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PUBLIC WORKS BUSINESS CENTER
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INSTALLATION MANAGEMENT AGENCY
FORT BRAGG, NORTH CAROLINA

DECISION DOCUMENT FOR RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) REMEDIAL ACTION (RA) SOLID WASTE MANAGEMENT UNIT (SWMU) 14, (DSERTS #FTBR014) FORT BRAGG, NORTH CAROLINA

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DRAFT FINAL

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1.0 SCOPE OF THE DECISION DOCUMENT/REMEDIAL ACTION. A Resource Conservation and Recovery Act of 1976 (RCRA) facility investigation (RFI) has been completed for Operable Unit (OU) 3 at the Fort Bragg Military Reservation. OU3 consists of Solid Waste Management Units (SWMUs) 8, 9, and 2/14, which are abandoned landfills occupying the flanks of a north–south-trending stream valley formed by Beaver Creek and its tributaries (See Figure 3.1). SWMU 14 lies within the boundaries of SWMU 2. The North Carolina Department of Environment and Natural Resources (NCDENR) approved a finding of no further action for SWMU 2 (NCDENR 1996) in 1996. Consequently, SWMU 2 is excluded from the scope of this Decision Document (DD). The RFI report was approved by NCDENR. The SWMUs 8 and 9 are evaluated in separate decision documents. The conclusions and recommendations for SWMU 14, listed below, were reached by the U.S. Geological Survey (USGS) and documented as stated below in the RFI report based on the data collected in 1994 and 1995 (USGS 1996).

a. Six contaminants were discovered in surface soil: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, and arsenic. Restriction of future residential and industrial land use at SWMU 14 should alleviate the risk posed by polycyclic aromatic hydrocarbons (PAHs) in surface soil to potential future occupational workers, residents, and trespassers. The maximum concentration of arsenic (1.3 mg/kg) in surface soil at SWMU 14 was comparable to arsenic concentrations (range of 0.13 to 4.0 mg/kg) detected in soil samples from a background location (BS1); therefore, no further action was recommended for arsenic in surface soil.

b. Four constituents [tetrachloroethene (PCE), arsenic, iron, and manganese] were confirmed in samples of groundwater. The Fort Bragg water treatment plant currently provides treated municipal water to the cantonment area for drinking water purposes; groundwater in the cantonment area was not used as a source of drinking water. The RFI and corrective measures study (CMS) recommended that if Fort Bragg adhered to this practice in the future and did not use groundwater at SWMU 14 as a water supply source, that would alleviate any risk posed by the constituents to potential future residents.

c. Thirty-one contaminants were identified in surface soil, including 16 semivolatile organic compounds (SVOCs), 3 pesticides, the polychlorinated biphenyl (PCB) Aroclor-1254, and 11 metals. Results of the risk characterization indicated that terrestrial wildlife species that might live or forage at SWMU 14 were unlikely to be at risk from exposure to these contaminants in surface soil at the site. Adverse effects to terrestrial invertebrates from exposure to contaminants in surface soil were also found to be unlikely. Maximum and average exposure point concentrations of aluminum, chromium, and vanadium exceeded plant reference toxicity values. This indicates that sensitive plant species were potentially at risk from exposure to these contaminants in surface soil; however, any potential risks posed by these analytes might not be site-related. Background concentrations of aluminum, chromium, and vanadium, at other background sample locations on the installation, also exceeded their respective reference toxicity values.

d. Five metals were identified as contaminants for surface soil. For streambed sediment, 2 volatile organic compounds (VOCs), 11 SVOCs, 3 pesticides, and 3 metals were identified. Wildlife receptors are unlikely to be at risk from exposure to concentrations in surface water and sediment associated with SWMU 14. Aquatic receptors downstream from SWMU 14 might be at risk from exposure to aluminum, iron, lead, and zinc in surface water because concentrations of these analytes exceeded screening values and were slightly elevated relative to upstream concentrations.

e. Aquatic receptors in Beaver Creek might be at risk due to the presence of fluoranthene, pyrene, chlordane, and dieldrin in sediment at concentrations exceeding screening values. Although fluoranthene and pyrene were detected in surface soil at SWMU 14, these contaminants (fluoranthene, pyrene, chlordane, and dieldrin) were also detected in upstream sediment samples at comparable concentrations; therefore, any potential risks posed by these contaminants might not be site-related.

f. Additional characterization was performed at OU3, subsequent to the publication of the RFI, to more thoroughly evaluate the groundwater characteristics and the methane concentrations at the landfills in SWMU 8, SWMU 9, and SWMU 14. This DD uses information from the RFI report (USGS 1996), along with supplemental data collected from subsequent investigations, in 1999, 2000, and 2001. The combined information is used to develop and evaluate corrective actions for the abandoned landfill at SWMU 14 to achieve the proposed remedial levels. Potentially applicable corrective action technologies and alternatives are screened and evaluated to address soil and groundwater contamination and elevated levels of methane in soil at SWMU 14.

g. The Selected Remedy for SWMU 14 is Passive Venting, Institutional Controls for Soil, Groundwater and Methane Monitoring, and Implementation of Operations and Maintenance (O&M) Plan. This alternative takes measures to reduce the methane concentration in the soil considering the location of the structures adjacent to areas of high methane soil gas. In addition, the land areas that would need to be restricted by fencing are currently being used for vehicle storage. This alternative also reduces the restrictions that must be placed on land use. The institutional controls in this alternative will provide a combination of land-use restrictions and prohibitions as well as a physical barrier with warning signs around the perimeter of the abandoned landfill containing PAHs in excess of remedial levels. Land-use restrictions will be documented through the Base Master Plan (BMP), fencing, and signage.

1.1 SITE BACKGROUND. The SWMU 14 is bounded on the north and south by wooded areas, on the west by Beaver Creek, and on the east by the Fort Bragg Central Receiving Area (see Figure 3.1). SWMU 14 consists of two small landfills designated as 14a and 14b that were established on top of the north-central portion of SWMU 2. Landfills 14a and 14b were active from 1985 to 1986 and occupy a total of approximately 5 acres. Only construction debris was reportedly disposed of in SWMU 14. Both landfills are unlined and have a vegetative cover consisting of grasses and scrub pines. Debris disposed of at Landfills 14a and 14b is partially exposed along the steep slopes facing Beaver Creek.

1.2 REGULATORY BACKGROUND.

a. Fort Bragg is a U.S. Department of Defense (DOD) facility in the Installation Restoration Program (IRP). Under the IRP, the facility is required to work toward compliance with Federal and State environmental laws and regulations. In 1988, a RCRA facility assessment of the reservation was performed to identify areas of concern with respect to compliance with RCRA and the Hazardous and Solid Waste Amendments (Kearney, Inc. and DPRA, Inc. 1988). Fort Bragg holds a RCRA permit issued by the U.S. Environmental Protection Agency (EPA) Region IV and NCDENR. An RFI was performed to address environmental conditions at 31 SWMUs and 7 areas of concern at Fort Bragg in accordance with

RCRA corrective action guidelines. The RFI included a field investigation of OU3 in 1994 and 1995 to determine the nature and extent of contamination in soil and groundwater and the potential for migration of contamination from the source areas. Soil gas surveys were performed to obtain preliminary information for locating soil-boring sample collection and monitoring well installation sites. The RFI report for OU3 was completed in December 1996 (USGS 1996). Additional field investigations to update information on contamination levels at OU3 were conducted in March and April 1999, March 2000, March 2001, and August 2002.

b. The regulatory authority governing the action at SWMU 14 is the RCRA 40 Code of Federal Regulations 264, Title II, Subpart C, Section 3004 (42 United States Code 690 et seq.). Regulatory criteria and guidance for corrective actions at SWMU 14 include both soil and groundwater cleanup standards as well as methane monitoring and mitigation criteria.

c. Soil cleanup criteria include the risk-based remedial goal objectives (RGOs) calculated by the USGS in the 1996 RFI. Other guidance used in establishing remedial levels for soil include the North Carolina total petroleum hydrocarbons (TPH) guidance levels for soil (NCDENR 1993) and the Revised Interim Soil Lead Guidance for Comprehensive Environmental Response, Compensation and Liability Act and RCRA Corrective Action Facilities, EPA Office of Solid Waste and Emergency Response Directive 9355.4-12 (EPA 1994).

d. For groundwater the North Carolina Standards for Groundwater Protection [15A North Carolina Administrative Code (NCAC), EPA maximum contaminant levels (MCLs) for drinking water, and 2L 0202 (hereafter called NC 2L) and the interim maximum acceptable concentration (IMAC)] are criteria for cleanup.

e. The methane results collected were compared to the lower explosive limit (LEL) for methane of 5 percent. As a reference point, the North Carolina operational requirements for permitted municipal solid waste landfills (Title 15A, Chapter 13, Subchapter 13B, Section .1600) require owners and operators to ensure that:

(1) The concentration of methane gas generated by the facility does not exceed 25 percent of the LEL for methane in facility structures (1.25 percent) and

(2) The concentration of methane gas does not exceed the LEL for methane at the facility property boundary.

