RFI REPORT REVIEW
KIRTLAND AIR FORCE BASE
NEW MEXICO
EPA ID NO. NM9570024423

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Solid Waste
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Site	:	Kirtland Air Force Base
EPA Work Assignment Manager	:	Ms. Nancy Morlock
Telephone	:	214/655-6650
Prepared by	:	PRC Environmental Management, Inc.
PRC Project Manager	:	Ms. Joan Middleton
Telephone	:	214/754-8765

Approved:

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Stephen D. Phillips
Regional Manager

CONTENTS

Sheet 1 of 2

CONTENTS

Sheet 2 of 2

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1.0 INTRODUCTION

PRC reviewed and evaluated the RFI report for conformance with the (1) requirements of Hazardous and Solid Waste Amendments (HSWA) Permit No. NM9570024423, issued by EPA Region 6, effective November 14, 1990, (2) RCRA Interim Final RFI Guidance Document (EPA 530/SW-89-031), and (3) Interim Final RCRA Corrective Action Plan (EPA 530/SW-88-028).

During this work assignment, PRC reviewed several background documents in EPA Region 6 files. PRC's comments address (1) implementation of the work plan/sampling and analysis (WP/SAP) (Section 2.0), (2) deficiencies in the completeness of the RFI report (Section 3.0), and (3) conclusions and recommendations (Section 4.0).

PRC reviewed and evaluated the following 18 sites:

Site Number	Site Name
1	Landfill No. 1
2	Landfill No. 2
3	Landfills No. 4, 5, and 6
4	Kirtland Fire Control Training Area, including two drains
5	Sewage Lagoons
6	Golf Course Pond
8	Detonation Pit Explosive Ordinance Disposal (EOD) Range
9	Tijeras Arroyo
10	McCormick Ranch
11	Landfill No. 3
13	Abandoned Landfill
14	Manzano Sludge Drying Beds
	Manzano Sewage Overflow Lagoon 1
	Manzano Sewage Overflow Lagoon 2
	Manzano Sewage Overflow Lagoon 3
	Manzano Sewage Overflow Lagoon 4
15	Manzano Base Dump
17	Fill Area Southeast of Kirtland Sewer Lagoons
18	Unnamed Dump
19	Lake Christian
20	Landfill A
21	Landfill B

2.0 WORK PLAN/SAMPLING AND ANALYSIS PLAN

This section describes the primary deficiencies in the implementation of the WP/SAP. PRC compared the scope of work outlined in the WP/SAP with the investigative work actually performed during the RFI, as described in the RFI Technical Report (Report).

The objectives and proposed work elements of the WP/SAP were achieved only partially. A review of the Report indicated that generally less work than originally proposed was completed at several of the investigated sites. The resultant deficiencies were grouped within categories discussed in the following subsections.

2.1 BOREHOLE SAMPLING

In the WP/SAP, borehole sampling analysis was scheduled at specific, predetermined depth intervals, and at additional intervals based on odor, discoloration, or organic vapor analyzer (OVA) instrument readings. The Report indicates that, in some cases, fewer samples were obtained than had originally been scheduled (at, for example, site 3). One reason for collecting fewer samples was that some sampling locations were changed or deleted (at, for example, site 4). Also, it appears that no attempt was made to collect samples at the intervals where elevated OVA or explosimeter readings were recorded. At some sites, additional samples were apparently collected; however, the additional collection is not explained or described (at, for example, sites 1 and 11).

2.2 BOREHOLE LOGGING

Borehole logging was not performed in accordance with the approved WP/SAP. The borehole logs do not provide OVA or explosimeter readings. Limited sampling information is indicated on the logs. Samples were obtained at infrequent intervals, which exceeded the 5-foot interval specified in the WP/SAP. No geologic features are included in the lithologic descriptions. Finally, soil descriptions are apparently based on a nonstandard combination of the Wentworth and Unified Soil Classification Systems rather than one accurate classification system.

2.3 SOIL-GAS SURVEYS

Soil-gas surveys were not performed at sites 14 and 15, as was proposed in the WP/SAP. Also, the analytical equipment was not calibrated by using gas phase standards in accordance with the WP/SAP. Instead, an unusual and nonstandard methodology—based on headspace readings from aqueous samples—was used as a calibration method.

2.4 GROUNDWATER MONITORING WELL INSTALLATIONS

The WP/SAP indicated that groundwater monitoring wells would be built with the top of screen—25-foot stainless steel—placed at about 5 feet above the static groundwater level. However, several of the groundwater monitoring wells were screened below the lowest seasonal groundwater level and, in some cases, included screen lengths of up to 45 feet (at, for example, site 3). Also, during the seasonal high groundwater levels that occur in late winter and early spring, almost all of the groundwater monitoring wells will be screened significantly below the top of the groundwater table. This assumption is based on a seasonal groundwater surface fluctuation of about 20 feet, shown in Figure 2.3.2.4.3 on page 2.29 of the Report. Also, many monitoring wells were built with

filter packs that exceeded the 2-foot clearance recommended in the WP/SAP (at sites 1, 2, 3, 4, 5, 6, 9, 10, and 19).

