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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER	2. GOVT ACCESSION NO. H124 081
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)* Survey and Assessment of Hawthorne Army Ammunition Plant, Hawthorne, Nevada, Final Report, September 1981, US Army Toxic and Hazardous Materials Agency, Aberdeen PG, MD	5. TYPE OF REPORT & PERIOD COVERED Final Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Toxic and Hazardous Materials Agency Aberdeen Proving Ground, MD 21010	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Commander Hawthorne Army Ammunition Plant Hawthorne, Nevada 89405	12. REPORT DATE September 1981
	13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)* US Army Toxic and Hazardous Materials Agency Aberdeen Proving Ground, MD 21010	15. SECURITY CLASS. *(of this report)* UNCLASS
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*
Distribution Unlimited, Cleared for Public Release

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Ground water	Nitrates/Nitrites
Contaminant migration	RDX
TNT	Installation Restoration
Picric Acid	Hawthorne Army Ammunition Plant
	Hawthorne Naval Ammunition Depot

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*
The purpose of this report is to document work performed at Hawthorne Army Ammunition Plant (HWAAP) by the US Army Toxic and Hazardous Materials Agency as a part of the Army's Installation Restoration Program. The work includes an assessment (records search) and environmental contamination survey.

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The environmental contamination survey focused primarily on a potential groundwater contamination problem. Based upon a search of records it had been concluded that explosives wastes from plant operations could be migrating off post in the shallow aquifer.

The survey concluded that a significant problem did not exist. Groundwater contamination by TNT is limited and the levels of contamination are low.

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List of Figures and Tables

I. INTRODUCTION.

A. Objective.

The purpose of this report is to document the work performed by the US Army Toxic and Hazardous Materials Agency (USATHAMA) at Hawthorne Army Ammunition Plant (HWAAP) which includes an installation assessment (records search) and an environmental contamination survey. Based on the records search findings, the contamination survey focused primarily on groundwater contamination resulting from previous explosives waste disposal operations.

B. Authority.

One of the missions of USATHAMA is to "provide centralized intensive management and direction for the identification and control of toxic and hazardous materials and related contamination on Army properties."[1] The USATHAMA Installation Restoration (IR) program has been developed to evaluate potential contamination problems at Army installations resulting from past waste disposal practices. The IR program is conducted along the following steps: installation assessment, environmental contamination survey, remedial actions systems development and operations.[1,2]

C. Background.

Until 1 October 1977, HWAAP was a Naval facility. The transfer from the Department of Navy (DN) to the Department of Army (DA) was the result of a Department of Defense (DOD) decision to give DA the mission of providing all branches of the armed services with conventional ammunition. This consolidation effort transferred two complete Naval installations, HWAAP and McAlester Army Ammunition Plant, to the Army.

After the transfer of these installations, US Army Armament Materiel Readiness Command (ARRCOM) requested USATHAMA, then known as Project Manager for Chemical Demilitarization and Installation Restoration (PMCDIR), to conduct assessments of these installations to determine if there was any contamination resulting from past waste disposal practices.[3]

HWAAP is located approximately 135 miles (220 kilometers) southeast of Reno and immediately south of Walker Lake in the west central portion of Nevada (Figure I-1). The installation surrounds the town of Hawthorne. It is located in Mineral County, in a gently sloping valley bounded by the Wassuk Range on the west, the Gillis Range and Walker Lake on the northeast, and by Excelsior Mountains on the southeast (Figure I-2). The valley floor is about 4,000 feet (1,220 meters) above sea level. The facility utilizes an area of approximately

154,000 acres (62,320 hectares) of which the Army controls 148,517 acres (60,100 ha). HWAAP consists of production facilities, storage facilities, transportation facilities, transfer docks, test ranges, disposal areas, engineering shops, and administrative and housing facilities.

Water for the installation is supplied by mountain reservoirs and deep wells (i.e., wells in excess of 300 ft). The reservoir water is of excellent quality and, after chlorination, is used for drinking. Well water is of questionable quality and is primarily used for process water and firefighting. Annual rainfall is approximately 5 inches (14 centimeters) on the valley floor. The average net rainfall, i.e., rainfall less evaporation, is minus 45 inches (-114 cm) per year.

II. Summary of Work Prior to Environmental Contamination Survey.

A. Installation Assessment Report No. 114.

1. General.

In accordance with DA plans to acquire the then Naval Ammunition Depot (NAD), Hawthorne, an installation assessment was conducted to determine the existence of toxic and hazardous materials, and related contamination, emphasizing those areas posing a potential for migration to off-post areas.

The onsite phase of the records review was performed 20 to 25 June 1977; however, data was collected through other Agency sources through 15 July 1977. The report[4] was published in August 1977 and reflects the status on HWAAP as of 15 July 1977.

2. Findings.

Explosive wastes from loading and demilitarization operations were dumped into open pits and unlined settling ponds throughout the production area from World War II through July 1977. A typical explosives washout pit is pictured at Figure II-1. Of the 25 sites which were identified, there are seven principal fluid disposal sites, past and present. Five of them--areas 101, 101-41, 101-44, 103-16 and 103-41--were used for explosive wastes whereas the other two were used for sewage. (See Figure II-2 for locations of fluid disposal sites.) Table II-1 lists the materials known to have been used and disposed of at the seven sites.

A disposal area for mustard and phosgene chemical munitions exists in an area located south of US Highway 95 near the eastern depot boundary. Chemical analyses of samples taken from the munitions were negative. Examination of vapors from the pits gave negative response with the M-15 chemical detectors.

Several test ranges were identified and examined; however, of particular concern is the range near Walker Lake where extensive munitions testing was conducted from World War II to the early seventies. Most of the rounds impacted in the lake, and it is suspected that many remain there as unexploded ordnance (UXO).

Table II-1. Data regarding principal fluid-disposal sites

Area	Distance upgradient from lake (miles)	Approximate depth to "regional" water table (feet)[1]	Years of first and most recent use[2,3]	Materials used and disposed of (subsidiary components in parentheses)[2]
103-41	1.7	20	About 1952 to 1968	Ammonium picrate, ammonium nitrate, TNT (Sodium sulfide; nitrocellulose "Smokeless Powder" for ignition of explosives within the disposal beds)
Army sewage	3	90	1930's (?) to current year (1979)	Domestic sewage, "Industrial Area" wastes
City sewage	3	90	Mid-1950's (?) to current year	Municipal wastes
103-16[4]	4	90	1946 to current year	Ammonium picrate, TNT, RDX, (sodium sulfide, sodium hydroxide, dimethyl hydrazine, nitric acid)
101	6	120 ?	1940 to current year	TNT, RDX, (PETN, ammonium picrate, calcium chloride)
101-41	6	150 ?	1944-76	TNT, RDX, (calcium chloride)
101-44	7	170 ?	Early 1960's to current year	TNT, RDX, (calcium chloride, sodium sulfide)

[1] Probable depth without ground-water mound resulting from percolation of wastes.

[2] Information sources: 103-41 and 103-16 areas, William K. Glenzer (U.S. Navy, retired, written commun., 1976 and 1979) and Dell L. Mortensen (U.S. Army, oral commun., 1979); 101, 101-41, and 101-44 areas, D. L. Mortensen (oral commun., 1979) and Louie Dellamonica (U.S. Army, written commun., 1974)

[3] Year of last intensive use: 103-41 area, 1968; 103-16 area, 1969 (103-10 building, about 1975); 101 area, about 1975; 101-41 area, about 1947.