1.3 SITE OVERVIEW.

a. Fort Bragg is situated in northwestern Cumberland County and northern Hoke County. Cumberland County occupies about 661 $mile^2$ and has a population of about 303,000 people. Hoke County occupies about 414 $mile^2$ and has a population of about 34,000 people (U.S. Census Bureau 2000a).

b. Fort Bragg had a combined military and civilian population of approximately 29,000 in 2000 (U.S. Census Bureau 2000b). The principal population centers near Fort Bragg are the city of Fayetteville, 5 miles southeast, and Spring Lake, adjacent to the northeastern boundary of Fort Bragg. The estimated populations of Fayetteville and Spring Lake in 2000 were 121,000 and 8,000, respectively (U.S. Census Bureau 2000b).

c. With the exception of the urban areas of Fayetteville and Spring Lake, land near Fort Bragg is primarily forested, with scattered private dwellings, farms, and small communities. SWMU 14 is bounded on the east by Fort Bragg's Central Receiving facility, which includes storage buildings, storage yards, and other offices. The Defense Reutilization and Marketing Office is located to the east of SWMU 14.

d. Drinking water supplies for Fort Bragg and surrounding areas are primarily obtained from surface water sources. Water used at Fort Bragg is obtained from the Little River, which has a drainage area of about 348 $mile^2$. The average rate of water use at Fort Bragg was 7.2M gal/day in 1994 (USGS 1996). Water is impounded at two dams near the water treatment plant. Two supplemental water-supply reservoirs are maintained at Fort Bragg, Lake McArthur in the northwestern corner of the military reservation and McKellers Pond at the northwestern edge of the cantonment area. These two lakes, which drain into the Little River, have storage capacities of 9.6 and 2.6B gal, respectively (USGS 1996). Water supplies for the city of Fayetteville, which is southeast of Fort Bragg, and Spring Lake, to the north of Fort Bragg, are obtained from the Cape Fear River and impoundments along Cross Creek and Lower Cross Creek that drain the southeastern part of Fort Bragg.

e. There are 28 water-supply wells at Fort Bragg. Reported well depths range from 62 to 600 ft below land surface (BLS), with a median reported depth of 93 ft; reported yields range from 5 to 170 gal/min. Water levels in these 28 wells range from 11.5 to 85 ft BLS. Eleven of the 28 wells at Fort Bragg are located in the cantonment area. All are used to irrigate golf courses. Well 10, approximately 5 miles east of OU3 at Smith Lake Bath House and 320 ft BLS, provided potable water at the time of the RFI (USGS 1996). The Smith Lake well has subsequently been plugged and abandoned. Five of the 11 irrigation wells are located at the Officer's Club Golf Course, north and upgradient of OU3, and are in the Beaver Creek drainage area. The bottoms of the well screens are estimated to be at elevations ranging from 150 to 220 ft, suggesting that they are screened in the Middendorf aquifer and the underlying Cape Fear aquifer. Based on regional groundwater flow directions, it is unlikely that contaminants potentially present at OU3 would affect the quality of water at these wells. The remaining wells at Fort Bragg are outside of the cantonment area and are used for potable water supply. Because groundwater from SWMUs at OU3 flows directly to Beaver Creek, it is not likely to affect these wells or the more distant potable supply wells.

1.4 TOPOGRAPHY, PHYSIOGRAPHY, AND CLIMATE.

a. Fort Bragg is situated in the Sand Hills hydrologic zone of the North Carolina Coastal Plain. The Coastal Plain extends westward from the Atlantic Ocean to the Fall Line, a distance of about 130 miles. The Fall Line is the boundary between the Coastal Plain and Piedmont physiographic provinces. The Sand Hills area is characterized by deep, sandy soil and has the most variable topography and highest land-surface elevations in the Coastal Plain. Topography at Fort Bragg is characterized by gently to steeply sloping ridges; the highest ridges are in the western and central part of the military reservation. Elevations range from approximately 550 ft above mean sea level (AMSL) in the western part of the military reservation to approximately 150 ft AMSL in the northeastern part of the military reservation along the Little River.

b. The climate at Fort Bragg is classified as subtropical with long, hot summers and mild winters. From 1951 to 1980, the mean annual rainfall was 47.80 in. From 1984 to 1993, the mean annual precipitation at Pope Air Force Base, which is located approximately 3 miles north of SWMU 14, was 45.99 in. Intense rainstorms occur primarily during the summer months. During this period, relative humidity ranged from an average of 63 percent in April to 76 percent in August. From 1984 through 1993, the mean annual temperature was 62.4°F. The prevailing wind direction at Fort Bragg is from the southwest, with an average velocity of about 9 mph (USGS 1996).

1.5 SITE GEOLOGY.

a. Geologic units in the Fort Bragg area, from oldest to youngest, consist of the Carolina Slate Belt rocks, which comprise the basement rock, the Cape Fear Formation, and the Middendorf Formation. Carolina Slate Belt rocks, which underlie the younger sedimentary rocks, are of Precambrian and Cambrian age and are composed of metavolcanic, metasedimentary, and igneous rock (USGS 1996). In some areas, these rocks were exposed to weathering before the overlying sediments were deposited, creating a zone of porous saprolite at the top of the basement rock. The elevation of the top of basement rock ranges from 180 ft above sea level at Southern Pines (USGS 1996), near the western edge of the military reservation, to 110 ft below sea level near the confluence of the Cape Fear River and Rockfish Creek (USGS 1996). The Cape Fear and Middendorf Formations overlie the basement rock and saprolite. These formations are part of the generally southeastward-dipping and -thickening wedge of sediments that constitutes the Atlantic Coastal Plain deposits. These formations are generally considered representative of an upper delta-plain environment (USGS 1996).

b. The Cape Fear Formation is continuous throughout the Fort Bragg area. It is overlain by the Middendorf Formation, except along the Little River and some of its tributaries, and in the lower reaches of Beaver Creek and Rockfish Creek where the Middendorf Formation has been eroded (USGS 1996). The uppermost part of the Cape Fear Formation consists of pale- to medium-gray clay and sandy clay ranging in thicknesses from 10 to 15 ft. The top of the Cape Fear Formation is 177 ft above sea level at SWMU 14 (Well 2-14MW1). The thickness of the Cape Fear Formation is about 120 ft at SWMU 14 (USGS 1996).

c. The Middendorf Formation is exposed at land surface throughout the Fort Bragg area and overlies the Cape Fear Formation (USGS 1996). The Middendorf Formation is thickest beneath the upland areas of Fort Bragg, where it is about 80 ft thick. A 5- to 9-ft clay layer in the upper part of the Middendorf Formation underlies the cantonment area. This clay layer ranges in elevation from 210 to 202 ft at SWMUs 2 and 14 (USGS 1996). The Middendorf Formation is composed of tan, cross-bedded, medium- and fine-grained, micaceous quartz sand and clayey-sand interbedded with clay or sandy-clay lenses or layers. Gravel beds, ranging from 10 to 20 ft thick and consisting of rounded pebbles 1 to 6 in. in diameter, occur in the basal portion of the Middendorf Formation.