2.5 SURFACE GEOPHYSICAL SURVEYS

Page 134 of the SAP indicates that surface geophysical surveys were to be conducted at eight sites. However, Table 1.2.2.1, on page 20 indicates that geophysical surveys would be conducted at only seven sites. The Report indicates that geophysical surveys were conducted at only four sites, and the data agree.

2.6 ANALYTICAL PROCEDURES

Only limited portions of the analytical results were discussed in the Report. The reported results typically presented the maximum concentrations detected, and—for groundwater samples—results were provided only for dissolved inorganic constituents detected in field filtered samples. Analytical results based strictly on filtered samples could be significantly biased and fail to indicate actual conditions. As previously mentioned, soil-gas results were reported in relative headspace concentrations, based on calibrations performed from headspace concentrations obtained from aqueous solutions. Such a calibration procedure for soil gas makes it difficult, if not impossible, to provide a meaningful interpretation of the soil-gas results.

2.7 DATA VALIDATION

The main concern with the analytical data is the presence of significant blank contamination in both the laboratory and field blanks. Also, most of the blank contaminants reported are not considered common laboratory contaminants. Section 1.9.3 of the SAP states that the impact of blank contamination on data results would be assessed. However, the Report never discusses the actual impact of the contamination on the validity and usability of the data. The Report also fails to adequately discuss the surrogate recoveries and their impact on data validation. For example, sample KAFB011707 had surrogate recoveries for the dioxin and furan analysis that were below the reported quality control (QC) limits. Section 4.2.1 of the Report does not discuss the impact of these low recoveries on the sample results. The Report should discuss (1) all data that are affected by poor QC results, and (2) their usability.

The deficiencies in the implementation of the WP/SAP have resulted in the generation of technically deficient data, which are insufficient to support a corrective measures study (CMS).

3.0 RFI REPORT

This section describes the deficiencies of the Report.

3.1 DEFICIENCIES—GENERAL

This subsection addresses general deficiencies in the (1) field investigation activities; drilling, groundwater monitoring well installation, and sampling, (2) background and action level concentrations, (3) potential contaminant pathways and receptors, and (4) regional environmental setting.

3.1.1 Drilling, Groundwater Monitoring Well Installation, and Sampling

The drilling description—which includes hand augering, hollow stem augering, and mud rotary drilling for groundwater monitoring wells—indicated that OVA instruments were used to monitor possible contamination encountered during drilling. It further indicated that samples were to be collected at—in addition to predetermined depth intervals—intervals determined on the basis of OVA readings. However, reviews of the individual site descriptions, boring logs, and other records do not indicate that OVA readings were recorded or that additional samples were collected. Page 3.8 of the Report indicated that explosimeter readings reached levels that were considered excessive for safe working conditions and that the drilling operations were temporarily suspended at sites 1, 2, 3, 4, 10, 11, and 15.

As discussed in the previous paragraph, explosimeter readings exceeded levels specified for safe working conditions during the drilling of borings at sites 1, 2, 3, 4, 10, 11, and 15. The Report did not provide the elevated meter readings. This information would be useful in characterizing waste source and contaminated environmental media. Such information should have been recorded on field boring logs as a routine part of the drilling operation, by an environmental field crew working under the current standard of care.

Groundwater monitoring wells were installed during Stage 2A by using bentonite additives in the drilling fluids to maintain borehole stability. Removal of bentonite from less transmissive zones during the development process would have likely been difficult. As a result, the monitoring wells may actually be monitoring only the most transmissive portion of the saturated interval in which they were installed. As a consequence, water quality results from these wells may not be representative of the entire formation.

Between summer and winter, the well design does not accommodate the fluctuations in the groundwater table. As a consequence, wells that may have been screened across the groundwater table for late summer conditions could be as much as 20 feet below the top of the groundwater table during winter. As a result, the monitoring wells would not necessarily monitor the same portion of the aquifer over a complete seasonal sequence. Page 3.8 of the Report stated that groundwater levels were measured to define seasonal variations in the groundwater levels. However, there is no information regarding the establishment or definition of the seasonal variations from the monitoring wells installed during Stage 2A.

Page 3.10 of the Report stated that, before groundwater monitoring wells purged for sampling purposes, headspace in the monitoring well was monitored with an OVA to determine whether organic vapors were present. This information, which was not recorded, would have provided useful information on (1) possible vapor or gas-phase contamination above the groundwater table, and (2) possible off-gassing from any dissolved constituents within the groundwater.

