AREE 34, VINT HILL FARMS STATION, WARRENTON, VIRGINIA
SYSTEMATIC PLANNING OUTLINE (7/31/2003 Rev 5)

A. Conceptual Site Model

1. Geology

    a. Overburden Material

    - Saprolitic soil
    - Composed primarily of silt and clay with some fine sand, grading to silt and fine sand
    - Penetration density increases with depth
    - Grades into weathered rock
    - Depth ranges from 23 ft bgs (MW34-6D) to 30 ft bgs (MW34-7D)
    - Small area where there are less fines and lower density (MW34-3/NP-PZ2)

    b. Bedrock

    - Red-brown siltstone immediately beneath saprolitic soil
    - Dark gray shale underlying siltstone in eastern (MW34-6D) and southern (MW34-5D) portions of site
    - Fractured bedrock
    - Top of bedrock gently slopes toward the southwest

2. Hydrogeology

    a. Saturated Overburden Material

    - Overburden groundwater cannot sustain 150 gpm over an extended period, therefore not considered an aquifer
    - Drilled monitoring wells to 18 to 26 ft bgs (approximately first water-bearing zone)
    - Depth to groundwater ranges from approximately 4 to 12 ft bgs
    - Depth to groundwater varies seasonally by as much as 2 ft
    - Hydraulic conductivity is very low (as evidenced by the very slow recharge in MW34-1, MW34-2, and MW34-4)
    - There is one small area (MW34-3/NP-PZ2) where hydraulic conductivity is higher

- Direction of horizontal groundwater flow is generally north-northwest, but immediately downgradient of site becomes west-northwest

b. Fractured Bedrock Aquifer

- Drilled monitoring wells to 60 to 61 ft bgs (approximately first water-bearing zone)

- Depth to groundwater ranges from approximately 8 to 18 ft bgs

- Semi-confined, with the unfractured bedrock and saprolite acting as confining units

- Recharge to the fractured bedrock aquifer occurs at outcrop areas and from percolation from the overburden along fractures

- Hydraulic conductivity is relatively low (as evidenced by the slow recharge in MW34-5D and MW34-6D)

- There is one small area (MW34-7D) where hydraulic conductivity is higher

- Direction of horizontal groundwater flow generally ranges between east and east-southeast in the vicinity of the parking lot

- Slight changes in direction appear to be related to precipitation events

- Historical groundwater elevation data (from Phase I/II RIs) indicate that there is a groundwater divide in the fractured bedrock aquifer (i.e., at some location, groundwater will flow to the west toward western South Run tributary [WSRT])

- USEPA identified a large bedrock fracture to the west of Bldg. 2400 which intersects with the WSRT headwaters

c. Overburden/Bedrock Interconnection

- Generally there is a downward vertical gradient between the saturated overburden material and the fractured bedrock aquifer

- There are very strong downward vertical gradients at the MW34-2/6D and MW34-4/5D well clusters indicating a very poor connection between the two units and that the weathered bedrock is acting as a nearly impermeable zone in these areas

- There is a slight downward vertical gradient, which occasionally reverses to a slight upward vertical gradient, at the NP-PZ2/MW34-7D well cluster indicating a relatively good hydraulic connection between the two units that may reverse under long periods of no recharge

3. Contamination

   a. Contaminants of Concern

      - The chemicals of concern are chlorinated VOCs that are commonly used as solvents/degreasers, and their breakdown products

   b. Extent

      - Groundwater data have been collected from 26 temporary monitoring wells, 12 permanent overburden monitoring wells, and 3 permanent bedrock monitoring wells
      - Soil data have been collected at 2-ft intervals to 16 ft bgs at four locations near areas of known groundwater contamination
      - Temporary monitoring well results in the saturated overburden material suggest that the contamination in the groundwater is sporadic
      - Total VOC concentrations in the saturated overburden material have ranged from non-detect to 736.5 μg/L (at MW34-4)
      - VOCs also observed at elevated levels in the fractured bedrock aquifer
      - Total VOC concentrations in the fractured bedrock aquifer have ranged from 2.9 to 342.5 μg/L, with the highest concentration being detected in MW34-7D (the most hydraulically upgradient well on the site – but not upgradient of the site)
      - PCE/TCE contamination is predominant in one portion of the site, while CCl_4 contamination is predominant in another portion of the site
      - Monitoring wells that have been sampled over an extended period of time (e.g., NP-PZ2) show little change in contaminants and concentrations
      - No VOCs were detected in soil samples collected from the vadose zone in the overburden material adjacent to MW34-2, MW34-3, NP-PZ2, and one point central to the first three identified

   c. Source

      - No known source identified to date
      - Multiple sources are probable based on distribution of chemicals
      - Abandoned sewer line running from southeastern side of Bldg. 2400 to the east/northeast through the parking lot is a potential source of contamination (see Figure E-1)
      - Small incinerator (former Building T-223) located adjacent to the MW34-4/MW34-5D well cluster is a potential source of contamination (see Figure E-1)

- A source below Bldg. 2400 is possible
- Concentrations detected in MW34-7D could be from a source further away
- Site has been covered by a parking lot since 1966 based on review of building drawings

4. Potential Receptors

   a. The only public drinking water wells within a one-mile radius of AREE 34 in Fauquier County, Virginia, are the five public water supply production wells located within the boundaries of the former VHFS

   b. There are 23 private drinking water wells within a one-mile radius of AREE 34 in Fauquier County, Virginia, all of which are outside the boundaries of the former VHFS

   c. The closest drinking water well is Production Well #1, located approximately 400 ft south-southeast (approximately downgradient) of AREE 34

      - Production Well #1 is “open-hole” to 400 ft bgs and draws water from the fractured bedrock
      - Quarterly monitoring of Production Well #1 was initiated upon discovery of VOC contamination in the fractured bedrock aquifer at AREE 34
      - Historic and recent (i.e., February and May 2003) testing of water extracted from Production Well #1 has shown that the drinking water source has not been impacted by the contamination at AREE 34 (i.e., no VOCs have been detected)

   d. Other drinking water wells located within the boundaries of the former VHFS are further away and do not appear to be downgradient of AREE 34

   e. Possible future exposure scenarios are exposure to construction workers excavating in the contaminated area and vapor intrusion into buildings constructed on top of the contaminated area

B. Project Objectives

1. Obtain data to locate source(s) of contamination or show that a major source does not exist

2. Obtain data to understand the lateral and vertical extent of contamination in both the saturated overburden and the fractured bedrock aquifer within the limits of the site

3. Obtain data to characterize the fractured bedrock aquifer at the site

4. Obtain data to determine whether a complete exposure pathway exists currently or is likely to exist in the future

5. Obtain data to determine viability of natural attenuation as a possible remedial alternative

6. Obtain data to evaluate in-situ bioremediation as a possible remedial alternative

7. Obtain data to evaluate in-situ oxidation as a possible remedial alternative

C. <u>Data Gaps</u>

1. Source(s) of contamination

2. Extent of contamination in saturated overburden and fractured bedrock aquifer at the site

3. Aquifer characteristics (e.g., hydraulic conductivity, flow characteristics) at the site

4. Geochemical characteristics of the saturated zone at the site

5. Location of groundwater divide in the fractured bedrock aquifer, if present within the vicinity of the site

6. Location and orientation of bedrock fractures within the vicinity of the site

D. <u>Investigation Tools</u>

This section will present possible investigation tools that have been considered for use at AREE 34 and rationale for why they will or will not be used at this time. This section will discuss what data each investigation tool provides, the applicability/limitations of the investigation tool in general and at AREE 34 (i.e., how will it perform at AREE 34), and the value added to using the investigation tool. This section will also address how the information provided by each investigation tool will be integrated with the information obtained from other investigation tools, and how that information will feed into the conceptual site model. For example, how the Membrane Interface Probe (MIP) results will be integrated with the soil and groundwater chemistry data and the soil/bedrock stratigraphic data to further develop the conceptual site model.

