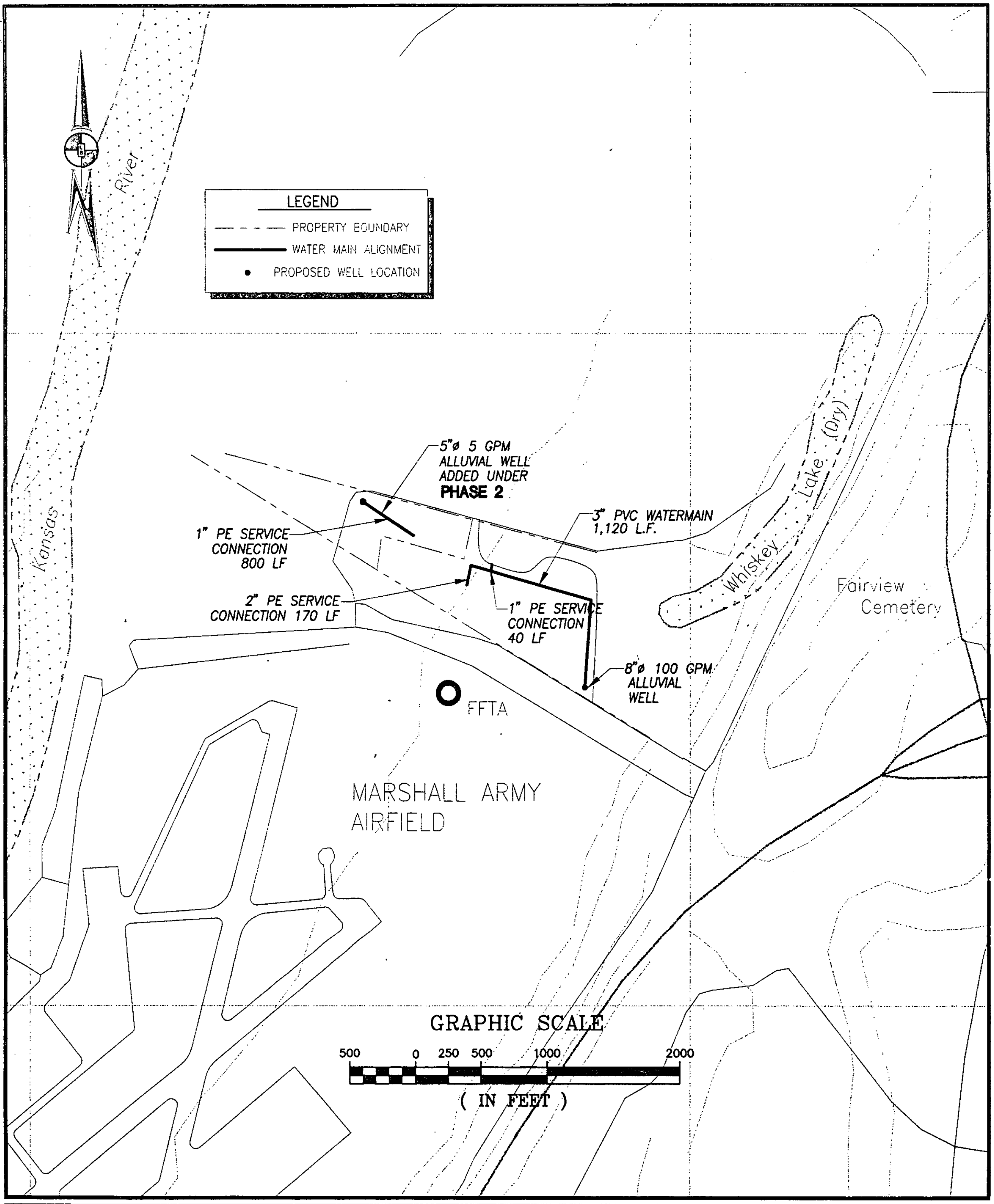

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Figure 4-5:
NEW M-1, NEW R-1/R-2 COMMON WELL CONCEPTUAL ALTERNATIVE

Scale: As Shown

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Table 4-5
Engineering Evaluation/Cost Analysis
FFTA-MAAF
Exposure Control Alternative 3
Replace R-1 and R-2 with Common Well; Contingency Replace Well M-1

			Phase 1 - Well R1&R2				Contingency Phase - Well M-1			
ITEM	DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT COST	CONSTRUCTION COST	O&M	ESTIMATED QUANTITY	UNIT COST	CONSTRUCTION COST	O&M
A	*GROUNDWATER WELL*									
1	Complete well installation - 8-inch	EA	1	$ 7,500	$ 7,500					
2	Complete well installation - 5inch	EA					1	$ 5,000	$ 5,000	
3	Residential service connections, 1-inch PE pipe, in place	EA	1	$ 650	$ 650		1	$ 650	$ 650	
4	Commercial service connections, 2-inch PE pipe, in place	EA	1	$ 1,000	$ 1,000					
5	Pipe, 1-inch, PE, in place	LF	40	$ 15	$ 600		800	$ 15	$ 12,000	
6	Pipe, 2-inch, PE, in place	LF	170	$ 16	$ 2,720					
7	Pipe, 3-inch, Schedule 80 PVC, in place	LF	1,600	$ 27	$ 43,232					
8	2-inch backflow preventor (R-2)	EA	1	$ 480	$ 480					
9	Pump Test	LS	1	$ 10,000	$ 10,000					
B	*SURFACE RESTORATION*									
1	Abandon existing well	EA	2	$ 1,000	$ 2,000		1	$ 1,000	$ 1,000	
C	*ELECTRICAL SERVICE*									
1	Electrical service connection	LF	45	$ 10	$ 450		800	$ 10	$ 8,000	
D				*SUBTOTAL*	$ 68,632				$ 26,650	
E	CONST. CONTINGENCY =	20%			$ 13,726				$ 5,330	
F				*CONSTRUCTION SUBTOTAL*	$ 82,358				$ 31,980	
G	ENGINEERING / CONSTRUCTION INSPECTION	10%			$ 6,863				$ 2,665	
H	ADMIN/LEGAL	5%			$ 3,432				$ 1,333	
I				*CONSTRUCTION TOTAL*	$ 92,653				$ 35,978	
J	ANNUAL OPERATIONS AND MAINTENANCE					$ 1,400				$ 600
K	PRESENT WORTH (O&M): P1 - 5 years; P2 - 3 years	7%				$ 5,740				$ 1,575
L	PRESENT WORTH (O&M): 25 years	7%				$ 17,373				$ 7,282
				PHASE 1 PROJECT	$ 98,393		*CONTINGENCY PROJECT*		$ 32,798	

Note: - O&M includes quarterly monitoring of VOCs
- No additional O&M for facilities has been added

SUMMARY

Phase-1 for 5 years:	**$**	**98,393**
Phase-1 and Contingency for 5 years :	**$**	**131,191**
Phase-1 for 30 years :	**$**	**98,393**
Phase-1 and Contingency for 30 years :	**$**	**147,809**

Table 4-6
Engineering Evaluation/Cost Analysis
FFTA-MAAF
Exposure Control Alternative 3a
Replace Well R-2; Bottled Water For R-1; Contingency Replace M-1 Well

			Phase 1 - Well R1&R2				Contingency Phase - Well M-1			
ITEM	DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT COST	CONSTRUCTION COST	O&M	ESTIMATED QUANTITY	UNIT COST	CONSTRUCTION COST	O&M
A	*GROUNDWATER WELL*									
1	Complete well installation - 8-inch	EA	1	$ 7,500	$ 7,500					
2	Complete well installation - 5inch	EA					1	$ 5,000	$ 5,000	
3	Residential service connections, 1-inch PE pipe, in place	EA					1	$ 650	$ 650	
4	Commercial service connections, 2-inch PE pipe, in place	EA	1	$ 1,000	$ 1,000					
5	Pipe, 1-inch, PE, in place	LF					800	$ 15	$ 12,000	
6	Pipe, 2-inch, PE, in place	LF	1,200	$ 16	$ 19,200					
7	Pump Test	LS	1	$ 10,000	$ 10,000					
B	*SURFACE RESTORATION*									
1	Abandon existing well	EA	2	$ 1,000	$ 2,000		1	$ 1,000	$ 1,000	
C	*ELECTRICAL SERVICE*									
1	Electrical service connection	LF	45	$ 10	$ 450		800	$ 10	$ 8,000	
D				*SUBTOTAL*	$ 40,150				$ 26,650	
E	CONST. CONTINGENCY =	20%			$ 8,030				$ 5,330	
F				*CONSTRUCTION SUBTOTAL*	$ 48,180				$ 31,980	
G	ENGINEERING / CONSTRUCTION INSPECTION	10%			$ 4,015				$ 2,665	
H	ADMIN/LEGAL	5%			$ 2,008				$ 1,333	
I				*CONSTRUCTION TOTAL*	$ 54,203				$ 35,978	
J	ANNUAL OPERATIONS AND MAINTENANCE					$ 3,900				$ 600
K	PRESENT WORTH (O&M): P1 - 5 years; P2 - 3 years	7%				$ 15,991				$ 1,575
L	PRESENT WORTH (O&M): 25 years	7%				$ 48,395				$ 7,282
				PHASE 1 PROJECT	$ 70,193			*CONTINGENCY PROJECT*	$ 32,798	

Note: - O&M includes quarterly monitoring of VOCs; provision of R-1 bottled water
- No additional O&M for new well operations has been added

SUMMARY

Phase-1 for 5 years:	**$**	**70,193**
Phase-1 and Contingency for 5 years :	**$**	**102,991**
Phase-1 for 30 years :	**$**	**70,193**
Phase-1 and Contingency for 30 years :	**$**	**140,381**

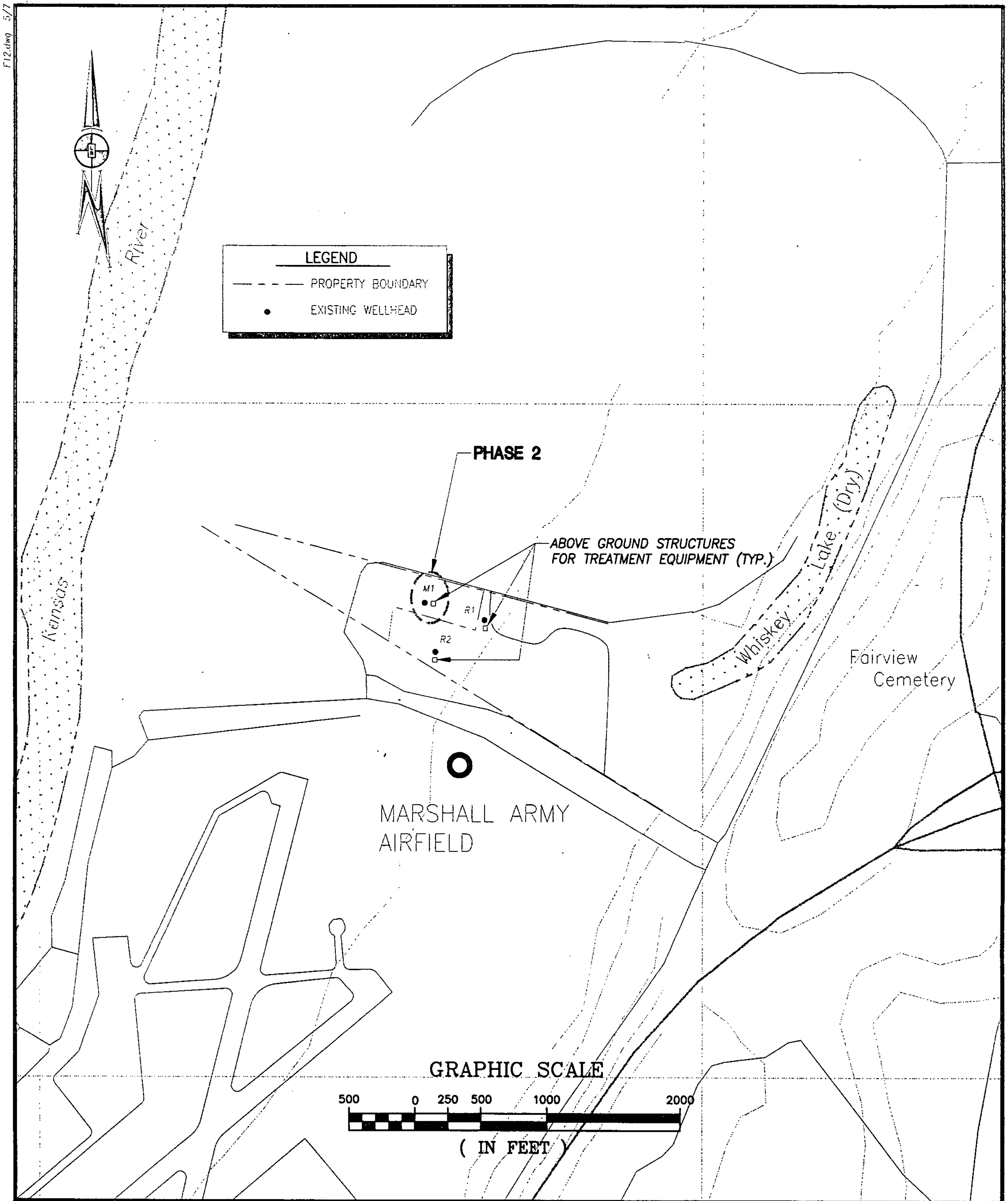

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Figure 4-6:
WELLHEAD TREATMENT CONCEPTUAL ALTERNATIVE