[4] Includes adjacent 103-10 decontamination building.

Courtesy of USGS

B. Aerial Infrared Photography (December 1978 - January 1979).

Rome Research Corporation was contracted by USATHAMA to conduct an aerial color infrared photography study and interpretation. The purpose of this survey was to determine if contamination of groundwater could be traced by studying surface plant growth features.

Because of the unusual characteristics of HWAAP's environment (Figure II-3), it was difficult to determine if an area was stressed due to contamination or if the plant growth in the area was normal. Even though the program staff was able to identify probable stress areas, this type of study was not very useful in the overall assessment of HWAAP.[5]

C. Summary of US Geological Survey Work Performed at HWAAP Under DN Direction.

1. General.

Prior to the transfer of HWAAP to the DA, the DN in concert with the US Geological Survey (USGS) conducted a study in three phases (see Figure II-4 for locations) to assess the possibility of groundwater contamination. The dates and purposes of each of these phases were as follows:

Phase I.[6] November 1974 - June 1975: To ascertain whether groundwater had been contaminated by explosive wastes in the immediate vicinity of the disposal ponds at the 103-41 area.

Phase II.[7] June 1976 - November 1977: To determine whether groundwater had been contaminated by percolation from disposal beds and ditches adjacent to the 103-16 demilitarization facility.

Phase III.[8] August 1977 - November 1977: To attempt to delineate the aerial extent of groundwater contamination from the waste disposal beds near the 103-41 demilitarization area. This phase of the survey was cut short when the installation was transferred to the DA.

2. Phases I and III (Area 103-41).

Among the several disposal sites at 103-41, a cluster of six beds, the closest of which is about 1,300 ft (400m) northwest of the main demilitarization building, was chosen for study in Phase I. These disposal beds were constructed in 1957, and were used for disposal of composition D (ammonium picrate) waste, amatol (TNT plus ammonium nitrate) and TNT.

Nine exploratory wells were drilled in immediate proximity to the disposal area in order to determine whether groundwater had been contaminated by percolating explosive wastes from the disposal beds. Two of the wells were placed in upgradient locations. Saturated deposits were found about 20 feet (6m) beneath the disposal beds.

Water samples from wells adjacent to or downgradient from the disposal pits showed the presence of TNT. However, most wells showed TNT to be present only at trace levels (i.e., 2-20 parts per billion (ppb)). Well 8 was found to have the highest concentration of TNT, 620 ppb. The compound DNT was also

detected in water sampled from this well. The two upgradient wells showed no detectable TNT. Nitrate/nitrite concentrations above background levels were also present i some of the wells.

Subsequent to this effort 17 additional wells were drilled in the area northwest of the 103-41 disposal pits. (This effort was entitled Phase III by USGS.) These wells were emplaced no more than approximately 1000 feet (300m) from the disposal area and were located for the most part downgradient from the wells which made up the Phase I survey. This effort was performed in an attempt to delineate the areal extent of the contamination.

Analysis of water samples taken from the Phase III wells showed levels of nitrate/nitrite above background, and several of the wells were found to contain TNT. The highest concentration of TNT (300 ppb and 430 ppb, in two separate determinations) was in well 32 which is located near the disposal pits. In general it appeared that a narrow plume of TNT contamination existed in a northwesterly direction with the highest values in the area of wells 8 (Phase I well), 32, 33 and 25. Well 21 which was located farthest downgradient from the disposal area also showed detectable levels of TNT (Figure II-5).

3. Phase II (Area 103-16).

The USGS Phase II effort focused on area 103-16. This area is located approximately two miles southeast (upgradient) from area 103-41. The 103-16 facility was used during several periods, beginning in 1946. Disposal beds associated with this facility had received wastes that included composition B (ammonium picrate), TNT and RDX.

Chemical analysis of the groundwater samples revealed nitrate/nitrite levels to be above background in most cases; however, the water did not contain significant quantities of TNT or RDX. Only one of the samples from one of the wells showed TNT at a trace level. This well indicated a positive for TNT during only one of the three sampling rounds. It was concluded that, despite the extensive use of the explosives waste disposal area, the groundwater in the vicinity of the 103-16 disposal area was not contaminated.

III. Environmental Contamination Survey.

A. Approach to Sampling and Analysis.

The Installation Assessment Report documented all known contamination present at HWAAP which was the result of past operations. This included areas where unexploded ordnance was present and production facilities which were contaminated with explosives. The report concluded that contamination migration from disposal pits used in previous demilitarization and production operations was a concern and that Walker Lake might be contaminated with explosives. The USATHAMA environmental contamination survey addressed the migration of contamination in groundwater from the former disposal pits and the possible contamination of Walker Lake.

Seven disposal areas of concern, as noted in Table II-1, were highlighted. From this list the most probable potential contributor to groundwater contamination was considered to be area 103-41 because of the

shallow depth to the top of the water table. The depth to the top of the water table at other potential sources is 90 ft. (27m) or more. The location of these sources in relation to each other is shown on Figure II-2. Groundwater was known to be flowing northwestward toward Walker Lake. Area 103-41 also was judged to present the highest potential for off-post migration because of its proximity to the installation boundary.

The USGS had performed three initial investigations for the Navy prior to the transfer of the installation to the Army. These investigations included the placement of shallow wells within a few hundred feet of the disposal pits at area 103-41 (Phases I and III) and area 103-16 (Phase II).

Under USATHAMA direction an environmental contamination survey was performed at HWAAP to determine if contamination migration was occurring and the potential for off-post migration of contamination.

For this effort 32 wells were placed in three rows downgradient from the seven disposal areas highlighted in the Installation Assessment Report (between the disposal areas and Walker Lake). The alignment of wells was designed to intercept contamination migrating toward the post boundary from any source area. However, due to the Phase III USGS data, the primary concern was contamination migration from the 103-41 area. Low level TNT in the aquifer near 103-41 was documented in the Phase III, as well as in the Phase I, study. Phase II addressed the 103-16 area; no explosive contamination was found in the aquifer beneath that disposal area.

B. Performers.

The performers for the USATHAMA environmental contamination survey program are listed below along with responsibilities.

US Department of the Interior, Geological Survey (Carson City, NV, unless otherwise noted):

Groundwater sampling
Laboratories for chemical analysis (Denver, CO)
Physical properties soils testing
Evaluation and reporting of chemical and physical analysis data
Evaluation and reporting of geological and hydrological information
Phase IV report

US Army Corps of Engineers (Portland District):

Field drilling
Monitoring well installation

Hawthorne AAP:

Engineering survey of borehole sites
General support services
Site safety for field drilling
Marking and protection of monitoring wells

Explosives Ordnance Detachment:

Field clearance support

US Army Armament Materiel Research and Development Command (ARRADCOM) (Large Caliber Weapons Systems Lab):

Laboratories for chemical analysis of Walker Lake samples

US Army Medical Bioengineering Research and Development Lab:

Environmental hazard evaluation

C. Field Investigations and Chemical Analyses.

From the previous studies performed by the USGS in Phases I, II and III, it was known that groundwater was moving to the northwest toward Walker Lake. Based upon the available water table contour (Figure III-1) it was concluded that groundwater contaminated by any of the seven disposal sites noted in the records search report would be "funneled into a rather narrow band near the lake" and that the cross section near Walker Lake requiring intensive evaluation was approximately 8,000 feet (2440m) long.