1. Site History

    a. “Old-timer” interviews

    b. Building drawings/inspections

2. Remote Sensing

    a. Geophysical surveys (to identify underground utilities, or the like)

3. Soil/Groundwater Accessing

    a. Hollow-stem augers

    b. Air rotary rig

    c. Geoprobe

    d. CPT rig

   e. Hammer drill

4. Soil/Bedrock Stratigraphy

   a. Fracture trace analysis using aerial photographs

   b. Geophysical surveys to locate bedrock fractures

   c. Down-hole video taping of open boreholes

   d. Oriented bedrock cores – not selected for use at this time due to cost

5. Soil Chemistry

   a. On-site and off-site analysis (see Table D-1)

      - Encore samplers for VOC samples

      - Total organic carbon

      - Direct mass spec (a.k.a., ion trap mass spec) (faster analysis) versus GC (better quantification when paired with a mass spec or ECD)

      - USEPA SW-846 Method 8260B

   b. MIP with concentrated gas traps

   c. Soil gas survey (e.g., Gore sorbers, active soil gas)

6. Groundwater Chemistry/Biochemistry

   a. On-site and off-site chemical analysis (see Table D-1)

      - Direct mass spec (a.k.a., ion trap mass spec, ITMS) (faster) versus GC/MS (better quantification)

      - USEPA SW-846 Method 8260B

   b. MIP with concentrated gas traps

   c. Passive diffusion samplers – not selected for use at this time

   d. Temporary wells

   e. Monitoring wells in the saturated overburden and fractured bedrock aquifer

   f. On-site and off-site geochemical analysis to assess natural attenuation potential

g. Microorganism speciation – to be considered if geochemical analysis shows promise for natural attenuation

7. Groundwater Hydraulics

   a. Geo-flow meter

   b. Hydraulic tests (e.g., Production Well #1, MW34-7D)

   c. Dye tracer testing – not selected for use at this time

8. Data Integration

   a. 3-D data visualization/mapping - real-time data sharing

E. <u>Current Contract Investigation Plans</u>

1. Site History

   a. “Old-timers” interviews to identify possible sources of VOC contamination found at AREE 34

   b. Building drawing review to identify possible sources of VOC contamination (e.g., septic systems, underground utilities, etc.) found at AREE 34

   On June 25 – 26, 2003, Shaw Environmental, Inc. (Shaw) personnel reviewed historical building drawings available at the former VHFS to glean information regarding the activities that might have occurred in the vicinity of AREE 34. This summary presents the findings from the historical building drawing review. Figure E-1 shows the buildings in the vicinity of AREE 34 along with the building numbers that have been used to identify the buildings over time. In the text of this summary, the current building numbers are used.

   The primary buildings in the barn complex are Buildings 2290 and 2300. Shortly after purchasing the property in 1942, the War Department renovated the barn complex and installed the sewage treatment plant (STP) at the headwaters of WSRT and Production Well No. 1. During the 1942 renovations, the War Department installed toilets on both floors of Buildings 2290 and 2300 that connected to the STP (i.e., a septic system was not used), which has since been abandoned and partially removed, at the headwaters of WSRT. A portion of the water line, which was installed in 1942, that impacts the AREE 34 parking lot is shown on Figure E-1.

   Prior to the 1942 renovations, the ground floor of Building 2290 was primarily dirt. During the 1942 renovations, the War Department added a 4-inch thick concrete floor with drain trenches (which were later covered during renovations in 1954). Also in 1942, a boiler room was attached to the south side of the barn complex silo (connected to Building 2290). It appears that the chimney for the boiler room was located in the silo.

Prior to the 1942 renovations, Building 2300 had a partially dirt floor. The horse stables in this building drained to cesspools and out the door onto the ground.

While drawings were being reviewed, Ralph Woodward, a long-time employee at VHFS, provided information on several former VHFS employees who worked in the barn complex from 1950 to 1959. Mr. Woodward indicated that one of the buildings in the barn complex was used as a laboratory for processing aerial photographs. Per Mr. Woodward, these operations were apparently moved in 1959 when the EPIC Building (Building 166), a large photo processing laboratory operated by the USEPA, became operational. Shaw is planning to interview former VHFS employees in the near future to confirm this information, to the extent possible, and to obtain more details regarding the operations that occurred in the barn complex and in Buildings 2400 and 2410.

Building T-223, a small "building" formerly located where monitoring wells MW34-4 and MW34-5D are currently located (see Figure E-1), was identified on historical building drawings and aerial photographs. This "building" was definitely present in 1966, and may have been present as early as 1954 (i.e., it was not shown on a 1953 drawing). Building T-223 was no longer present in 1992; the exact date of demolition is not certain, but was some time after 1984. Through review of the historical building drawings and aerial photographs and through discussions with Mr. Woodward, Building T-223 was identified as a paper incinerator possibly used for the destruction of sensitive documents. The incinerator sat either on the ground or on a concrete pad (unclear from the aerial photographs) and was covered by a roof.

Building 2410 was built in approximately 1952 and was initially used as a warehouse, with cable storage to the north. Building 2410 was used as a maintenance shop in 1958, a warehouse and woodshop in 1970, and more recently as an administration building.

Building 2320 was used as a carpenter shop in late 1950. Equipment present included a milling machine, a drill press, and a lathe.

Building 2400 was built in approximately 1964. The former photo neutralization pit, removed and "clean closed" by the Virginia Department of Environmental Quality (VDEQ), was part of the original construction of Building 2400. In 1964, Building 2400 housed a machine shop, spray paint booth, welding room, photo room, dark rooms, and printed circuit lab. The concrete slab in this building is 4 to 6 inches thick. In areas, the slab is 5 inches thick on 6 inches of porous fill; there may be some rebar as well as a vapor barrier between the slab and the porous fill.

During construction of Building 2400 in 1964, the sanitary sewerline was redirected around the building. As a result, a portion of the sewerline existing at that time was abandoned as shown on Figure E-1. The portion of the abandoned sewerline under Building 2400 was grouted. The abandoned sewerline initiates at the southeastern end of Building 2410. Per one drawing, the manhole at Building 2410 had a top elevation of 414.32 feet above mean sea level (ft amsl) and an invert elevation of 406.65 ft amsl. The abandoned sewerline traveled 431 ft to the next manhole at Building 2400 which had a top elevation of 406.62 ft amsl and an invert elevation of 401.98 ft amsl. That is, the abandoned sewerline is approximately 5 to 8 ft deep.

The parking lot behind Building 2400 was constructed in 1966.

Figure E-1 highlights the most significant findings from the historical building drawing review. As shown on Figure E-1, the line of monitoring wells showing high concentrations of TCE and PCE (i.e., NP-PZ2 and MW34-2 in particular) are in line with the abandoned sewerline behind Building 2400. This abandoned sewerline initiated at Building 2410, which does not appear to have used chlorinated solvents. Further, monitoring well MW34-1, located near the start of the abandoned sewerline, does not contain detectable levels of VOCs. The highest concentrations of VOCs, particularly CCl_4, identified at AREE 34 are at the location of monitoring well MW34-4. As discussed above and shown on Figure E-1, monitoring well MW34-4 is located at the former location of an incinerator.

2. Remote Sensing

   a. Geophysical investigation to locate septic fields, underground utilities, bunkers, etc. (e.g., ground penetrating radar [GPR], electromagnetic [EM] surveys) (Optional)

      Note: Based on the findings of the historical building drawing review, there is no immediate need to conduct this geophysical investigation.

3. Soil/Bedrock Stratigraphy

   a. Fracture trace analysis using historical aerial photographs, focusing on the vicinity of AREE 34.

   b. Geophysical investigation to locate bedrock fractures (e.g., very low frequency) (Optional)

4. Groundwater Chemistry/Biochemistry

   a. Groundwater sampling of MW34-2, MW34-3, MW34-4, MW34-5D, MW34-6D, MW34-7D, and NP-PZ2 for Target Compound List (TCL) VOCs to confirm the analytical results from the SRI

      See Tables E-1 and E-2 for analytical results (not validated).

   b. Groundwater sampling of MW34-1, MW34-2, MW34-3, MW34-4, MW34-5D, MW34-6D, MW34-7D, NP-PZ1, NP-PZ2, and NP-MW4 for geochemical parameters (i.e., sulfide, sulfate, nitrate, dissolved oxygen, ferrous iron, methane, ethane, ORP, pH, temperature, alkalinity, hydrogen, chloride, TOC, carbon dioxide and ethene) to evaluate natural attenuation

5. Groundwater Hydrology

   a. Geo-flow meter to assess, to the extent possible, the groundwater flow direction in each of the three bedrock monitoring wells (i.e., MW34-5D, MW34-6D, and MW34-7D)

b. 48-Hour constant rate aquifer hydraulic testing of Production Well #1, including analysis of extracted groundwater at 0 hour, 6 hours, 24 hours, and 48 hours for TCL VOCs

   Note: This aquifer hydraulic test has been postponed until early 2004 in response to a request by the Vint Hill Economic Development Authority.