Scale: Not to Scale

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Table 4-7
Engineering Evaluation/Cost Analysis
FFTA-MAAF
Exposure Control Alternative 4
Wellhead Treatment by GAC Adsorption @ Existing Wells

ITEM	DESCRIPTION	UNIT	Phase 1 - Well R1&R2 QUANTITY	UNIT COST	CONSTRUCTION COST	O&M	Contingency Phase - Well M-1 QUANTITY	UNIT COST	CONSTRUCTION COST	O&M
A	*TREATMENT SYSTEM*									
1a	GAC treatment equipment (5 gpm residential)	EA	1	$ 3,500	$ 3,500		1	$ 3,500	$ 3,500	
1b	GAC treatment equipment (100 gpm)	EA	1	$ 4,000	$ 4,000					
2	Water Softener Pretreatment	EA	2	$ 1,200	$ 2,400		1	$ 1,200	$ 1,200	
3	Residential service connections, 1-inch PE pipe	EA	1	$ 650	$ 650		1	$ 650	$ 650	
4	Commercial service connections, 2-inch PE pipe	EA	1	$ 1,000	$ 1,000					
5	Above ground infrastructure (including electrical)	EA	2	$ 5,000	$ 10,000		1	$ 5,000	$ 5,000	
6	Batch/treatability Testing	LS	1	$ 2,500	$ 2,500					
B				*SUBTOTAL*	$ 24,050				$ 10,350	
C	CONST. CONTINGENCY	20%			$ 4,810				$ 2,070	
D			*CONSTRUCTION SUBTOTAL*		$ 28,860				$ 12,420	
E	ENGINEERING / CONSTRUCTION INSPECTION	10%			$ 2,405				$ 1,035	
F	ADMIN/LEGAL	5%			$ 1,203				$ 518	
G			*CONSTRUCTION TOTAL*		$ 32,468				$ 15,405	
H	ANNUAL OPERATIONS AND MAINTENANCE					$ 7,200				$ 3,600
I	PRESENT WORTH (O&M): P1 - 5 years; P2 - 3 years	7%				$ 29,521				$ 9,447
J	PRESENT WORTH (O&M): P1-30 years;P2-28years	7%				$ 91,141				$ 45,490
			PHASE 1 PROJECT		$ 61,989		*CONTINGENCY PROJECT*		$ 21,706	

Note:
- Residential service connection consists of 25 feet of piping and no water meter.
- O&M includes quarterly carbon replacement / disposal, monitoring; and pre&post unit replacement every 10 years
- Existing well/mechanical equipment to be retained
- Percent of Flow: M1-28.5%; R1-28.5%$; R2-43%

SUMMARY

Phase-1 for 5 years :	**$**	**61,989**
Phase-1 and Contingency for 5 years :	**$**	**83,695**
Phase-1 for 30 years :	**$**	**123,609**
Phase-1 and Contingency for 30 years :	**$**	**176,794**

5.0 EVALUATION OF EXPOSURE CONTROL ALTERNATIVES

This section presents a detailed evaluation of potential alternatives remaining after the initial screening performed in Section 4.0. This evaluation will develop the rationale for relative ranking of the exposure control action alternatives in Section 6.0.

5.1 Evaluation Criteria

In order to adequately address the CERCLA requirements at the site, nine evaluation criteria have been developed by the U.S. EPA. These criteria are defined in the NCP and are discussed in further detail in an EE/CA guidance document (EPA/540-R-93-057). These first seven criteria are:

1. Overall protection of human health and the environment;
2. Compliance with ARARs;
3. Long-term effectiveness;
4. Control of exposure to contaminants;
5. Short-term effectiveness;
6. Implementability; and
7. Cost.

There are two additional criteria that are considered in final selection in the Action Memorandum:

8. State acceptance; and
9. Community acceptance.

A more detailed discussion of the nine evaluation criteria is presented below. Each exposure control alternative is then evaluated in Table 5-1.

5.1.1 Overall Protection of Human Health and the Environment

This evaluation criterion provides an overall assessment of protection based on an evaluation of the other criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. Evaluation of overall protection addresses the following:

- How well a specific site exposure control action achieves protection over time; and
- How well site risks are reduced.

5.1.2 Compliance with ARARs

This evaluation criterion is used to determine how each remedial alternative complies with federal and state ARARs as defined in Section 3.0. Each alternative is evaluated in detail for the following:

- Compliance with chemical-specific ARARs;
- Compliance with action-specific ARARs;
- Compliance with location-specific ARARs; and
- Incorporation of appropriate criteria, advisories, and guidance, i.e. "To Be Considered" information or "TBCs."

Section 3.0 presents an overall list of ARARs and TBC data that were used, as appropriate, to evaluate the exposure control alternatives.

5.1.3 Long-Term Effectiveness

This evaluation criterion addresses the results of the exposure control action in terms of the risk remaining at the site after the exposure control objectives have been met. The components of this criterion include compliance with drinking water MCLs; the adequacy and suitability of controls used to manage treatment residuals or untreated wastes; and the long-term reliability of management controls for providing continued protection from contamination (i.e. the assessment of potential failure of the technical components).

5.1.4 Control of Exposure To Contaminants

This evaluation criterion addresses the degree of exposure control provided by each alternative. Factors to be evaluated include the treatment process or alternate water supply source employed; the degree of contaminant reduction expected in treatment processes; and the type and quantity of treatment residuals.

5.1.5 Short-Term Effectiveness

This evaluation criterion addresses the impacts of the exposure control action during the construction and implementation phases preceding the attainment of the exposure control objectives. Factors to be evaluated include protection of workers during construction, environmental impacts resulting from the implementation of the exposure control actions, and the time necessary to achieve protection.

5.1.6 Implementability

This criterion addresses the technical and administrative feasibility of implementing an exposure control action, and the availability of various services and materials required during its implementation. *Technical feasibility* factors include construction and operation issues, reliability of the technology, ease of undertaking Contingency Phase exposure control actions, and the ability to monitor the effectiveness of the option. *Administrative feasibility* includes the ability and time required for substantive permit compliance and coordination with regulatory agencies. Factors employed in evaluating the *availability of services and materials* include availability of treatment, storage and disposal services with required capacities; availability of equipment and specialists; and availability of prospective technologies for competitive bidding.

5.1.7 Cost

The types of costs that would be addressed for Phase 1 and 2 measures include: capital costs, operation and maintenance (O&M) costs, present worth of short term capital and O&M costs, and potential long term costs. Capital costs consist of direct and indirect costs. Direct costs include expenditures for the equipment, labor and materials necessary to install exposure control actions. Indirect costs include expenditures for engineering, financial, and other services required to complete the implementation of options. Annual O&M costs include auxiliary materials and energy, disposal of residues, purchased services, and rehabilitation costs.

This assessment includes an evaluation of the costs of the exposure control actions on the basis of present worth. Present worth analysis allows alternatives to be compared on the basis of a single cost representing an amount that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the alternative over its planned life. A required operating performance period is assumed for present worth and is a function of the discount rate and time. In accordance with current financial markets, a discount rate of seven percent is assumed for present worth calculations. The "study estimate" costs provided herein for the remedial actions are intended to reflect estimated actual costs with an accuracy of -30 to +50 percent.

5.1.8 State Acceptance

This assessment is to be performed as part of the Action Memorandum development and public comment process and evaluates the technical and administrative issues and concerns that administrative agencies from the State of Kansas may have regarding the recommended exposure control alternative. The factors to be evaluated include features of the action that the state supports, has reservations about, or opposes.

5.1.9 Community Acceptance

This assessment is also to be performed as part of the Action Memorandum development and public comment process and incorporates public input into the analysis of the recommended exposure control alternative. Factors of community acceptance to be discussed include features of the support, reservations and opposition of the community. Fort Riley has an existing community relations plan and conformance with this plan will be a component of the assessment of this criterion.

5.2 Analysis of Alternatives

The following alternatives passed the screening process in Chapter 4.0 and are evaluated in detail:

Alternative 1 - Extension of Fort Riley Water Supply System
Alternative 2 - Extension of Morris County Water Supply System
Alternative 3 - Installation of New Replacement Wells: Common Alluvial Well for R-1 and R-2; Separate Alluvial Well for M-1 If Needed
Alternative 4 - Provision of Wellhead Treatment: GAC Process

The results of the detailed comparative analysis are presented in Table 5-1 for the first seven criteria. These results are utilized in Section 6.0 to develop a comparative ranking of alternatives, and in the Section 7.0 recommendation on which exposure control alternative is likely to provide the best overall performance. Evaluation and comparison of results for the final two criteria is to be completed as part of the Action Memorandum development and the final selection process.

Table 5-1
Comparative Summary of Evaluation Criteria

EVALUATION CRITERIA	EVALUATION COMMENTS			
	Alternative 1 Extension of Fort Riley Water Supply System	**Alternative 2** Extension of Morris County Water Supply System	**Alternative 3** Installation of New Wells	**Alternative 4** GAC Wellhead Treatment
Overall Protection of Human Health and the Environment	This alternative would be protective of human health by provision of an alternate source of drinking water (an off-site system). The residential and commercial land use could continue with unrestricted use of the water supply for domestic purposes and consumption. This exposure control alternative is fully protective of the environment.	This alternative would be protective of human health by provision of an alternate source of drinking water from an off-site system. The residential and commercial land use could continue with unrestricted use of the water supply for domestic purposes and consumption. This exposure control alternative is fully protective of the environment.	This alternative would be protective of human health by provision of wells in an aquifer or location not currently contaminated, or likely to be contaminated in the future. Trends in the analytical data indicate that the groundwater contaminant plume is migrating from the MAAF FFTA to the northeast. Hence, future exposure control is somewhat uncertain. This exposure control alternative is fully protective of the environment.	This alternative would be protective of human health by provision of a GAC treatment process at each existing wellhead, to remove contaminants from the water supply prior to use. Some uncertainty exists should proper O&M discontinue for a period, potentially exposing users to contamination or causing service disruptions. Trends in the analytical data indicate that the groundwater contaminant plume is migrating from the MAAF FFTA to the northeast. Hence, future exposure control may involve treating increased concentrations of contaminants. This exposure control alternative is fully protective of the environment and has the added benefit that some reduction of contaminants already in the environment will be achieved through treatment.
ᴗmpliance With ARARs	This alternative provides a source of water that is monitored by the purveyor to verify and maintain compliance with drinking water MCLs.	This alternative provides a source of water that is monitored by the purveyor to verify and maintain compliance with drinking water MCLs.	Continued monitoring is required to ensure that the pumped groundwater does not become contaminated above MCL levels.	Continued monitoring is required to ensure that the GAC treatment process is removing contaminants to below MCL levels from the water supply prior to use.
Long-term Effectiveness	This alternative provides for full exposure control in the future for contaminants associated with the MAAF FFTA. Any unrelated future water quality problems affecting this alternate water source would also affect the site users. Once installed, this alternative can be continued, or discontinued on any date in the future; providing excellent flexibility.	This alternative provides for full exposure control in the future for contaminants associated with the MAAF FFTA. Any unrelated future water quality problems affecting this alternate water source would also affect the site users. Once installed, this alternative can be continued, or discontinued on any date in the future; providing excellent flexibility.	This alternative provides exposure control assuming that groundwater contamination does not migrate into the zone of influence of the new wells. Such migration of groundwater contamination is considered unlikely but in the long-term is uncertain, and may impact the water supply provided under this alternative.	This alternative provides exposure control assuming that treatment processes are maintained. There is a minimal risk of failure of the treatment process since redundant GAC units can be used.
Control of Exposure To Contaminants	Human exposure to contaminants in the site subsoils is unlikely to occur unless excavation activities were performed. During construction of this alternative, measures are required to protect workers, and to properly dispose of contaminated soils and groundwater that are encountered. Land use controls would be needed to limit this exposure in the future.	Human exposure to contaminants in the site subsoils is unlikely to occur unless excavation activities were performed. During construction of this alternative, measures are required to protect workers, and to properly dispose of contaminated soils and groundwater that are encountered. Land use controls would be needed to limit this exposure in the future.	Human exposure to contaminants in the site subsoils is unlikely to occur unless excavation activities were performed. During construction of this alternative, measures are required to protect workers, and to properly dispose of contaminated soils and groundwater that are encountered. Land use controls would be needed to limit this exposure in the future.	Human exposure to contaminants in the site subsoils is unlikely to occur unless excavation activities were performed. Land use controls would be needed to limit this exposure in the future. Residual wastes from the process include saturated carbon media, which must be properly handled and disposed of to control exposure to O&M personnel.
Short-term Effectiveness	This alternative can be implemented with a 100 percent short-term effectiveness within a one-year period. Proper measures are required to protect workers during construction.	This alternative can be implemented with a 100 percent short-term effectiveness within a one-year period. Proper measures are required to protect workers during construction.	This alternative can be implemented with a 100 percent short-term effectiveness within a one-year period. Proper measures are required to protect workers during construction.	This alternative can be implemented with a 100 percent short-term effectiveness within a one-year period, assuming a proper O&M program is adhered to. Proper measures are required to protect workers during construction.