d. The base of the Middendorf Formation consists of 10 to 30 ft of coarse- to fine-grained sand and clayey sand. The clay-sand and sandy-clay beds in the upper part of the Middendorf Formation and throughout most of the Cape Fear Formation are thinner and more finely grained than the sand unit at the base of the Middendorf Formation. Below the sand unit at the base of the Middendorf Formation is a 5- to 10-ft-thick clay and sandy-clay unit that forms the uppermost bed of the Cape Fear Formation. This clay unit is distinguished from the clays at the lower Middendorf Formation by its compactness. The sand unit at the base of the Middendorf Formation and the thick clay and sandy-clay unit at the top of the Cape Fear Formation mark the formation contact.

e. The soils within the Fort Bragg cantonment area are the result of weathering of these unconsolidated sandy sediments of the Coastal Plain. The soils range from moderately well drained to excessively well drained. Soils in upland areas are sandy, acidic, and low in organic matter and have low fertility. The upland soils have brittle, loamy or clayey subsoils associated with Blaney, Gilead, and Lakeland soil types. Soils in low-lying areas typically have a heavier texture (containing more organic and clayey material) than upland soils. Soils in low-lying areas are poorly drained, resulting in swampy areas along streams. Johnston loam is typically found in low-lying areas of Fort Bragg (USGS 1996). Because many of these soils have similar properties, transition zones between the soil types are not always apparent.

1.6 SITE HYDROLOGY.

a. An east–west trending ridge divides Fort Bragg into two drainage subbasins. The northern subbasin drains into Little River; the southern subbasin drains into tributaries of Cross Creek and Rockfish Creek. Surface runoff at SWMU 14, which is in the southern subbasin, drains into Beaver Creek. Beaver Creek flows into Cumberland Creek, a tributary of the Cape Fear River, which is east of Fort Bragg. Streams located on the military reservation generally are low gradient and, in many areas, have poorly defined channels that grade into swampy areas. Streambeds consist of unconsolidated materials, typically silt or clay.

b. Several impoundments are present at Fort Bragg and include Lake McArthur in the northwestern corner of the military reservation, McKellers Pond in the northeastern part, and Smith

Lake in the southeastern part. There are no natural lakes at Fort Bragg.

c. The Fort Bragg area is underlain by three freshwater aquifers: the saprolite-basement, Cape Fear, and Middendorf aquifers. The saprolite-basement rock aquifer is below the Cape Fear Formation, and its depth ranges from 140 ft BLS in low-lying parts of the cantonment area to 300 ft or more BLS in the central and western parts of Fort Bragg. The saprolite-basement aquifer is generally assumed to yield little water, and no supply wells in this area are known to solely tap this aquifer. The Cape Fear aquifer is composed of the Cape Fear Formation, which is primarily clay interbedded with silt and silty sand under confined conditions. The uppermost 5 to 10 ft of the Cape Fear Formation in the Fort Bragg area form the Cape Fear confining unit. This confining unit restricts vertical movement of water between the overlying sediments and the silty-sand units of the Cape Fear aquifer. Several wells on the Fort Bragg reservation might be screened in this aquifer. East of Fort Bragg, the Cape Fear aquifer is used for public and industrial water supplies (USGS 1996).

d. The Middendorf aquifer primarily consists of coarse- to fine-grained silty or clayey sands with interbedded light-gray to tan clays. The interbedded and discontinuous clay layers in this aquifer support local perched water zones. Perched water zones in the Fort Bragg area generally are within 20 ft of land surface, and groundwater in these perched zones is under unconfined conditions and referred to as the "surficial aquifer." The saturated thickness of the water table within a perched water zone is typically only a few feet. Many of the perched water zones dry out during the growing season and are not a reliable source of water supply.

e. Groundwater in the lower part of the Middendorf aquifer is commonly under confined or semiconfined conditions, as determined by interbedded clay layers, whereas groundwater in the upper part of the Middendorf aquifer is under unconfined conditions. The potentiometric surface of the aquifer is as much as 80 ft BLS in upland areas of the military reservation and near land surface along perennial streams (discharge areas for the Middendorf aquifer).

f. The sandy soils, which cover most of Fort Bragg and the Sand Hills hydrologic area, are leached beds of the Middendorf Formation. These sands are highly permeable and allow rapid infiltration of precipitation, which is the primary source of groundwater recharge.

1.7 SITE ECOLOGY.

a. The SWMU 14 is in the south-central part of the Fort Bragg cantonment area. The SWMU 14 is an unlined, mostly covered, abandoned landfill. The SWMU 14 is approximately 700 yd downstream of SWMU 8.

b. Ecological receptors at SWMU 14 include terrestrial, wetland, and aquatic animals and plants. Although a survey of the terrestrial and wildlife flora and fauna potentially using the OU3 area has not been performed, Fort Bragg supports numerous species of wildlife (USGS 1996). Species or groups that are known to occur at the installation and that might occur within SWMU 14 include the cotton mouse, short-tailed shrew, red fox, eastern meadowlark, red-tailed hawk, raccoon, and great blue heron. No rare, endangered, or threatened species are known to occur at SWMU 14.

c. Much of SWMU 14 is covered by tall grasses. Aquatic receptors in Beaver Creek, the tributaries that flow into the creek, and surrounding wetlands include invertebrates, plants, algae, amphibians, and fish. The native fish population in the perennial rivers, streams, and lakes at Fort Bragg includes blue gill, chain pickerel, grass pickerel, large mouth bass, redbreast, red ear, warmouth, bowfish, bullhead catfish, carp, channel catfish, and gizzard shad.

2.0 PURPOSE OF CORRECTIVE ACTION SELECTION. The EPA has provided risk based corrective action guidance that specifies the major components to be considered in selecting a corrective action. These include the following threshold criteria: (1) protect human health and the environment and the management of wastes; (2) attain media cleanup standards set by the implementing agency (i.e., NCDENR); (3) control the source of the releases so as to reduce or eliminate, to the extent practicable, further releases that might pose a threat to human health and the environment; (4) comply with any applicable standards for management of wastes; and (5) other factors. Corrective action alternatives meeting the threshold criteria are then balanced against the following: (1) long-term reliability and effectiveness; (2) reduction of toxicity, mobility, or volume of wastes; (3) short-term effectiveness; (4) implementability; and (5) cost.

2.1 2001 CMS FIELD INVESTIGATION. The 2001 CMS field investigation was conducted in March, April, and October 2001 to investigate the current groundwater characteristics and obtain additional data on methane generation. The field investigation for SWMU 14 included groundwater sampling, methane monitoring, and the performance of methane pilot tests. The objectives of this field investigation for OU3 are described in the following paragraphs.

a. The objectives of the methane gas measurements at SWMU 14 were to:

(1) Determine if methane gas is being generated in the landfills at levels above the threshold of concern; and

(2) Determine if methane gas is migrating to areas outside the boundaries of the SWMUs; and

(3) Determine if buildings and structures east of the SWMU 14 boundary might be impacted by off-site migration of methane; and

(4) Determine the need for methane gas mitigation controls, or confirm that no further action is needed, and identify site-specific requirements for implementation, if necessary.

b. Groundwater Sampling. Groundwater samples were collected from selected existing monitoring wells installed during previous investigations at OU3. Four monitoring wells at SWMU 14 were selected for sampling based on the results from previous sampling events. Groundwater samples were analyzed for VOCs, SVOCs, pesticides, metals, and PAHs. The parameters of pH, specific conductance, temperature, dissolved oxygen, and turbidity were measured during sampling.

c. Soil Gas and Air Survey. Soil gas samples were collected using the direct-push method (Geoprobe® rig) and hand-augured boreholes. Concentrations of methane, oxygen, and carbon dioxide were measured for all soil gas samples. At selected soil gas sample locations, measurements of VOC concentrations were made using a photoionization detector.

(1) Ambient air measurements of methane concentrations were collected at structures located on, or adjacent to, the landfill and at various locations around the perimeter of and within the landfill boundaries. Methane measurements were made using a Landtec™ GA-90 landfill gas monitor. In addition, a total of eight soil gas samples were submitted to Vaportech

Services, Inc., for laboratory analysis of methane, carbon dioxide, oxygen, and nitrogen.