   - Evaluate hydraulic properties of the fractured bedrock aquifer
   - Understand the interconnection between Production Well #1 and the bedrock monitoring wells at AREE 34
   - Ensure that the water produced by Production Well #1 is acceptable for use as drinking water
   - Assess the potential for future adverse impact on Production Well #1

c. Aquifer hydraulic test of monitoring well MW34-7D (Optional)

   - Need for test will be based on the findings of the Production Well #1 aquifer hydraulic test
   - Understand the hydraulic properties of the impacted portion of the fractured bedrock aquifer
   - Understand the interconnection between MW34-7D, which shows significant contamination, and the other two bedrock monitoring wells at AREE 34, which show minimal contamination

F. Future Investigations

1. Overburden Screening Investigation – Data Quality Objectives (DQOs) summarized in Table F-1

   a. MIP with concentrated gas traps

      - Utilize one geoprobe rig to advance MIP to obtain real-time VOC data. At each sample location, the MIP will be advanced to bedrock or refusal (whichever is first encountered). As the MIP is advanced, continuous readings will be recorded. In addition, concentrated gas traps will be collected every 5 ft for on-site ITMS analysis for VOCs.

        The same geoprobe rig will be used to collect verification soil samples and to install temporary wells for collection of verification groundwater samples, as described below. The time to switch the geoprobe rig from driving the MIP to driving a Macro-Bore soil sampler is minimal, and is more cost effective than paying the mobilization and substantial standby time for a second geoprobe rig. A second geoprobe rig may be mobilized during the second week of the investigation if the Project Team decides there are sufficient samples to be collected for the Overburden Soil Risk Assessment sampling and analysis phase (see Item F.2).

- Sample location decision matrix – see Figures F-1 and F-2

  - Initiate sampling with MIP near monitoring wells MW34-1, MW34-2, NP-PZ2, and MW34-4 (i.e., known "clean" and "contaminated" areas) for proof of technology. Repeat testing at these locations if Project Team believes there were possible false negatives. The results of this step will be used to assess whether the MIP with concentrated gas traps is an acceptable tool for investigating AREE 34 given site conditions and the level of contamination. The rest of the bullets in this item (Item F.1.a) assume that the MIP is an acceptable screening tool.

  - Move to locations of known contamination and/or potential source locations identified during historical building drawing review and/or "old-timer" interviews. If contamination is found in these locations, move out in four directions using a 10-ft grid and sample with the MIP. Continue sampling using 10-ft grid until the level of contamination drops significantly.

  - Move to perimeter of Building 2400 and continue MIP screening on 50-ft spacing. If contamination is found at any of the sampled locations, move out in four directions using a 10-ft grid and sample with the MIP. Continue sampling using 10-ft grid until the level of contamination drops significantly.

  - Once targeted sampling is completed, continue sampling using 50-ft grid over 250 ft x 400 ft area for general area coverage (see Figure F-2). If contamination is found at any of the sampled locations, move out in four directions using a 10-ft grid and sample with the MIP. Continue sampling using 10-ft grid until the level of contamination drops significantly. Note: At the discretion of the Project Team, based on review of the 3-D data visualization, samples may not be collected at every point on the 50-ft grid shown on Figure F-2.

- Conduct verification sampling (soil and groundwater) for a daily minimum of one soil (encore sampler) and one groundwater (temporary well) sample each from one "contaminated" and one "clean" location (see Figure F-3), if possible based on the results of the day's screening effort. At the end of each day, the Project Team will identify a "clean" location and a "contaminated" location for verification soil and groundwater (temporary well) sampling. Split samples will be analyzed on site using the ITMS and also off-site using GC/MS. The verification soil and groundwater samples will verify that the MIP and ITMS on-site screening is providing reliable results. In addition, the soil verification samples will provide data suitable for use in risk assessment (see Item F.2).

  - Verification samples will be collected from boreholes advanced within 10 inches of selected MIP boreholes

  - Verification soil samples will be collected using the same geoprobe rig that is used to advance the MIP. Verification soil samples will be collected using Macro-Bore soil samplers with disposable acetate liners. Soil samples will be collected from the most permeable zone within the depth interval of interest using encore samplers.

  - Collect verification groundwater samples using temporary wells constructed in geoprobe boreholes

- Geoprobe boreholes for temporary wells will be advanced using the same geoprobe rig that is used to advance the MIP

- A minimum of two temporary wells will be installed daily: one in a "clean" location; and one in a "contaminated" location. Additional temporary wells may be installed at the discretion of the Project Team.

- Utilize on-site lab (ITMS) to provide real-time results for verification samples – provides quantification of individual VOC analytes

- Send splits for 100% of minimum verification samples (soil and groundwater) off-site for further verification analysis (24-hour turnaround) by certified laboratory with full QA/QC – provides data of acceptable quality for risk assessment

- Utilize 3-D mapping of data for real-time data sharing and to assist in directing search plan (after 3rd day)

  - Allows integration of MIP screening results, on-site and off-site verification soil/groundwater sample analytical results, risk assessment soil sample results (see Item F.2), and monitoring well analytical results

  - Also useful for mapping stratigraphic data

- Other screening methodologies (see Table F-2) will be considered as backup investigation tools if the MIP fails (e.g., breaks during advancement, insufficient detection limit) or can not be used because of accessibility issues.

b. Alternate screening methods

The alternate screening methods identified in Table F-2 will be considered as backup investigation tools in the event the MIP fails to provide acceptable results or there are accessibility issues (e.g., inside buildings).

i. Geoprobe/ITMS Soil and Groundwater Analysis – Exterior Locations

  - Sample selection decision matrix (similar to Figure F-1)

  - Utilize one geoprobe rig to collect Macro-Bore soil samplers (using disposable acetate liners and encore samplers) at predetermined depths for on-site ITMS analysis. The Macro-Bore sampler will be driven to bedrock or refusal. A second geoprobe rig will be mobilized on site if the Project Team determines that it will be more cost effective due to the volume of samples to be collected.

    - Initiate sampling near monitoring wells MW34-1, MW34-2, NP-PZ2, and MW34-4 (i.e., known "clean" and "contaminated" areas) for proof of technology. Repeat testing at these locations if Project Team believes there were possible false negatives. The results of this step will be used to assess whether this approach, which involves the collection of a large number of soil samples, is an acceptable tool for investigating AREE 34 given site conditions and the level of contamination. The rest of the bullets in this item (Item F.1.b.i) assume that this is an acceptable screening approach.

- Move to locations of known contamination and/or potential source locations identified during historical building drawing review and/or “old-timer” interviews. If contamination is found in these locations, move out in four directions using a 10-ft grid and collect additional samples. Continue sampling using 10-ft grid until the level of contamination drops significantly.

- Move to perimeter of Building 2400 and continue MIP screening on 50-ft spacing. If contamination is found at any of the sampled locations, move out in four directions using a 10-ft grid and collect additional samples. Continue sampling using 10-ft grid until the level of contamination drops significantly.

- Once targeted sampling is completed, continue sampling using 50-ft grid over 250 ft x 400 ft area for general area coverage (see Figure F-2). If contamination is found at any of the sampled locations, move out in four directions using a 10-ft grid and collect additional samples. Continue sampling using 10-ft grid until the level of contamination drops significantly. Note: At the discretion of the Project Team, based on review of the 3-D data visualization, samples may not be collected at every point on the 50-ft grid shown on Figure F-2.