3.1.2 Soil-Gas Survey

The methodology used to calibrate the gas chromatograph is a nonstandard and unrecognized procedure for soil-gas survey work. It is also inconsistent with the methodology and/or procedure proposed in the approved WP/SAP. The modification of the approved methodology has not been explained. For soil-gas survey work, the gas chromatograph should be calibrated with gas-phase standards, as supplied to laboratories for routine calibrations for gas-phase analysis. The reporting of

the soil-gas survey results in terms of headspace concentration relative to aqueous or dissolved phase concentration is inappropriate and could significantly underestimate the actual gas phase. Based on the calibration methodology that was used, the only apparent use for the soil-gas results is to indicate the possible presence of soil-gas constituents. Based on the various discussions in the Report, high soil-gas concentrations are apparently present at several sites.

3.1.3 Environmental Setting

The Report's description of the regional physical and geologic setting is apparently reasonable and adequate to define these characteristics in terms of the RFI requirements. In addition, the surface water hydrology describes the area and is also adequate for RFI purposes. However, the description of groundwater hydrology is limited and raises additional questions that could have significantly affected (1) the adequacy of the RFI characterization, and (2) the description of contaminant migration, exposure pathways, and potential receptors. The deficiencies and questions are related mainly to the effects of seasons on groundwater level trends and flow direction.

The Report includes seasonal water level data for one well—KAFB production well 5. Based on the observations recorded in this well, there was a seasonal variation of about 20 feet and an observed decrease in overall water levels from 1986 through 1993. The hydrograph for this well raises the question of whether other wells in the area are experiencing similar trends and, if so, whether this trend is the result of rainfall, season, or seasonally-related pumping effects.

Only one regional groundwater table map is provided for the KAFB area. This regional map is based on September 1992 conditions. A comparison of this map with the previously referenced well 5 data makes it apparent that this regional groundwater table map was based on the seasonal low groundwater table condition.

For RFI purposes, a seasonal high groundwater condition should also be mapped to determine whether there are flow direction changes and/or gradient changes associated with the change in seasons. In addition, the regional groundwater table map shows inferred contours in certain areas, indicating that a basin or trough has developed across KAFB. However, an explanation for this inferred feature is not explained in the Report. Also, the influence of the pumping of KAFB production wells and municipal pumping (northeast of the site) of the groundwater beneath KAFB is not clearly defined. In addition, the regional groundwater table map shows numerous faults within the KAFB boundary. However, except for the Tijeras fault in the southeast corner of KAFB, little information is provided concerning the effects of these faults on the groundwater table. Further, based on a review of site-specific information, the regional groundwater map may be oversimplified and may indicate groundwater flow directions that do not actually occur at individual sites. These discrepancies at individual sites may be a result of local or site-specific recharge influence and/or geologic features.

Page 2.21 indicates that perched groundwater was encountered during the drilling of some wells. No further reference could be located in the site-specific descriptions or on the boring logs.

The regional environmental setting has not yet been sufficiently characterized to support a CMS.

3.1.4 Background Concentrations

The Report indicates that 18 background soil samples were collected at locations upslope and updip from seven of the 18 investigated sites. Sixteen of these samples were collected at depths of 3 to 5 feet, and the other two samples were collected at depths of about 25 feet. Eight background groundwater samples were collected from wells upgradient of four of the 18 sites that were investigated.

Although the background soil samples may be upslope from specific sites, they may be downslope of another site or sites (background sites 4, 5, and 18). These background soil samples were also possibly obtained from a variety of different soil classifications and horizons. The background groundwater samples may be upgradient from specific sites; however, they may be downgradient of another site or sites (background sites 1, 2, 3, and 10). Data from these background sampling locations may not represent actual background conditions. Therefore, the use of these background concentrations, compared to site-specific concentrations, could generate false-negative results. Conclusions based on questionable background levels being exceeded should not be used for input into a CMS.

3.1.5 Risk-Based Action Levels

The use of proposed risk-based action levels, as described in the Report, is inappropriate while characterization is still limited and incomplete. The application of action levels to limited data may imply minimal risk when significant sources and/or contamination have yet to be identified. Therefore, risk-based action levels should be applied only when the characterization at each site has been completed. Furthermore, the human health risk-based action levels should be based on the most current toxicological data rather than outdated proposed subpart S levels.

3.1.6 Potential Contaminant Pathways and Receptors

The identification of potential contaminant pathways and receptors, as described in the Report, is inappropriate while characterization is still limited and incomplete. The identification of potential contaminated pathways and receptors from limited data may imply minimal risk when significant sources and/or contaminant pathways have yet to be identified. Therefore, potential contaminant pathways and receptors should be identified after the characterization at each site has been completed.

3.2 DEFICIENCIES—SITE-SPECIFIC CHARACTERIZATION

This subsection addresses the deficiencies in the site-specific characterizations for the (1) environmental setting, (2) waste source, and (3) contaminated environmental media.