(2) During the October 2001 investigation, ambient air measurements of methane were made at each SWMU 14 soil gas sampling location and in structures and buildings east and southeast of the landfill boundary. Five soil gas samples were randomly collected from the sampling locations and sent for laboratory analysis as a quality assurance check on the field measurements. The lab and field measurements were identical.

(3) Measurements of soil gas concentrations of methane were made at 19 locations at SWMU 14. Methane was detected at four of these locations. Methane concentrations in soil gas at these locations exceeded the LEL only at sample depths of 4 ft and below, with the exception of the 2-ft interval at one location, which also exceeded the LEL. Permanent soil gas monitoring points were installed at three locations at SWMU 14.

(4) Methane measurements were made of soil gas at a total of 38 locations at depths of 4 and 8 ft below ground surface in the vicinity of SWMU 14 in October 2001. Methane was detected at eight of these locations. Concentrations at six of the eight locations exceeded the LEL at both the 4- and 8-ft depths. Concentrations at the other two locations, which were set up as permanent monitoring points (14CP-8 and 14CP-10), were less than 25 percent of the LEL. Permanent soil gas monitoring points were set up at eight additional locations in the vicinity of SWMU 14 during the October investigation.

d. Groundwater. Groundwater samples were collected from Wells 2-14MW2, 2-14MW12, 2-14MW13, and 2-14MW18 at SWMU 14. The constituents detected in groundwater samples collected from these monitoring wells are indicated in Table 2-9. Of these detected concentrations, iron at two wells (2-14MW2 and 2-14MW18), manganese at one well (2-14MW18), chloroform at one well (2-14MW2), and PCE at three wells (2-14MW2, 2-14MW12, and 2-14MW13) exceeded their respective North Carolina groundwater protection standards. The locations of these wells with respect to SWMU 14 are indicated on Figure 2-9. It should be noted that the highest concentration of PCE was detected at the upgradient well, 2-14MW2. This finding is consistent with previous results.

2.2 SITE RECOMMENDATIONS. The following presents the conclusions of the field investigation, as documented in the letter report (Science Applications International Corporation 2001c), and their impact on the DD models for SWMU 14.

a. Data gaps previously determined to impact decisions needed for preparation of the DD have been addressed, and preparation of the DD can proceed.

b. Methane has not been detected in ambient air at SWMU 14. Methane is present in soil gas at the northeastern and southeastern boundaries of SWMU 14 and extends eastward beyond the defined boundary of the SWMU.

c. Concentrations of iron, manganese, chloroform, and PCE exceeded their respective North Carolina groundwater protection standards in some monitoring wells at SWMU 14. Of the chemicals that exceeded the NC 2L standards, iron and manganese also exceed the federal secondary MCLs and PCE exceeded the primary MCL. The highest level of PCE (8.9 μg/L) occurs at an upgradient well and; therefore, the source of PCE contamination is not believed to be SWMU 14. Groundwater has been adequately characterized to proceed with development of the CMS for SWMU 14.

d. The DD will evaluate remedial alternatives that ensure the protection of human health and the environment based on controlling and/or reducing the potential exposure to contaminants at SWMU 14. Potential alternatives to be evaluated include:

(1) Institutional controls including land-use restrictions enforced through the Fort Bragg Master Plan, and/or

(2) Potential landfill closure requirements, and

(3). Long-term groundwater monitoring, and/or

(4) Monitoring to evaluate the generation and migration of methane and to meet closure requirements, and

(5) Controls for the mitigation of methane at SWMU 14 and in nearby buildings and structures.

3.0 PURPOSE. The EPA has established corrective action standards that reflect the major technical components that should be included with a selected remedy. These standards include the following: (1) protect human health and the environment; (2) attain media cleanup standards set by the implementing agency (e.g., NCDENR); (3) control the source of the releases so as to reduce or eliminate, to the extent practicable, further releases that might pose a threat to human health and the environment; (4) comply with any applicable standards for management of wastes; and (5) other possible factors.

3.1 REMEDIAL RESPONSE OBJECTIVES. The presence of residual soil and groundwater contaminants at concentrations above regulatory criteria and RGOs and elevated levels of methane in the subsurface soil within, and contiguous to, the boundaries of SWMU 14, warrants corrective action. The remedial response objectives for SWMU 14 are to monitor the groundwater to determine whether further action is needed, to prevent inadvertent human exposure to buried waste and any residual soil contaminants, and to protect the public from potential hazards associated with elevated levels of methane within and around the landfill. The selected corrective actions would provide the technology(ies) necessary to minimize exposure to contaminant concentrations in the groundwater, provide adequate protection of the public from elevated methane levels, and achieve the best overall results with respect to such factors as effectiveness, implementability, and cost.

a. Surface soil. Contaminants in SWMU 14 surface soil include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and arsenic for residential exposures. Benzo(a)pyrene is the only chemical identified for occupational or trespasser exposures. Land use at SWMU 14 is dominated by the presence of the Central Receiving Facility and the adjacent salvage and demobilization yard containing damaged or inoperable military vehicles. Plans for future use are for continued industrial development around SWMU 14. A truck inspection station is planned for the northern side of the building. Because of the current and planned future uses, the industrial-exposure RGOs calculated by the USGS would be appropriate from a direct exposure to soil risk (0.5 mg/kg); however, the groundwater protection standard of 0.091 mg/kg is more conservative and, therefore, has been selected as a target concentration.

b. Subsurface soil. No contaminants were identified in subsurface soil at SWMU 14.

c. Surface water. No contaminants were identified in the RFI for surface water. The RFI identified four metals in surface water at SWMU 14 (aluminum, iron, zinc, and lead) that exceeded threshold values. Concentrations upstream were comparable to those downstream; therefore, the metals might not be originating from the landfill. The RFI recommended that no action be taken for surface water because reducing the metals migrating to surface water from the landfill would not mitigate adverse effects to biota.

d. Streambed sediments. No chemicals of concern were identified in sediment by the RFI for SWMU 14. The PAHs were identified in the RFI as potentially producing an adverse effect in aquatic receptors. The RFI concluded that for SWMU 14 the presence of PAHs was not site-related because the upstream concentrations were comparable to those downstream.

e. Groundwater. The PCE, arsenic, iron, and manganese were identified as contaminants in groundwater at SWMU 14. The PCE was present in the background well at higher concentrations than in the on-site wells. Regulatory levels for these compounds are presented in Table 3-2.

Table 3-2. Compounds Exceeding Regulatory Levels in Groundwater at SWMU 14

Constituent	NC 2L or MCL (μg/L)	Range of Detected Concentrations (μg/L)	Basis of Remedial Level (μg/L)
Iron	11,000	120–28,000	Background criterion[a]
Manganese	50	3.2–600	NC groundwater standards
Arsenic	10	10–13	NC groundwater standards
PCE	0.7	3.5–9.4	NC groundwater standards

[a]If naturally occurring metals background exceeds 2L and MCL, then remedial level is set at background.
MCL = Maximum contaminant level.
NC = North Carolina.
PCE = Tetrachloroethene.
SWMU = Solid waste management unit.

3.2 SCREENING OF CORRECTIVE ACTIONS. This section identifies corrective action technologies applicable to the SWMU 14 abandoned landfill and screens the technologies with respect to effectiveness, implementability, and cost. The technologies that are retained following screening are presented as corrective action alternatives that address the limiting of exposure to contaminated groundwater and surface soil and reducing potential hazards associated with elevated levels of methane in subsurface soil. The corrective action alternatives are then evaluated with respect to protection of human health and life-cycle cost. Technologies and alternatives to address the elevated methane present in the soil are discussed separately from the groundwater and soil technologies and alternatives.