• Conduct verification sampling (soil and groundwater) for a daily minimum of one soil (encore sampler) and one groundwater (temporary well) sample each from one “contaminated” and one “clean” location (similar to Figure F-3), if possible based on the results of the day’s screening effort. At the end of each day, the Project Team will identify a “clean” location and a “contaminated” location for verification soil and groundwater (temporary well) sampling. Split samples will be analyzed on site using the ITMS and also off-site using GC/MS. The soil split samples will provide soil data suitable for risk assessment, while to groundwater splits will verify that the soil sample screening with the geoprobe is correlating with actual groundwater concentrations.

  - Verification samples will be collected from boreholes advanced within 10 inches of selected screening boreholes

  - Verification soil samples will be collected using the same geoprobe rig that is used for the geoprobe soil screening sampling. Verification soil samples will be collected using Macro-Bore soil samplers with disposable acetate liners. Soil samples will be collected from the most permeable zone in the depth interval of interest using encore samplers.

  - Collect verification groundwater samples using temporary wells constructed in geoprobe boreholes

  - Geoprobe boreholes for temporary wells will be advanced using the same geoprobe rig that is used for the geoprobe soil screening sampling

- A minimum of two temporary wells will be installed daily: one in a “clean” location; and one in a “contaminated” location. Additional temporary wells may be installed at the discretion of the Project Team.

- Utilize on-site lab (ITMS) to provide real-time results for verification samples – provides quantification of individual VOC analytes

- Send splits for 100% of minimum verification samples (soil and groundwater) off site for further verification analysis (24-hour turnaround) by certified laboratory with full QA/QC – provides data of acceptable quality for risk assessment

- Utilize 3-D mapping of data for real-time data sharing and to assist in directing search plan (after 3rd day)

  - Allows integration of geoprobe soil screening sampling ITMS results, on-site and off-site verification soil/groundwater sample analytical results, risk assessment soil sample results (see Item F.2), and monitoring well analytical results

  - Also useful for mapping stratigraphic data

ii. Soil Gas Survey (Active or Passive [e.g., Gore Sorbers]) – Primarily Building Interior

- Decision matrix (to be developed)

- Search for source under Building 2400 or other areas not accessible to geoprobe

- Utilize MIP data to determine the “need for” and initial “number and location of” active/passive soil gas samples

- Utilize hammer drill to drill holes for sample collection, and air pump to purge and collect gas sample (active soil gas)

- Utilize hammer drill to install Gore Sorbers (passive soil gas)

- Active soil gas samples will be analyzed on site for VOCs using ITMS, while passive soil gas samples will be analyzed off site for VOCs by the Gore sorber manufacturer

- The need for off-site analysis of active soil gas sample splits will be made at the discretion of the Project Team

2. Overburden Soil Risk Assessment Sampling – DQOs summarized in Table F-1

The scope of the Overburden Soil Risk Assessment sampling will be determined by the Project Team based on the results of the MIP and ITMS on-site screening. Since the verification soil samples are suitable for risk assessment, it is possible that additional risk assessment soil sampling may not be required (see decision matrix [Figure F-4]). Dependent upon the determined scope of the Overburden Soil Risk Assessment sampling effort, a second geoprobe rig may be mobilized to the site so that the MIP investigation can proceed concurrently with the risk assessment sampling.

Note that the groundwater samples identified as part of this phase of the field effort will be collected from temporary wells which do not provide data acceptable for risk assessment purposes. Rather, any groundwater sampling conducted as part of this phase of the field effort will be collected to help determine the “need for” and “number and location of” additional overburden monitoring wells for either collection of groundwater samples for risk assessment purposes or for long-term monitoring (see Item G.1.a).

- Review overburden screening investigation results (MIP or alternate screening method) utilizing 3-D data visualization to identify locations of VOC contamination. Project Team decides the nature and magnitude of Overburden Soil Risk Assessment sampling (see Figure F-4). This decision will consider whether verification soil samples have already been collected for off-site analysis at locations of interest for the Overburden Soil Risk Assessment sampling effort during the verification sampling effort.

- Risk assessment soil samples will be collected using Macro-Bore soil samplers with disposable acetate liners. Soil samples will be collected from the most permeable zone in the location and depth interval of interest using encore samplers.

- Utilize on-site lab (ITMS) to provide real-time results to be sure split samples being sent off site for analysis are likely to provide anticipated results (an issue due to soil heterogeneity).

- Send 100% of split soil samples off site for analysis using GC/MS (24-hour turnaround) by certified laboratory with full QA/QC – provides data of acceptable quality for risk assessment

- As desired to further evaluate the groundwater contamination, additional temporary wells may be installed at the discretion of the Project Team. Temporary wells will be constructed in geoprobe boreholes. Groundwater samples collected from the temporary wells will be analyzed using the on-site ITMS. Since any samples collected using temporary wells will not be suitable for use in risk assessment, the need for off-site analysis of groundwater samples during this phase of the field effort will be at the discretion of the Project Team (e.g., in the event that the Project Team is not confident in some of the screening results).

3. Bedrock Investigation

   a. Monitoring wells in the fractured bedrock

      - Install adequate number of monitoring wells (2 to 4 estimated) to allow triangulation to assess horizontal groundwater flow direction and to assess VOC contamination in the fractured bedrock aquifer

      - Determine location of additional monitoring wells after completion of MIP and/or soil gas investigations

      - Utilize air rotary rig to drill boreholes to install bedrock monitoring wells

- Utilize down-hole video taping of open boreholes prior to monitoring well installation

G. Possible Remedial Approaches

1. Long-term Monitoring

   a. Install additional monitoring wells in the saturated overburden, if necessary

   - Need for additional monitoring wells and locations will be based on results of MIP investigation

   - Utilize hollow-stem augers or air rotary rig to drill boreholes to install overburden monitoring wells. Type of drill rig to be used will be determined by other drilling activities that may be implemented at the same time (e.g., Bedrock Investigation).

   b. Remediation Goals

   - Establish Risk-based Cleanup Levels ($1x10^{-6}$ cancer risk for individual predominant VOCs, HI = 1 non-cancer risk for group of predominant VOCs impacting the same target organ)

   - Utilize MCLs as remediation goal when they are higher than Risk-based Cleanup Level for an individual VOC

2. Possible Source or Hot Spot Treatment Using an In-situ Technique

   a. In-situ Bioremediation

   b. In-situ Oxidation

3. Institutional Controls (e.g., deed restrictions limiting groundwater use)

   a. Commonwealth of Virginia does not have a groundwater classification system (i.e., all groundwater has potential for use as drinking water unless formally restricted)

Table D-1
Comparison Between MIP, ITMS, and GC/MS for AREE 34 Contaminant Delineation Study

Method	Sensitivity	Capacity	Costs
Membrane Interface Probe (MIP) by Columbia Technologies or Vironex	Readings sensitive to approximately 500 ppb total VOCs.	8-10 holes or locations per day to approximately 30 feet per hole.	<u>Columbia Technologies</u> 10 days MIP logging: $35,000 ($3,500/day) 10 days of SmartScan™ trapping: $5,000 5 days field sampling team w/ large probe: $8,250 ($1,650/day) 25 days per diem: $3,125 ($125/man/day) Mobilization/demobilization: $1,000 SmartData Solutions™ Data Management, Processing and Interactive Webcast: $4,500 TOTAL: $56,875 Standard rates are based on a total of 9 hours of field, prep, decon and travel. Additional Costs: Probes lost or damaged due to subsurface conditions are charge at $1,500 each. **<u>Pricing pending from Vironex</u>**
VOCs by Ion Trap MS (ITMS) by Tri-Corders: Aq & So: USEPA SW-846 8265	Aqueous: 5 µg/L Soil: 20 µg/kg Air: Gas (traps) dependent upon matrix. Approximately 100 ppbv.	Soils, GW, and air trap samples: 60-90 samples per day for soil and water. No significant time difference to switch between soil and GW. Minimal time to switch to air.	Air, Soil, and GW: $3,600/day lab cost (includes mobilization cost); $360/hr ($180 half hr) cost if over 10 hours/day
VOCs by GC/MS by Vironex: Aq: USEPA SW-846 5030B/8260B So: USEPA SW-846 5035/8260B	Air: 5 ppbv (Tedlar bags) Aqueous: 5 µg/L (10 µg/L for poor purgers) Soil: 10 µg/kg (20 µg/kg for poor purgers)	Soils and GW: 25-30 samples per day for soil and water. No significant time difference to switch between soil and GW. Air (collect using discrete Tedlar bag samples): 25-30 samples per day for air using second GC unit.	Soil and GW: $1,500/day lab cost; $500 mobilization cost; $72/sample cost ($2,160/30 samples) Air (Tedlar bag samples): **<u>Pricing pending from Vironex</u>**