Table 5-1 (Continued)
Comparative Summary of Evaluation Criteria

EVALUATION CRITERIA	EVALUATION COMMENTS			
	Alternative 1 **Extension of Fort Riley Water Supply System**	**Alternative 2** **Extension of Morris County Water Supply System**	**Alternative 3** **Installation of New Wells**	**Alternative 4** **GAC Wellhead Treatment**
Implementability	This alternative is readily constructed, with moderate permitting requirements. The technology is well-documented, and all materials and services are available in the region. A relatively modest O&M cost is associated with the long-term use of this alternative. A continued administrative burden for Fort Riley is also associated with this alternative.	This alternative is readily constructed, with moderate permitting requirements. The technology is well-documented, and all materials and services are available in the region. From a construction standpoint, this option is less implementable than Alternative 1, due to a longer distance to connect to the existing system. However, from an administrative and O&M standpoint, this alternative is more implementable than Alternative 1 since Fort Riley's direct involvement is not required. A relatively modest O&M cost is associated with the long-term use of this option.	This alternative is readily constructed, with substantial permitting requirements. The technology is well-documented, and all materials and services are available in the region. No facility O&M costs are associated with this option, since the well users are currently operating similar units and no new costs would be incurred. Periodic monitoring of the groundwater quality by Fort Riley would be required. It is also possible that the users could make future claims against Fort Riley should the well system ever malfunction. Even unfounded claims will likely require investigation.	This alternative is readily constructed, with moderate permitting requirements. The technology is well-documented, and all materials and services are available in the region. O&M costs over the long-term will become significant, due to the need for changing and disposal of spent carbon media. Sporadic complaints from users could occur regarding water quality and necessitate repeated investigations, even if unfounded.
Cost	Phase 1 (5 yrs): $305,300 Phase 1+Contingency (5 yrs): $308,000 Phase 1 (30 yrs): $311,200 Phase 1+Contingency (30 yrs): $316,200	Phase 1 (5 yrs): $606,600 Phase 1+Contingency (5 yrs): $610,200 Phase 1 (30 yrs): $612,400 Phase 1+Contingency (30 yrs): $618,300	Phase 1 (5 yrs): $ 98,400 Phase 1+Contingency (5 yrs): $131,200 Phase 1 (30 yrs): $ 98,400 Phase 1+Contingency (30 yrs): $148,000	Phase 1 (5 yrs): $ 62,000 Phase 1+Contingency (5 yrs): $ 84,000 Phase 1 (30 yrs): $124,000 Phase 1+Contingency (30 yrs): $177,000

6.0 COMPARATIVE RANKING OF EXPOSURE CONTROL ALTERNATIVES

In this Section, the results of the detailed evaluation in Section 5.0 are used to compare each alternative against the others based upon ranking factors assigned according to an alternative's relative fulfillment of the first seven EPA criteria. The initial part of this Section is a description of the ranking system used in the comparative analysis. The remainder of the Section is the comparative analysis, organized according to the evaluation criteria.

6.1 Ranking System for Comparative Analysis

The alternatives are ranked against the evaluation criteria on the basis of incremental differences between alternatives. Sections 6.4 through 6.8 summarize the alternative rankings for each of the criteria.

A competitive and quantitative comparison has been performed in order to rank the full list of alternatives which were subjected to the detailed analysis. In this case, four alternatives were carried through the detailed analysis, and each alternative is given a ranking based on how each alternative is rated compared to the other three alternatives. Equal rankings were assigned if it was not possible to significantly differentiate performance for a given criteria. The most favorable alternative(s) are assigned a "1," and so on, with a "10" being the least favorable ranking. This ranking method will be employed for each of the seven criteria.

Unless stated otherwise, performance and ranking under each criterion is based on addressing control of exposure to groundwater contamination.

6.2 Overall Protection of Human Health and the Environment

Alternative 1 - Extension of Fort Riley Water Supply System, is protective of human health and the environment because an alternate source of water supply with unrestricted use would be provided, and the alternative is fully protective of the environment.

Alternative 2 - Extension of Morris County Water Supply System, is equally protective compared to Alternative 1.

Alternative 3 - Installation of New Replacement Wells, is protective compared to Alternatives 1 and 2 in the short-term; however, the potential exists for migration of the contamination to the new wells at some date in the future. This alternative is nonetheless considered to be fully protective of public health from a practical point of view since the well water quality will need to be monitored for as long as a contaminant plume remains, providing for early warning of plume migration.

Alternative 4 - GAC Wellhead Treatment, is protective compared to Alternatives 1 and 2, assuming that the treatment units are properly operated and maintained. This alternative is fully protective of the environment although there is a small potential for the treatment system to malfunction and cause temporarily elevated contamination levels in the water supply.

The rankings for overall protection of human health and the environment are therefore assigned as follows:

Alternative 1:	1
Alternative 2:	1
Alternative 3:	2
Alternative 4:	3

6.3 Compliance with ARARs

The controlling ARAR compliance issue associated with the EE/CA is satisfying Drinking Water MCLs. Also discussed are secondary issues regarding permit requirements for the installation and use of the alternative technologies.

Alternative 1 would fully comply with ARARs for drinking water, as appropriate for an extension to the Fort Riley Water System. Permitting requirements for the implementation of this alternative would be moderate.

Alternative 2 would have an equivalent ARAR compliance and permitting level as Alternative 1, with the drinking water compliance appropriate to the Morris County Water System.

Alternative 3 would comply with drinking water MCLs according to calculations of the potential contamination plume migration. Uncertainty exists for the future compliance with these MCLs, based on an unlikely potential for aberrant migration of the plume into the zone of influence of the new wells. Permitting requirements for the implementation of this alternative are more than for Alternatives 1 and 2.

Alternative 4 would be in compliance with drinking water MCLs, assuming that the systems are properly operated and maintained. This factor would be controlled by the use of a vendor to operate and maintain the system on a scheduled basis, as well as the initial batch testing that would be performed to ensure that the system configuration is compatible with the existing and potential future contaminants in the groundwater. Permitting requirements for this alternative are greater than for Alternatives 1 and 2, and less than Alternative 3.

The rankings for compliance with ARARs are therefore assigned as follows:

Alternative 1:	1

Alternative 2:	1
Alternative 3:	4
Alternative 4:	3

6.4 Long-Term Effectiveness and Permanence

The basis for evaluating this criteria is the degree of exposure control provided by each alternative and the continued exposure control over the long-term.

Alternatives 1 and 2 provide the greatest level of long-term effectiveness and permanence of exposure control. The use of these alternatives could continue indefinitely in the future, or be discontinued if appropriate in the short-term, thus providing flexibility in implementation.

Alternative 3 provides exposure control in the long-term, though less than Alternatives 1 and 2 due to the potential for future contamination occurring in the new wells.

Alternative 4 also provides exposure control in the long-term, although less than Alternatives 1 and 2 due to the on-going reliance on proper O&M by a vendor.

Based on available data and current projections, all four alternatives should provide permanent and effective exposure control in the long-term, although Alternative 3 lacks the inherent ability to adjust exposure control in the long-term in the event that currently unforeseen changes in environmental conditions occur.

The rankings for long-term effectiveness and permanence are therefore assigned as follows:

Alternative 1:	1
Alternative 2:	1
Alternative 3:	4
Alternative 4:	4

6.5 Control of Exposure To Contaminants

This criterion provides consideration of human exposure to contaminants both during and after implementation of the alternative actions.

Alternatives 1, 2 and 3 provide a high level of protection, with any potential for exposure controllable by future land use controls governing excavation in contaminated soils and groundwater monitoring programs in the case of Alternative 3.

Alternative 4 could include similar future land use controls regarding excavation, but would require proper handling of spent (contaminated) carbon media by the vendor. In addition, there is some potential for temporary exposures to contaminated water should the system ever experience malfunctions in between O&M personnel visits.

The rankings for control of exposure to contaminants are therefore assigned as follows:

Alternative 1:	1
Alternative 2:	1
Alternative 3:	1
Alternative 4:	4

6.6 Short-Term Effectiveness

All of the alternatives provide exposure control in the short-term (within one year), although Alternatives 1 and 2 will have slightly longer construction periods. Protection of workers will be a consideration during implementation of Alternatives 1, 2 and 3, with slightly greater focus on Alternative 4 which involves treatment of contaminated groundwater.

The rankings for short-term effectiveness are therefore assigned as follows:

Alternative 1:	2
Alternative 2:	2
Alternative 3:	1
Alternative 4:	2

6.7 Implementability

There are no technical implementability concerns associated with any of the alternatives since well-documented technologies are involved, with materials and services available in the region.

Alternative 1 has modest O&M costs, however, it would entail an additional ongoing administrative responsibility for Fort Riley. Alternative 2 has similar O&M costs to Alternative 1, without any Fort Riley involvement. Alternative 2 requires construction over a relatively long distance to connect to the Morris County system. Alternative 3 has the slight O&M costs and administrative responsibility associated only with periodic monitoring, while Alternative 4 has administrative responsibility and the highest O&M costs due to system monitoring and periodic removal and replacement of the carbon media.

The rankings for implementability are therefore as follows:

Alternative 1:	6
Alternative 2:	6
Alternative 3:	1
Alternative 4:	8

6.8 Cost

Tables 4-3, 4-4, 4-5 and 4-7 have been prepared to provide order of magnitude cost estimates for each alternative, and are used for comparing alternatives only since they are based in part on engineering judgement and reasonable assumptions. Based on the estimates developed, the rankings for Phase 1 construction and five year present worth O&M costs are as follows:

Alternative 1:	8
Alternative 2:	10
Alternative 3:	2
Alternative 4:	1

It is noted that, if bottled water is used for R-1 under Alternative 3, it would rank the same as Alternative 4 on a cost basis.

ALTERNATIVE NUMBER AND NAME CROSS REFERENCE TABLE

ALTERNATIVE NUMBER	ALTERNATIVE NAME
Alternative 1	Extension of Ft. Riley Water System
Alternative 2	Extension of Morris County Water System
Alternative 3	Installation of New Replacement Wells
Alternative 4	Provision of Wellhead Treatment: GAC Process

7.0 RECOMMENDED EXPOSURE CONTROL ALTERNATIVE

This section summarizes the comparative analysis of alternatives completed in Section 6.0, resulting in a preferred exposure control alternative which is recommended for implementation.

The four alternatives retained for detailed evaluation were evaluated, compared and sequentially ranked for each of the seven criteria. A summation of the rankings for each alternative over the five criteria is shown in Table 7-1, with the best overall ranking being represented by the lowest number.

Although no statistical inferences can be made from the overall comparison based on the criteria-specific rankings for each alternative, a summation of the rankings is nonetheless useful. For these four alternatives, the ranking score illustrates the following:

- Alternative 3 (New Replacement Wells) ranks higher than the other alternatives;
- The strengths/weaknesses and costs/benefits associated with Alternatives 1 and 2 balance out in various ways so that there is no identifiable second best alternative; and
- Alternative 4 is the least desirable alternative.

Based on the ranking score results, Alternative 3, consisting of provision of new replacement wells with the potential option of using bottled water at R-1, is the preferred exposure control alternative and is recommended for implementation.

Table 7-1
Summary of Alternative Screening

Criteria	**Alternative 1** Extend Ft. Riley System	**Alternative 2** Extend Morris System	**Alternative 3** New Wells	**Alternative 4** Wellhead GAC
Overall Protection	1	1	2	3
Compliance With ARARs	1	1	4	3
Long Term Effectiveness	1	1	4	4
Exposure Control	1	1	1	4
Short Term Effectiveness	2	2	1	2
Implementability	6	6	1	8
Cost	8	10	2	1
Total Ranking Score	20	22	15	25

8.0 REFERENCES

1-1. Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA, EPA's Office of Solid Waste and Emergency Response, EPA540-R-93-057, August 1993.

2-1. *Site Investigation for Former Fire Training Area - Marshall Army Airfield, Fort Riley, Kansas,* Prepared by Louis Berger & Associates, Inc., for U.S. Army Corps of Engineers, Missouri River Division, Kansas City District, August 1995.

2-2. Fort Riley Marshall Army Airfield water wells - Data on pump tests performed in March 1983 for the U.S. Army Corps of Engineers, Kansas City District, Kansas City, Missouri.

2-3. Installation of test well & aquifer tests, Fort Riley, Kansas - Data on pump tests performed by Schwab-Eaton, Inc. in 1974 and 1975 for the U.S. Army Corps of Engineers, Kansas City District, Kansas City, Missouri.

2-4. Pump tests and expansion of the well field along McCormick Avenue, Fort Riley, Kansas - Data on pump tests performed by The Benham Group, Inc. in June and December 1989 for the U.S. Army Corps of Engineers - Kansas City District, Kansas City, Missouri.

2-5. Highlight from AEHA report memo entitled "Results of Synthetic Organic Chemical Survey for 1st Infantry Division (Mechanized) and Fort Riley", U.S. Army Environmental Hygiene Agency, 20 March 1992.