The Report discusses characterization in terms of environmental setting (geologic and hydrogeologic) waste source, and environmental media contamination for each solid waste management unit (SWMU) on a site-specific basis. However, a review of the individual site-specific characterizations makes it apparent that there are deficiencies that are common to many of the sites. For the purpose of streamlining, comments have been consolidated into a generic format with annotation of site-specific examples. This approach has been used to avoid the repetition that would result from commenting on the same issues on a site-by-site basis.

3.2.1 Environmental Setting

This subsection describes deficiencies in the environmental setting regarding the geologic and hydrogeologic characterization.

3.2.1.1 Geologic

Because of the limited amount of subsurface exploration that was performed, and/or the poor to nonexistent field records that are available from the field exploration activities, geologic characterization at each of the 18 sites is poorly defined. Typically, the boring logs for each site fail to provide the following information:

- Elevations
- Field screening results
- Method of sample collection
- Frequency of sample collection
- Whether drill cuttings or samples were described
- When perched groundwater is encountered
- When saturated conditions are encountered
- Geologic features (such as the presence of a clay layer within a sand or whether the sand has a clayey matrix)
- Drill action

Soil descriptions are apparently based on a nonstandard combination of the Wentworth and Unified Soil Classification Systems. The geophysical borehole logs conducted as part of the exploration activities are of poor quality. In many cases, interpretation of the geophysical log and the corresponding boring log (needed for calibration) is impossible. Finally, any general orientation of subsurface conditions (such as cross sections and plan views) that might influence contaminant movement has not been interpreted and provided.

3.2.1.2 Hydrogeologic

The hydrogeologic characterization is limited. In the unsaturated zone, the presence of perched groundwater, although noted on page 2.21 of the Report, is not reported at the individual sites at which it was encountered. With respect to the saturated zone, the individual site-specific flow directions, based on groundwater surface contouring, have—in many instances—been developed in a manner that is inconsistent with conventional technical practice (at sites 1, 3, and 6). Based on the data in the Report, other interpretations are possible. In addition, the site-specific flow direction information presented in the Report, which could also be affected by seasonal effects and the adjacent KAFB and municipal pumping activities, have not been evaluated. The effects of groundwater

mounding or recharge have not been discussed, although a review of the individual site-specific topographies indicates surface depressions and/or water bodies that would serve as recharge locations (at sites 1, 3, 5, 6, 9, 10, 13, 14, 17, 18, and 19). In addition, a review of the groundwater level data indicates mounding or local recharge at sites 6 and 10.

The impact of the geologic depositional environment, with particular reference to more transmissive zones (such as gravel) that could affect groundwater flow and serve as preferential pathways for contaminant migration, is not discussed. The Report also fails to mention less transmissive zones (such as silt and clays) that could function as barriers to downward migration and cause perching and lateral contaminant migration. Also, there is little discussion, except for the Tijeras Fault, of the impact of faulting on site-specific hydrogeology. There are several questions regarding the influence of the numerous faults, within the KAFB boundary, that could become barriers to flow or preferential conduits for contaminant migration. In addition, because of the graben-type nature of the faulting pattern, the presence of faulting could also result in local reversal of groundwater flow patterns.

In many cases, the monitoring well locations and vertical screen placements are inadequate to fully define site-specific hydrogeologic conditions. Based on a limited characterization of the regional environmental setting, monitoring wells may not have been located appropriately to define both upgradient and downgradient conditions, or screened across the top of the seasonal high and low groundwater tables. Groundwater-level data could be misleading, and additional unidentified flow paths may be present. Also, the excessive filter packs placed above the top of the well screens (sites 1, 2, 3, 4, 5, 6, 9, and 10) could provide a preferential contaminant pathway to the groundwater table. Most of the information regarding monitoring well spacing, screen placement, and groundwater flow direction was apparently based on a previously assumed regional flow pattern that has not been fully characterized. Apparently, little adjustment was made in the field as new information became available.

The monitoring wells were drilled by using a bentonite additive in the drilling fluid. Use of bentonite-based drilling fluids may affect the quality of groundwater level data. Because of the effective hydraulic communication of the screened interval, slightly different groundwater levels could result.

In addition, the original proposed screen intervals are considered excessive by general standard guidance; also, the proposed 25-foot length at site 3 was extended to as much as 45 feet. The use of these long screens tends to yield an average groundwater level readings over an extended vertical interval and, as a consequence, may mask the effects of vertical gradients.

Slug test data were not included in the Report. Only the final conclusions obtained from the slug test data were provided. As a consequence, PRC was unable to evaluate the slug test data for accuracy or applicability.

The site-specific environmental settings have not yet been sufficiently characterized to support a CMS.