Table E-1

Summary of Detected AREE 34 Groundwater Analytical Results - Saturated Overburden (July 2003) (Not Validated)

PARAMETER	MCL	Analytical Results				
Site ID		**MW34-2**		**MW34-3**	**MW34-4**	**NP-PZ2**
Field Sample Number		**MW34-2-0703**	**MW34-2-0703D**	**MW34-3-0703**	**MW34-4-0703**	**NP-PZ2-0703**
Collection Date		7/1/2003	7/1/2003	7/1/2003	7/1/2003	7/1/2003
Volatile Organic Compounds (mg/L)						
Carbon Tetrachloride	5	3.7	3.5 D	<1.0	86.1	<1.0
Chloroform	100	3.3	3.9 D	<1.0	9.2	<1.0
1,1-Dichloroethane	NE	2.2	2.2 D	<1.0	4.8	0.84 J
1,1-Dichloroethene	7	21.3	22.4 D	9.1	64.1	24.5
cis-1,2-Dichloroethene	70	4.6	5.0 D	1.1	11.2	0.72 J
Tetrachloroethene	5	39.0	40.6 D	13.4	24.9	32.1
1,1,2-Trichloroethane	5	2.1	1.9 D	<1.0	1.7	1.1
Trichloroethene	5	22.2	23.3 D	4.2	38.6	16.4

Shaded values exceed the corresponding MCL.

D - Duplicate analysis.

J - Reported value may not be accurate or precise (estimated).

MCL - Maximum Contaminant Level - The maximum permissible level of a contaminant in drinking water which is delivered to any user of a public water system.

NE - No MCL established for this parameter.

Table E-2

Summary of Detected AREE 34 Groundwater Analytical Results - Bedrock Aquifer (July 2003)
(Not Validated)

PARAMETER	**MCL**	**Analytical Results**		
Site ID		**MW34-5D**	**MW34-6D**	**MW34-7D**
Field Sample Number		**MW34-5D-0703**	**MW34-6D-0703**	**MW34-7D-0703**
Collection Date		6/30/2003	6/30/2003	7/1/2003
Volatile Organic Compounds (mg/L)				
Carbon Tetrachloride	5	8.5	0.58 J	1.0
Chloroform	100	7.0	1.2	0.87 J
1,1-Dichloroethane	NE	<1.0	<1.0	3.8
1,2-Dichloroethane	5	<1.0	<1.0	1.4
1,1-Dichloroethene	7	<1.0	<1.0	190 Di
cis-1,2-Dichloroethene	70	<1.0	<1.0	2.7
Tetrachloroethene	5	12.4	<1.0	149 Di
1,1,1-Trichloroethane	200	<1.0	<1.0	1.1
1,1,2-Trichloroethane	5	<1.0	<1.0	4.5
Trichloroethene	5	0.60 J	<1.0	71.3

Shaded values exceed the corresponding MCL.
Di - Diluted result.
J - Reported value may not be accurate or precise (estimated).
MCL - Maximum Contaminant Level - The maximum permissible level of a contaminant in drinking water which is delivered to any user of a public water system.
NE - No MCL established for this parameter.

Table F-1
Data Quality Objectives for AREE 34 Contaminant Delineation Study

DQO Elements		AREE 34 MIP and ITMS On-Site Screening DQOs	AREE 34 Screening Performance Verification Sampling DQOs	AREE 34 Risk Assessment Overburden Soil Sampling and Analysis DQOs
1. STATE THE PROBLEM	PROBLEM STATEMENT	A Remedial Investigation (RI) and Supplemental Remedial Investigation (SRI) were performed for groundwater and soil at AREE 34 indicating VOC concentrations (primarily PCE, TCE, and CCl_4) in the groundwater. As a result of the RI / SRI data, further on-site screening delineation is required to: 1) Locate source(s) of contamination or show that a major source does not exist, and 2) Identify the lateral and vertical extent of contamination in the saturated overburden.	Historical concentrations of individual VOC constituents have been found within or around 100 ppb. This level approaches the sensitivities of the site screening tools. To verify the screening data, verification split samples are proposed for collection and analysis. The verification samples may also be used in the risk assessment.	Groundwater and soil samples at AREE 34 are to be collected at areas indicating VOC concentrations (primarily PCE, TCE, and CCl_4). The soil and groundwater samples will both be analyzed on site by ITMS. Split soil samples are to be sent to the off-site lab for VOC analysis by GC/MS for use in risk assessment. The groundwater samples may be sent off-site at the discretion of the Project Team. The on-site ITMS groundwater results are to provide data to determine possible future locations of overburden monitoring wells for risk assessment and/or long-term monitoring as well as provide assessment of ongoing site conditions. The number of samples and sampling locations will be determined by the Project Team based upon the site screening data. The risk assessment will be performed to: 1) Obtain additional data as to the nature and extent of VOC contamination, 2) Obtain additional data to evaluate the possibility of remediation by in-situ oxidation or in-situ bioremediation, and 3) Determine whether impacted areas pose a risk scenario at AREE 34.
2. IDENTIFY THE DECISION	DECISION STATEMENT	Preliminarily delineate the spatial distribution of VOC constituents at AREE 34 in groundwater and soil.	"Verify" that MIP and ITMS screening data are "good". Verification samples are to be collected daily during on-site screening with the MIP and ITMS to establish a correlation between the site screening tools and verification samples.	Provide additional data for VOC constituents at AREE 34 to perform risk assessment of impacted areas.
	ALTERNATIVE ACTIONS	1) No additional evaluation is necessary. 2) Further study is warranted.	1) No additional verification is necessary. 2) Further verification methods are warranted.	1) No additional assessment is necessary. 2) Further risk assessments are warranted.
3. IDENTIFY THE INPUTS TO THE DECISION	CHEMICALS OF INTEREST	VOC constituents to be considered based on the historical data. Membrane interface probe (MIP) will be used as a screening tool to characterize semi-quantitatively total VOCs in the subsurface using Geoprobe percussion soil equipment. In addition, samples will be trapped at 5-foot intervals and analyzed using Ion Trap Mass Spec (ITMS) analysis to provide additional screening data. The MIP and ITMS screening will be performed down to bedrock or refusal, whichever is first encountered at each location.	VOC constituents are primarily PCE, TCE, and CCl_4.	VOC constituents are primarily PCE, TCE, and CCl_4.
	PHYSICAL DATA	Sample locations will be mapped based on field measured grid system.	Sample locations will be mapped based on field measured grid system.	Sample locations will be mapped based on field measured grid system.
	ANALYTICAL METHODS	<u>On-Site Chemical Screening Data</u>: VOCs: MIP VOCs: ITMS, USEPA SW-846 8265	<u>On-Site Split Verification Chemical Data</u>: VOCs by ITMS: Aq & So: USEPA SW-846 8265 <u>Off-Site Split Verification Chemical Data</u>: VOCs by GC/MS: Aq: USEPA SW-846 5030B/8260B So: USEPA SW-846 5035/8260B	<u>On-Site Chemical Data</u>: VOCs by ITMS: Aq & So: USEPA SW-846 8265 <u>Off-Site Chemical Data</u>: VOCs by GC/MS: Aq: USEPA SW-846 5030B/8260B So: USEPA SW-846 5035/8260B

Table F-1
Data Quality Objectives for AREE 34 Contaminant Delineation Study (Continued)

