3.0 ENVIRONMENTAL SETTING AT RVAAP

The material presented in this section describes the physical characteristics of the WBG and surrounding environment that are factors in understanding the potential contaminant transport pathways, receptor populations, and exposure scenarios with respect to the evaluation of human health and ecological risks. The geology, hydrogeology, climate, and ecological characteristics of RVAAP were originally presented in Section 3.0 of the *Phase I Remedial Investigation Report for 11 High-Priority Sites at RVAAP* (USACE 1997a). Site-specific data from the Phase II RI, as well as local and regional information that have been gathered since the Phase I RI, are used to develop a Conceptual Site Model (CSM) of WBG, presented at the end of this section.

3.1 SURFACE FEATURES

The topography at WBG is characterized by gently undulating contours that decrease in elevation from west to east. Elevations at the WBG vary from 341.1 to 312.3 m (1084.9 to 993.2 ft) amsl across the site. The highest elevations are at the extreme western end of the WBG, in the vicinity of Pads #28 and 43 (see **Figure 1-3**). The topography of the site was mapped by the USACE in February 1998, on a (2-ft) contour interval, with an accuracy of 0.02 ft from aerial photographs taken during spring 1997. This survey is the basis for topography presented in figures in this Phase II RI Report.

3.2 METEOROLOGY AND CLIMATE

RVAAP has a humid continental climate characterized by warm, humid summers and cold winters. Precipitation varies widely throughout the year. The driest month is, on average, February, and the wettest month is July. Data from the National Weather Service compiled from 1951 to 1998 indicate that the average rainfall for the area is 38.72 in. annually. The average snowfall is 42.4 in. annually.

3.3 SURFACE WATER HYDROLOGY

Most surface water drainage flows from west to east across the WBG. Three small streams cross the site, all of which are tributaries to Sand Creek, a major drainage feature at RVAAP. Site construction appears to have modified what was originally a dendritic drainage pattern, with the northern two tributaries being straightened to some degree. Mack's Pond is located in the southwest quadrant of WBG, near its southern perimeter. The pond is fed by surface water drainage from the higher elevations at the western end of the WBG, and drains eastward in a creek that joins Sand Creek east of George Road. Beaver ponds are located in low areas in the central and southeast quadrant of the WBG between Pallet Roads B and C, and their extents vary from year to year. The extreme northwest corner of WBG (Pads 58-61) drains northeastward toward the pistol range. The drainage system at RVAAP feeds the West Branch of the Mahoning River. The West Branch is located at the east end of RVAAP, and flows southward to the Michael J. Kirwan (otherwise known as West Branch) Reservoir, immediately south of RVAAP.

3.4 GEOLOGY

The investigation of WBG and the background sampling sites have added new detail to the geologic framework of RVAAP. Seven background monitoring well borings were drilled to bedrock, and seven were completed in glacial sediments throughout the installation. Five monitoring wells were installed in the unconsolidated material at WBG. Lithologic logs from these boreholes are used to further characterize the surface and subsurface geology of WBG and the entire installation. These data, added to the Phase I geologic information, will be used to develop a conceptual model for WBG. Boring logs provided in Appendix A illustrate the vertical sequence of lithologies in detail. Lithologic data from the 14 background monitoring well borings have been used to revise **Figure 3-1** presented in the *Phase I Remedial Investigation Report for 11 High-Priority Sites at RVAAP* (USACE 1997a).

3.4.1 Glacial Deposits

Bedrock at RVAAP is overlain by deposits of the Lavery Till in the western portion of the facility, and the younger Hiram Till and associated outwash deposits in the eastern portion (ODNR 1982). Unconsolidated glacial deposits vary considerably in thickness and character across the site. The thickness of glacial deposits is greatest in a suspected buried bedrock valley that trends northeast–southwest across the installation. The buried valley is suspected to be greater than 46 m (150 ft) deep in some parts of RVAAP (ODNR 1982). The glacial overburden on bedrock has been entirely removed by construction activities at other locations at RVAAP, such as at Ramsdell Quarry Landfill, where rock is exposed at the ground surface (USACE 1998c). Ground moraine deposits comprise the majority of the glacial deposits in the remainder of the eastern portion of RVAAP. Glacial lake deposits may also have been encountered, as suggested at BKGmw-014. The thickness of the glacial material was greater than 15.7 m (50 ft) in boreholes that were abandoned in the search for shallow bedrock. Till deposits consist of laterally discontinuous assemblages of yellow-brown, brown, and gray silty clays to clayey silts, with sand and rock fragments.