2-6. Communication with the Junction City Plant Manager at the Water Treatment Plant regarding water supply wells.

2-7. Communication with a City of Ogden representative regarding water supply wells and their locations.

2-8. Jewett, John H., *Bulletin 39 - The Geology of Riley and Geary Counties, KS,* University of Kansas Publications, December 1941.

2-9. Communication with KDHE regarding the wells located at the speedway.

2-10. KDHE Inspection on 4 April 1993 of water well located on the speedway property, R-2, Junction City, KS, 66441, north of MAAF.

2-11. U.S. Army Environmental Hygiene Agency, *Industrial Hygiene Comprehensive Survey Report*, 9 May 1979.

2-12. U.S. Army Toxic and Hazardous Material Agency Report, *Installation Assessment of the Headquarters, 1st Infantry Division (Mechanized) and Fort Riley, Kansas,* December 1984.

2-13. Memorandum for Record, Subject: Perchloroethylene Spill, from Chief, Environmental Office, Fort Riley, KS, 9 September 1982.

2-14. *Installation Wide Site Assessment for Fort Riley, Kansas*, Prepared by Louis Berger & Associates, Inc., for U.S. Army Corps of Engineers, Missouri River Division, Kansas City District, 7 December 1993.

2-15. *Sampling and Analysis Plan for Site Investigations of High Priority Sites at Fort Riley, Kansas*, Prepared by Louis Berger & Associates, Inc., for U.S. Army Corps of Engineers, Missouri River Division, Kansas City District, 20 August 1993.

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2-17. *Work Plan Pilot Test Study Soil Vapor Extraction and Bioventing Systems, Former Fire Training Area, Marshall Army Airfield, Fort Riley, Kansas*, Prepared by Louis Berger & Associates, Inc., for U.S. Army Corps of Engineers, Missouri River Division, Kansas City District, August 1994.

2-18. *QCSR for Site Investigations of High Priority Sites at Fort Riley*, Prepared by Louis Berger & Associates, Inc., for U.S. Army Corps of Engineers, Missouri River Division, Kansas City District, 17 December 1993.

2-19. *QCSR for Site Investigation of the High Priority Sites at Fort Riley*, Prepared by Louis Berger & Associates, Inc., for U.S. Army Corps of Engineers, Missouri River Division, Kansas City District, 22 July 1994.

2-20. *QCSR for Pilot Test Study SVE and Bioventing Systems*, Prepared by Louis Berger & Associates, Inc., for U.S. Army Corps of Engineers, Missouri River Division, Kansas City District, 9 September 1994.

2-21. *QCSR for Off-Post Soil and Groundwater Screening Samples at FFTA-MAAF*, Prepared by Louis Berger & Associates, Inc., for U.S. Army Corps of Engineers, Missouri River Division, Kansas City District, 11 November 1994.

2-22. *QCSR for Periodic Groundwater Monitoring at FFTA-MAAF*, Prepared by Louis Berger & Associates, Inc., for U.S. Army Corps of Engineers, Missouri River Division, Kansas City District, 11 November 1994.

2-23. *QCSR for Periodic Groundwater Monitoring at FFTA-MAAF*, Prepared by Louis Berger & Associates, Inc., for U.S. Army Corps of Engineers, Missouri River Division, Kansas City District, 8 December 1994.

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2-29. *Data Summary Reports*, Prepared by Louis Berger & Associates, Inc., for U.S. Army Corps of Engineers, Missouri River Division, Kansas City District, 7 December 1994.

4-1. *Recommended Standards for Water Works*, Great Lakes Upper Mississippi River Board of State Public Health & Environmental Managers, 1987.

4-2. Personal communication; KDHE, Bureau of Water, 9/27/96.

4-3. *Policies, General Considerations and Design Requirements for Public Water Supply Systems in Kansas,* KDHE Public Water Supply Section, 1995.

4-4. *Recommended Standards for Water Works*, Great Lakes Upper Mississippi River Board of State Public Health & Environmental Managers, 1987.

4-5. Bucher, Willis & Ratliff Corporation; *Study of Water Distribution and Storage System, Fort Riley, Kansas*; January 1996.

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4-7. Personal communication; Morris County Rural Water District No.1, Manager of Operations, 9/19/96.

4-8. Personal communication; City of Ogden, City Clerk, 8/13/96.

4-9. Personal communication; City of Junction City, City Engineer, 9/16/96.

4-10. Personal communication; Schwab-Eaton, P.A., acting City Engineer, 8/21/96.

4-11. Personal communication; Kansas Division of Water Resources; Groundwater Operations Engineer, 9/27/96.

APPENDIX A

GROUNDWATER MONITORING RESULTS
OCTOBER 1993 - AUGUST 1996

Table 10-1 (continued): EXPANDED SI GROUNDWATER DATA -- FFTA-MAAF

August 1996

(Positive detections only)

Sample Location	FP-94-08	FP-94-09	FP-94-10	FP-94-11		FP-96-18	FP-96-19	FP-96-20	FP-96-21	FP-96-21B	FP-96-21C	FP-96-22	FP-96-23	FP-96-24	MCL and KSWQS
Sample Identification	FP-94-08	FP-94-09	FP-94-10	FP-94-11	FP-94-102	FP-96-18	FP-96-19	FP-96-20	FP-96-21	FP-96-21b	FP-96-21c	FP-96-22	FP-96-23	FP-96-24	
Sample Date	8/20/96	8/21/96	8/21/96	8/20/96	8/20/96	8/20/96	8/19/96	8/21/96	8/20/96	8/20/96	8/20/96	8/21/96	8/21/96	8/21/96	
Volatiles (units in ug/L)															
Trichloromethane (THM)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	100 (a)
Trichloroethylene	ND(<0.6)	10	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	5
Ortho-Xylene	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	10,000
Ethylbenzene	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	700
Toluene	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	1,000
Tetrachloroethylene	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	5
1,2-Dichloroethylene (Total)	ND(<0.5)	150	ND(<0.5)	22	22	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	7.4	ND(<0.5)	70 (b)
Meta &/or Para-Xylene	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	10,000
Semivolatiles (units in ug/L)															
Naphthalene	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	NAv
Priority Pollutant Metals (units in mg/L)															
Arsenic, Total	ND(<0.005)	0.006	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	0.043	0.02	ND(<0.005)	0.022	0.017	0.006	ND(<0.005)	ND(<0.005)	0.05
Chromium, Total	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	0.1 (c)
Lead, Total	ND(<0.003)	ND(<0.003)	ND(<0.003)	0.003	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	0.015 (e)
Selenium, Total	ND(<0.005)	ND(<0.005)	0.006	0.021	0.022	0.016	ND(<0.005)	ND(<0.005)	0.006	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	0.022	0.05
Zinc, Total	ND(<0.010)	0.015	0.018	0.014	0.013	0.025	ND(<0.010)	0.012	0.015	ND(<0.010)	ND(<0.010)	ND(<0.010)	ND(<0.010)	ND(<0.010)	5(c)
Total Petroleum Hydrocarbons (units in ug/L)															
TPH-GRO	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	NAv
TPH-DRO	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	NAv
Natural Attenuation															
Methane (units in ug/L)	4.6	64	ND(<2.0)	ND(<2.0)	ND(<2.0)	5.3	240	4.1	ND(<2.0)	ND(<2.0)	ND(<2.0)	8.1	7.9	ND(<2.0)	NAv
Calcium, Total (units in mg/L)	NA	170	NA	NA	NA	NA	NA	NA	176	NA	128	NA	NA	NA	NAv
Iron, Total (units in mg/L)	3.8	10.8	1.8	0.2	0.3	4.8	44.3	1.5	1.6	6.8	0.8	9.3	6.1	0.3	0.3 (d)
Magnesium, Total (units in mg/L)	NA	30	NA	NA	NA	NA	NA	NA	30	NA	26	NA	NA	NA	NAv
Manganese, Total (units in mg/L)	NA	1.76	NA	NA	NA	NA	NA	NA	1.09	NA	0.86	NA	NA	NA	0.05 (d)
Potassium, Total (units in mg/L)	NA	10	NA	NA	NA	NA	NA	NA	24	NA	4	NA	NA	NA	NAv
Sodium, Total (units in mg/L)	NA	62	NA	NA	NA	NA	NA	NA	16	NA	34	NA	NA	NA	NAv
Alkalinity, as CaCO3 (units in mg/L)	497	580	480	372	372	372	1410	550	485	414	430	540	430	440	NAv
Nitrate as N (units in mg/L)	ND(<1)	ND(<1)	2.19	2.57	2.74	1.24	ND(<1)	ND(<1)	1.8	ND(<1)	ND(<1)	ND(<1)	ND(<1)	10.7	10
Sulfate (units in mg/L)	140 J	117 J	95 J	86.5	80.5	160	856	116 J	16.6	51.6 J	14.7 J	95.5 J	240 J	104	250 (g)
Chloride (units in mg/L)	11 J	52 J	4.46 J	3.94 J	5.5 J	11.1 J	10.2 J	8.99 J	7.4 J	18.2 J	28.1 J	5.33 J	5.88 J	5.55	250 (g)
TOC (units in mg/L)	NA	20	NA	NA	NA	NA	NA	NA	9.6	NA	12	NA	NA	NA	NAv
DO (units in ppm)	0.5	2.2	2.7	0.3	NA	0.5	0.0	0.8	3.3	0.0	0.0	0.0	0.1	3	NAv
Oxidation/Reduction Potential (units in mV)	-91	-37	140	263	NA	-71	-188	-134	-13	-123	-62	-95	-107	184	NAv
Iron (II), Ferrous (units in mg/L)	3	8.8	0.1	0.1	NA	4.8	19	0.7	0.6	6	0.8	8.9	6.9	0.13	NAv
Iron (III), Ferric (by difference - units in mg/L)	0.8	2	1.7	0.1	NC	0.0	25.3	0.8	1.0	0.8	0.0	0.4	-0.8	0.17	NAv

Shaded values represent concentrations that are equal to or exceed the MCL or Treatment Threshold

NAv: Standard Not Available

NA: Not Analyzed

ug/L: micrograms per liter

mg/L: milligrams per liter

mV: millivolts

NC: Not Calculated

MCL: Federal Maximum Contaminant Level. From: Drinking Water Regulations and Health Advisories, Office of Water, United States Environmental Protection Agency, May 1995.

KSWQS: Kansas Surface Water Quality Standards. From: Kansas Department of Health and Environment, July 1994. For all compounds listed, the KSWQS is the same value as the MCL.

J Estimated value

UJ Compound not detected above Practical Quantitation Limit (PQL), which may be imprecise or inaccurate.

TPH: Total Petroleum Hydrocarbons

GRO: Gasoline Range Organics

DRO: Diesel Range Organics

(a) The value presented represents the MCL for total trihalomethanes.

(b) The value presented represents the MCL for cis-1,2-dichloroethylene; the MCL for trans-1,2-dichloroethylene is 100 ug/L.

(c) The MCL represents both hexavalent and trivalent chromium.

(d) Secondary Drinking Water Standard

(e) MCLs have not been established for copper and lead. Instead, the Safe Drinking Water Act has established Treatment Thresholds (TT), above which treatment is required.

(f) Calculated from diesel standard.

(g) Secondary Drinking Water Standard.

FP-94-102: Blind field duplicate of FP-94-11

For a complete list of analytes, see 14 October 1996 Quality Control Summary Report (QCSR)

Table 10-1: EXPANDED SI GROUNDWATER DATA -- FFTA-MAAF

August 1996

(Positive detections only)