The environmental contamination survey drilling program consisted of three rows of wells, located 1,200, 3,200 and 5,200 feet (370, 980, and 1,580 m) downgradient from the northwesternmost disposal bed at area 103-41 (Figure III-2). Each row was situated perpendicular to the presumed direction of groundwater movement, enabling the wells to "intercept" any contaminated shallow groundwater migrating toward the lake. The shore of the lake is located about 9,000 feet (2,740m) from the 103-41 disposal area.

The Phase II work showed the aquifer, the top of which is approximately 90 feet below land surface, in the vicinity of the 103-16 disposal area, not to be contaminated with nitroaromatic compounds. Explosive wastes disposal sites 101, 101-41 and 101-44 were known to be situated in locations over 100 feet (30m) from the top of the water table. For these reasons the potential for groundwater contamination from these sites was considered to be very low. Therefore, the primary focus of the survey effort was the 103-41 area.

Because of the possibility of encountering unexploded ordnance, particularly in the row of wells closest to Walker Lake, a magnetometer sweep of a proposed drill site was first conducted to clear the area for drilling. Once the drill site was cleared, drilling was accomplished using the cable-tool percussion technique. During the drilling, soil samples were collected for subsequent laboratory physical properties testing. Additionally, after the wells were completed, water level recovery measurements were made at select sites.

During the environmental contamination survey effort, a total of 32 wells were installed, and groundwater samples were taken for chemical analyses. Soil samples were also taken for chemical analyses from the saturated zone in order to determine if TNT were present in the aquifer material. Chemical

analyses of water samples from these wells showed the presence of explosives in only one well. This well (27B) was located in the row of wells closest to the disposal pit. The level of contamination was 11 ppb. In no case were detectable concentrations of DNT, RDX or picrate (expressed as picric acid) found.

Well 27 is located downgradient from Phases I and III wells which showed TNT contamination. Analyses of samples from wells downgradient from well 27 did not show detectable levels (detection limit 2 ppb) of TNT. Therefore, it appears that TNT has not migrated to the second row of wells located approximately 3,200 feet (980m) from the source area.

Analyses for total recoverable nitrogen (nitrate, nitrite, ammonium and organic nitrogen) did indicate the presence of a contamination plume running from the disposal bed area through all three rows of wells. The plume of contamination consisted largely of nitrate levels above a 2 parts per million (ppm) background level. A second nitrate plume was also found. This plume is believed to emanate from the Army sewage treatment plant (Figure III-3). Both plumes move toward Walker Lake.

Soil samples from the saturated zone from most of the 32 sites were analyzed for explosives (TNT, RDX and picrate). No detectable levels were found. The detection limit was 25 ppb.

Based upon the disposal history of the 103-41 area and the extent of the nitrite contamination plume, it was concluded that nitrate contamination could be moving toward Walker Lake at a rate of at least 150 ft/yr (50 m/yr) and perhaps at a rate as great as 250 ft/yr (80 m/yr). As noted above, of the explosives only TNT was found to be migrating. Its rate of migration was judged to be significantly slower than that of nitrate.

For the 32 wells installed in the survey the depth to the top of the water table increased from about 5 feet (2m) below land surface at the western-most well (closest to Walker Lake) to about 21 feet (6m) at the eastern-most well (closest to disposal pits). Inspection of soil samples from the borings indicated that all 32 wells penetrated unconsolidated sedimentary deposits with grain sizes ranging from gravel-dominated to clay-dominated. USGS notes the presence of gravel in most of the borings in the zone 10 to 30 feet (3 to 9 m) below the surface.

This information (coupled with the estimates of hydraulic conductivity, which were based on field water recovery measurements, and additional assumptions) was used to estimate groundwater flow velocity. Estimates are consistent with the estimated total nitrogen (nitrate) movement rate.

D. Environmental Considerations.

1. Groundwater Contamination.

The only contaminant found to be widespread in the groundwater system was total nitrogen. Total nitrogen is composed of nitrate, nitrite, ammonia and organic nitrogen. Nitrate was typically the major constituents. Two plumes of contamination are moving toward the shore of Walker Lake (Figure III-3). This interpretation is based upon values above a 2 ppm background level. Although there are some elevated values found in the plume emanating from the 103-41 disposal pits (several wells had total nitrogen values of greater then 40 mg/l with the highest value being 130 mg/l), these are confined to an area near the disposal pits. The values are for the most part less than 10 mg/l in the three rows of wells installed during the environmental contamination survey. By way of comparison, the National Primary Interim Drinking Water Regulations (NPIDWR) maximum contaminant level for nitrate (as N) is 10 mg/l.

Explosive contamination is limited in extent, but some contamination migration of TNT has occurred. TNT contamination is primarily limited to a few wells within 1000 feet (300m) of the 103-41 disposal area, in no case exceeding one ppm. Traces of DNT were also detected in two wells. RDX and ammonium picrate (as picric acid) were not detected.

TNT is the only hazardous compound which has been found to be migrating, and a narrow plume of this material has advanced at least 1,200 feet (370m) but not more than 3,200 feet (980m) from the source area. Within the plume there are only 4 wells showing contamination greater than 10 ppb: two wells adjacent to the disposal pit area showing several hundred ppb contamination levels; a well approximately 700 feet (210m) downgradient showing contamination at approximately 25 ppb; and a well at 1,200 feet (370m) downgradient showing contamination at 11 ppb. The proposed DA drinking water criterion is 44 ppb.* Therefore, only the two wells near the sludge disposal pits exceed the criterion. Additionally, the shallow aquifer is not a source of drinking water.

Based upon the analytical and hydrogeological data, the rate of movement of TNT in the groundwater system is slower than the rate of groundwater flow. This is different than the case of the inorganic nitrogen compounds which appear to be moving at about the same rate as the groundwater, but is consistent with the chemistry of the compounds. Nitrates and nitrites are highly soluble and negatively charged; they are not sorbed to the clay particles nor do they tend to precipitate from solution. TNT, although fairly soluble, is not nearly as soluble as nitrate/nitrite and, because of its organic nature and molecular structure, would be expected to have more interaction with clays and, therefore, migrate at a slower rate.

*Unofficial interim criteria being developed by US Army specifically for DOD installations.

Estimated rates of groundwater flow are similar to the rate at which Walker Lake is receding. USGS, in their Phase III study, reported that the "shore line of Walker Lake has been retreating northwest at an average of about 230 ft/yr (70 m/yr) since 1950." This is due to the fact that the evaporation rate is greater than the amount of rainfall and also because the amount of water flowing into Walker Lake is decreasing. TNT contamination, even if neither further attenuation, dilution, nor dispersion occurred, therefore, would never reach the shore of the lake.

2. Walker Lake.

In November 1978 samples of water and sediments taken from Walker Lake were analyzed[10]. The water was found to be free of TNT, picric acid and RDX (detection levels being 1 ppb, 10-20 ppb, 10-20 ppb, respectively). Two of the twelve sediment samples were found to contain TNT. No RDX or picric acid was found. The levels in the sediment samples were determined to be between 50 and 200 ppb in one sample and between 5 and 20 ppb in the other. It is believed this limited, low level contamination is the result of firings conducted into the lake.