BKGmw-004 (see **Figure 2-2**) was underlain by unconsolidated, well-sorted, well-rounded, medium-grained sand, similar to the outwash deposits in the northeastern corner of RVAAP. This sand extended from 3 to 11.3 m (10 to 36 ft) bgs, and was underlain by gravel and interbedded clays, silts, and sands, to a depth greater than 15.7 m (50 ft).

BKGmw-014 encountered approximately 12.6 m (40 ft) of a fairly homogeneous, low-plasticity, low-permeability gray silt that was also encountered at Load Line 1 during the *Phase I Remedial Investigation Report for 11 High-Priority Sites at RVAAP* (USACE 1997a). Based on the layered nature and uniformity of silt-sized particles, these may be glacial lake deposits similar to those present beneath the Kirwan Dam located just south of the RVAAP. The base of the silt was not penetrated in this boring. The silt was present at LL1mw-063, -065, and -066 and at several well points from the Phase I RI in the southeastern quadrant of RVAAP. Although it has low permeability, the silt was observed to be saturated; thus, it may be considered as an aquitard. A separate geotechnical investigation was conducted in the Phase II study, and the report is included in its entirety in Appendix H.

At WBG, the glacial materials encountered in the five monitoring well borings consist of clays and silty clays interbedded with fine- to medium-grained sand. The shallow water-bearing zones consist of sands with clays and silts, and vary in thickness from 0.18 m (0.6 ft) to 1.5 m (5 ft). The thickness of glacial cover in the WBG was not investigated in the Phase II RI. However, because WBG may be situated across the axis of the suspected buried bedrock valley, the glacial material may be many tens of feet thick.

3.4.2 Sedimentary Rocks

The high-priority AOCs at RVAAP are located in the eastern half of the installation; therefore, the background characterization was intended to focus on the bedrock lithologies found in that area. The objective unit of the Facility-Wide Background Investigation was the Sharon Member of the Pennsylvanian Pottsville Formation, which unconformably overlies the eroded Cuyahoga Formation on the eastern half of RVAAP. The Sharon Member has two subunits: the upper Sharon Shale and the lower Sharon Sandstone/Conglomerate. The Sharon Shale is a light to dark gray, hard, fissile shale. The shale subunit has been eroded and is absent in many