DQO Elements		AREE 34 MIP and ITMS On-Site Screening DQOs	AREE 34 Screening Performance Verification Sampling DQOs	AREE 34 Risk Assessment Overburden Soil Sampling and Analysis DQOs
3. IDENTIFY THE INPUTS TO THE DECISION, CONTINUED	METHOD QUANTITATION LIMITS	MIP: Readings sensitive to approximately 500 ppb total VOCs. ITMS: Gas (trap) dependent upon matrix. Approximately 100 ppbv.	ITMS: Aqueous: 5 µg/L Soil: 20 µg/kg GC/MS: Aqueous: 5 µg/L (10 µg/L for poor purgers) Soil: 10 µg/kg (20 µg/kg for poor purgers)	ITMS: Aqueous: 5 µg/L Soil: 20 µg/kg GC/MS: Aqueous: 5 µg/L (10 µg/L for poor purgers) Soil: 10 µg/kg (20 µg/kg for poor purgers)
	FIELD QUALITY CONTROL SAMPLES	Split Performance Verification Samples (positive and negative QC checks) daily per screening technique per matrix. More samples may be required at the discretion of Project Team depending upon MIP and ITMS performance.	Not Applicable	Field duplicate at 10% per matrix (soil only). NOTE: Soil samples will be collected using disposable acetate liners and encore samplers; therefore, equipment blanks are not required. Further, trip blanks are only required for aqueous samples. Since GW samples from temporary wells will not be used for risk assessment, QC samples are not required for GW samples.
	DATA USE	Contaminant Delineation	MIP/ITMS Screening Verification and Risk Assessment	Risk Assessment and Contaminant Delineation
	VALIDATION DATA LEVEL	USACE Level II	Aq: USACE Level II Soil: Risk Assessment Samples: USACE Level IV (USEPA Region III Modifications to the NFGs)	Aq: USACE Level II Soil: USACE Level IV (USEPA Region III Modifications to the NFGs)
4. DEFINE THE BOUNDARIES OF THE STUDY	ACTION LEVELS	Not Applicable	Soil: USEPA Region III Risk-Based Concentrations for Residential Soil	Soil: USEPA Region III Risk-Based Concentrations for Residential Soil
	MEDIA TO SAMPLE	Gas (trap @ 5 foot internals to bedrock or refusal)	Subsurface soils and groundwater	Subsurface soil and groundwater
	SPATIAL BOUNDARIES	The main impact area identified for the purpose of this sampling to be within approximately 200 ft in all directions within AREE 34 from the most heavily suspected contaminated point.	The main impact area identified for the purpose of this sampling to be within approximately 200 ft in all directions within AREE 34 from the most heavily suspected contaminated point.	The main impact area identified for the purpose of this sampling to be within approximately 200 ft in all directions within AREE 34 from the most heavily suspected contaminated point.
	TIME FRAME	Approximately two weeks	Approximately two weeks	Approximately two weeks
	PRACTICAL CONSTRAINTS	Loamy soil, underground utilities in soil matrix, and limited access areas under buildings.	Loamy soil, underground utilities in soil matrix, and limited access areas under buildings.	Loamy soil, underground utilities in soil matrix, low recharge for groundwater sampling, and limited access areas under buildings.
	SCALE	The concentrations of VOC contaminants in soil will be screened within a 400'x400' area (approximately).	The concentrations of VOC contaminants in soil will be screened within a 400'x400' area (approximately).	The concentrations of VOC contaminants in soil will be screened within a 400'x400' area (approximately).
5. DEVELOP A DECISION RULE	DECISION RULE	The screening data will provide information to where further sampling is warranted as well as characterizing specific points at AREE 34.	Use verification samples in conjunction with screening data for establishing sampling points for future risk assessment sampling. Verification soil samples will also be used in the risk assessment.	If concentrations are below USEPA Region III RBCs for residential soil, then no additional assessment is necessary. Otherwise, perform risk assessment.
6. SPECIFY TOLERABLE LIMITS ON DECISION ERRORS	DECISION ERROR TOLERANCE	Statistical comparisons will not be made for this screening investigation; therefore, no limits on decision errors have been made.	If the data are statistically evaluated, a 95% confidence level will be used during the risk assessment.	If the data are statistically evaluated, a 95% confidence level will be used during the risk assessment.

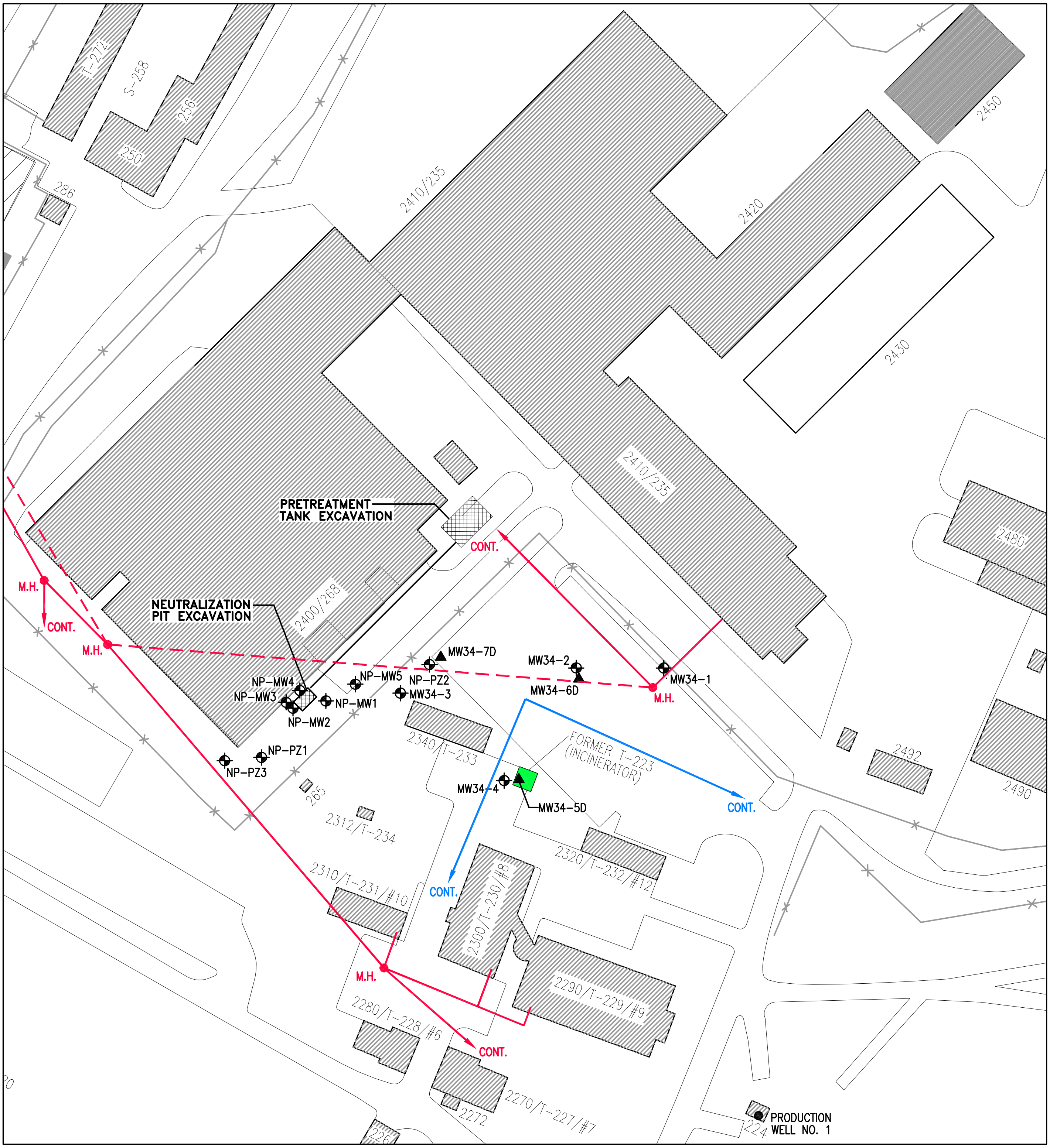
Table F-1
Data Quality Objectives for AREE 34 Contaminant Delineation Study (Continued)

DQO Elements		AREE 34 MIP and ITMS On-Site Screening DQOs	AREE 34 Screening Performance Verification Sampling DQOs	AREE 34 Risk Assessment Overburden Soil Sampling and Analysis DQOs
7. OPTIMIZE THE DESIGN FOR OBTAINING DATA	SAMPLING DESIGN	Start at MW34-1, MW34-2, NP-PZ2, and MW34-4 and confirm that screening methodology works. Move to locations of known contamination and/or identified potential sources of contamination; determine extent of any detected contamination. Move to perimeter of Building 2400 and continue screening at 50 ft intervals; determine extent of any detected contamination. Move to grid area and continue screening on 50 ft grid; determine extent of any detected contamination.	Collect one soil and one groundwater (temporary well) sample each from one “contaminated” and one “clean” location daily for both on-site and off-site analysis. Additional samples may be collected at the discretion of the Project Team.	Collect additional soil and groundwater (temporary well) samples for on-site and/or off-site analysis as determined by the Project Team. The Project Team will decide the location and number of samples based on 3-D data visualization of MIP and ITMS screening results. Soil data are to be used for risk assessment, and groundwater data are to be used to assess need for and location of additional overburden monitoring wells.