3.2.2 Waste Source

There is very little waste source characterization in the Report. The field soils investigation procedures generally consisted of (1) limited surficial soil sampling—to typically 3 feet below ground surface (bgs)—at sites 3, 8, 14, 17, 18, and 20, (2) limited shallow subsurface sampling—typically

25 to 100 feet bgs—at sites 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 15, 19, 20, and 21, and (3) soil sampling outside of the actual boundaries of sites 2, 3, 10, 11, and 19. At some of these sites, two or more of these soils investigation procedures were combined. Based on these procedures, no investigation has been performed within, or directly beneath, the SWMUs at about half of the sites. Nevertheless, contaminants have been detected at several of these sites that did not have investigations within, or directly beneath, the SWMU (at, for example, sites 2 and 3).

Surface geophysical surveys at sites 1, 2, 3, and 13 indicated significant conductivity and/or magnetic anomalies. Surface soil-gas surveys at sites 1, 2, and 3—at about 3 feet bgs—detected chlorinated solvents and petroleum hydrocarbons. However, as previously noted, the soil-gas survey calibrations were performed by using a nonstandard methodology; therefore, the actual soil-gas source concentrations are unknown.

Drilling activities were suspended at sites 1, 2, 3, 4, 10, 11, and 15, because the explosimeter readings of vapor or gas-phase material exiting the borehole exceeded safe levels for drilling operations. At sites 2, 3, 10, and 11, drilling was performed outside of the site boundaries—neither within, or beneath, the SWMU.

At some locations (for example, site 10), no sampling was conducted at the depth of the probable source. Sampling was conducted to the 100-foot depth; however, the documented depth of the explosives testing exceeded 300 feet bgs.

The Stage 2 waste source characterization results were not completely integrated into this latest Stage 2A Report. Data obtained somewhat contemporaneously should be combined to provide overall conclusions in the Report.

Based on the information in the Report and the previous Stage 2 report, there are waste sources at sites 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 13, 15, 19, and 20. Several waste sources have been identified by investigative work performed only around the perimeters of some sites. In this case, higher concentrations would apparently be encountered if characterization was conducted within, or directly beneath, these sites. Present site-specific waste source characterizations are insufficient for input into the CMS.

3.2.3 Contaminated Environmental Media

Soil and/or sediment contamination from synthetic organic constituents (SOC) and petroleum hydrocarbons were detected at sites 1, 2, 3, 4, 8, and 19. However, soils were typically sampled only at predetermined depth intervals. These samples were not necessarily collected at locations—within, beneath, or around the site—most likely to confirm the presence or absence of contaminants. Because soil samples were collected at predetermined depths, sampling was not always conducted as deep as the probable source areas (at, for example, site 10). It appears that no attempt was made to adjust sample intervals to sample more fine-grained soils where contaminants might be residually absorbed and/or possibly perched. It also appears that no soil samples were collected from the zones in which the presence of high vapor or gas phase (as indicated from field screening activities) was indicated. In conclusion, the limited site-specific characterization and investigative approaches may have hidden significant soil contamination.

Based on the explosimeter results during drilling, there is obviously vapor-phase or soil-gas contamination within and around sites 1, 2, 3, 4, 10, 11, and 15. Soil-gas surveys at sites 1, 2, and 3 have indicated volatile organic compounds at these sites. However, because of the methodology used for the soil-gas analysis, it is difficult to identify the level of vapor-phase or soil-gas contamination. Also, other sites that indicate SOC and petroleum hydrocarbon contamination could contain soil-gas contamination.

Groundwater contamination has been indicated at sites 1, 2, 3, 5, 6, and 9. However, no groundwater monitoring wells were installed at sites 8, 11, 13, 14, 15, 17, 18, 20, and 21. Many of the sites with monitoring wells do not have enough wells to fully characterize contaminants in the groundwater. Also, these monitoring wells have nonstandard excessive screen lengths, which are screened below the seasonal low water table (at site 3) and below the seasonal high water table (at sites 1, 2, 3, 4, 5, 6, 9, and 10). Because of the excessive screen lengths that are screened below the seasonal fluctuating groundwater tables, these well installations may not provide representative results or even detect contaminants. For example, at site 3, three of the five monitoring wells are screened below the seasonal low groundwater table, and the other two wells are screened across the seasonal low groundwater table. At the seasonal high groundwater table, the latter two monitoring wells would be about 20 feet below the groundwater table surface. The other three monitoring wells would be even more than 20 feet below the seasonal high groundwater table. As previously discussed, the monitoring wells may not necessarily be in a downgradient or preferred flow path location. Contaminant plumes in the groundwater may not be detected by the present site-specific groundwater monitoring systems. Also, the perched groundwater observed during drilling at some locations was neither sampled nor analyzed.

In summary, the only conclusive information provided is that the surrounding environmental media have been affected by releases from many of the SWMUs. The contaminated environmental media have not yet been characterized sufficiently to support a CMS.