In December 1978, USATHAMA requested the US Army Medical Bioengineering Research and Development Laboratory to evaluate these data and determine if the level of TNT contamination presented a hazard to the environment. The hazard analysis was based on available toxicity data and an assumed partition coefficient between water and sediment of between 1/20 and 1/5. It was concluded that if the areas of contamination were not widespread, and if there were good mixing of lake waters, dissolved TNT levels would be low (or not observable as was the case in the water samples taken) and the hazard to aquatic life would be minimal.[11]

VI. CONCLUSIONS.

A. Groundwater Contamination Migration.

1. 103-41 Area.

The Installation Assessment Report concluded that there were several explosive waste disposal pits at Hawthorne which could be contaminating the groundwater. At the time of the Installation Assessment Report writing, USGS had published its Phase I investigation findings which indicated TNT to be present in the groundwater in the immediate proximity of the 103-41 area disposal beds.

A full evaluation of the groundwater between these disposal pits and Walker Lake indicates that TNT has migrated in a narrow plume to a distance of between 1,200 and 3,200 feet downgradient from the disposal pits. Contamination levels were, in no case, above a part per million. In only two cases are the concentration of TNT above the proposed DA drinking water criterion; these two wells are located within a few hundred feet of the disposal pits. The shallow groundwater is not used as a drinking water supply.

TNT is migrating at a rate slower than the rate of groundwater movement. The rate of groundwater movement is roughly equivalent to the rate at which the shoreline of Walker Lake is receding. Migration off post into Walker Lake will, therefore, not occur.

Nitrogen compounds, primarily nitrate, are migrating in two plumes toward Walker Lake. One plume apparently has originated from the Army sewage treatment system, and the other, from the 103-41 disposal area. Based upon the levels found in the groundwater as compared to the NPIDWR nitrate maximum contaminant level of 10 ppm, and the usage of Walker Lake, this contamination migration poses no environmental hazard.

2. 103-16, 101, 101-41, and 101-44 Areas.

USGS in its Phase II report determined that explosives had not contaminated the groundwater beneath the 103-16 production area. It can be concluded that, based upon the depth to the top of the water table, the 101, 101-41, and 101-44 disposal areas also pose no threat to the groundwater.

B. Walker Lake.

The low level and non-widespread nature of the sediment contamination (TNT) in Walker Lake does not pose a hazard to aquatic life.

TNT, RDX and picric acid were not detected in the water.

C. UXO's.

As documented by the installation assessment (Installation Assessment of Naval Ammunition Depot Hawthorne, Nevada, Report No. 114), several areas have large numbers of unexploded ordnance present.

D. Mustard Disposal Site.

As documented in the Installation Assessment Report, mustard may still exist beneath the surface at the mustard disposal site. However, based on hydrogeological and meteorological conditions contamination would not migrate to the aquifer. The depth to groundwater at the site is approximately 275 feet. Additionally, the groundwater levels are continually dropping in the HWAAP area further increasing the depth to the water table. The average annual evaporation rate at HWAAP is 50 inches and rainfall is only 5 inches annually. Therefore, it is concluded that contamination, if present in the soils at the site, would not reach the aquifer.

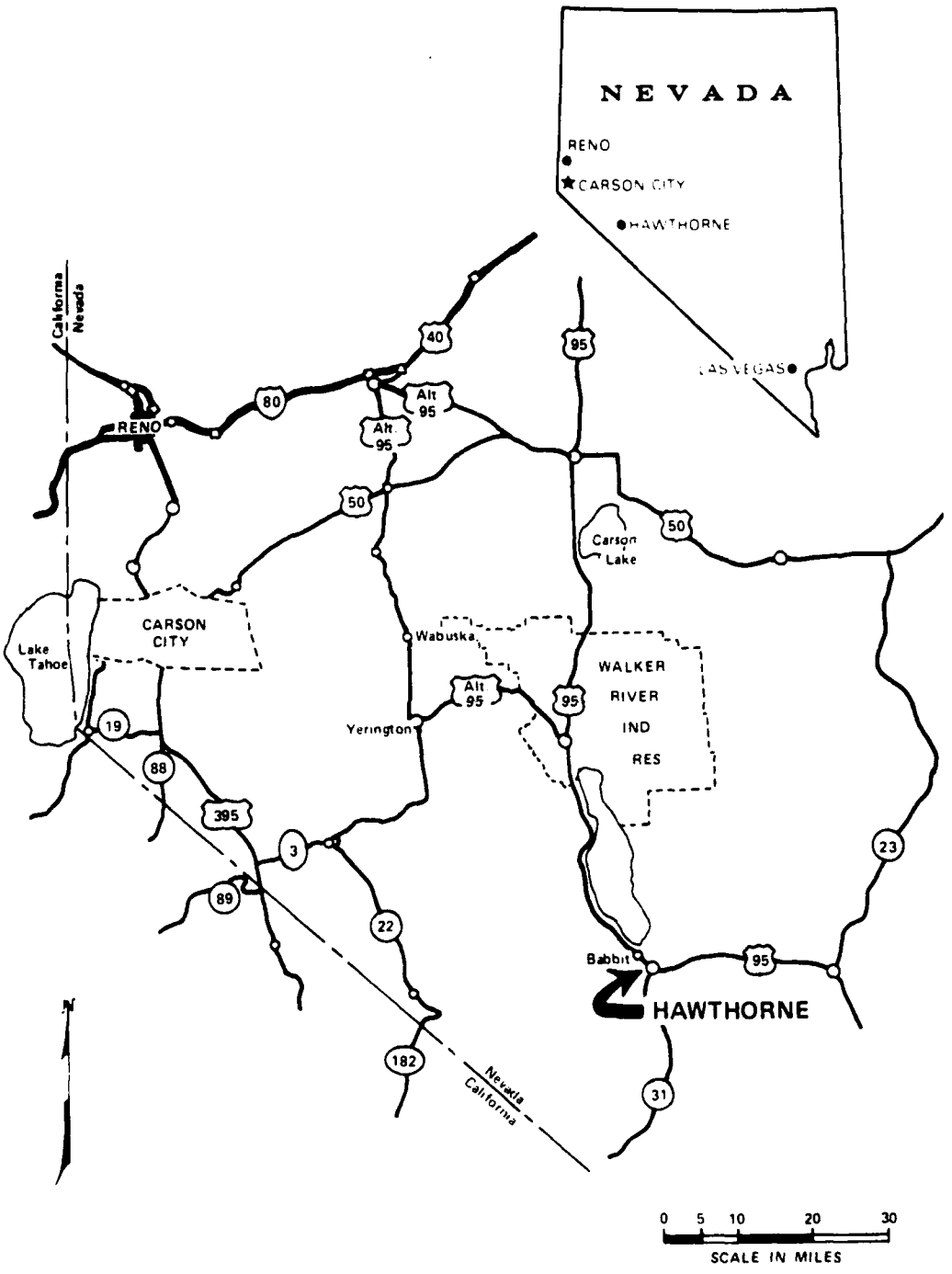

Figure I-1. Map of Nevada showing location of Hawthorne Army Ammunition Plant.