Table F-2
Alternate Screening Methodology Considerations

Consideration	Active Soil Gas	Passive Soil Gas	Geoprobe/ITMS Soil and Groundwater Sampling and Analysis
Accessibility - Indoors			
fits thru 36" wide opening	yes	yes	no
fits thru 80" high opening	yes	yes	no
overhead restrictions	no	no	yes
significant noise	some	some	yes
able to relocate easily	yes	yes	no
short sampling time	yes	yes/no*	no
Accessibility - Outdoors			
slope restrictions	no	no	some
overhead utility restrictions	no	no	some
significant noise	some	some	yes
able to relocate easily	yes	yes	yes
short sampling time	yes	yes/no*	no
Analytical			
possible real-time data	yes	no	yes
able to collect sample immediately	yes	no	yes
use MIP analytical setup	yes	no	yes
possible off-site analysis	yes	yes	yes
Extent of Contamination			
ability to identify contamination at depth	poor	poor	very good
representative of large lateral extent	no	some	no
Other Considerations			
indoor use - acceptable to Owner/Tenant	likely	likely	not likely

* Readily installed and collected; however, must be left in place for approximately 2 weeks.



LEGEND:

BUILDING

FENCE

MW34-4 ..... OVERBURDEN MONITORING WELL

MW34-7D ..... BEDROCK MONITORING WELL

PRODUCTION WELL NO. 1 ..... PRODUCTION WELL

M.H. ..... MANHOLE

WATERLINE (APPROX. LOCATION)

SEWERLINE (APPROX. LOCATION)

ABANDONED SEWERLINE (APPROX. LOCATION)

N

0 50 100

SCALE IN FEET

US ARMY CORPS OF ENGINEERS

BALTIMORE DISTRICT

CONTRACT NO. DACA31-01-F-0142

Shaw™ Shaw Environmental, Inc.

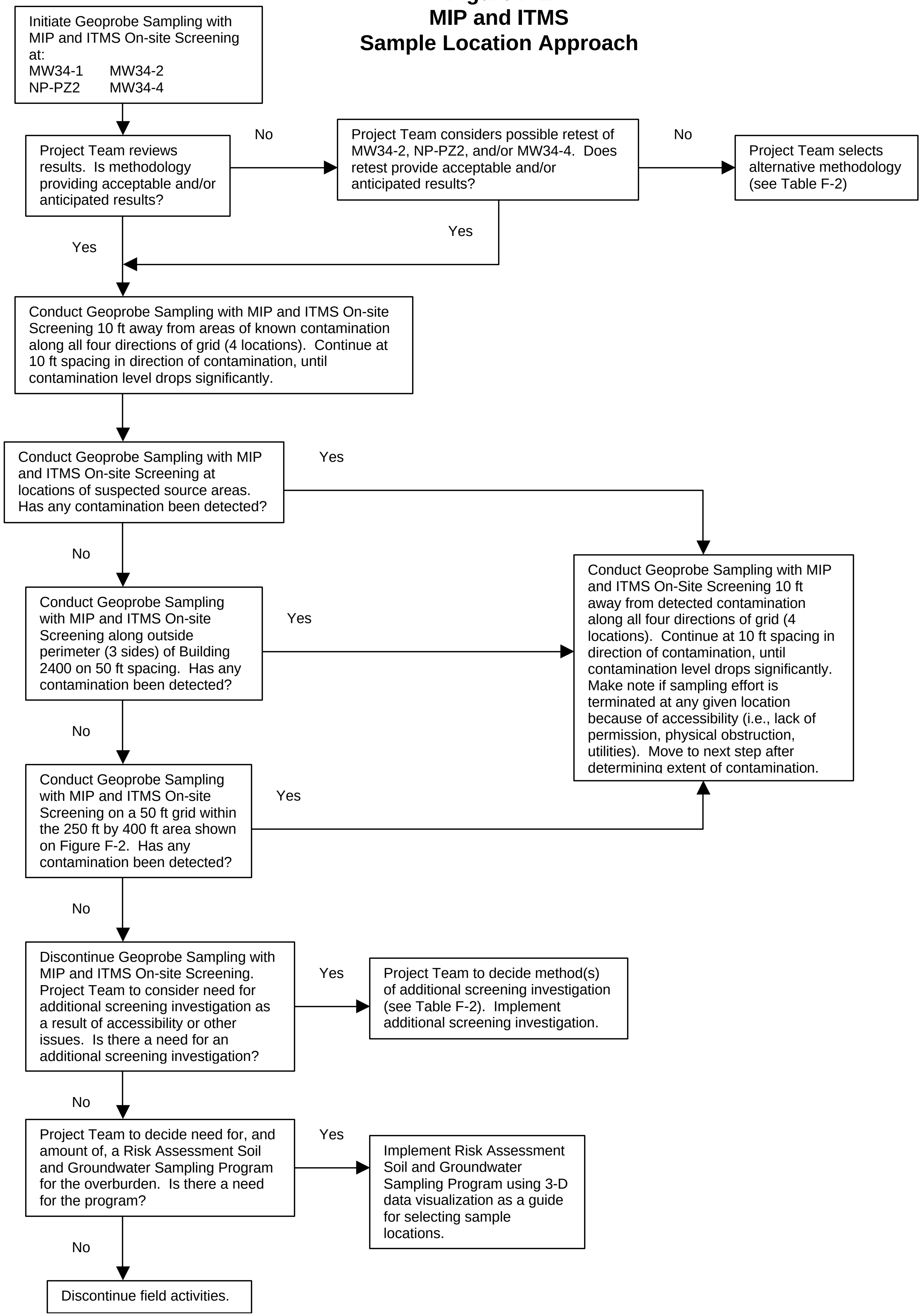
PREPARED	WSS	TASK NO:	84507908000000
CHECKED	NZ	SHAW DWG NO:	
DATE	7-31-03		GSA1-080-01-002