Sample Location	FP-93-01	FP-93-02		FP-93-02b	FP-96-02c	FP-93-03	FP-93-04		FP-96-04b	FP-96-04c	FP-93-05	FP-93-06	FP-93-07	FP-96-07c	FP-94-12PZ	BLDG801	MCL and KSWQS
Sample Identification	FP-93-01	FP-93-02	FP-93-101	FP-96-02b	FP-96-02c	FP-93-03	FP-93-04	FP-93-100	FP-96-04b	FP-96-04c	FP-93-05	FP-93-06	FP-93-07	FP-96-07c	FP-94-12PZ	BLDG801	
Sample Date	8/18/96	8/18/96	8/18/96	8/18/96	8/18/96	8/18/96	8/15/96	8/15/96	8/17/96	8/17/96	8/13/96	8/13/96	8/14/96	8/14/96	8/17/96	8/13/96	
Volatiles (units in ug/L)																	
Trichloromethane (THM)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	100 (a)
Trichloroethylene	ND(<0.6)	**28**	**27**	**3.3**	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	5
Ortho-Xylene	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	**95**	**95**	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	10,000
Ethylbenzene	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	**83**	**90**	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	700
Toluene	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	**5.6**	**5.6**	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	ND(<0.4)	1,000
Tetrachloroethylene	ND(<1.1)	**27**	**28**	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	ND(<1.1)	5
1,2-Dichloroethylene (Total)	ND(<0.5)	**6.4**	**6**	ND(<0.5)	ND(<0.5)	ND(<0.5)	**5.1**	**5.4**	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	70 (b)
Meta &/or Para-Xylene	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	**170**	**180**	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	10,000
Semivolatiles (units in ug/L)																	
Naphthalene	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	**32**	**39**	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	NAv
Priority Pollutant Metals (units in mg/L)																	
Arsenic, Total	ND(<0.005)	ND(<0.005)	ND(<0.005)	**0.018**	**0.011**	ND(<0.005)	**0.016**	**0.016**	**0.022**	**0.015**	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	0.05
Chromium, Total	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.002)	**0.025**	ND(<0.002)	0.1 (c)
Lead, Total	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	**0.027**	**0.021**	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	0.015 (e)
Selenium, Total	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	0.05
Zinc, Total	ND(<0.010)	ND(<0.010)	ND(<0.010)	ND(<0.010)	ND(<0.010)	ND(<0.010)	ND(<0.010)	ND(<0.010)	**0.013**	ND(<0.010)	ND(<0.010)	**0.013**	ND(<0.010)	**0.01**	**0.016**	ND(<0.010)	5(c)
Total Petroleum Hydrocarbons (units in ug/L)																	
TPH-GRO	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	**1300**	**1200**	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	NAv
TPH-DRO	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	**1700 (f)**	**1600 (f)**	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	ND(<100)	NAv
Natural Attenuation																	
Methane (units in ug/L)	**15**	**2.1**	**3.2**	**10**	ND(<2.0)	**4.2**	**4800**	**2500**	ND(<2.0)	ND(<2.0)	**4.1**	**3.5**	ND(<2.0)	ND(<2.0)	NA	**2.5**	NAv
Calcium, Total (units in mg/L)	**113**	**162**	**166**	NA	**122**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NAv
Iron, Total (units in mg/L)	**6.4**	**2.1**	**2.2**	**10.3**	**1**	**3**	**17.3**	**16.9**	**5.7**	**1.4**	**1.6**	**3.6**	**2.4**	ND(<0.1)	NA	ND(<0.1)	0.3 (d)
Magnesium, Total (units in mg/L)	**16**	**14**	**15**	NA	**23**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NAv
Manganese, Total (units in mg/L)	**0.33**	**0.37**	**0.39**	NA	**0.65**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.05 (d)
Potassium, Total (units in mg/L)	**4**	**6**	**6**	NA	**4**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NAv
Sodium, Total (units in mg/L)	**9**	**8**	**9**	NA	**33**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NAv
Alkalinity, as CaCO3 (units in mg/L)	**354**	**425**	**426**	**463**	**441**	**468**	**560**	**550**	**444**	**438**	**338**	**318**	**336**	**384**	NA	**395**	NAv
Nitrate as N (units in mg/L)	ND(<1)	**1.2**	**1.29**	ND(<1)	ND(<1)	ND(<1)	ND(<1)	ND(<1)	ND(<1)	ND(<1)	ND(<1)	ND(<1)	ND(<1)	**1.68**	NA	ND(<1)	10
Sulfate (units in mg/L)	**43.8 J**	**53.8 J**	**52.8 J**	**46.8 J**	**59.4 J**	**47.6 J**	**51.6**	**49.4**	**40.8 J**	**55 J**	**29.9**	**23.7**	**26.1**	**59.9**	NA	**59.1**	250 (g)
Chloride (units in mg/L)	**13.2 J**	**9.42 J**	**10.3 J**	**10.4 J**	**21.9 J**	**5.07 J**	**13.4**	**13.8**	**15.8 J**	**25.3 J**	**8.56**	**22.6**	ND(<1)	**28.1**	NA	**27.1**	250 (g)
TOC (units in mg/L)	**3.6**	**5.1**	**3.6**	NA	**3.1**	NA	NA	NA	NA	NA	NA	NA	**3.3**	**3.2**	NA	NA	NAv
DO (units in ppm)	**0.0**	**0.9**	NA	**0.0**	**0.0**	**3.1**	**0.0**	NA	**0.1**	**0.0**	**1.1**	**6.6**	**6.5**	**0.4**	**0.0**	**4.2 (h)**	NAv
Oxidation/Reduction Potential (units in mV)	**-117**	**84**	NA	**-133**	**-61**	**128**	**-183**	NA	**-90**	**-71**	**-20**	**-63**	**-451**	**210**	**-602**	**335**	NAv
Iron (II), Ferrous (units in mg/L)	**6.3**	**1.7**	NA	**8.9**	**1.1**	**2.9**	**5.1**	NA	**6.8**	**1.4**	**0.8**	**3.4**	**1.9**	**0.01**	NA	**0.02**	NAv
Iron (III), Ferric (by difference - units in mg/L)	**0.1**	**0.4**	NC	**1.4**	**-0.1**	**0.1**	**12.2**	NC	**-1.1**	**0.0**	**0.8**	**0.2**	**0.5**	NC	NC	NC	NAv

Shaded values represent concentrations that are equal to or exceed the MCL or Treatment Threshold

NAv: Standard Not Available

NA: Not Analyzed

NC: Not Calculated

ug/L: micrograms per liter

mg/L: milligrams per liter

mV: millivolts

MCL: Federal Maximum Contaminant Level. From: Drinking Water Regulations and Health Advisories, Office of Water, United States Environmental Protection Agency, May 1995.

KSWQS: Kansas Surface Water Quality Standards. From: Kansas Department of Health and Environment, July 1994.

For all compounds listed, the KSWQS is the same value as the MCL.

J Estimated value

UJ Compound not detected above Practical Quantitation Limit (PQL), which may be imprecise or inaccurate.

TPH: Total Petroleum Hydrocarbons

GRO: Gasoline Range Organics

DRO: Diesel Range Organics

(a) The value presented represents the MCL for total trihalomethanes.

(b) The value presented represents the MCL for cis-1,2-dichloroethylene; the MCL for trans-1,2-dichloroethylene is 100 ug/L.

(c) The MCL represents both hexavalent and trivalent chromium.

(d) Secondary Drinking Water Standard. No KSWQS is available.

(e) MCLs have not been established for copper and lead. Instead, the Safe Drinking Water Act has established Treatment Thresholds (TT), above which treatment is required.

(f) Calculated from diesel standard.

(g) Secondary Drinking Water Standard.

(h) Questionable value - aeration of sample was probable

FP-93-101: Blind field duplicate of FP-93-02

FP-96-100: Blind field duplicate of FP-93-04

For a complete list of analytes, see 14 October 1996 Quality Control Summary Report (QCSR)

Table 10-1 (concluded): EXPANDED SI GROUNDWATER DATA -- FFTA-MAAF
August 1996
(Positive detections only)

Sample Location	M-1		R-1	R-2	MCL and KSWQS
Sample Identification	M-1	M-6	R-1	R-2	
Sample Date	8/21/96	8/21/96	8/15/96	8/15/96	
Volatiles (units in ug/L)					
Trichloromethane (THM)	**9.7**	**11**	ND(<0.5)	ND(<0.5)	100 (a)
Trichloroethylene	ND(<0.6)	ND(<0.6)	**44**	**46**	5
Ortho-Xylene	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	10,000
Ethylbenzene	ND(<0.7)	ND(<0.7)	ND(<0.7)	ND(<0.7)	700
Toluene	**11**	**11**	ND(<0.4)	ND(<0.4)	1,000
Tetrachloroethylene	ND(<1.1)	ND(<1.1)	**77**	**50**	5
1,2-Dichloroethylene (Total)	**13**	**16**	**49**	**64**	70 (b)
Meta &/or Para-Xylene	ND(<0.6)	ND(<0.6)	ND(<0.6)	ND(<0.6)	10,000
Semivolatiles (units in ug/L)					
Naphthalene	ND (<10)	ND (<10)	ND (<10)	ND (<10)	NAv
Priority Pollutant Metals (units in mg/L)					
Arsenic, Total	ND(<0.005)	**0.017**	**0.018**	**0.017**	0.05
Chromium, Total	ND(<0.002)	ND(<0.002)	ND(<0.002)	ND(<0.01)	0.1 (c)
Lead, Total	ND(<0.003)	ND(<0.003)	ND(<0.003)	ND(<0.003)	0.015 (e)
Selenium, Total	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	0.05
Zinc, Total	**0.201**	**0.544**	ND(<0.010)	ND(<0.010)	5(c)
Total Petroleum Hydrocarbons (units in ug/L)					
TPH-GRO	ND(<100)	ND(<100)	ND(<100)	ND(<100)	NAv
TPH-DRO	ND(<100)	ND(<100)	ND(<100)	ND(<100)	NAv
Natural Attenuation					
Methane (units in ug/L)	**170**	**130**	**57**	**26**	NAv
Calcium, Total (units in mg/L)	NA	NA	NA	NA	NAv
Iron, Total (units in mg/L)	**3.4**	**8.4**	**10.8**	**8.3**	0.3 (d)
Magnesium, Total (units in mg/L)	NA	NA	NA	NA	NAv
Manganese, Total (units in mg/L)	NA	NA	NA	NA	0.05 (d)
Potassium, Total (units in mg/L)	NA	NA	NA	NA	NAv
Sodium, Total (units in mg/L)	NA	NA	NA	NA	NAv
Alkalinity, as CaCO3 (units in mg/L)	**440**	**470**	**499**	**457**	NAv
Nitrate as N (units in mg/L)	ND(<1)	ND(<1)	ND(<1)	ND(<1)	10
Sulfate (units in mg/L)	**115 J**	**116 J**	**73.6**	**63.4**	250 (d)
Chloride (units in mg/L)	**11.1 J**	**11.2 J**	**12.3**	**17.9**	250 (d)
TOC (units in mg/L)	NA	NA	NA	NA	NAv
DO (units in ppm)	**2.6**	NA	**0.0**	**1.8 (h)**	NAv
Oxidation/Reduction Potential (units in mV)	**327**	NA	**-105**	**-75**	NAv
Iron (II), Ferrous (units in mg/L)	**6.3**	NA	**5.1**	**5.1**	NAv
Iron (III), Ferric (by difference - units in mg/L)	**-2.9**	NC	**5.7**	**3.2**	NAv

Shaded values represent concentrations that are equal to or exceed the MCL or Treatment Threshold

NAv: Standard Not Available

NA: Not Analyzed

ug/L: micrograms per liter

mg/L: milligrams per liter

mV: milllivolts

NC: Not Calculated

MCL: Federal Maximum Contaminant Level. From: Drinking Water Regulations and Health Advisories, Office of Water, United States Environmental Protection Agency, May 1995.

KSWQS: Kansas Surface Water Quality Standards. From: Kansas Department of Health and Environment, July 1994. For all compounds listed, the KSWQS is the same value as the MCL.

J Estimated value

UJ Compound not detected above Practical Quantitation Limit (PQL), which may be imprecise or inaccurate.

TPH: Total Petroleum Hydrocarbons

GRO: Gasoline Range Organics

DRO: Diesel Range Organics

Table 10-2: EXPANDED SI GROUNDWATER DATA -- FFTA-MAAF

October 1993; July/August and October 1994; January, April, August and December 1995; and May/June 1996 and August 1996 Data

(Positive detections only)

Sample Location	FP-93-01		FP-93-02									FP-96-02b		FP-96-02c		FP-93-03		MCL AND KSWQS
Sample Identification	FP-93-01-02	FP-93-01	MAAF-MW-2	FP-93-02	FP-93-02-02	FP-93-02	FP-93-02-4	FP-93-02-05	FP-93-02-06	FP-93-02-07	FP-93-02	FP-96-02b-07	FP-96-02b	FP-96-02c-07	FP-96-02c	FP-93-03-07	FP-93-03	
Sample Event	Oct-94	Aug-96	Oct-93	Jul/Aug-94	Oct-94	Jan-95	Apr-95	Aug-95	Dec-95	May/June -96	Aug-96	May/June -96	Aug-96	May/June-96	Aug-96	May/June-96	Aug-96	
Volatiles (ug/L)																		
1,2-Dichloroethylene	ND (<0.5)	ND (<0.5)	**76**	**29**	**21**	**5.5**	**140**	**110**	**14**	**5.8**	**6.4**	ND (<0.5	ND (<0.5	ND (<0.5)	ND (<0.5)	ND (<0.5)	**,0.5**	70 (a)
Benzene	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	**0.8**	ND (<0.8)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4	ND (<0.4	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	5
ortho-Xylene	**0.7**	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<1.2)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6	ND (<0.6	ND (<0.6)	ND (<0.6)	ND (<0.7)	ND (<0.7)	10000
Methane	NA	**15**	NA	NA	NA	NA	NA	NA	NA	NA	**2.1**	NA	**10**	NA	**2**	NA	**4.2**	NAv
Tetrachloroethylene	ND (<1.1)	ND (<1.1)	**210**	**140**	**100**	**16**	**320**	**110**	**52**	**32**	**27**	ND (<1.1	ND (<1.1	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	5
Trichloroethylene	ND (<0.6)	ND (<0.6)	**21**	**56**	**43**	**4.4**	**93**	**47**	**56**	**40**	**28**	ND (<1.1	**3.3**	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<0.6)	5
Trichloromethane	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	**0.5**	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	**4.3**	ND (<0.5	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	80
Priority Pollutant Metals (mg/L)																		
Arsenic	ND (<0.01)	ND (<0.1)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	**0.014**	**0.018**	**0.014**	**0.011**	ND (<0.01)	ND (<0.005)	0.05
Lead	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003	ND (<0.003	ND (<0.003)	ND (<0.003)	**0.004**	ND (<0.003)	0.015 (b)
Selenium	ND (<0.005)	ND (<0.005)	**0.009**	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	**0.005**	ND (<0.005)	ND (<0.005)	ND (<0.005	ND (<0.005	ND (<0.005)	ND (<0.005)	**0.005**	ND (<0.005)	0.05
Silver	ND (<0.01)	ND (<0.02)	ND (<0.01)	**0.03**	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005	ND (<0.005	ND (<0.005)	ND (<0.005)	ND (<0.01)	ND (<0.005)	0.1 (b)
Water Quality Testing																		
TOC (mg/L)	NA	**3.6**	NA	**26**	NA	NA	NA	NA	NA	NA	**5.1**	NA	**3.6**	NA	NA	NA	NA	NAv
TOX (mg/L)	NA	NA	NA	**144**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NAv
COD (mg/L)	NA	NA	NA	ND (<10)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NAv
BOD (mg/L)	NA	NA	NA	ND (<5)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NAv
Total Petroleum Hydrocarbons (ug/L)																		
TPH-GRO (ug/L)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	**170**	**100**	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	NAv
TPH-DRO (ug/L)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	**210**	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	ND (<100)	NAv