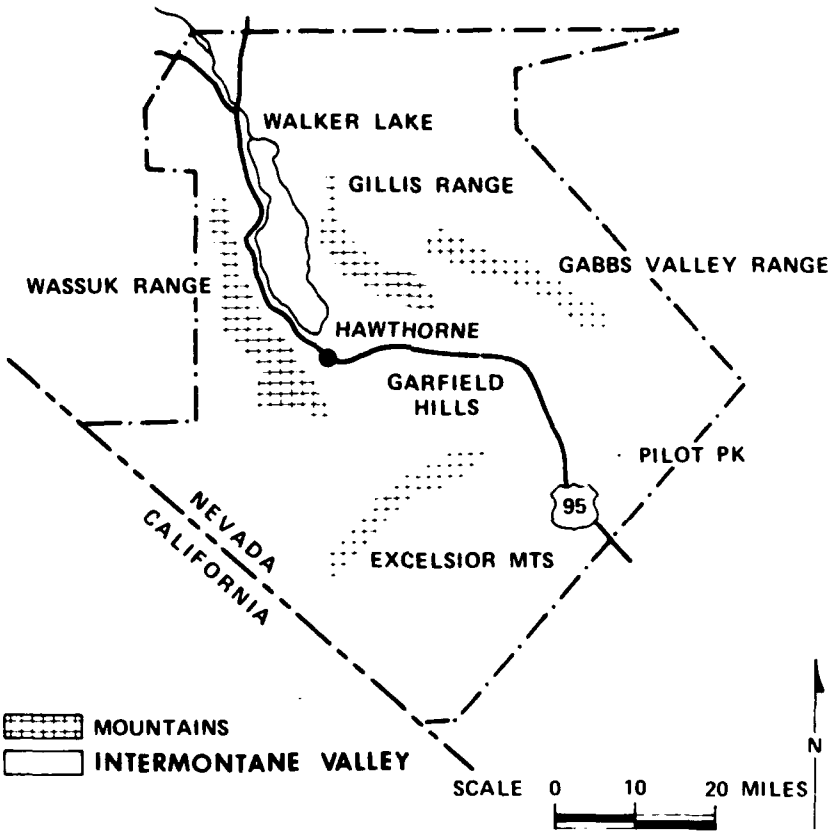

Figure I-2. Mineral County, NV, in the Great Basin Section of the Basin and Range Province.

Figure II-1. TYPICAL DISPOSAL PIT

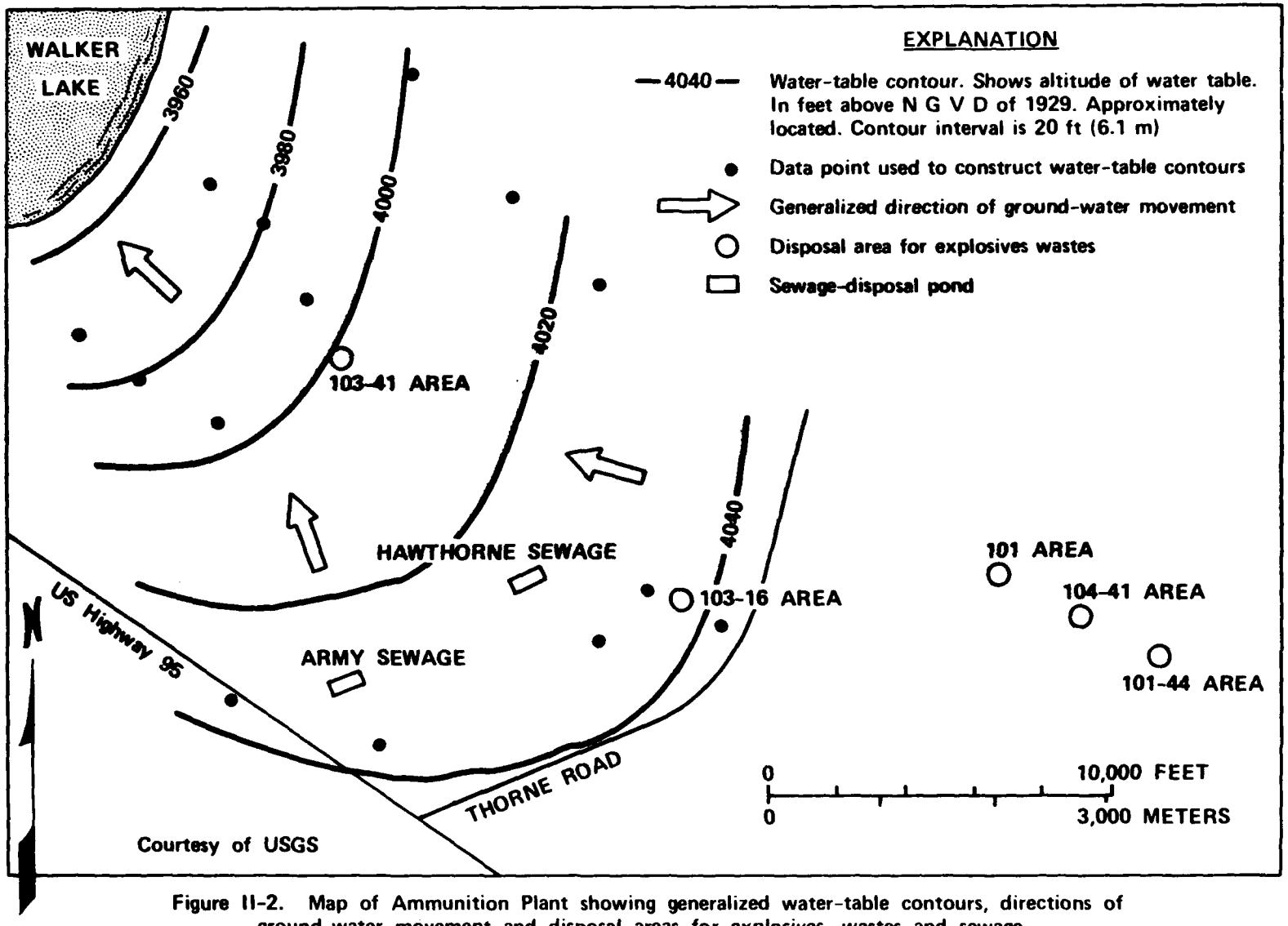

Figure II-2. Map of Ammunition Plant showing generalized water-table contours, directions of ground-water movement and disposal areas for explosives, wastes and sewage.