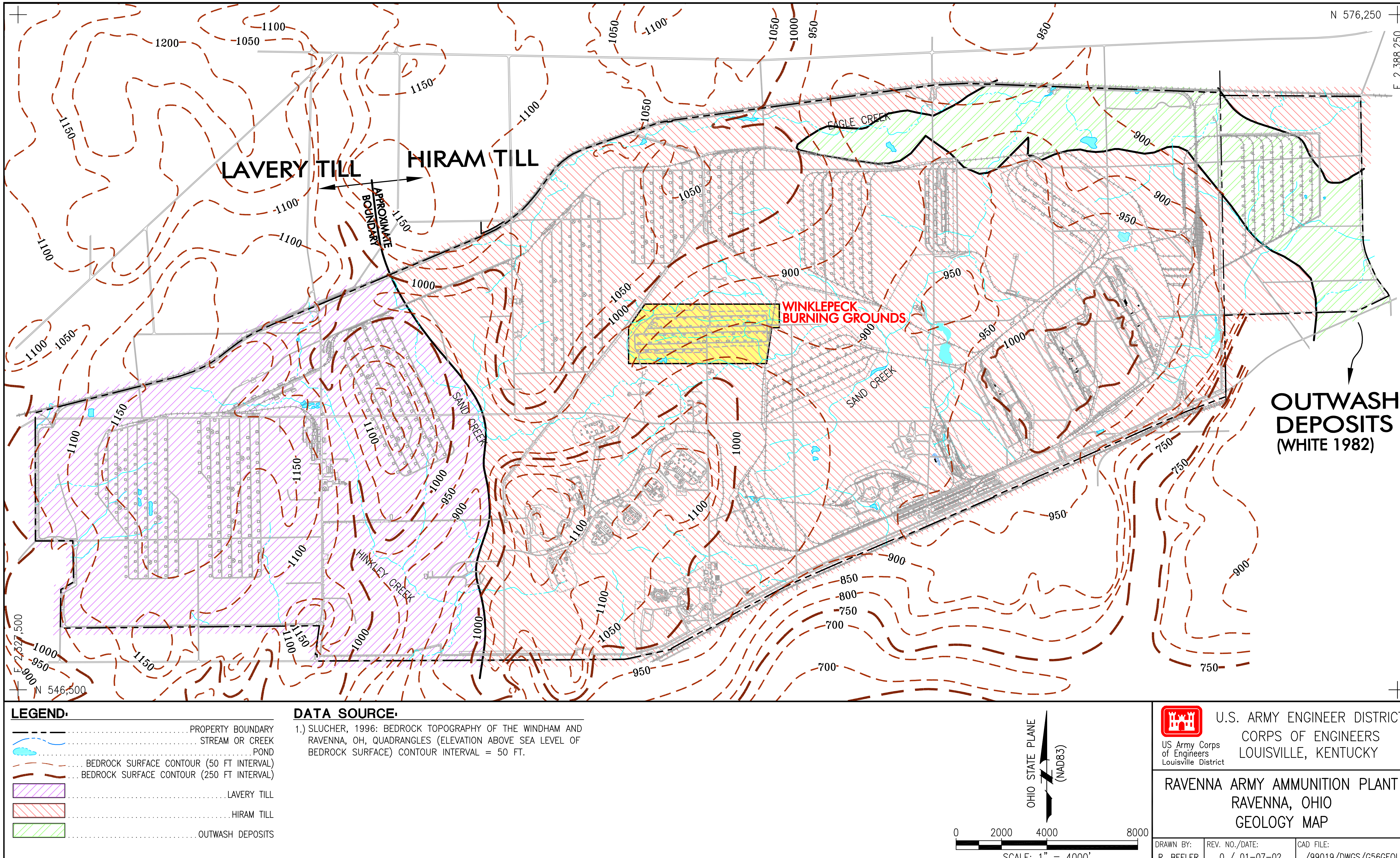

Figure 3-1. Geologic Map of Unconsolidated Deposits and Bedrock Topography at RVAAP

locations at RVAAP. The Sharon Sandstone is highly porous and permeable, cross-bedded and, at some locations, highly fractured and weathered. The conglomeratic facies of this sandstone is not present at all locations.

Bedrock was encountered in seven of the 14 background monitoring well borings: BKGmw-006, -008, -010, -012, -015, -018, and -020. The background locations were chosen using existing bedrock topography and glacial drift thickness maps (ODNR 1982) to identify areas where bedrock was suspected to be less than 30 ft bgs. The proposed background monitoring wells are shown in the *SAP Addendum for the Phase II Remedial Investigation at Winklepeck Burning Grounds and Facility-Wide Background Investigation at RVAAP* (USACE 1998a). However, because of unexpectedly deep bedrock at several locations, only BKGmw-012, -008, -006, -010, and -015 were installed in their originally proposed locations. BKGmw-018 and -020 were relocated to the west, in portions of the installation where the Pottsville Formation was known to be shallow (see **Figure 2-2**).

Background monitoring wells completed in the sandstone were BKGmw-006, -008, -010, and -018. BKGmw-012, -015, and -020 were completed in the Sharon Shale.

Depth to bedrock at WBG has been inferred from lithologic information from four monitoring well borings drilled in 1992 for the OBG RCRA unit at Pad #37. These wells were completed in unconsolidated material at the top of bedrock, at depths ranging from 5.5 to 7 m (18 to 23 ft) bgs. There is no information about whether the bedrock is sandstone or shale (USAEHA 1992). Bedrock was not encountered in the monitoring well borings installed for the Phase II RI at WBG. One of the 1997 Geoprobe borings at the Deactivation Furnace Area was pushed without refusal to 13 m (43 ft), while the other also reached a total depth of 13 m (43 ft) but had to be hammered the last 2 m (6 ft).

3.5 SOILS

Soils at RVAAP are derived from the Wisconsin-age silty clay glacial till that mantles much of RVAAP. Distributions of major soil types are discussed in detail in the Soil Survey of Portage County, Ohio (USDA 1978). Much of the native soil present at RVAAP has been reworked or removed during construction activities and operation of the installation. According to the Portage County Soil Surveys, the major soil types found at RVAAP's high-priority AOCs are silt or clay loams with permeabilities ranging from 6.0×10^{-7} to 1.4×10^{-3} cm/s. At WBG, soils of the Mahoning series, which have permeabilities of 4.2×10^{-4} to 1.4×10^{-3} cm/s, are the dominant type. Additional geotechnical data collected during the Phase II RI can be found in the geotechnical report (Appendix H).