4.0 CONCLUSIONS AND RECOMMENDATIONS

This section presents PRC's conclusions and recommendations regarding the WP/SAP and the Report.

4.1 GENERAL

This subsection discusses the general conclusions and recommendations concerning the (1) implementation of the WP/SAP, and (2) the overall content of the Report.

4.1.1 Conclusions

4.1.1.1 WP/SAP

In comparing the WP/SAP scope of work with the investigative work actually performed during the RFI, PRC has concluded that generally less work than was originally proposed was completed at a number of the investigated sites. The investigation was generally deficient in the areas of (1) borehole sampling, (2) borehole logging, (3) soil-gas surveys, (4) groundwater monitoring well installations, (5) surface geophysical surveys, (6) analytical procedures, and (7) data validations. Because of these deficiencies in the implementation of the WP/SAP, the data that have been generated are technically deficient and will not support a CMS.

4.1.1.2 RFI Technical Report

In the Report, sites 1, 2, 3, 4, 8, 9, 10, 11, 14, and 19 have been recommended for additional investigation. Sites 5, 6, 13, 15, 17, 18, 20, and 21 have been recommended for no further action. PRC has determined that the characterizations of the environmental setting, waste source, and environmental media at all 18 sites are (1) limited and poorly-defined, and (2) should be completed. In particular, incomplete characterizations at sites 5, 6, 13, 15, 17, 18, 20, and 21 do not support recommendations of no further action. PRC has concluded that additional investigation is required at all 18 sites, except site 5. Site 5 is being addressed under RCRA closure and the New Mexico Environment Department.

Additional investigation at all 18 sites should provide the site-specific characterizations needed to support a CMS or a determination that no further action is required.

4.1.2 Recommendations

Each site should be assessed, and an investigation characterization strategy—incorporating all prior results—should be developed. This strategy should meet the characterization requirements of the RFI so that recommendations for a CMS or no further action can be stated and supported.

A work plan or phased work plan—outlining each site-specific strategy—should be prepared for each site. The deficiencies in investigation and environmental setting, wastes and sources, and contaminated media characterization—discussed throughout this document—should be considered. At a minimum, the recommendations outlined in the following subsections should be incorporated into the site-specific work plans.

4.2 RFI CHARACTERIZATIONS

This subsection discusses specific conclusions and recommendations regarding the RFI characterizations of the environmental setting, waste sources, and contaminated environmental media.

4.2.1 Environmental Setting

4.2.1.1 Conclusions

Regional

Based on the information provided, PRC has concluded that the description of the regional hydrogeology is limited and requires additional information regarding (1) the KAFB and regional groundwater wells used as data points, (2) the effects of season on groundwater level trends and flow direction, (3) the influence of KAFB production wells and municipal well fields (northeast of KAFB), and (4) the effects of faulting on the groundwater table. The regional environmental setting, with respect to the hydrogeology, has not been sufficiently characterized to presently support a CMS.

Site-Specific

Based on the information provided, PRC has concluded that the descriptions of the geologic and hydrogeologic conditions at each site are either poorly defined or nonexistent.

Geologic

Geologic characterization at each of the 18 sites is poorly defined because, (1) subsurface exploration was limited, and/or field records of the field exploration activities are poor to nonexistent, and (2) no interpretation of the general orientation of subsurface conditions (such as cross sections and plan views) that might influence contaminant movement was provided. Deficiencies in the field records included the (1) lack of detailed boring logs describing the activities performed, (2) lack of soil descriptions based one standard classification system, such as the Unified Soil Classification System, and (3) lack of geophysical borehole logs of usable quality.

Hydrogeologic

The hydrogeologic characterizations at the nine sites (sites 1, 2, 3, 4, 5, 6, 9, and 10) at which groundwater conditions were evaluated are limited. Groundwater monitoring wells have not been installed at sites 8, 11, 13, 14, 15, 17, 18, 20, and 21; therefore, hydrogeologic characterization at these sites has not been performed. Characterization at the nine sites that were evaluated is poorly defined, as follows:

- There is no information or explanation concerning site-specific or local hydraulic and/or geologic influences on groundwater levels and flow directions
- No conventional technical procedure was used for contouring groundwater flow directions (at sites 1, 3, and 6)
- Groundwater levels and flow directions could be affected by
  - the location of groundwater monitoring wells
  - the depths at which the well screens and filterpacks were set
  - the use of bentonite-based drilling fluids
  - excessive screen lengths
- Documentation of the slug test data was lacking

The site-specific geologic and hydrogeologic environmental settings have not been sufficiently characterized to support a CMS.

4.2.1.2 Recommendations

At a minimum, PRC recommends the actions listed in the following subsections to assist in a complete environmental setting characterization that can support a CMS.

Regional

Additional information should be provided to characterize the regional environmental setting, as outlined in the KAFB HSWA permit and RCRA corrective action guidance.