3.3 SCREENING CRITERIA. The first step in the development of corrective action alternatives involves the identification and screening of suitable remedial technologies for meeting the stated remedial response objectives. The technologies presented are evaluated for their general ability to protect and reduce the risk to human health. The technologies are discussed sufficiently to allow them to be compared using three general criteria that will function as balancing factors: effectiveness, implementability, and cost. An explanation of each criterion is provided below. This criterion evaluates the extent to which a corrective action reduces overall risk to human health and the environment. It also considers the degree to which the action provides sufficient long-term controls and reliability to prevent exposures that exceed levels protective of human and environmental receptors. Factors considered include performance characteristics and expected durability. Relative screening-level costs are included for each corrective action technology. The estimates are intended to facilitate evaluation and comparison among technologies.

3.4 EVALUATION OF CORRECTIVE ACTION TECHNOLOGIES.

a. Technologies evaluated for Soils and Groundwater. A no-action with groundwater monitoring required alternative and four categories of corrective action technologies were identified for the soil and groundwater: (1) institutional controls: land-use controls and physical barriers; (2) capping; (3) native soil cover; and (4) groundwater monitoring. The technologies were evaluated using the screening criteria of effectiveness, implementability, and cost. The no-action alternative provides a baseline against which other technologies can be compared. Under the no-action alternative, no further action would be taken to mitigate risks posed by materials in the landfill. Groundwater monitoring would be performed to document groundwater contaminant concentrations. This alternative has the lowest associated cost. The acceptability of the no-action alternative is judged in relation to the assessment of known site risks and by comparison with other corrective action technologies. The no-action alternative is not considered viable because it provides no reliable or effective method for protecting human health; therefore, the no-action alternative has been eliminated from further evaluation.

(1) Institutional controls include actions taken to restrict access to contaminated areas by establishing land-use controls or by providing physical barriers. Land-use controls include controls implemented through the BMP. Requirements would be documented in the BMP. Physical barriers include installation of chain-link fencing and placement of signs or markers around the SWMU 14 landfill boundary or contaminated areas. Land-use restrictions and/or physical barriers would provide effective, readily implementable, and cost-effective methods for preventing inadvertent human exposure to buried waste at the site; therefore, this technology has been retained for further consideration.

(2) Capping would include placing a low-permeability clay cover on the SWMU 14 landfill. Placement of the clay cap would require a state-approved erosion control plan and silt fencing around the perimeter of the site. The capped area would be seeded with grass to minimize erosion of the area. The clay cap would minimize infiltration into the buried debris and minimize the potential for human exposure to the buried waste. The depth of the waste is unknown and could be below the water table; therefore, the effectiveness of a low-permeability cap to prevent leaching is uncertain. Current land uses at the landfill site create impediments to implementation of a low-permeability cap. Existing structures at SWMU 14 and stored equipment would need to be removed before a cap could be placed. In addition, placement of a low-permeability cap could encourage further migration of the methane outside the landfills' boundaries. For these reasons, the low-permeability cap has been eliminated from further evaluation.

(3) Placement of a native soil cover on the landfills would minimize inadvertent human exposure to buried waste, minimize transport of contaminants through surface water runoff and air dispersion, and still allow the methane within the landfill to dissipate. It has been suggested by NCDENR that an appropriate soil cover would be 18 to 24 in. thick with vegetation to minimize erosion. A native soil cover is present over portions of some of the landfills. As with the low-permeability cap, existing land uses impose impediments to placement of native soil cover; however, the cover could be used as a hot-spot treatment covering the areas posing the greatest risk and leaving existing structures in place. Placement of the native soil cover would require a state-approved erosion control plan and silt fencing around the perimeter of the site. The SWMU 14 already has a sufficient soil cover in the area in which

PAHs exceeded remedial levels; therefore, native soil cover has been eliminated.

(4) Groundwater monitoring would include sampling and analysis of site monitoring wells to establish contaminant concentration trends or to verify that hazardous constituents leaching from buried waste are not posing a threat to human health. Groundwater monitoring is effective and readily implementable and can be a cost-effective method for monitoring changes in the site conditions and providing an early warning to prevent potential human exposure to contaminated groundwater; therefore, groundwater monitoring has been retained for further consideration.

b. Technologies for Methane in Subsurface Soil. A no-action alternative and three categories of corrective actions for the elevated methane concentrations were identified: (1) institutional controls, (2) active methane venting with physical barriers, and (3) passive methane venting with physical barriers. The technologies were evaluated using the screening criteria of effectiveness, implementability, and cost. The no-action alternative provides a baseline against which other technologies can be compared. Under the no-action alternative, no further methane monitoring and no methane mitigation would be performed. No cost would be associated with the selection of this alternative. The acceptability of the no-action alternative is judged in relation to the assessment of known site risks and by comparison with other corrective action technologies. Methane levels exceed allowable limits (5 percent at the SWMU boundary) at SWMU 14; therefore, the no-action alternative for methane is not considered viable because it provides no reliable, or effective, method for ensuring human safety and has been eliminated from further evaluation.

(1) Institutional controls include actions taken to restrict access to areas at the landfills potentially containing elevated methane levels by establishing land-use controls or by providing physical barriers that would prevent excavation or subsurface construction activities and monitoring. Land-use controls would include restrictions implemented through the BMP and placement of signs restricting access or activities conducted at the site. Physical barriers could include installation of chain-link fencing around the landfill's boundaries or around areas found to contain elevated methane levels. Monitoring would include installation of permanent soil gas monitoring points within the landfill and inside buildings on or near the landfill or in areas of high soil gas

measurements outside the landfill. Land-use restrictions, monitoring, and/or physical barriers would provide effective, readily implementable, and cost-effective methods for preventing human exposure to elevated methane levels at the site; therefore, institutional controls have been retained for further consideration.

(2) Passive venting of methane would relieve soil gas pressures and allow monitoring and control of methane at selected points. This system would rely on natural pressure gradients and convection to move the landfill gas to the vent wells and subsequently to the atmosphere. This is a simple and cost-effective technology, which could be implemented with minimal impact to potential future use of the site; therefore, passive venting has been retained for further consideration.

(3) Passive venting is proposed over active methane gas recovery because the soil porosity in the area is relatively high, allowing the methane to flow without active systems. Because there are no detectable ambient air concentrations, the risk of methane buildup is low, and thus, the potential safety threat is low. Active vacuum extraction of methane at this site is not warranted and has been eliminated from further consideration. The recharge rate is low making mining of the methane at this site cost prohibitive.

3.5 CORRECTIVE ACTION ALTERNATIVES. The technologies retained following the screening step were combined in various ways to develop alternatives that would meet the remedial response objective of protection of human health and safety. Regardless of the alternative, the landfill will require a civil survey to establish the legal landfill boundaries for the BMP.

a. Alternative 1: Institutional Controls, Groundwater and Methane Monitoring, and Implementation of O&M Plan.

(1) Fencing and warning signs would be used to prevent unauthorized entry into the contaminated areas and areas having high levels of methane in soil gas. All soil borings containing concentrations exceeding the remedial levels (as well as residential RGOs) were located in Landfill 14a; therefore, Landfill 14a would be fenced off and posted to prevent human contact with soil containing benzo(a)pyrene exceeding the remedial levels. Areas containing methane in soil gas exceeding the LEL would also be fenced off. Tentative locations of the fences are presented in Figure 3-1. Eleven permanent soil gas-monitoring points installed during the soil gas survey

(Figure 3-1) would be maintained, and data would be recorded every 9 months for at least 10 years. Methane monitors with alarms would be installed in Building J-2535. These methane monitors would also be maintained according to O&M requirements provided by the manufacturer.

(2) The BMP would be used to prohibit any inappropriate development of Landfill 14a until the PAHs had degraded to the residential RGOs. Based on published half-life values for PAHs (Suthersan 1997), this condition should be met in 8 years, as calculated from an RFI sample collected in 1996. Consequently, the PAHs should degrade to residential RGOs by 2004. The landfill, which ceased operations in 1986, could continue to generate methane for another 10 years. Consequently, a 5-year review would be performed to assess the effectiveness of the remedy and to determine whether land-use controls and monitoring should be continued.