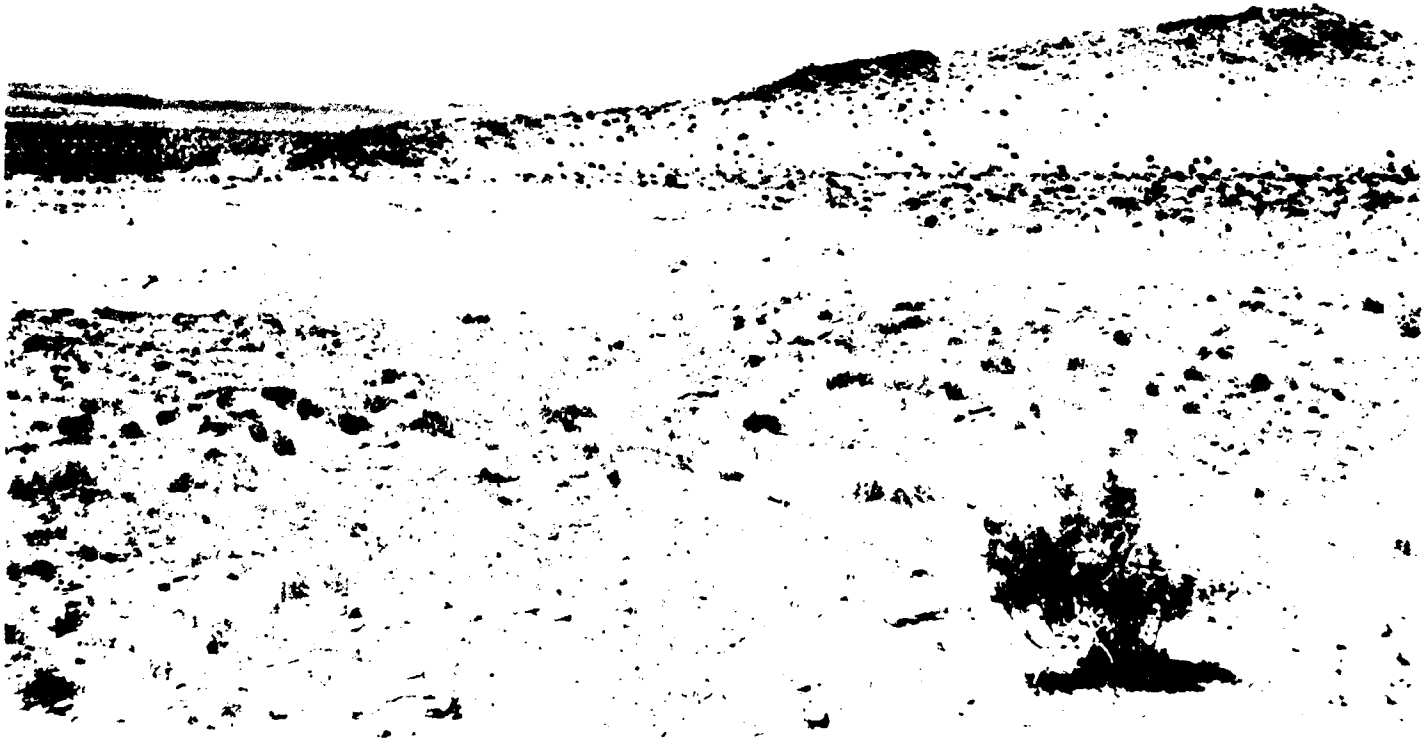

Figure II-3. Typical ground covering at HWAAP.

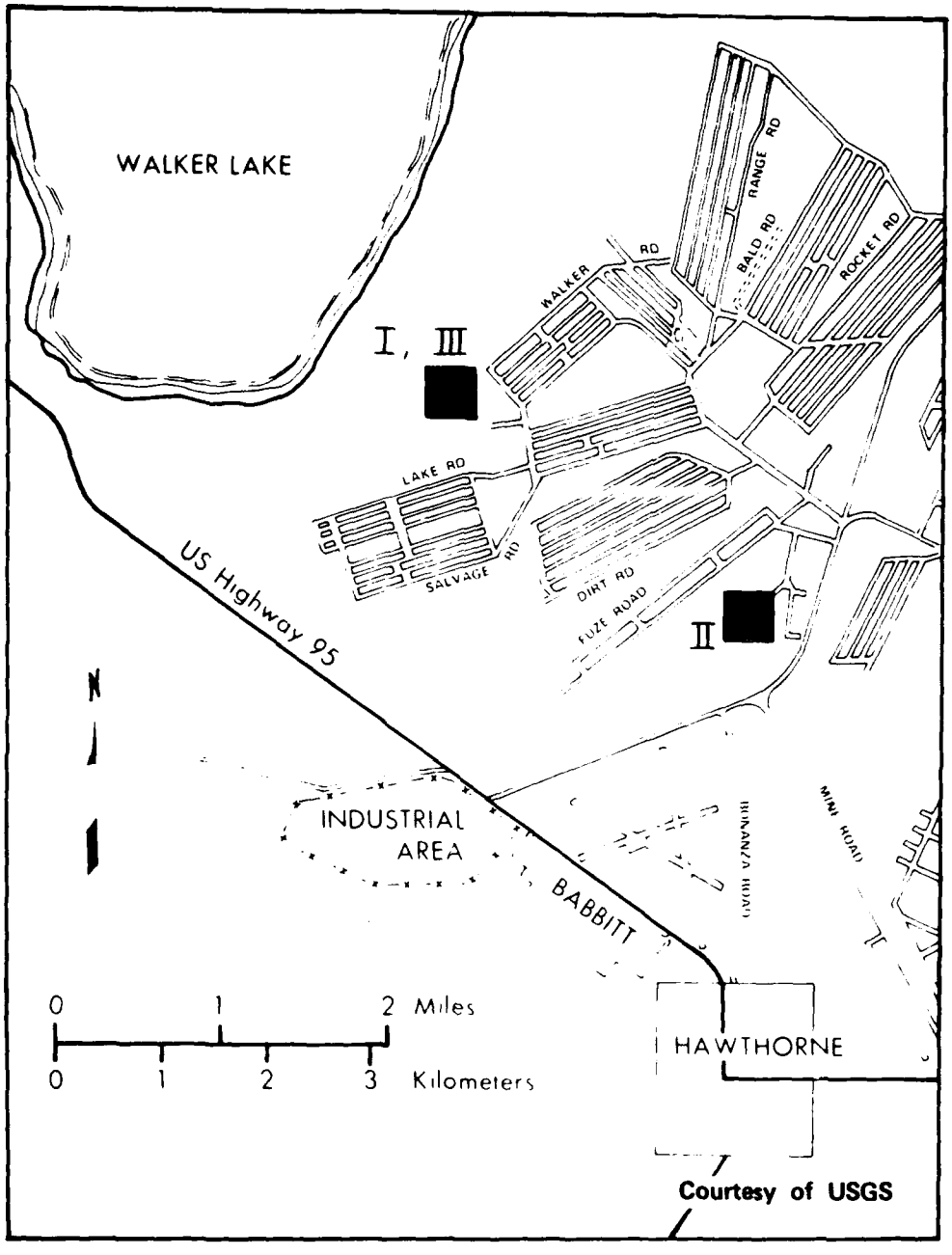

Figure II-4. Map of Hawthorne Army Ammunition Plant showing location of study areas for investigation Phases I, II, and III.