3.6 HYDROGEOLOGY

3.6.1 Unconsolidated Sediments

Sand and gravel aquifers are present in the buried-valley and outwash deposits in Portage County, as described in the *Phase I Remedial Investigation Report for 11 High-Priority Sites at RVAAP* (USACE 1997a). Generally these saturated zones are too thin and localized to provide large quantities of water for industrial or public water supplies. However, they are sufficient for residential water supplies. Recharge of these units comes from surface water infiltration of precipitation and surface streams. Lateral continuity of these aquifers is not known.

Slug tests were performed at the five newly installed monitoring wells at WBG and the seven unconsolidated background wells in May 1998. They reveal moderately high horizontal hydraulic conductivities in the unconsolidated materials underlying WBG. Hydraulic conductivities measured during the Phase II RI range from 2.12×10^{-2} to 5.65×10^{-4} cm/s. Monitoring wells BKGmw-004, -017, and -019 could not be evaluated because the results of the slug tests were inconsistent and inconclusive, despite repeated attempts at testing. The calculated results for the WBG Phase II RI and background unconsolidated wells are shown in **Table 3-1**. The slug test data are presented graphically in Appendix B.

The previously installed wells at the OBG were slug tested in 1992 (USAEHA 1992), and data were reduced using the Bouwer and Rice method (Bouwer 1989). Average hydraulic conductivities varied from 1.02×10^{-3} cm/s in OBG-1 to 4.46×10^{-6} cm/s in OBG-4.

A generalized potentiometric surface map for WBG, compiled from water level data collected prior to groundwater sampling in May 1998, is presented in **Figure 3-2**. The water level data indicate a regional east–southeast flow direction with an approximate gradient of 0.0198 feet per foot. It should be noted, however, that the sparse distribution of wells over the area of the WBG allows only general interpretations to be made. Local perturbations in flow direction and gradient are likely, given the topography, various surface water features, and geologic conditions at WBG.

3.6.2 Bedrock

The sandstones of the Sharon Member, and in particular the Sharon Conglomerate, were the primary sources of groundwater during RVAAP's active phase, although some wells were completed in the Sharon Shale. Past studies of the Sharon Conglomerate indicate that the highest yields come from the true quartz-pebble conglomerate facies, and from jointed and fractured zones. Where it is present, the overlying Sharon Shale acts as a relatively impermeable confining layer for the sandstone. Monitoring wells completed in the Sharon sandstones at Ramsdell Quarry Landfill in July 1998 typically had hydraulic conductivities of 1×10^{-4} cm/s (USACE 1998c). Wells completed in the Sharon Shale generally exhibit much lower hydraulic conductivities than those in the sandstone. Hydraulic conductivities in monitoring wells BKGmw-015 and -020 could not be evaluated because of poor response of the wells to the test. Slug tests conducted during the Phase II RI at the background bedrock wells are summarized in **Table 3-2.**

3.7 DEMOGRAPHY AND LAND USE

RVAAP consists of 8668.3 ha (21,419 acres) and is located in northeastern Ohio approximately 37 km (23 miles) east–northeast of Akron and 48.3 km (30 miles) west–northwest of Youngstown. RVAAP occupies east–central Portage County and southwestern Trumbull County. According to the 1990 Census, the total populations of Portage and Trumbull counties were 142,585 and 227,813, respectively. The population centers closest to RVAAP include the city of Ravenna, (population 12,069) located approximately 3.2 km (2 miles) from the western site boundary in Portage County, and the city of Newton Falls (population 4866), located approximately 1.6 km (1 mile) from the southeastern site boundary in Trumbull County.

The RVAAP facility is located in a rural area, and is not in close to any major industrial or other developed areas. Based on data from the United States Census Bureau (1992) and the Portage County Soil and Water Conservation District Resources Inventory (1985), approximately 55 percent of Portage County, in which the majority of RVAAP acreage is located, consists of either woodland or farmland acreage. The Michael J. Kirwan Reservoir (also known as the West Branch Reservoir) is the closest major recreational area and is located adjacent to the western half of RVAAP south of State Route 5.