(3) The BMP would also be used to prohibit potable water wells at the site. No wells may be installed on the Base for purposes other than monitoring without first establishing risk from groundwater use. Groundwater would be sampled every nine months to establish trends in the contaminant levels for a total of five events. Wells sampled during the first sampling event are listed in Table 2.1. Samples from the first sampling event would be analyzed for RCRA metals, VOCs, SVOCs, PAHs, and pesticides/PCBs. Contaminants detected during the initial sampling event would be screened against background (for metals only), federal MCLs, and NC 2L or IMAC groundwater standards. A new list of substances exceeding North Carolina 2L standards or MCLs, Contaminant of Concern (COCs) would be developed following the screening process. The wells to be sampled every nine months on a routine basis to monitor the groundwater would be identified following evaluation of the data from the first sampling event and would include only those wells that exceeded standards during the first sampling event. Analytes would be limited to the substances that exceeded standards. The results of the groundwater and methane sampling would be presented in an annual report, in association with the O&M report. Annual reports would include a table presenting historical groundwater monitoring data and updated hydrogeologic cross sections.

b. Alternative 2: Passive Venting, Institutional Controls for Soil, Groundwater and Methane Monitoring, and Implementation of O&M Plan.

(1) In addition to the technologies discussed above, passive vents would be installed to reduce the concentration of methane gas in the landfill soil. Physical barriers would be erected around the vents to ensure human safety and to protect the vents from damage. Soil gas monitoring points currently in place would remain. Five additional permanent monitoring points would be installed. Methane monitors with alarms would be installed in Building J2535 adjacent to the affected area. These monitors would be maintained and tested every 9 months. Signs would be placed on the four Quonset huts warning of a potential explosive hazard. The five new soil gas monitoring points and eleven existing soil gas-monitoring points would be maintained and monitored every nine months. Methane generation would be expected to continue for up to another 10 years.

(2) Fencing and signs would be used to discourage site access and contact with soil in Landfill 14a. The BMP would preclude inappropriate uses of the fenced area until the contaminants had degraded to below residential RGOs, estimated to be approximately 10 years after the RFI sampling in 1996.

(3) Groundwater would be sampled every nine months to establish trends in the contaminant levels for five events. Wells to be sampled during the first sampling event are listed in table 2-1. Samples from the first sampling event would be analyzed for RCRA metals, VOCS, SVOCS, PAHS, and pesticides/PCBS. Substances detected during the initial sampling event would be screened against background (for metals only), Federal MCLS, and NC 2l or IMAC groundwater standards. A list of substances exceeding NC 2l standards or MCLS would be produced following the screening process. The wells, to be sampled every nine months for a total of five events, to monitor the groundwater would be identified following evaluation of the data from the first sampling event and would include only those wells that exceeded MCLS or NC 2l standards during the first sampling event. Analytes would be limited to substances that exceeded the standards. The results of the groundwater and methane sampling would be presented in an annual report, in association with the O&M report, which would include updated historical data tables and geological cross sections. After the fifth sampling event, groundwater trends would be reviewed, and based on the data groundwater sampling might be discontinued or continued. The bmp would be used to prohibit potable water wells at the site. No wells may be installed on the base for purposes other than monitoring without first establishing risk from groundwater use.

Table 2.1. Proposed Monitoring Well Network for SWMU 14, Fort Bragg, North Carolina

Well ID	Water Level Elevation[a] (ft)	Rationale
2-14MW2	201.93	Upgradient monitoring well designated as the background well for SWMU 14 during the RFI. Concentrations of arsenic, iron, chloroform, and tetrachloroethene have exceeded the NC 2L Groundwater Protection Standards at this well.
2-14MW10	196.49	Monitoring well located in a general lateral position to the hydraulic gradient at SWMU 14. However, this well contained iron at a concentration above the NC 2L Groundwater Protection Standard during the RFI.
2-14MW11	197.13	Monitoring well located downgradient of SWMU 14. This well contained iron at a concentration above the NC 2L Groundwater Protection Standard during the RFI.
2-14MW12	197.56	Monitoring well located downgradient of SWMU 14. This well has contained iron and tetrachloroethene at concentrations above the NC 2L Groundwater Protection Standards.
2-14MW13	198.44	Monitoring well located downgradient of SWMU 14. This well has contained tetrachloroethene at concentrations above the NC 2L Groundwater Protection Standard.
2-14MW14	198.48	Monitoring well located downgradient of SWMU 14. This well has contained arsenic and tetrachloroethene at concentrations above the NC 2L Groundwater Protection Standards.
2-14MW17	194.71	Monitoring well located downgradient of SWMU 14. This well contained iron and manganese at concentrations above the NC 2L Groundwater Protection Standards during the RFI.
2-14MW18	193.71	Monitoring well located downgradient of SWMU 14. This well has contained iron, manganese, and sulfate at concentrations above the NC 2L Groundwater Protection Standards.
2-14MW19	199.86	Deep monitoring well located within boundary of SWMU 14. This well contained iron, tetrachloroethene, and bis(2-ethylhexyl)phthalate concentrations above NC 2L Groundwater Protection Standards during the RFI.

[a]Water levels measured 12/14/02.
NC = North Carolina.
RFI = Resource Conservation and Recovery Act Facility Investigation.
SWMU = Solid Waste Management Unit.

(4) Five-year reviews would be conducted to assess the continued effectiveness of the controls and to determine whether they should be continued or modified based on then-current soil concentrations, soil gas concentrations, and groundwater trends. Based on the expected degradation rate of PAHs and generation time of methane, it is anticipated that after one 5-year review, the fence maintenance and restrictions related to soil contaminants could be discontinued. If required, soil gas vents and methane alarms would be maintained through two 5-year reviews. It is assumed for the purposes of the cost estimate that the groundwater will have reached the remedial levels by the first 5-year review and that groundwater monitoring can be discontinued after 5 sampling events.

3.6 EVALUATION FACTORS. Based on the results of the technology screening, all the alternatives are considered applicable to the site and implementable; therefore, two primary evaluation factors were used to select the preferred corrective action alternative: protection of human health and life-cycle costs.

a. Protection of Human Health. For the soil and groundwater, each alternative's effectiveness at protecting human health is dependent upon its ability to prohibit human activity associated with the disturbance of surface soil and the usage of groundwater. For the methane alternatives, effectiveness at protecting human health is dependent upon each alternative's ability to protect humans from the explosion hazard associated with elevated levels of methane contained in the soil or in impacted structures. For each alternative, the level of protection of human health was evaluated and compared with those of the other alternatives for that medium.

b. Life-Cycle Costs. The life-cycle cost estimates are budget estimates based on conceptual designs and are to be used for alternative comparisons. Costs are estimated for capital construction, administration, and O&M. Ten years will be used as the O&M period for SWMU 14 based on the presumption that the landfills, which operated between 1985 and 1986, could continue to generate methane for another 10 years. The cost estimates were derived from current information, including vendor quotes and conventional cost-estimating guides. The actual cost of the project would depend on the labor and material costs, site conditions, competitive market conditions, final project scope, and implementation schedule at the time the corrective action is initiated. The life-cycle cost estimates are not adjusted to present worth costs, and no escalation factors have been applied.