Shaded values represent concentrations that are equal to or exceed the MCL or Treatment Threshold

NA: Not Analyzed
NAv: Standard Not Available
ug/L: micrograms per liter
mg/L: milligrams per liter

BOD: Biochemical Oxygen Demand
TPH: Total Petroleum Hydrocarbons
GRO: Gasoline Range Organics
DRO: Diesel Range Organics

TOC: Total Organic Carbon
TOX: Total Halogenated Compounds
COD: Chemical Oxygen Demand
J: Estimated Concentration

The October 1993 samples were collected on 27, 28, 29 October 1993 and 3 and 19 November 1993.
The July 1994 samples were collected on 6, 7 and 8 July 1994; volatiles analyses is based on samples recollected in August 1994.
The identification in the QCSR for all VOC resamples (July/August 1994) is the well identification followed by "-1R".
The October 1994 samples were collected on 9, 10 and 11 October 1994.
The January 1995 samples were collected on 20, 21 and 22 January 1995.
The April 1995 samples were collected on 24 and 25 April 1995.
The August 1995 samples were collected on 22, 23 and 24 August 1995.
In August 1995, method detection limits for arsenic, chromium, copper, nickel, silver and zinc were lowered.
The December 1995 samples were collected between 12 and 14 December 1995.
In December 1995, Building 801, the backup water supply well for Marshall Army Airfield, was sampled for the first time.
The May 1996 samples were collected between 28 and 30 May 1996.
The August 1996 samples were collected between 14 and 21 August 1996.
Complete analyte list can be found in the Quality Control Summery Report (QSCR) prepared for that sampling event.

MCL: Federal Maximum Contaminant Level. From: Drinking Water Regulations and Health Advisories,
Office of Water, United States Environmental Protection Agency, May 1995.
KSWQS: Kansas Surface Water Quality Standards. From: Kansas Department of Health and Environment, July 1994.
For all compounds listed, the KSWQS is the same value as the MCL.
(a) The value presented represents the MCL for cis-1,2-dichloroethylene;
the MCL for trans-1,2-dichloroethylene is 100 ug/L.
(b) Secondary Drinking Water Standard. No KSWQS is available.

Table 10-2 (continued): EXPANDED SI GROUNDWATER DATA -- FFTA-MAAF

October 1993; July/August and October 1994; January, April, August and December 1995; and May/June and August 1996 Data

(Positive detections only)

Sample Location	FP-93-04									FP-96-04b		FP-96-04c		MCL AND KSWQS
Sample Identification	MAAF-MW-4	FP-93-04	FP-93-04-2	FP-93-04	FP-93-04-4	FP-93-04-05	FP-93-04-06	FP-93-04-07	FP-93-04	FP-96-04b-07	FP-96-04b	FP-96-04c-07	FP-96-04c	
Sample Event	Oct-93	Jul/Aug-94	Oct-94	Jan-95	Apr-95	Aug-95	Dec-95	May/June -96	Aug-96	May/June-96	Aug-96	May/June-96	Aug-96	
Volatiles (ug/L)														
1,2-Dichloroethylene	**4100**	**820**	**710**	**3.3**	**1.8**	**3.3**	ND (<2.5)	ND (<0.5)	**5.1**	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	70 (a)
Benzene	**64**	ND (<20)	**6.0**	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<2.0)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	5
Dichloromethane	ND (<45)	ND (<45)	ND (<9.0)	**1.4B**	ND (<0.9)	ND (<0.9)	ND (<4.5)	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)	5
Ethylbenzene	**190**	**150**	**100**	**50**	**48**	**47**	**33**	**140**	**83**	ND (<0.7)	ND (<0.7)	ND (<0.7)	ND (<0.7)	700
meta- &/or para-Xylenes	**320**	**560**	**370**	**220**	**100**	**84**	**84**	**320**	**170**	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	10000
ortho-Xylene	**330**	**310**	**200**	**150**	**58**	**51**	**45**	**160**	**95**	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	10000
Tetrachloroethylene	ND (<55)	ND (<55)	ND (<11)	ND (<1.1)	**1.1**	ND (<1.1)	ND (<5.5)	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	5
Toluene	**3200**	**150**	**83**	**2.3**	**1.2**	**5.5**	ND (<2.0)	**1.5**	**5.6**	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	1000
Trichloroethylene	ND (<30)	ND (<30)	ND (<6.0)	**1.9**	**1.3**	ND (<0.6)	ND (<3.0)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	5
Semivolatiles (ug/L)														
2-Methyl Naphthalene	**31**	**14**	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	NAv
4-Methylphenol	**15**	ND (<10)	ND (<10)	ND (<10)	ND (<10)	**21**	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	NAv
Bis (2-Ethylhexyl) Phthalate	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)	6
Naphthalene	**73**	**45**	**29**	**13**	ND (<10)	**20**	**21**	**21**	**32**	ND (<10)	ND (<10)	ND (<10)	ND (<10)	NAv
Priority Pollutant Metals (mg/L)														
Arsenic	**0.01**	MD (<0.01)	ND (<0.01)	ND (0.01)	ND (<0.01)	**0.013**	**0.014**	**0.012**	**0.016**	**0.031**	**0.022**	**0.022**	**0.015**	0.05
Lead	**0.004**	ND(<0.003)	ND(<0.003)	**0.013**	**0.006**	**0.040**	**0.010**	**0.049**	**0.027**	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	0.015 (b)
Water Quality Testing														
TOC (mg/L)	NA	**8**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NAv
TOX (mg/L)	NA	**216**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NAv
COD (mg/L)	NA	**35**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NAv
BOD (mg/L)	NA	**8**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NAv
Total Petroleum Hydrocarbons (ug/L)														
TPH-GRO (ug/L)	**13000**	**3600**	**2200**	**1900**	**1700**	**730**	**1000**	**1500 J**	**1300**	ND (<100)	ND (<100)	ND (<100)	ND (<100)	NAv
TPH-DRO (ug/L)	1200	ND (<100	ND (<100	1090 (c)	678 (d)	150 (e)	960 (c)	2600 (f,g)	**1700 (f)**	ND (<100)	**ND (<100)**	ND (<100)	**ND (<100)**	NAv

Shaded values represent concentrations that are equal to or exceed the MCL or Treatment Threshold

NA: Not Analyzed
NAv: Standard Not Available
ug/L: micrograms per liter
mg/L: milligrams per liter

TOC: Total Organic Carbon
TOX: Total Halogenated Compounds
COD: Chemical Oxygen Demand
BOD: Biochemical Oxygen Demand

The October 1993 samples were collected on 27, 28, 29 October 1993 and 3 and 19 November 1993.
The July 1994 samples were collected on 6, 7 and 8 July 1994; volatiles analyses is based on samples recollected in August 1994.
The identification in the QCSR for all VOC resamples (July/August 1994) is the well identification followed by "-1R".
The October 1994 samples were collected on 9, 10 and 11 October 1994.
The January 1995 samples were collected on 20, 21 and 22 January 1995.
The April 1995 samples were collected on 24 and 25 April 1995.
The August 1995 samples were collected on 22, 23 and 24 August 1995.
In August 1995, method detection limits for arsenic, chromium, copper, nickel, silver and zinc were lowered.
The December 1995 samples were collected between 12 and 14 December 1995.
In December 1995, Building 801, the backup water supply well for Marshall Army Airfield, was sampled for the first time.
The May 1996 samples were collected between 28 and 30 May 1996.
The August 1996 samples were collected between 14 and 21 August 1996.
Complete analyte list can be found in the Quality Control Summery Report (QSCR) prepared for that sampling event.

MCL: Federal Maximum Contaminant Level. From: Drinking Water Regulations and Health Advisories, Office of Water, United States Environmental Protection Agency, May 1995.
KSWQS: Kansas Surface Water Quality Standards. From: Kansas Department of Health and Environment, July 1994. For all compounds listed, the KSWQS is the same value as the MCL.
B: Analyte detected in the associated method blank; result has not been blank corrected.

(a) The value presented represents the MCL for cis-1,2-dichloroethylene; the MCL for trans-1,2-dichloroethylene is 100 ug/L.
(b) MCLs have not been established for copper and lead. Instead, the Safe Drinking Water Act has established Treatment Thresholds (TT), above which treatment is required.
(c) Calculated from a kerosene standard.
(d) Calculated from a kerosene and motor oil standard.
(e) Calculated from a motor oil standard.
(f) Calculated from a diesel standard.
(g) Result of Reparation/Analysis outside of holding time was 3800 ug/l.
(h) Secondary Drinking Water Standard. No KSWQS is available.

Table 10-2 (continued): EXPANDED SI GROUNDWATER DATA -- FFTA-MAAF

October 1993; July/August and October 1994; January, April, August and December 1995; and May/June and August 1996 Data

(Positive detections only)

Sample Location	FP-93-05							
Sample Identification	MAAF-MW-5	FP-93-05	FP-93-05-02	FP-93-05	FP-93-05-4	FP-93-05-05	FP-93-05-06	FP-93-05
Sample Event	Oct-93	Jul/Aug-94	Oct-94	Jan-95	Apr-95	Aug-95	Dec-95	Aug-96
Volatiles (ug/L)								
1,2-Dichloroethylene	ND (<0.5)	ND (<0.5)	**0.8**	**0.8**	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)
Dichloromethane	ND (<0.9)	ND (<0.9)	ND (<0.9)	**1.4B**	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)
Tetrachloroethylene	**1.2**	**3.5**	**1.7**	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)
Toluene	ND (<0.4)	ND (<0.4)	**0.8**	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)
Trichloroethylene	**1.2**	**2.4**	**1.7**	ND (<0.6)	**0.7**	ND (<0.6)	ND (<0.6)	ND (<0.6)
Priority Pollutant Metals (mg/L)								
Arsenic	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.005)	**0.012**	ND (<0.01)
Chromium	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.002)	**0.004**	ND (<0.01)
Copper	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.010)	ND (<0.010)	ND (<0.02)
Lead	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)	ND (<0.003)
Nickel	ND (<0.04)	ND (<0.04)	ND (<0.04)	ND (<0.04)	ND (<0.04)	ND (<0.010)	ND (<0.010)	ND (<0.04)
Selenium	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	**0.006**	ND (<0.005)	ND (<0.005)
Silver	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.005)	ND (<0.005)	ND (<0.01)
Zinc	ND (<0.010)	ND (<0.010)	ND (<0.010)	ND (<0.010)	ND (<0.010)	ND (<0.010)	**0.051**	ND (<0.010)
Water Quality Testing								
TOC (mg/L)	NA	3	NA	NA	NA	NA	NA	NA
TOX (mg/L)	NA	12	NA	NA	NA	NA	NA	NA
COD (mg/L)	NA	11	NA	NA	NA	NA	NA	NA

Sample Location	FP-93-06			FP-93-07					FP-96-07c
Sample Identification	FP-93-06-06	FP-93-06-07	FP-93-06	MAAF-MW-7	FP-93-07	FP-93-07-05	FP-93-07-06	FP-93-07	FP-96-07c
Sample Event	Dec-95	May/June-96	Aug-96	Oct-93	Jul/Aug-94	Aug-95	Dec-95	Aug-96	Aug-96
Volatiles (ug/L)									
1,2-Dichloroethylene	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)
Dichloromethane	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)
Tetrachloroethylene	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)
Toluene	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)
Trichloroethylene	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)
Priority Pollutant Metals (mg/L)									
Arsenic	**0.007**	ND (<0.005)	ND (<0.01)	**0.010**	ND (<0.01)	ND (<0.01)	**0.010**	ND (<0.01)	ND (<0.01)
Chromium	**0.003**	ND (<0.002)	ND (<0.01)	**0.030**	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)
Copper	ND (<0.010)	ND (<0.010)	ND (<0.02)	**0.030**	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)	ND (<0.02)
Lead	ND (<0.003)	ND (<0.003)	ND (<0.003)	**0.010**	**0.003**	**0.008**	ND (<0.003)	ND (<0.003)	ND (<0.003)
Nickel	ND (<0.010)	ND (<0.010)	ND (<0.04)	**0.050**	ND (<0.04)	ND (<0.04)	ND (<0.04)	ND (<0.04)	ND (<0.04)
Selenium	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)
Silver	ND (<0.005)	ND (<0.005)	ND (<0.01)	ND (<0.01)	**0.01**	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)
Zinc	**0.012**	**0.016**	ND (<0.010)	**0.150**	ND (<0.010)	ND (<0.010)	**0.013**	ND (<0.010)	ND (<0.010)
Water Quality Testing									
TOC (mg/L)	NA	NA	NA	NA	**3**	NA	NA	**3.2**	**3.3**
TOX (mg/L)	NA	NA	NA	NA	**6**	NA	NA	NA	NA
COD (mg/L)	NA	NA	NA	NA	ND (<10)	NA	NA	NA	NA