In December 1998, a signing ceremony was held to initiate transfer of much of the land at RVAAP to the National Guard Bureau. Roughly 7082 ha (17,500 acres) of RVAAP's 8668.3 ha (21,419 acres) are to be released by the Army IOC to the Ohio National Guard (ONG). At present, ONG uses RVAAP land and facilities for training (primarily light maneuvers including a drop zone, Tank Table IV range, and land navigation),

Table 3-1. Horizontal Hydraulic Conductivities in Phase II RI Unconsolidated Monitoring Wells, WBG and Background

Monitoring Well ID	Screened Interval (depth ft bgs)	Total Depth (ft bgs)	Geologic Material Adjacent to Screen	Slug-Test determined Hydraulic Conductivity (cm/s)	Laboratory determined Hydraulic Conductivity (cm/s)	Depth Ranges of Laboratory Permeability Sample (ft)
BKGmw-004	9.1 to 19.1	19.5	Medium-grained sand	[c]		
BKGmw-005	10.2 to 18.2	19.0	Medium-grained sand	2.78×10^{-3}		
BKGmw-013	15.2 to 25.2	25.5[a]	Sand and gravel with silt	1.65×10^{-3}		
BKGmw-016	8.4 to 18.4	19.0	Sand with silt	1.26×10^{-3}	7.41×10^{-7}	14 – 15.5
BKGmw-017	23.2 to 33.2	34.8	Medium-grained sand with silt	[c]		
BKGmw-019	23.0 to 33.0	34.0	Silty sand and gravel	[c]		
BKGmw-021	7.7 to 17.7	19.0[b]	Medium-grained sand	3.59×10^{-3}	2.48×10^{-4}	12 – 14
WBGmw-005	8.3 to 18.3	19.0	Clay with sand	3.87×10^{-5}	1.19×10^{-7}	14 – 15.5
WBGmw-006	7.6 to 17.6	19.0[b]	Sandy silty clay	2.45×10^{-3}	9.16×10^{-8}	9 – 10.8
WBGmw-007	13.4 to 23.4	24.0	Clay and sand	2.12×10^{-2}	3.39×10^{-8}	9 – 10.5
WBGmw-008	8.1 to 18.1	18.5	Sand	8.85×10^{-3}	4.50×10^{-8}	12 – 13.5
WBGmw-009	11.4 to 21.4	24.0[b]	Silty Sand	5.65×10^{-4}	4.45×10^{-8}	9 – 11

[a] Bedrock was not encountered; therefore, boring was backfilled and screened at 15.2 to 25.2 ft bgs.
[b] Unconsolidated well collapsed; filled in to depth indicated by bottom of screened interval.
[c] Hydraulic conductivity could not be calculated because of data transmission errors during slug tests.