3.7 EVALUATION OF CORRECTIVE ACTION ALTERNATIVES. The paragraphs below summarize the evaluation of the corrective action alternatives with respect to the primary evaluation factors of protection of human health and life-cycle cost.

a. Alternative 1: Institutional Controls and Groundwater and Methane Monitoring. This alternative would protect human health by (1) providing for the implementation of land-use controls through enforcement of the BMP to prevent access to contaminated soil and groundwater or exposure to methane hazards and (2) erecting and maintaining a fence and warning signs to discourage unauthorized access to the site, thereby preventing human exposure to contaminated soil and methane explosion hazards. Building J2535 would be equipped with methane monitors, which would provide an alarm if the indoor methane levels reached 25 percent of the LEL. Data on methane would be collected every 9 months for 10 years (Landfill operations ended in 1986. Assuming 25 years of methane generation, methane should attenuate by 2011. Five-year reviews will determine whether to continue methane monitoring). Groundwater data would be collected for five sampling events. Following the fifth sampling event, the data would be reviewed, and if the NC 2L standards were not exceeded, a finding of no further action would be requested from the state. A 5-year review would take place to examine the data and determine, based on trends seen in the methane and groundwater data (if groundwater monitoring wasn't previously discontinued) over time, whether to continue sampling, discontinue sampling, or modify the remedy in order to continue to protect human health and the environment. Fencing and signage must be maintained until soil sampling is conducted to demonstrate the PAHs have degraded to protective remedial levels (expected to be within the next 5 years). Installation of potable water wells would be prohibited unless it is demonstrated through sampling and analysis that the water is safe to drink. This alternative is estimated to cost $387,000.

b. Alternative 2: Passive Venting, Institutional Controls, Groundwater Monitoring. Alternative 2 would be more protective than Alternative 1 because it would reduce methane concentrations in the soil rather than exclude people from high soil gas areas. Protection from PAHs in surface soil would be afforded by fencing and signs and land-use restrictions imposed by the BMP until the contaminants had degraded to safe levels. Groundwater data would be collected for five sampling events. Following the fifth sampling event, the data would be reviewed, and if the NC 2L standards were not exceeded, a finding of no further action would be requested from the state. The BMP would also prohibit potable water wells at the site. Five-year reviews would be conducted to assess the effectiveness of the controls and determine whether it was necessary to continue controls or modify the remedy to ensure protection of human health. The lower life cycle cost of methane remediation was a factor in the design of this alternative. It is expected that methane generation would end within the next 10 years making the higher costing Alternative cost prohibitive. This alternative is estimated to cost $355,000.

3.8 SELECTED CORRECTIVE ACTIONS.

a. Alternative 2 (Passive Venting, Institutional Controls for Soil, Groundwater and Methane Monitoring, and Implementation of O&M Plan) has been selected for SWMU 14. Alternative 2 was selected over Alternative 1 because it is prudent to take measures to reduce the methane concentration in the soil considering the location of the structures adjacent to areas of high methane soil gas. In addition, the land areas that would need to be restricted by fencing are currently being used for vehicle storage. Alternative 2 also reduces the restrictions that must be placed on land use. Finally, Alternative 2 costs less than Alternative 1 while offering a greater measure of protection. The institutional controls in this alternative will provide a combination of land-use restrictions and prohibitions as well as a physical barrier with warning signs around the perimeter of the abandoned landfill containing PAHs in excess of remedial levels. Land-use restrictions will be documented through the BMP, fencing, and signage.

b. Alternative 2 has been selected because it will provide the highest level of protection of human health. The institutional controls described for this alternative will provide an increased level of protection of human health and an adequate degree of long-term reliability and effectiveness as well as short-term effectiveness. The institutional controls under this alternative can be easily and cost-effectively implemented. Justification for selection of this corrective action is further detailed in the following evaluations of effectiveness, implementability, and cost. Groundwater monitoring will be performed for five sampling events to evaluate contaminant concentration trends, and a decision as to whether further action will be needed after this monitoring period will be made based on the resulting data.

3.9 EFFECTIVENESS.

a. Alternative 2 will be an effective means of minimizing human exposure to PAH-contaminated soil, buried waste, and elevated methane levels associated with SWMU 14. Venting of the soil gas will be highly effective in minimizing the potential for methane concentrations to build up in a structure to the point of being a safety hazard. Indoor concentrations of methane are currently below the detection limit, and vents will decrease the probability of methane leaking into structures. The alarm-equipped monitors will impose an additional layer of safety. Perimeter fencing, fence-mounted warning signs, and documented land-use restrictions will be highly effective and will provide long-term reliability with respect to preventing human exposure through physical contact with the buried waste within the boundaries of SWMU 14. To maintain an acceptable level of long-term reliability and effectiveness, the BMP will establish land-use controls. Prior to planning any construction activities at Fort Bragg, the BMP will be reviewed. In addition, the BMP and the Fort Bragg Directorate of Public Works will review all construction projects during the planning stages for approval.

b. The perimeter fencing will effectively prevent entry into Landfill 14a, which will prevent human exposure to buried waste and elevated levels of PAHs. Signs will be mounted on the fence around the site to note the use and entry restrictions. The restrictions will need to remain in effect until soil sampling demonstrates that the PAHs have attenuated to the remedial level of 0.91 mg/kg for benzo(a)pyrene.

c. The groundwater-use restrictions will provide an effective method for preventing the use of groundwater at the site for drinking water or irrigation. The surficial aquifer is not used as a source of drinking water at Fort Bragg. The BMP will be modified to officially restrict its use, preventing future use of the surficial groundwater at the site. A safety evaluation of the groundwater will be conducted prior to development of any wells within the cantonment area other than monitoring wells. These restrictions could be lifted if the review, after five sampling events, finds that the groundwater quality has improved sufficiently.

d. An O&M program will be administered to inspect and replace (or repair) fencing, warning signs, vent wells, and methane monitors, which might deteriorate over time. Site groundwater monitoring wells will be inspected every nine months during sampling. Implementation of the O&M Plan will ensure the effectiveness of this program.

3.10 Cost. The estimated total project life-cycle cost of installing the vents, alarms, fence, and warning signs; performing groundwater and methane monitoring; administering activities associated with the acquisition of legal controls; performing O&M activities; and providing management and oversight is $355,000 ($141,000 capital costs and $214,000 O&M costs).

3.11 REMEDIAL ACTION.

a. Prior to beginning construction, land-use requirements for the site will be incorporated into the BMP, which will include all restrictions and provisions documented in this DD. The BMP will include a description of institutional controls provided in this DD. The appropriate implementing document(s) will include land-use prohibitions and restrictions, including those related to activities that disturb the subsurface and to construction of structures. Groundwater use will also be prohibited. Reference to relevant corrective action documents for SWMU 14 will also be included in the BMP.

b. A survey plat for SWMU 14 will be prepared by a professional land surveyor certified in the state of North Carolina. The plat will be included in the BMP. The survey plat will indicate the location and dimensions of the landfill with respect to permanently surveyed benchmarks. The plat will contain a prominently displayed note that states Fort Bragg’s obligation to prohibit disturbance of the SWMU 14 landfill in accordance with this DD.

c. Five-year reviews will be used to determine whether the controls are adequate, are no longer needed, or should be expanded. These reviews will use the groundwater and soil gas monitoring data to be collected to determine what, if any, action to take.

d. Fencing and Warning Signs. Approximately 2,095 linear feet of fence will be installed at SWMU 14. The fence will block access to the vents and PAH-contaminated surface soil at SWMU 14. One double-swing gate (20 ft wide) will be provided to allow access to the fenced-off areas of the landfills. Three-ft-wide gates will be installed on the fences surrounding the vents. Details of the fencing are shown in Figure 3-1. Ten permanent warning signs will be mounted on the fence at approximately 200-ft intervals surrounding the perimeter of SWMU 14a. One sign will be placed on the access gate of each of the fences surrounding the four vents located outside the fenced landfill boundary. One sign will be placed at each of the four entrances to the Quonset huts, and one sign will be placed at each entrance to Building J2535. Additional signs will be posted on affected structures.

(1) The signs on the vent well gates will be worded as shown below.

FORMER LANDFILL
EXPLOSIVE GAS WARNING
NO TRESPASSING
CONTACT PWBC (910) 396-3341, EXT. 353
REGARDING USE RESTRICTIONS

---

(2) The signs on the fence surrounding SWMU 14a will be worded as shown below.

FORMER LANDFILL
PAH-CONTAMINATED SOIL
NO TRESPASSING
CONTACT PWBC (910) 396-3341, EXT. 353
REGARDING USE RESTRICTIONS
POTENTIAL HEALTH HAZARD

---

(3) The signs on Building J2535 will be worded as shown below.

THIS BUILDING EQUIPPED WITH
EXPLOSIVE GAS MONITORS
EVACUATE IMMEDIATELY
IF ALARM SOUNDS CALL 911
NO SMOKING OR OPEN FLAMES

---

(4) The signs on the Quonset huts will be worded as shown below.

WARNING: THIS BUILDING IS
CONSTRUCTED ON A FORMER LANDFILL.