Sample Location	FP-94-12PZ				Building 801			MCL AND KSWQS
Sample Identification	FP-93-12PZ-05	FP-93-12PZ-06	FP-93-12PZ-07	FP-94-12PZ	Bldg801-06	BLDG801-07	BLDG801	
Sample Event	Aug-95	Dec-95	May/June-96	Aug-96	Dec-95	May/June-96	Aug-96	
Volatiles (ug/L)								
1,2-Dichloroethylene	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	70 (a)
Dichloromethane	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)	ND (<0.9)	5
Tetrachloroethylene	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	ND (<1.1)	5
Toluene	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	ND (<0.4)	1000
Trichloroethylene	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	ND (<0.6)	5
Priority Pollutant Metals (mg/L)								
Arsenic	ND (<0.01)	**0.007**	**0.009**	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.01)	0.05
Chromium	ND (<0.01)	**0.002**	**0.049**	**0.025**	ND (<0.002)	ND (<0.002)	ND (<0.01)	0.1 (b)
Copper	ND (<0.02)	ND (<0.010)	ND (<0.010)	ND (<0.010)	**0.012**	**0.065**	ND (<0.010)	1.3 (c)
Lead	ND (<0.003)	ND (<0.003)	**0.007**	ND (<0.003)	ND (<0.003)	**0.023**	ND (<0.003)	0.015 (c)
Nickel	ND (<0.04)	ND (<0.010)	**0.027**	ND (<0.04)	ND (<0.04)	ND (<0.04)	ND (<0.04)	0.1
Selenium	ND (<0.005)	ND (<0.005)	**0.005**	ND (<0.005)	ND (<0.005)	ND (<0.005)	ND (<0.005)	0.05
Silver	ND (<0.01)	ND (<0.005)	ND (<0.005)	ND (<0.01)	ND (<0.01)	ND (<0.01)	ND (<0.01)	0.1 (d)
Zinc	**0.016**	**0.018**	**0.033**	**0.016**	**0.013**	**0.060**	ND (<0.010)	5 (d)
Water Quality Testing								
TOC (mg/L)	NA	NA	NA	NA	NA	NA	NA	NAv
TOX (mg/L)	NA	NA	NA	NA	NA	NA	NA	NAv
COD (mg/L)	NA	NA	NA	NA	NA	NA	NA	NAv

Shaded values represent concentrations that are equal to or exceed the MCL or Treatment Threshold

NA: Not Analyzed
NAv: Standard Not Available
ug/L: micrograms per liter
mg/L: milligrams per liter

TOC: Total Organic Carbon
TOX: Total Halogenated Compounds
COD: Chemical Oxygen Demand
BOD: Biochemical Oxygen Demand

TPH: Total Petroleum Hydrocarbons
GRO: Gasoline Range Organics
DRO: Diesel Range Organics
J: Estimated Concentration

The July 1994 samples were collected on 6, 7 and 8 July 1994; volatiles analyses is based on samples recollected in August 1994.
The identification in the QCSR for all VOC resamples (July/August 1994) is the well identification followed by "-1R".
The October 1993 samples were collected on 27, 28, 29 October 1993 and 3 and 19 November 1993.
The October 1994 samples were collected on 9, 10 and 11 October 1994.
The January 1995 samples were collected on 20, 21 and 22 January 1995.
FP-94-12PZ was installed and developed in August 1994, and sampled for the first time in January 1995.
The April 1995 samples were collected on 24 and 25 April 1995.
The August 1995 samples were collected on 22, 23 and 24 August 1995.
In August 1995, method detection limits for arsenic, chromium, copper, nickel, silver and zinc were lowered.
The December 1995 samples were collected between 12 and 14 December 1995.
In December 1995, Building 801, the backup water supply well for Marshall Army Airfield, was sampled for the first time.
The May 1996 samples were collected between 28 and 30 May 1996.
The August 1996 samples were collected between 14 and 21 August 1996.
Complete analyte list can be found in the Quality Control Summery Report (QSCR) prepared for that sampling event.

MCL: Federal Maximum Contaminant Level. From: Drinking Water Regulations and Health Advisories, Office of Water, United States Environmental Protection Agency, May 1995.
KSWQS: Kansas Surface Water Quality Standards. From: Kansas Department of Health and Environment, July 1994. For all compounds listed, the KSWQS is the same value as the MCL.
B: Analyte detected in the associated method blank; result has not been blank corrected.

(a) The value presented represents the MCL for cis-1,2-dichloroethylene; the MCL for trans-1,2-dichloroethylene is 100 ug/L.
(b) The MCL represents values for both trivalent and hexavalent chromium.
(c) MCLs have not been established for copper and lead. Instead, the Safe Drinking Water Act has established Treatment Thresholds (TT), above which treatment is required.
(d) Secondary Drinking Water Standard. No KSWQS is available.

APPENDIX B

SUMMARY OF FORCE FLOW SYSTEM DATA

SUMMARY OF FORCED FLOW SYSTEM DATA (System: JC.FLO)

CONFIGURATION: Hazen-Williams Eq.

Flow = 110.00 gpm

Initial Pressure = 50.00 psia

FLUID PROPERTIES:

Specific Gravity = 1.000

Vapor Pressure = 0.34 psia

HEAD LOSSES (in feet)

	FLOW (gpm) 55	110	165
MINOR LOSSES:			
Valves & fittings	0.09	0.36	0.80
MAJOR LOSSES:			
Pipe HL using Hazen-Williams Eq	43.27	156.00	330.30
TOTAL SYSTEM HEAD:			
Total pipe and valve losses	43.36	156.36	331.09

SUMMARY OF FORCED FLOW SYSTEM DATA (System: GV.FLO)

CONFIGURATION: Hazen-Williams Eq.

Flow = 110.00 gpm

Initial Pressure = 46.00 psia

FLUID PROPERTIES:

Specific Gravity = 1.000

Vapor Pressure = 0.34 psia

HEAD LOSSES (in feet)

	FLOW (gpm) 55	110	165
MINOR LOSSES:			
Valves & fittings	0.09	0.34	0.77
MAJOR LOSSES:			
Pipe HL using Hazen-Williams Eq	40.31	145.31	307.65
TOTAL SYSTEM HEAD:			
Total pipe and valve losses	40.39	145.65	308.42

APPENDIX C

COST ESTIMATE DETAILS

Louis Berger & Associates, Inc.
295 Promenade Street, Providence, RI 02908
Tel 401.521.5980 • Fax 401.331.8956
A MEMBER OF THE BERGER GROUP
NGINEERS • PLANNERS • SCIENTISTS • ECONOMISTS

MEMORANDUM

TO: Carol Lee Dona, Ph.D., CEMRK-EP-ES

FROM: Dave Egan, Louis Berger & Associates (LBA)

DATE: 22 May 1997

COPIES: Janet Wade and Kyle Kirchner - Fort Riley
Mike Greene - CEMRK
Susan Knauf, Barry Millman and Charlie McKinley - LBA

RE: Revised GAC Wellhead Treatment Cost Estimate

As part of the EE/CA Working Draft review, LBA agreed to evaluate the GAC wellhead treatment cost estimates. The following revisions have been made to the Working Draft cost estimate for this option:

1. The specific GAC unit included in the Working Draft was a commercial unit (Calgon) typically used for groundwater treatment and reinjection projects, and not NSF certified for drinking water use. This unit was retained in the new estimate for use on Well R-2 only.

2. Figures were obtained for an NSF certified drinking water unit (Culligan), which has a higher installation cost due to the pre-and post treatment units that are recommended for drinking water use. This unit was used on Wells R-1 and M-1.

3. The O&M costs were adjusted to reflect a quarterly sampling and replacement of the carbon canisters, as opposed to monthly as assumed in the Working Draft. The O&M costs were also adjusted to reflect the need to replace the pre- and post treatment units every ten years.

The line item costs and revised total option cost estimate and for GAC wellhead treatment are attached for your review and comment.

WELLHEAD TREATMENT COST ESTIMATE
RESIDENTIAL DRINKING WATER SYSTEM

May 22, 1997

Source: Culligan Water Systems

System Requirements (installation costs):

A.	Pretreatment for iron/manganese removal:		
		Water Softener	$1,200
B.	Granular Activated Carbon System:		
		5μ Particulate Filter	
		3.3 CF Canisters (2 in series)	
		Water Meter	$2,700
C.	Posttreatment (disinfection for intermittent use):		
		UV system	$ 800
		TOTAL	**$4,700**

Annual Operation & Maintenance:

A. When breakthrough occurs (any detection of constituents) in first canister, it is removed, and second is moved up and new canister is placed into second position.

Assume canister changed quarterly, with carbon disposed by vendor (3.3 CF):

	Per Removal	$ 700
	Per Year	$2,800
B.	Monitoring of Water Quality:	
	Quarterly Sampling(EPA 624):	$ 200
	Per Year:	$ 800
	TOTAL:	**$3,600**

APPENDIX D

RECORDS OF COMMUNICATION

RECORD # 01

COMMUNICATION RECORD

MEETING MINUTES ______ TELECON RECORD ✓ INTERVIEW ______

PROJECT NAME: Fort Riley MAAF EE/CA

PROJECT NUMBER: JI 1061 Contract #: ______

DELIVERY/TASK#: Delivery Order 1 ______ Task: ______

[redacted]

CONTACT: — —______

AGENCY/TITLE: City of Ogden / City Clerk

PHONE # : 913-539-0311

DATE/TIME/PLACE: August 13, 1996

RECORDER: Christopher Shimkin

COMMENTS:

See Attached Page for conversation record.

FORM QAQC #1
FT RILEY MAAF-FFTA EE/CA

10/96
REVISION 1

Fort Riley, Kansas
Expose Control EE/CA

Water Supply

OGDEN MUNICIPAL WATER DISTRICT

Contact: [redacted] **Contacted on:** August 13, 1996

Summary:

- Total service population approx. 3,000. Serving a city population of approx. 1,800 and Riley County Rural District population of approx. 1,200.
- System storage of 200,000 gallons. Stored in a tower.
- Groundwater is pumped from three wells. One well has a capacity of 250 gpm and the other two are 300 gpm. At these pumping rates the system pumping capacity is approximately 1.2 MGD. The well are 60 feet deep with 10-foot screens.
- The most recent total average daily pumping rate is 400,000 gpd.
- System contains no booster pumps. The only pumps are located at the wellhead.
- System pressure ranges between 35 psi and 90 psi. The lowest system pressure is located on top of the hill where the storage tower is located. Pressures toward the southern end of the system (closer to MAAF) are higher.
- The system was originally installed in the 1950's. Expansion and upgrades have occured since then.
- Treatment with chlorine and phosphate is provided at the wellhead to soften the water.
- Minimum $7.00/1st 2000 gallons; $1.50/1000 thereafter; $200 meter hookup Monthly billing.

Material/Maps Available:

-

Follow-Up:

- System map with pipe sizes in the mail.

COMMUNICATION RECORD

RECORD # 02

MEETING MINUTES ______ TELECON RECORD ✓ INTERVIEW ______

PROJECT NAME: Fort Riley MAAF EE/CA

PROJECT NUMBER: JI - 1061 Contract #: ______

DELIVERY/TASK#: Delivery Order 1 ______ Task: ______

CONTACT: — —______

AGENCY/TITLE: Water Department

PHONE # : 913-239-3832

DATE/TIME/PLACE: August 15th 1996

RECORDER: Christopher Shimkin

COMMENTS:

See attached page

FORT RILEY WATER

Treatment Contact: [redacted] **Contacted on:**

System Contact(s): [redacted] **Contacted on:** August 15, 1996
Contacted on:

Summary: [redacted]

- System does not have enough user at present

- Select locations throughout the system are drained daily (40,000 - 50,000 gallons) in order to keep the water moving and water quality to standard.

- Pressures are good throughout the system. The fire department conducts flow and pressure tests.

- Two storage towers are located at MAAF. Ample supply is provided to MAAF through one tank only. The other tank is empty. Tank capacity unknown.

- Water is supplied to the MAAF elevated storage tank from Main Post. The well located at MAAF is used for emergency purposes only. It has not been activated since 1993.

- Camp Funston has two storage towers. As at MAAF, only one tower is used. The combined storage capacity of these two towers is approximately 1.5 million gallons.

- A firm (Berger Willis) from Salina, KS conducted a study of the water supply system with their report completed in January 1996.

Material/Maps Available:

- Berger Willis water distribution system report, Jan. 1996.