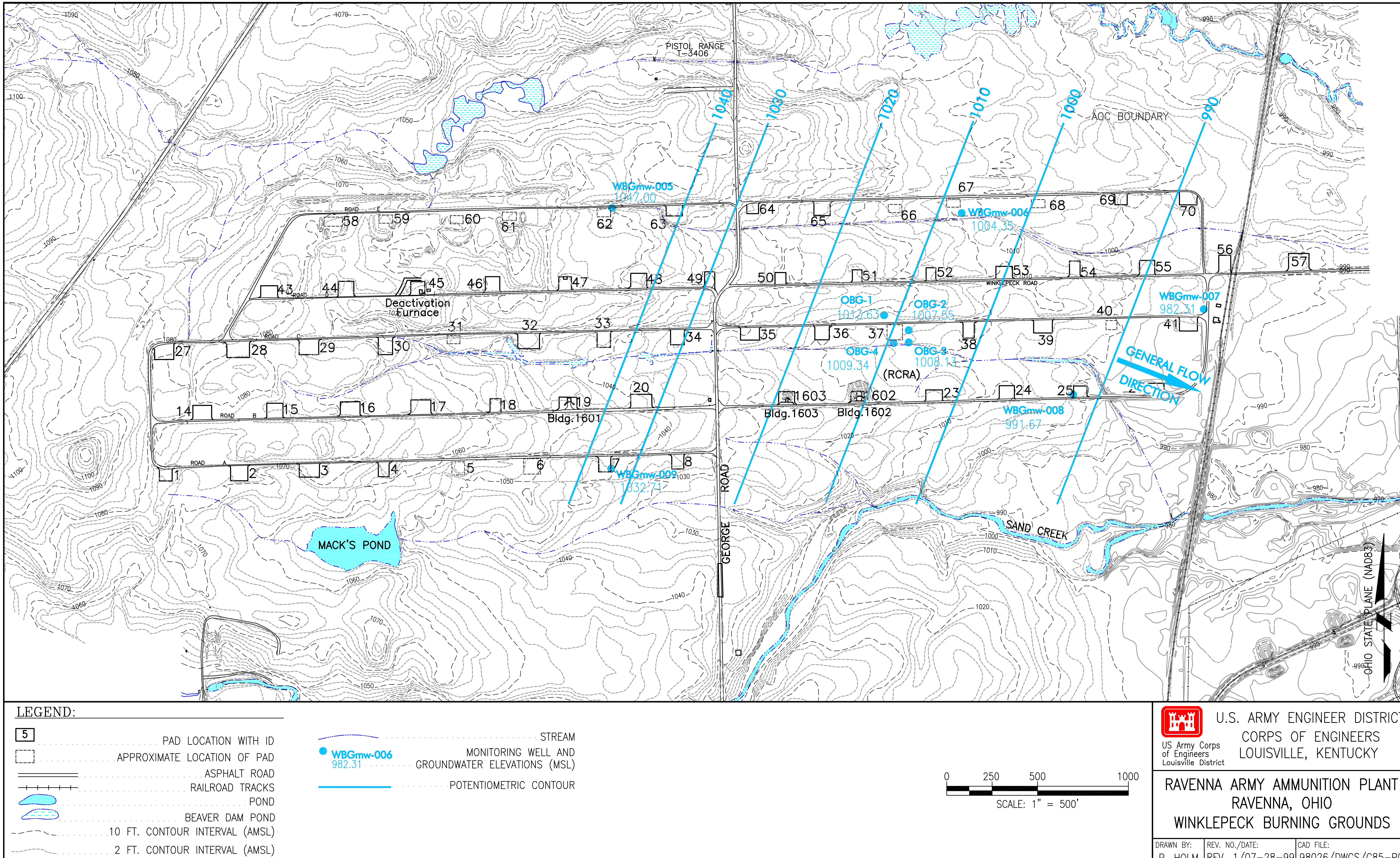

Figure 3-2. WBG Potentiometric Map

Table 3-2. Horizontal Hydraulic Conductivities in Phase II RI Background Bedrock Monitoring Wells

Monitoring Well ID	Screened Interval (depth ft bgs)	Total Depth (ft bgs)	Geologic Material Adjacent to Screen	Hydraulic Conductivity (cm/s)
BKGmw-006	24.7 to 34.7	35.1	Sandstone	6.64×10^{-4}
BKGmw-008	14.7 to 24.7	25.0	Sandstone	6.45×10^{-4}
BKGmw-010	8.9 to 18.9	22.0	Sandstone/shale	5.04×10^{-3}
BKGmw-012	39.6 to 59.6	59.8	Dark gray shale	3.32×10^{-5}
BKGmw-015	30.1 to 50.1	51.0	Dark gray shale	[a]
BKGmw-020	20.5 to 30.5	30.7	Dark gray shale	[a]
BKGmw-018	14.5 to 24.5	24.7	Sandstone	2.55×10^{-3}

[a] Hydraulic conductivity could not be calculated because of data transmission errors during slug tests.

maintenance, and storage of heavy equipment. Potential additional uses for the land identified by ONG include heavy maneuver training, tracked and wheeled vehicle training, a grenade range, and a light demolition area. The Ohio Air Force Reserves intends to use a portion of the ONG lands for a 1219-m (4000-ft) airstrip, and has performed an Environmental Assessment for this construction. Additional information on land use is presented in Section 6.3.

3.8 ECOLOGY

The dominant cover types at RVAAP, including WBG, are forests and old fields of various ages. Much of the land at RVAAP was cleared for agriculture before government acquisition of the property in the 1940s. More than 80 percent of RVAAP is now in forest. Most of the old field cover type is the result of earlier agricultural practices that left these sites with poor topsoil that still limits forest regeneration. Several thousand acres of agricultural fields were planted in trees during the 1950s and 1960s, but these plantings did not take well in areas with poor topsoil. Some fields, leased for cattle grazing during the same time period, were delayed in their reversion to forest. A few fields have been mowed, maintaining them as old field, and 36 ha (90 acres) are leased as hayfield (Morgan 1999).

From one-half to two-thirds [4,046 to 6,070 ha (10,000 to 15,000 acres)] of RVAAP meet regulatory definition of jurisdictional wetland. Wetland areas at RVAAP include seasonally saturated wetlands, wet fields, and forested wetlands. Most of these wetland areas exist because of poorly drained and hydric soils. Beaver impoundments contribute to wetland diversification on the site. High potential for negative impacts to wetlands exists simply because of the large areas of wetland.