BEFORE ENTERING, OPEN DOOR AND
ALLOW TO VENT FOR 1 MIN TO
ELIMINATE POTENTIAL ACCUMULATION
OF EXPLOSIVE LANDFILL GASES.

e. Each sign will have the dimension of 24 by 24 in. Warning signs will be metal plates with reflective paint and of weather-resistant construction. The signs will have a brown background and white lettering. All signs will be permanently labeled on the back with an identification number.

f. The fence and warning signs will be inspected every nine months in accordance with the O&M Plan. Damaged fencing and signs will be repaired or replaced as needed. Repair or replacement of the fence or signs will occur within one month of inspection. Should damage be observed between inspections, repair or replacement will occur within 1 month of observation.

3.12 GROUNDWATER MONITORING. Groundwater wells will be monitored every 9 months for five sampling events. The wells to be sampled at SWMU 14 are shown on Table 2-1. Nine wells will be sampled in the first sampling event and analyzed for RCRA metals, VOCs, SVOCs, PAHs, and pesticides/PCBs to establish a baseline. Contaminants detected during the initial sampling event will be screened against background (metals only), federal MCLs, and NC 2L or IMAC groundwater standards. Remedial levels will be derived for each substance that passes through the screening process in accordance with the following rules:

a. For naturally occurring metals only, if the background criteria (twice the mean background concentration) exceed the NC 2L or IMAC standard, then the remedial level is set equal to the background criterion. The target level is set equal to the NC 2L or IMAC standard. If there is no NC 2L or IMAC standard, then the target level is set equal to the federal MCL. Thereafter, the analyte list will be limited to the compounds for which remedial levels were set. The wells that will be routinely sampled will be those in which one or more of the compounds on the analyte list were detected.

b. The purpose of the monitoring is to establish contaminant concentration trends and determine whether additional actions are needed to address the groundwater that exceeds regulatory standards. These data will be reviewed following the five sampling events, based on the trends established by the periodic sampling, the decision will be made to discontinue groundwater monitoring, continue monitoring, or implement remedial measures.

3.13 PASSIVE VENTS. Landfill vents will be installed across the area of high methane concentrations in soil gas, as shown in Figure 3-1. The vents and the permanent soil gas monitoring points will be sampled every 9 months for five events.

4.0 CONCLUSION.

a. The Selected Remedy for SWMU 12 is Passive Venting, Institutional Controls for Soil, Groundwater and Methane Monitoring, and Implementation of O&M Plan) has been selected for SWMU 14. This alternative takes measures to reduce the methane concentration in the soil considering the location of the structures adjacent to areas of high methane soil gas. In addition, the land areas that would need to be restricted by fencing are currently being used for vehicle storage. This alternative also reduces the restrictions that must be placed on land use.

b. The institutional controls in this alternative will provide a combination of land-use restrictions and prohibitions as well as a physical barrier with warning signs around the perimeter of the abandoned landfill containing PAHs in excess of remedial levels. Land-use restrictions will be documented through the BMP, fencing, and signage. The estimated total project life-cycle cost of installing the vents, alarms, fence, and warning signs; performing groundwater and methane monitoring; administering activities associated with the acquisition of legal controls; performing O&M activities; and providing management and oversight is $355,000 ($141,000 capital costs and $214,000 O&M costs).

AL AYCOCK
COL, SF
Garrison Commander

ACRONYMS

AMSL	above mean sea level
BLS	below land surface
BMP	Base Master Plan
CMS	corrective measures study
COC	contaminant of concern
COPC	contaminant of potential concern
DOD	U.S. Department of Defense
DSERTS	Defense Sites Environmental Restoration Tracking System
ECOPC	Ecological Contaminant of Potential Concern
EPA	U.S. Environmental Protection Agency
HHCOC	human health contaminant of concern
IMAC	interim maximum acceptable concentration
IRP	Installation Restoration Program
LEL	lower explosive limit
MCL	maximum contaminant level
NC	North Carolina
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources
O&M	operations and maintenance
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
RCRA	Resource Conservation and Recovery Act of 1976
RD	remedial design
RFI	RCRA facility investigation
RGO	remedial goal objective
SAIC	Science Applications International Corporation
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TPH	total petroleum hydrocarbons
USGS	U.S. Geological Survey
VOC	volatile organic compound

Figure 3-1 SWMU 14 General Site Vicinity Map

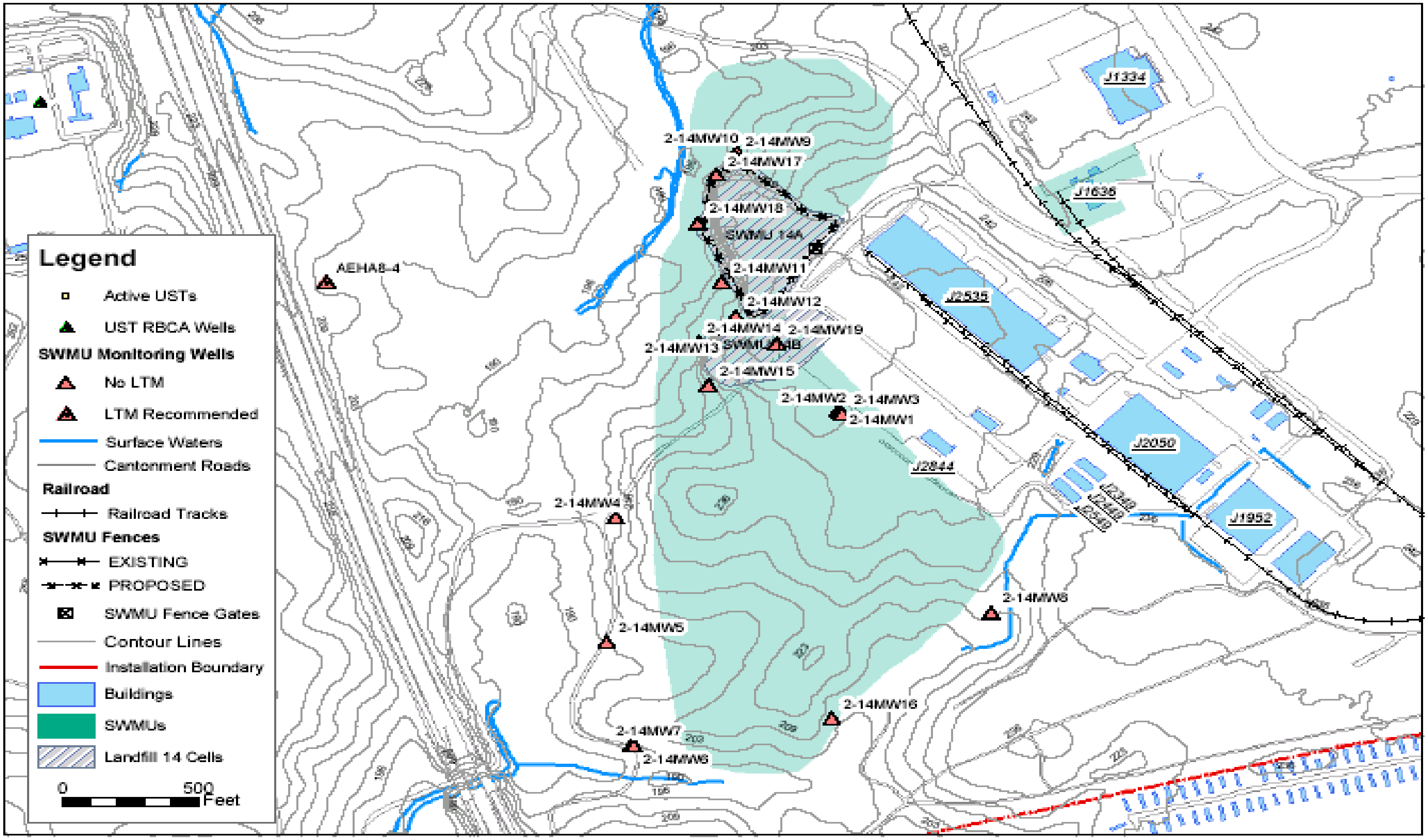

Figure 3-2 SWMU 14 Selected Remedy Detail Map