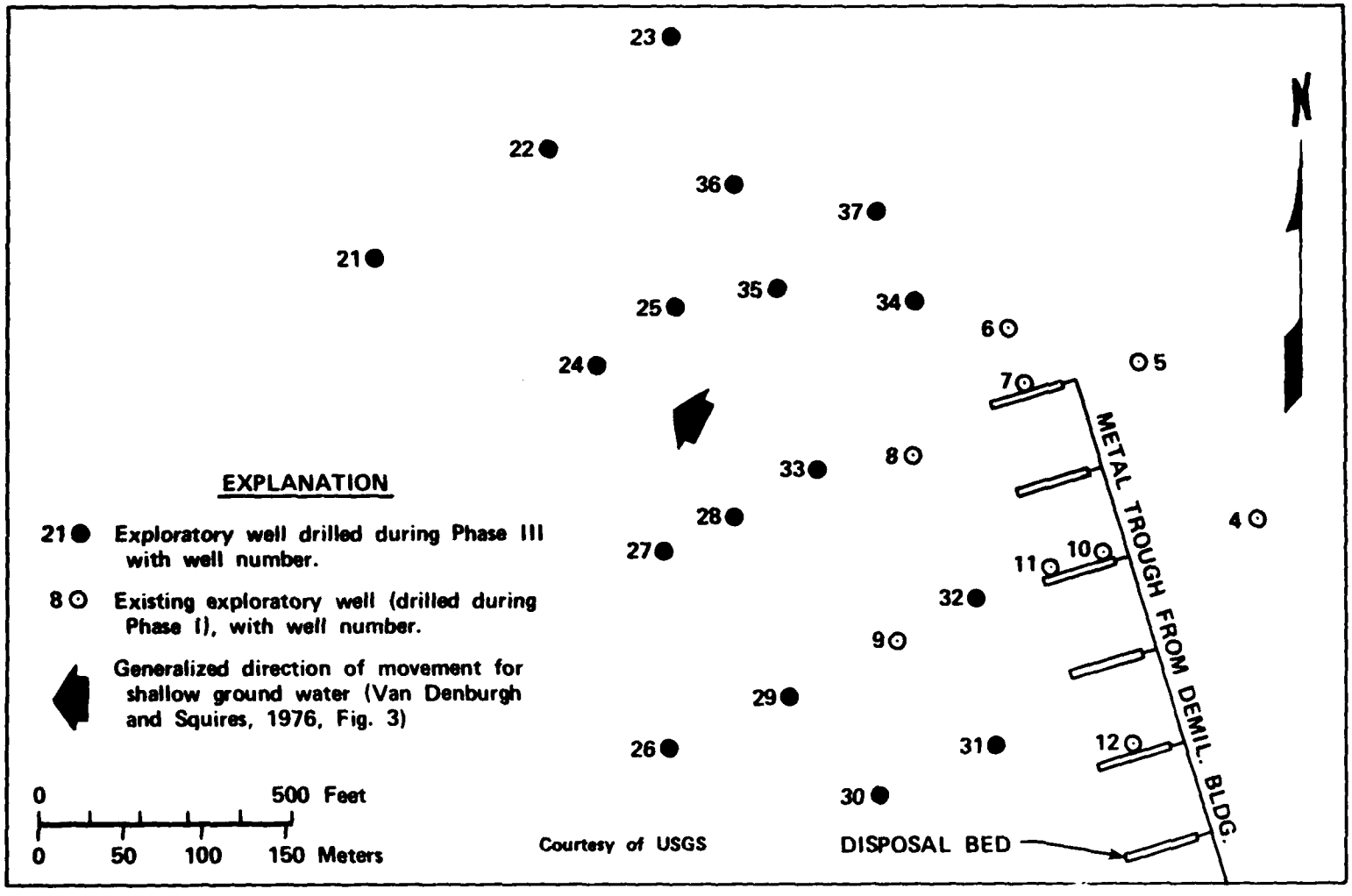

Figure II-5. Waste-disposal beds and Geological Survey exploratory wells near 103-41 demilitarization area.

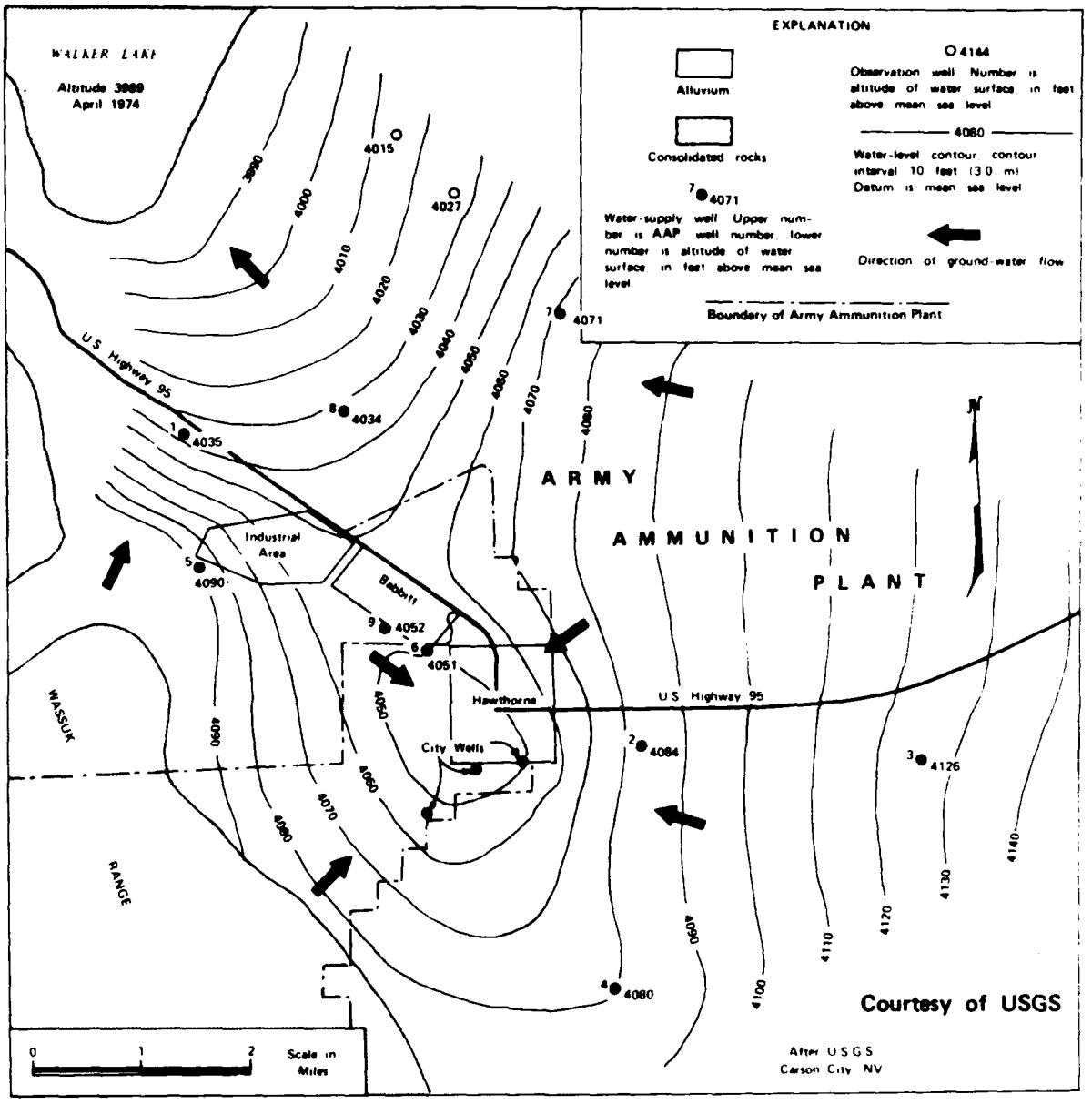

Figure III-1. Generalized Ground-Water Levels in the Hawthorne Area, 1974.