The flora and fauna present at RVAAP are varied and widespread. A total of 18 plant communities have been identified on facility property including marsh, swamp, and forest communities. Sixteen plant species listed as State Potentially Threatened have been identified at RVAAP. These include:

- Gray Birch,
- Round-leaved Sundew,
- Closed Bentian,
- Butternut,
- Blunt Mountain-mint,
- Northern Rose Azalea,
- Large Cranberry,
- Hobblebush,
- Long Beech Fern,

- Woodland Horsetail,
- Weak Sedge,
- Straw Sedge,
- Water Avens,
- Tall St. John's Wort,
- Swamp Oats, and
- Shining Ladies'-tresses.

A complete list of all rare species (plants and animals) found on RVAAP is provided in Appendix K.

A large number of animal species have been identified on facility property including 26 species of mammals, 143 species of birds, and 41 species of fish. Animal species listed as Ohio State Endangered (1999 inventory) include the Northern Harrier, Common Barn Owl, Yellow-bellied Sapsucker, Mountain Brook Lamprey, Graceful Underwing, Little Blue Heron, American Bittern, Canada Warbler, Osprey, and the Trumpeter Swan. Several animal species present at RVAAP also are listed as Ohio State Special Concern. These include:

- Sora,
- Virginia Rail,
- Four-toed Salamander,
- Smooth Green Snake,
- Woodland Jumping Mouse,
- Sharp-shinned Hawk,
- Solitary Vireo,
- Pygmy Shrew,
- Star-nosed Mole,
- Red-shouldered Hawk,
- Henslow's Sparrow,
- Cerulean Warbler,
- Common Moorhen, and
- Eastern Box Turtle.

Restricted land use and sound forest management practices have preserved and enabled large forest tracts to mature. Habitat conversion at RVAAP, unlike most other habitat conversions occurring nationwide, has been towards restoration of the forests that covered the area prior to its being cleared for agriculture. The reversion of these agricultural fields to mature forest provides a diversity of habitats from old field through several successional stages. Overall, the trend towards forest cover enhances the area for use by forest species, both plant and animal. Future IRP activities will require consideration of these species to ensure that detrimental effects on threatened or endangered RVAAP flora and fauna do not occur. This will be discussed in the Ecological Risk Assessment presented in Section 7.0. There are no federal, state, or local parks or protected areas on RVAAP facility property.

3.9 CONCEPTUAL SITE MODEL

Information gathered during the Phase I and the Phase II RIs has been used to develop a conceptual model for WBG (**Figure 3-3**). The elements of the CSM are as follows:

- The topography of WBG consists of gently undulating slopes and level areas that decrease in elevation from west to east. Elevations range from 1084.9 to 993.2 ft amsl.