Supporting documentation and data—including well construction and groundwater level data—should be provided for all of the groundwater wells that are used as data points. After these data have been evaluated, potential remaining data gaps can be identified.

A seasonal high groundwater table map should be constructed.

Discrepancies between groundwater level data at sites 1, 3, 6, and 10—concerning regional groundwater flow directions—should be resolved.

The effects of recharge and faulting on groundwater levels and flow direction should be defined clearly.

Site-Specific

Additional information should be provided to characterize the site-specific environmental settings, as outlined in the KAFB HSWA permit and the RCRA corrective action guidance.

Geologic

Information that should have been described on the boring logs, as outlined in the approved SAP, should be provided. At a minimum, the following information must be provided on any boring logs generated during additional site investigations:

- Elevations
- Field screening results
- How samples were collected
- Depths of sample collection
- Whether drill cuttings or actual soil samples were described
- When perched groundwater is encountered
- When saturated conditions are encountered
- Geologic features
- Description of drill action

One classification system, preferably the standard Unified Soil Classification System should be used to describe soils.

Geophysical borehole logs that can be used for correlation and calibration should be provided.

Interpretive summaries (such as cross sections and plan views) of subsurface conditions should be provided.

Site-specific work plans should be provided, and the rationale for the additional investigative work should be explained. These work plans should explain and demonstrate that a complete geologic characterization—capable of supporting a CMS—will be performed at each site.

Hydrogeologic

The rationale for the groundwater flow direction contours at sites 1, 3, and 6 should be explained.

The effects of various factors on site-specific groundwater levels and flow directions should be clearly defined:

- Seasonal groundwater levels
- Pumping of KAFB and adjacent municipal production wells
- Faulting
- Geologic depositional environment
- Site-specific recharge

The following site-specific factors, and their effects—potential or actual—on site-specific groundwater levels and flow direction, should be explained:

- Groundwater monitoring well locations
- Placement of well screens
- Lengths of well screens
- Lengths of filter packs
- Use of bentonite-based drilling fluids

Slug test data should be provided to enable an evaluation of accuracy or applicability.

Site-specific work plans should be provided, and the rationale for the additional investigative work should be explained. These work plans should explain and demonstrate that a complete hydrogeologic characterization—capable of supporting a CMS—will be performed at each site.

4.2.2 Waste Source Characterization

This subsection discusses the conclusions and recommendations regarding the RFI characterization for waste sources.

4.2.2.1 Conclusions

Based on the information provided, PRC has concluded that the waste source characterizations for each of the 18 sites is limited and not emphasized. Characterization techniques have included (1) surficial and subsurface exploration, (2) surface geophysical surveys, and (3) soil-gas surveys. Based on the limited characterizations, it has been documented that many of the sites contain waste sources, specifically sites 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 13, 15, 19, and 20. This is indicated by the presence of hazardous constituents, or sources of hazardous constituents, either within the SWMU and/or in the surrounding subsurface environmental media. Typically, a limited investigation was performed within, or directly beneath, the SWMU at about half of the sites. At these sites, higher concentrations of hazardous constituents are highly possible within, or directly beneath, the SWMU. The lack of information on waste sources at the remaining sites does not prove that wastes sources are not present at these locations. The waste source characterization is not sufficient to support a CMS.

4.2.2.2 Recommendations

At a minimum, PRC recommends the following to assist in a complete waste source characterization that can support a CMS:

- Additional information should provided to characterize waste sources, as outlined in the KAFB HSWA permit and the RCRA corrective action guidance.
- Information referenced in the Report—field screening results and locations of perched groundwater—should be provided.
- Site-specific work plans should be provided, and the rationale for the additional investigative work should be explained. These work plans should explain and demonstrate that a complete waste source characterization—capable of supporting a CMS—will be performed at each site.

4.2.3 Contaminated Environmental Media

This subsection discusses the conclusions and recommendations regarding the RFI characterization for contaminated environmental media, specifically soil, soil-gas, and groundwater.

4.2.3.1 Conclusions

Soil

Soil contamination has been indicated at sites 1, 2, 3, 4, 8, and 19. However, soils were typically sampled at predetermined depth intervals—not necessarily at locations within or around the sites that are most likely to confirm the presence or absence of contaminants. Also, sampling locations were apparently not adjusted when warranted by field conditions. Considering these limited site-specific characterizations and investigative approaches, some contaminated soils may not have been identified. The contaminated soils at each site have not been sufficiently characterized to presently support a CMS.

Soil-Gas

Significant vapor-phase gas or soil-gas contamination has been indicated, but not characterized or quantified, at sites 1, 2, 3, 4, 10, 11, and 15. At the sites at which soil-gas surveys were performed, soil-gas contamination may be more significant than indicated, because a nonstandard calibration procedure was used. Other sites, which have indicated SOC and petroleum hydrocarbon contamination, could contain soil-gas contamination. Site-specific soil-gas contamination has not been sufficiently characterized to support a CMS.