- System distribution maps.

Follow-Up:

- Mark Roberts to Pick-up report and maps. Photocopy report and return to Wainwright. Building 339. Speak with Rod Erickson if Wainwright not available.

COMMUNICATION RECORD

RECORD # 03

MEETING MINUTES ______ TELECON RECORD ✓ INTERVIEW ______

PROJECT NAME: Fort Riley MAAF EE/CA

PROJECT NUMBER: JI - 1061 Contract #: ______

DELIVERY/TASK#: Delivery Order 1 Task: ______

[redacted]

CONTACT: — —______

AGENCY/TITLE: Junction City's Engineer's Office / City Engineer

PHONE # : 913 - 223 - 5162

DATE/TIME/PLACE: September 16th, 1996

RECORDER: Christopher Shimkin

COMMENTS:

See attached pages (2)

JUNCTION CITY WATER DISTRICT

Treatment Contact: — **Contacted on:** August 13, 1996

[redacted] ed contact **Contacted on:**

(913) 762-5855

[contract operator - Professional Services Group, Inc., Houston, TX]

[redacted]

System Contact(s): — er **Contacted on:** Sept. 16, 1996

line

(913) 238-2512 - Engineering Department

— —**ontacted on:** August 21,1996

[redacted]

— — **Contacted on:** August 21,1996

[redacted]

Basement of Municipal Bld.

(913) 238-2512

Summary:

- (Premliminary from Kerry) System rated at 13 MGD

- (Preliminary from Kerry) Groundwater wells located next to the Republican River which is controlled by Milford Lake and the COE. 15 supply wells.

- Water is supplied to Grandview Plaza.

- According to Clarence - Average system pressure is 40 psi

- Accoriding to Clarence - Two storage tanks, one near the well field and one on the south side of Junction City.

- Accoriding to Clarence - Town is building a 1MG tank (to be completed in Nov.) to help increase pressures near a new industrial area on the west side of town. This new tank will support the industrial area and other new development.

Following from Tom Neal:

- 2.5 mgd presently, 10 mgd average, 15 mgd peak

- Two systems (low & high). Pressures in low system range between 50-80psi, high system ranges between 50-60psi, transmission main is 100-120psi.

- Three ground tanks in low system, only two being used with combined capacity of 1.3 MG. Unused tank is 0.5 MG. High system has one 0.5 MG elevated tank.

- Meter fee is $175; hookup fee is $5.00. Minimum 200 cubic feet $8.90; between 200 and 1000 cubic feet is $1.05/100 cubic feet; greater than 1000 is $1.30/100 cubic feet.

Material/Maps Available:

- Utility survey report prepared at the beginning of 1996. - Poor
- System maps from Clarence on two sheets.

COMMUNICATION RECORD

RECORD # 04

MEETING MINUTES ______ TELECON RECORD ✓ INTERVIEW ______

PROJECT NAME: Fort Riley MAAF EE/CA

PROJECT NUMBER: JI-1061 Contract #: ______

DELIVERY/TASK#: Delivery Order 1 ______ Task: ______

[redacted]

CONTACT ______

AGENCY/TITLE: Geary County Office

PHONE # : 913-238-6069

DATE/TIME/PLACE: August 21st, 1996

RECORDER: Christopher Shimkin

COMMENTS:

Refered all water supply questions to the Town engineer, which is a firm named Schwab-Eaton

FORM QAQC #1
FT RILEY MAAF-FFTA EE/CA

10/96
REVISION 1

COMMUNICATION RECORD

RECORD # 05

MEETING MINUTES ________ TELECON RECORD ✓ INTERVIEW________

PROJECT NAME: Fort Riley MAAF EE/CA

PROJECT NUMBER: JI - 1061 Contract #: ____________

DELIVERY/TASK#: Delivery Order 1 ____________ Task: ____________

[redacted]

CONTACT: — ——____________

AGENCY/TITLE: Schwab-Eaton, Engineer

PHONE # : 913-539-4687

DATE/TIME/PLACE: August 21st, 1996

RECORDER: Christopher Shimkin

COMMENTS:

See attached page

GRANDVIEW PLAZA

[redacted]

System Contact(s): — **Contacted on:** August 21, 1996

(913) 238-6069

[redacted]

— **Contacted on:** August 21, 1996

Manhattan, KS
(913) 539-4687 Fax: (913) 539-6419

Summary:

- Schwab-Eaton is a firm acting as the engineer for Grandview Plaza.
- All water is supplied from Junction City through an 8" line. There is literally an extention off of a water main in Junction City that feed Grandview Plaza. This line is several miles long.
- The water flows into Grandview Plaza using the pressure of the Junction City system.
- In-line booster pumps bring the water to two ground storage tanks. 50,000 and 100,000 gallons. The two tanks are able to be filled most of the way without the use of booster pumps. Just short of five feet from the top of the tank can be maintained with existing in-line pressure.
- The maximum amount of water available through the 8" line is around 400 gpm. (Clarence from Junction City says it's a 6" PVC supply line)
- According to Clarence in Junction City - pressure from Junction City entering Grandview Plaza is 75psi.
- Meter fee is $50; Water fee is $1.30/100 cubic feet.

Material/Maps Available:

-
-

RECORD # 06

COMMUNICATION RECORD

MEETING MINUTES ________ TELECON RECORD ✓ INTERVIEW ________

PROJECT NAME: Fort Riley MAAF EE/CA

PROJECT NUMBER: JI 1061 Contract #: ________

DELIVERY/TASK#: Delivery Order 1 ________ Task: ________

CONTAC[redacted]

AGENCY/TITLE: Morris County RWD / Manager

PHONE # : 913 - 482 - 3347

DATE/TIME/PLACE: August 23rd, 1996

RECORDER: Christopher Shimkin

COMMENTS:
See attached page

MORRIS COUNTY RURAL WATER DISTRICT

System Contact(s): — [redacted] **Contacted on:** August 23, 1996

Summary:

- Water supply from two wells, a third possible in the Fall of '96.
- Supply is from Clarks Creek Basin. Water is slightly hard. (385mg/l - 500)
- Storage tower capacity is 50,000.
- 10" line from wells supplies the storage tower.
- 270 miles of pipeline in four counties (Mostly Geary and Morris Counties)
- Serve over 400 customers, plus the towns of Alta Vista and Dwight.
- Using approximately 100,000 gallons/day. Well withdrawal cap is 300 gpm, but capacity is available for 500 gpm
- Pressure in transmission main is approx. 150 psi .
- Generally good water quality, some problem with iron, but typical for the area
- Hookup fee is $1,500; Minimun charge is $34.00 per month; $2.40/1000 gallons for first 5,000 gallons; $1.60/1000 gallons thereafter.

Material/Maps Available:

- Map indicating tower and well locations.
-

COMMUNICATION RECORD

RECORD # 07

MEETING MINUTES ______ TELECON RECORD ✓ INTERVIEW ______

PROJECT NAME: Ft. Riley EE/CA (Exposure Control Action)

PROJECT NUMBER: ______ Contract #: DACA 41-92-D-0001

DELIVERY/TASK#: Delivery Order 1 [redacted] Task: WORKING DRAFT

CONTACT: ______

AGENCY/TITLE: C.W. CRITES REAL ESTATE

PHONE # : (913) 238-5720

DATE/TIME/PLACE: 9/11/96

RECORDER: CBM

COMMENTS:

Mr. Crites was contacted to provide a quote for appraising several off-post properties affected by "MAAF FFTA plume". This data would be in support of property buy-out option.

Mr. Crites subsequently submitted an appraisal price quote and mapping of the area, dated 9/26/96.

COMMUNICATION RECORD

RECORD # 08

MEETING MINUTES ________ TELECON RECORD ✓ INTERVIEW ________

PROJECT NAME: Fort Riley MAAF EE/CA

PROJECT NUMBER: JI 1061 Contract #: ________

DELIVERY/TASK#: Delivery Order 1 ________ Task: ________

[redacted]

CONTACT: — —________

AGENCY/TITLE: KDHE

PHONE # : 913-296-5514

DATE/TIME/PLACE: September 18th, 1996

RECORDER: Christopher Shimkin

COMMENTS:

- Called to get a copy of state requirements to extend a municipal water system.

- Sent copy of State Statutes.

COMMUNICATION RECORD

RECORD # 09

MEETING MINUTES ________ TELECON RECORD ✓ INTERVIEW ________

PROJECT NAME: Fort Riley MAAF EE/CA

PROJECT NUMBER: JI-1061 Contract #: ________

DELIVERY/TASK#: Delivery Order 1 ________ Task: ________

[redacted]

CONTACT: ________

AGENCY/TITLE: KDHE / Water Quality Compliance

PHONE # : 913-296-5523

DATE/TIME/PLACE: September 20th, 1996

RECORDER: Christopher Shimkin

COMMENTS:

- Called to inquire if the municipal systems being investigated are in compliance with State drinking water Standards

- Morris County RWD #1
  Ogden
  Ft. Riley
  Grandview Plaza
  Junction City
  } All in compliance

FORM QAQC #1
FT RILEY MAAF-FFTA EE/CA

10/96
REVISION 1

COMMUNICATION RECORD

RECORD # 10

MEETING MINUTES ______ TELECON RECORD ✓ INTERVIEW ______

PROJECT NAME: Fort Riley MAAF EE/CA

PROJECT NUMBER: JI - 1061 Contract #: ______

DELIVERY/TASK#: Delivery Order 1 [redacted] Task: ______

CONTACT— —______

AGENCY/TITLE: Kansas Division of Water Resources

PHONE # : 913-296-3717

DATE/TIME/PLACE: September 25th, 1996

RECORDER: Christopher Shimkin

COMMENTS:

- Called to inquire about regulations regarding private well installations.
- Also asked about replacement of wells
- This office does not regulate private wells

RECORD # 11

COMMUNICATION RECORD

MEETING MINUTES ______ TELECON RECORD ✓ INTERVIEW ______

PROJECT NAME: Fort Riley MAAF EE/CA

PROJECT NUMBER: JI - 1061 Contract #: ______

DELIVERY/TASK#: Delivery Order 1 [redacted] Task: ______

CONTACT: —

AGENCY/TITLE: KDHE

PHONE # : 913-296-5514

DATE/TIME/PLACE: September 27th, 1996

RECORDER: Christopher Shimkin

COMMENTS:

- Called to discuss any requirement the State may have regarding design criteria for well withdrawal rates
- Said State does not have a standard for private well installations.

FORM QAQC #1
FT RILEY MAAF-FFTA EE/CA

10/96
REVISION 1

RECORD # 12

COMMUNICATION RECORD

MEETING MINUTES ______ TELECON RECORD ✓ INTERVIEW ______

PROJECT NAME: Fort Riley MAAF EE/CA

PROJECT NUMBER: JI 1061 Contract #: ______

DELIVERY/TASK#: Delivery Order 1 ______ Task: ______

[redacted]

CONTACT: ______

AGENCY/TITLE: CULLIGAN WATER

PHONE # : (401) 823-3000

DATE/TIME/PLACE: 5/20/97

RECORDER: CBM

COMMENTS:

- called to verify system requirements for drinking water use (GAC)
- stated that iron/manganese are suspected present (based on M-1 survey)
- Required system would include:

Pretreatment: Water Softener : $1200
5μ particle filter

GAC: 5gpm needs (2) 14" ⌀ (3.3 CF/tank) in series
+ water meter
(incl. particulate filter) $2,700

Post treatment: UV disinfection (for bacteria) $800

$4,700 TOTAL
for Installation

COMMUNICATION RECORD

RECORD # 13

MEETING MINUTES ______ TELECON RECORD ______ INTERVIEW______

PROJECT NAME: Ft. Riley MAAF EE/CA

PROJECT NUMBER: JI.1061 Contract #: ______

DELIVERY/TASK#: Delivery Order 1 ______ Task: ______

[redacted]

CONTACT: ______

AGENCY/TITLE: KDHE

PHONE # : (913) 296-3565

DATE/TIME/PLACE: 5/22/97

RECORDER: CBM

COMMENTS:

- Called re checking on drinking water ARARs
- "Public Water Supply" defined as >25 users
  R-1 (concession) would apply
  KDHE would do full permit/review
  - water rights determination
  - construction + design requirements
  - test for all primary + secondary constituents (no "grandfathering" possible)
  - sampling: monthly on bacteria
    yearly for nitrate/nitrite
- Supply would have to comply with all primary + secondary standards (R-1 use)
- M-1 and R-2 use would not be subject to permitting through KDHE.

RECORD # 14

COMMUNICATION RECORD

MEETING MINUTES ________ TELECON RECORD ________ INTERVIEW ________

PROJECT NAME: Ft. Riley MAAF EE/CA

PROJECT NUMBER: J1 1061 Contract #: ________

DELIVERY/TASK#: Delivery Order 1 [redacted] Task: ________

CONTACT: — —________

AGENCY/TITLE: KDWR

PHONE # : (913) 296-3717

DATE/TIME/PLACE: ________

RECORDER: CBM

COMMENTS:

- Called re water rights needs
- Residential (N-1, R-1) do not need permits unless public water supply (see Kate NOTES)
- Industrial – needs permit.
- Application will be sent for info.