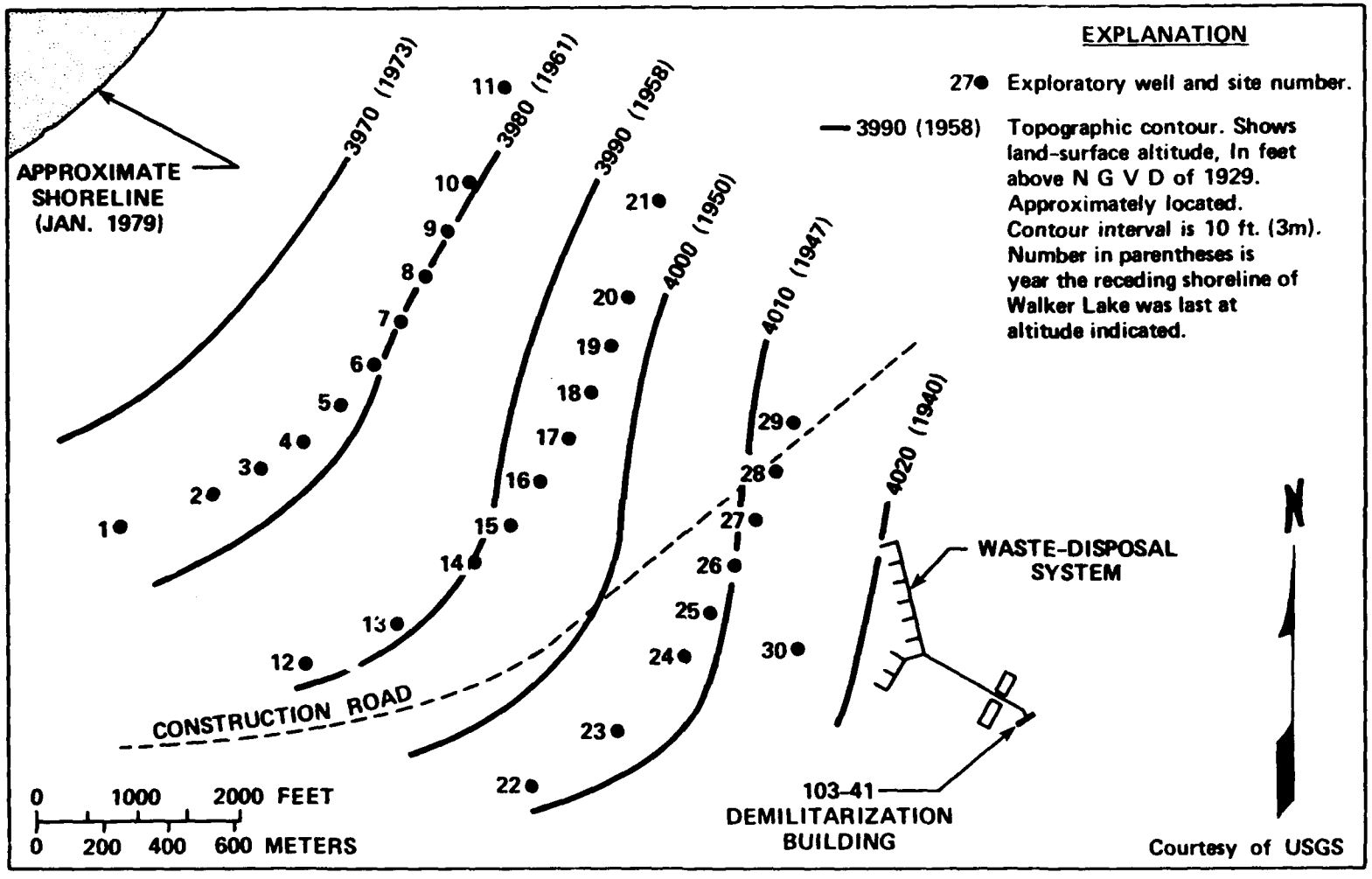

Figure III-2. Map of Phase IV study area showing nearby waste-disposal facilities, Geological Survey exploratory wells, and land-surface altitude. Lakeshore altitude in January 1979 was 3,956 ft (1,206 m) above N G V D of 1929.

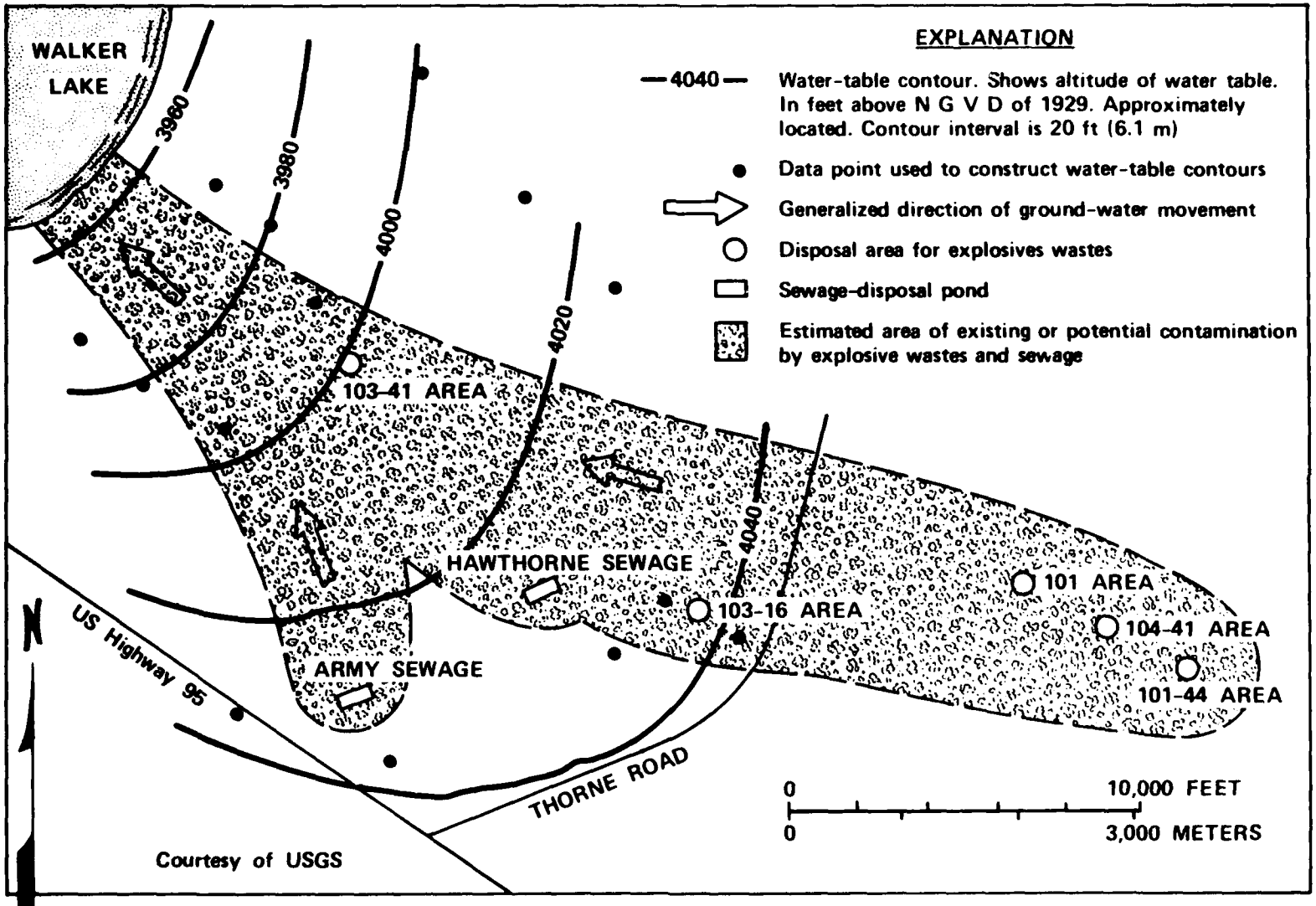

Figure III-3. Map of Ammunition Plant showing generalized water-table contours, direction of ground-water movement, disposal areas for explosives, wastes and sewage, and estimated lateral limits of existing or potential contamination.

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