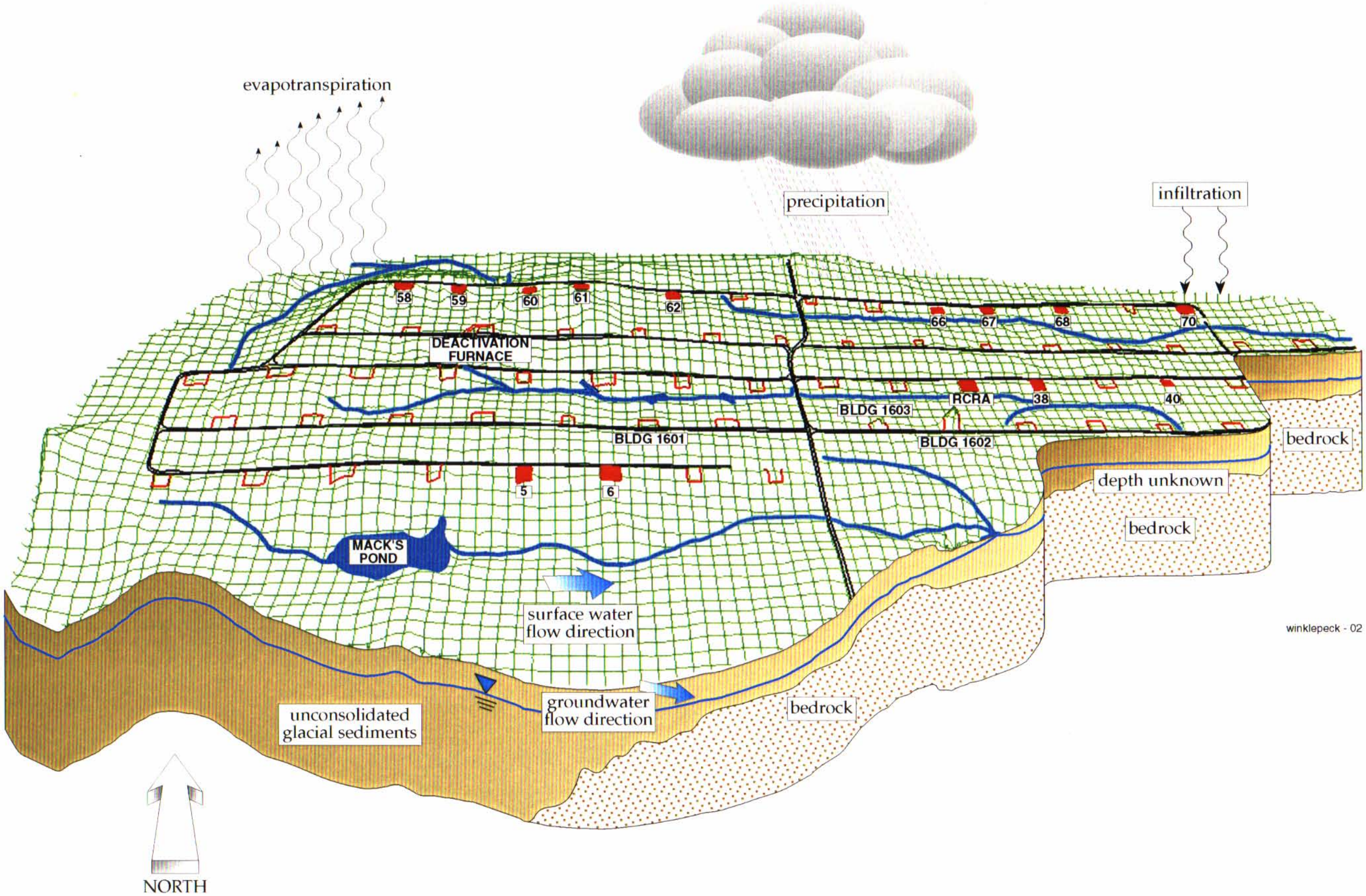

Figure 3-3. Hydrologic Conceptual Model for the Winklepeck Burning Grounds

- Low-permeability soils and glacial sediments cover much of the ground surface of WBG, except where the natural materials have been either eroded, removed, reworked, or covered during RVAAP operations.

- Groundwater is present in the sandy interbeds found in glacial materials that occur within about 7.6 m (25 ft) of the ground surface at WBG. The glacial material present at WBG is presumed to be many tens of feet thick. The more permeable sand units may be laterally discontinuous. It is not known whether the monitoring wells installed during the Phase II RI are in hydraulic communication with one another. Groundwater is presumed to flow from the western side of WBG to the east, based on the topography of the site and potentiometric surface data for the four previously existing and the five newly installed monitoring wells at the site. The water-bearing units behave as unconfined systems.

- Surface water flows from west to east across WBG in three small streams that are all tributaries that form Sand Creek and northward in a small stream draining Pads #58 through 61. Mack's Pond is located in the southwest quadrant of WBG. It is fed by the southernmost surface water channel, which drains the western end of the WBG. The pond drains eastward to an unnamed creek that eventually joins Sand Creek east of George Road. The stream north of Pallet Road B runs behind Pads #29 through 39, in the center of WBG. The northernmost stream runs from Pad #63 eastward beyond the AOC boundary. Beaver ponds are also present in low areas in the southeast quadrant of WBG. Groundwater accounts for all baseflow to the perennial streams.

Contaminant sources at WBG are the individual burning pads and roadside ditches that were used periodically to destroy explosives and other materials by burning. Some pads were used regularly, while others were rarely, or perhaps never, used. Burning of waste munitions may have caused detonations that disturbed the native soils below the burning pads and introduced contaminants into the subsurface soils. The crushed slag that was used throughout WBG for roads, pads, and driveways may also be a source of aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, magnesium, and zinc contamination. Contaminants released at WBG through these non-localized, non-permanent sources include heavy metals, explosives, propellants, and SVOCs.

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