Groundwater

Groundwater contamination has been indicated at sites 1, 2, 3, 5, 6, and 9. Investigated sites at which no groundwater monitoring wells were installed are sites 8, 11, 13, 14, 15, 17, 18, 20, and 21. In many cases, the sites with monitoring wells do not have enough wells to fully characterize contaminants in the groundwater. Also, the screen lengths and screened intervals may not provide representative results or even detect contaminants. Because of the potentially limited number of monitoring wells, locations, and screened intervals and lengths, contaminated plumes in the groundwater may not be detected by the present site-specific groundwater monitoring systems. The site-specific groundwater contamination has not been sufficiently characterized to support a CMS.

4.2.3.2 Recommendations

At a minimum, PRC recommends actions listed in the following subsections to assist in a complete contaminated environmental media characterization that can support a CMS.

Soil

Additional information should be provided to characterize site-specific soil contamination, as outlined in the KAFB HSWA permit and RCRA corrective action guidance.

Site-specific work plans should be provided, and the rationale for the additional investigative work should be explained. These work plans should explain and demonstrate that a complete soil contamination characterization—capable of supporting a CMS—will be performed at each site.

Soil-Gas

Additional information should be provided to characterize site-specific soil gas contamination, as outlined in the KAFB HSWA permit and RCRA corrective action guidance.

Additional soil-gas surveys should be performed at the sites at which previous results indicated the presence of soil-gas and volatile SOCs in the unsaturated zone.

Because about half of the investigated sites have indicated the presence of volatile SOCs, limited soil-gas surveys should be performed at all of the other sites.

Site-specific work plans should be provided, and the rationale for the additional investigative work should be explained. These work plans should explain and demonstrate that a complete soil-gas contamination characterization—capable of supporting a CMS—will be performed at each site.

The standard methodology, including gas-phase standards, outlined in the approved SAP should be used on all future soil-gas surveys.

Groundwater

Additional information should be provided to characterize site-specific groundwater contamination, as outlined in the KAFB HSWA permit and RCRA corrective action guidance.

The variance of the groundwater monitoring well construction should be explained. Future wells should be built in accordance with the approved SAP and standard methodology, unless an alternative can be supported.

Site-specific work plans should be provided, and the rationale for the additional investigative work should be explained. These work plans should explain and demonstrate that a complete groundwater contamination characterization—capable of supporting a CMS—will be performed at each site.

4.3 BACKGROUND AND ACTION-LEVEL DATA

This subsection discusses conclusions and recommendations regarding the background and action-level data described in the Report.

4.3.1 Conclusions

PRC has concluded that the data obtained from the background soil and groundwater sample locations are not usable. The soil and groundwater samples may have been collected upslope and upgradient from a specific site but may still be downslope or downgradient of another site or sites. These samples may also have been collected from various soil classifications and horizons. These background sample locations may or may not represent actual background conditions. Therefore, it may be difficult to determine whether the soil and groundwater samples collected during the site-specific investigations reflect concentrations that exceed actual background concentrations. Site-specific conclusions about whether contaminants are present in the environmental media should not be based on questionable background concentrations and used for input into a CMS.

PRC has also concluded that the use of proposed risk-based action levels is inappropriate while site characterization is still limited and incomplete. The application of risk-based action levels to limited data may imply minimal risks when significant sources and/or contamination have not yet been identified. Therefore, risk-based action levels should be applied only when the characterizations have been completed at each site.

4.3.2 Recommendations

At a minimum, PRC recommends the following to assist in developing and applying background and action level concentrations for input into a CMS:

- Specific constituent results used to develop background concentrations should be provided and explained. This should include information regarding soil types and classifications for unsaturated and saturated conditions. The sample collection

locations should also be included. After these data have been evaluated, the usability of the data for its intended purpose can be determined.

- Risk-based action levels should be applied after each site has been completely characterized. The action levels should be based on the most current toxicological data, not on outdated proposed RCRA subpart S regulations.

4.4 POTENTIAL CONTAMINANT PATHWAYS AND RECEPTORS

This subsection discusses conclusions and recommendations regarding the potential contaminant pathways and receptors described in the Report.

4.4.1 Conclusions

PRC has concluded that the identification of potential contaminant pathways and receptors is inappropriate while characterization is still limited and incomplete. The identification of potential contaminant pathways and receptors from limited data may imply minimal risk when significant sources or contaminant pathways have not yet been identified. Therefore, potential contaminant pathways and receptors should be identified when the characterization at each site is completed.

4.4.2 Recommendations

To assist in identifying potential contaminant pathways, and receptors for input into a CMS, PRC recommends that site-specific potential contaminant pathways and receptors be identified after each site has been completely characterized.

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