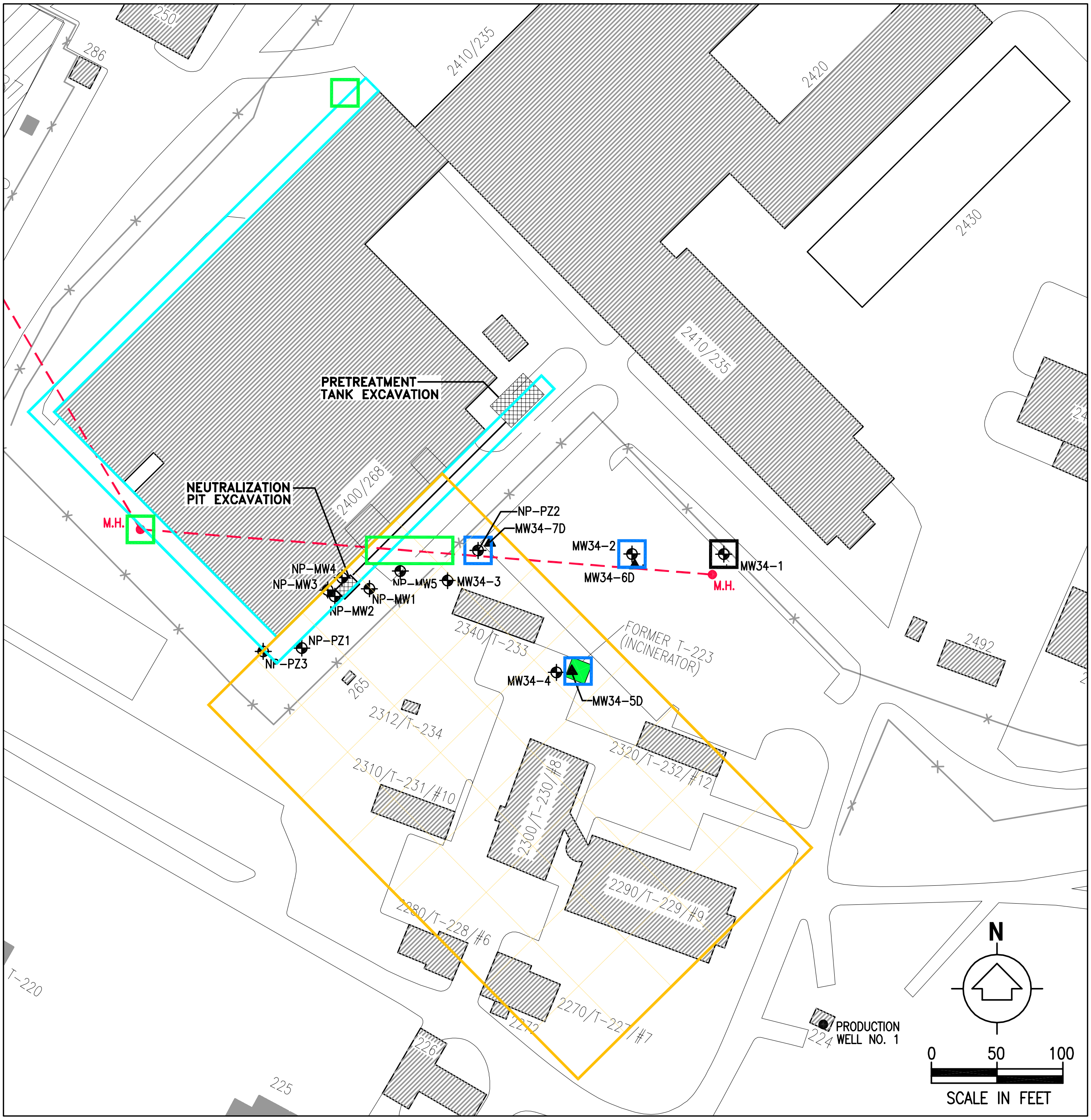
FIGURE E-1

VINT HILL FARMS STATION

AREE 34 – SURROUNDING BUILDING AND SITE FEATURES

Figure F-1
MIP and ITMS
Sample Location Approach





LEGEND:

BUILDING

FENCE

MW34-4 OVERBURDEN MONITORING WELL

MW34-7D BEDROCK MONITORING WELL

PRODUCTION WELL NO. 1 PRODUCTION WELL

M.H. MANHOLE

ABANDONED SEWERLINE (APPROX. LOCATION)

PROOF OF TECHNOLOGY SAMPLING POINT

PROOF OF TECHNOLOGY SAMPLING POINT/ KNOWN CONTAMINATION SAMPLING POINT

POTENTIAL SOURCE OF CONTAMINATION SAMPLING POINT

BUILDING 2400 PERIMETER SAMPLING POINT

250 FT BY 400 FT SAMPLING GRID

US ARMY CORPS OF ENGINEERS

BALTIMORE DISTRICT

CONTRACT NO. DACA31-01-F-0142	FIGURE F-2 VINT HILL FARMS STATION
Shaw Shaw Environmental, Inc.	AREE 34 SCREENING SAMPLING LOCATION PLAN
PREPARED WSS	TASK NO: 84507908000000
CHECKED NZ	SHAW DWG NO:
DATE 7-28-03	GSA1-080-01-001

Figure F-3
MIP and ITMS On-Site Screening and Associated Performance Verification Sampling at AREE 34

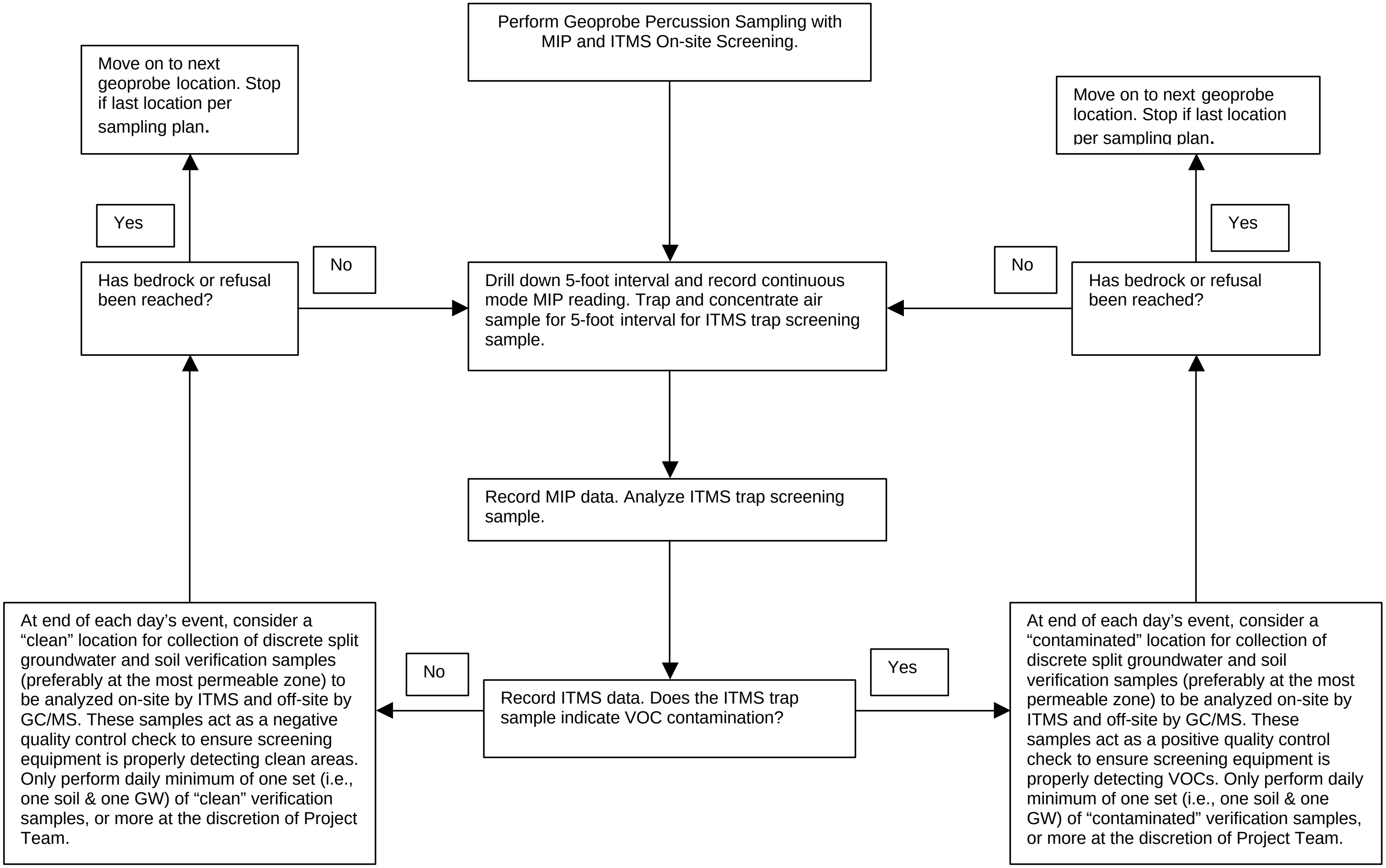


Figure F-4
Follow-on Overburden Soil Risk Assessment Sampling at AREE 34